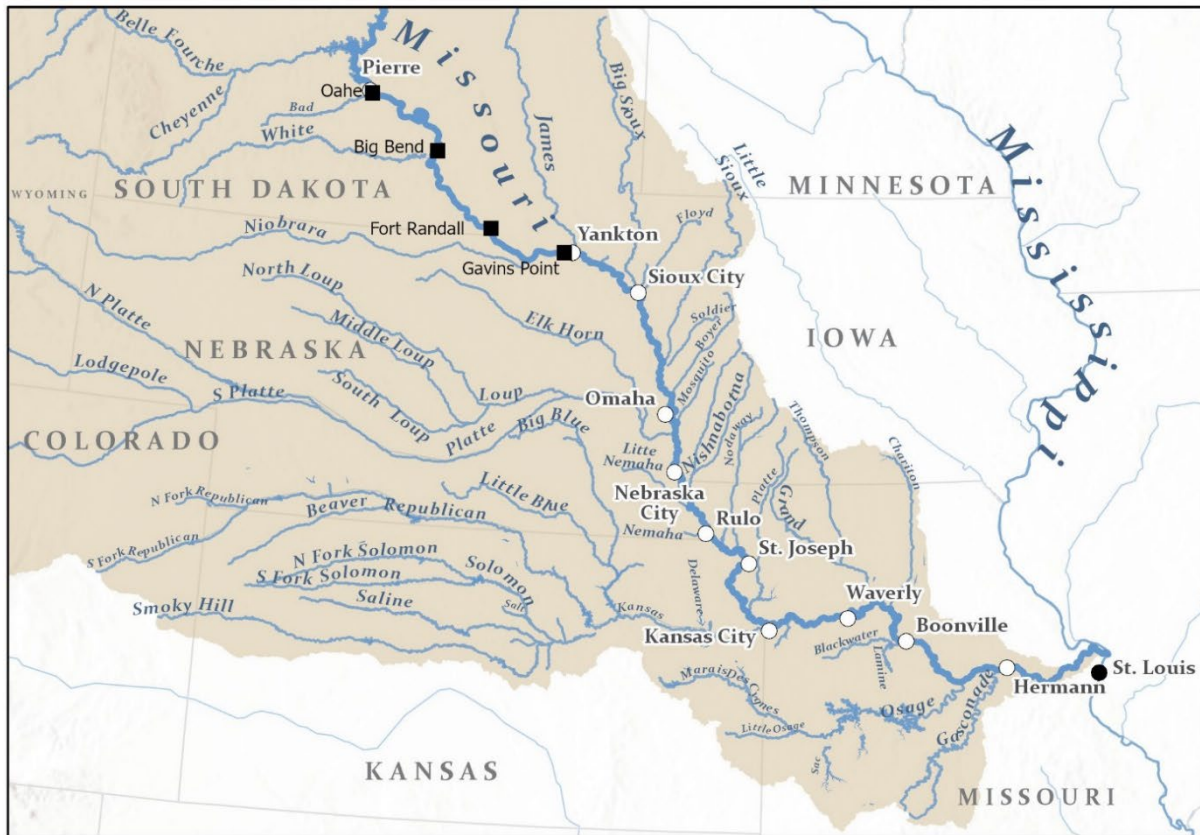**US Army Corps of Engineers ®**

Missouri River
Flow Frequency Study

Yankton, South Dakota to Hermann, Missouri

Appendix L: Agency Technical Review Comments

U.S. Army Corps of Engineers
Northwestern Division
Omaha District, Kansas City District, and
Missouri River Basin Water Management

June 2023

Agency Technical Review

The USACE project team and Agency Technical Review team employed the ProjNet – Dr. Checks software to track and respond to comments for the study, except for the HEC-WAT Monte Carlo analysis which was managed through meetings and email. This appendix captures the comments and backcheck actions taken during the ATR review of this study. The ATR review is divided into three primary components:

1. Qualitative Climate Assessment – combined Agency Technical Review (ATR) comments with District Quality Control Comments
2. Main Report (Dr. Checks report showing 54 comments, reviewer signed ATR certification)
3. HEC-WAT Review (comments provided by email, reviewer signed ATR certification)

Controlled Unclassified Information (CUI) Only

1.0 Combined DQC and ATR, Climate Assessment

Displaying 75 comments for the criteria specified in this report. Note: District Quality Control Review Comments from Erin Reinkemeyer and Jennifer Christensen are included along with ATR comments from Chris Frans since they were tracked in the same Dr. Checks Review.

Id	Discipline	Section/Figure	Page Number	Line Number
9298834	Climate	1.0 Introduction	1	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

May want to mention ECB 2018-14 was extended on 9-10-2020.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Concurred**
Added additional text to the document. **Close Comment**

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
9298838	Climate	2.0 Literature Review	1	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

"In our discussion, we primarily utilize the Northern Great Plains chapter, but have merged the information for all these regions to create a complete overview of the projected changes in the watershed".

If this climate change assessment is focused primarily on updated the lower Missouri River flow frequencies (Gavins Point to St. Louis???), recommend including additional detail related to observed and future trends (primarily related to precipitation) for the lower Missouri (Kansas and Missouri).

Submitted By: <u>Erin Reinkemeyer</u> (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Non-concurred**

Figure 1 does include the lower basin. The discussion of future precipitation and temperature covers the majority of the watershed and should be sufficient for providing an indication of observed trends.

Submitted By: <u>Jeremy Giovando</u> (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9298845 | Climate | 2.1 Observed Temperature and Precipitation | 2 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Inconsistent references including possible misspellings, etc. Verify all references are correct and are included in the references section of the document.

Easterling is included in the Vose et al 2017 reference. Should this all be one reference or is Easterling et al 2017 a separate reference? If so, the Easterling et al 2017 reference is missing from the references section.

Conant et al 2018? Or is this a different reference? If a different reference, need to include in the references section.

Larson & Schwien 2004 is missing from the references section.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332). Submitted On: Jun 25 2021

Evaluation **Concurred**

All references have been checked for spelling and in the reference section.

Easterling and Vose should be cited separately. Easterling presents a continental scale precipitation analysis, while Vose presents temperature trends.

Added Larson & Schwien to references.

Submitted By: <u>Jeremy Giovando</u> (509-540-6498) Submitted On: Aug 05 2021

1-0 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

| 9298885 | Climate | 2.1 Observed Temperature and Precipitation | 2 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

It seems like most of the literature review related to observed precipitation trends is primarily focused on the Upper Missouri. Are there a few trends that can be included related specifically to the Lower Missouri (Gavins to St. Louis)?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **For Information Only**

The 4th NCA is the most recent climate synthesis available for the MRB. The trends discussed are based upon CONUS-level synthesis and include to lower Missouri. The graphics from the other chapters are manily outside the MRB watershed and could confuse the reader.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

If possible, still recommend including figures similar to Figures 4 and 5 to visibly show the changes in both Kansas and Missouri. You may be able to avoid confusion by cropping out those two states from the southern plains and midwest sections of the 4th NCA.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9298889 | Climate | 2.1 Observed Temperature and Precipitation | 2 | last paragraph |

Comment Classification: **Controlled Unclassified Information (CUI)**

"The largest precipitation events typically occur in the upper basin."

Is this true for the Lower Missouri River Basin (including segments in the State of Missouri) where rainfaill has more influence from the Gulf of Mexico? Or is the statement more applicable to a comparison of regions in the Omaha District geospatial extents?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Corrected text to clarify mainstem Missouri River flooding is related to large precipitation events in the upper basin.

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9298894 | Climate | 2.1 Observed Temperature and Precipitation | 3 | First Line |

Comment Classification: **Controlled Unclassified Information (CUI)**

Hoerline et al 2013 is missing from the references section of the document.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Corrected in-line reference spelling.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: [Erin Reinkemeyer](#) (8163892332) Submitted On: Aug 25 2021.

Current Comment Status: **Comment Closed**

9298900 paragraph	Climate	2.1 Observed Temperature and Precipitation	3	First Line, 2nd

Comment Classification: **Controlled Unclassified Information (CUI)**

Possible inconsistencies with reference (Hoerline, Hoering, Hoerling et al 2013).

Submitted By: [Erin Reinkemeyer](#) (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**
Corrected inline reference spelling throughout the document.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: [Erin Reinkemeyer](#) (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9298940	Climate	Figure 2	3	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

In text description of Figure 2 includes a discussion of changing temperatures observed in the Lower Missouri. In my mind, this is primarily the Upper Missouri (Lower Missouri being downstream of Gavins).

Recommend including a map in the introduction that shows the Missouri River basin divided into Upper, Middle, and Lower so it is clear where the discussed trends apply spatially.

Submitted By: [Erin Reinkemeyer](#) (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Non-concurred**
There is not a precise definition of the upper, middle, and lower Missouri River Basin. The boundaries vary within literature and even with USACE products. Unfortunately summaries from the 4th NCA don't follow river basins, but rather political boundaries.

Submitted By: [Jeremy Giovando](#) (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: [Erin Reinkemeyer](#) (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

L-5

9298941   Climate   3.0 Analysis Tools   8   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Wood et al., 2004 reference is missing from the references section of the report.

Submitted By: [Erin Reinkemeyer](#) (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Added to reference to the bibliography.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: [Erin Reinkemeyer](#) (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9298950   Climate   4.0 Data   10   n/a

Comment Classification: **Controlled Unclassified Information (CUI)"n-day center moving averages."**

Why were average flows used instead of the annual maximum daily NRNI flow? Are there possible impacts to the nonstationarity analyses? For example, are nonstationarities detected for the different types of events such as 2011 and 2019 which had very long durations of high flows?

Submitted By: [Erin Reinkemeyer](#) (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Non-concurred**

The n-day center moving average does use daily data. It's often best practice to us moving average peaks for very large rivers. Similar analysis was completed for the Columbia River and the USGS is using n-day peaks in their current flow frequency assessment for the Dakotas.

There should be no impacts to the non-stationarity tests.

Submitted By: [Jeremy Giovando](#) (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: [Erin Reinkemeyer](#) (8163892332) Submitted On: Aug 25 2021 Current Comment Status: **Comment Closed**

9298954   Climate   4.0 Data - Table 4   10   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Specify the elevation datum (NGVD29 or NAVD88) in all tables.

Submitted By: [Erin Reinkemeyer](#) (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Removed elevation columns from all tables to avoid vertical datum discrepancies.

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9298957	Climate	4.0 Data - Figure 6	11	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

In the text preceding the figure, also include descriptions of the COOP and WBAN data sources. For instance, how are they related to the NRNI flow locations and GHCND stations?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021 Revised Jun 25 2021.

1-0   Evaluation **Concurred**

There is no relationship between NRNI flow locations and GHCND stations. NRNI flow locations are based upon USGS streamgage instruments and USACE dam locations.

For purposes of this study the differences between COOP sites and WBAN doesn't matter. We will modify the plot to label precip/temperature sites as "GHCND"

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9298959	Climate	4.0 Data - Figure 7	12	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

To remain consistent with the flow frequency study, should the Lower Missouri classification be extended from downstream of Gavins to the mouth? Or if wanting to keep separate: Lower Missouri – NWO, Lower Missouri - NWK

Lower Missouri River Frequency Flows Study is including updates to the mainstem gages located downstream of Gavins Point

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021 Revised Jun 25 2021.

1-0   Evaluation **Concurred**

The trend analysis zones were defined using the "

"MRB_CWMS_Priority.gdb" and feedback from NWD water management staff. We can modify the description of the two Lower Missouri basins to include "NWO" and "NWK".

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332) Submitted On: Aug 25 2021 Current Comment Status: **Comment Closed**

| 9298962 | Climate | 5.1 Nonstationarities - USGS Data | 13 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

May also want to state that the default sensitivity parameters were used and what those parameter values are.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

The default NSD tool parameters are documented in the NSD output screenshots provided in Appendix A. Added additional text to document to clarify.

Submitted By: <u>Daniel Hamill</u> (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

| 9299110 | Climate | Table 5 | 13 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Several nonstationaritites are in the 1957's. May want to include a brief description as to what may be contributing to the nonstationarities (federal reservoir construction, landcover changes, etc.).

Submitted By: <u>Erin Reinkemeyer</u> (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Added to document:

"Several nonstionarities occur within the USGS station gage data which may be a result of dam construction, land use and climate change. It is difficult to separate these causes simply by evaluating the gage data. Therefore, the focus of the nonstationarity analysis is presented in the next section using the NRNI flow data."

Submitted By: <u>Jeremy Giovando</u> (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Open Comment**

I don't see this text in the document. Please verify the added text was included.

Submitted By: <u>Erin Reinkemeyer</u> (8163892332) Submitted On: Aug 25 2021

2-0   Evaluation **Concurred**

Good catch. It has now been added to Section 5.1 immediately before Table 3.

Submitted By: <u>Jeremy Giovando</u> (509-540-6498) Submitted On: Sep 01 2021

2-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9299123 | Climate | n/a | 15 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

"A robust . . ."

May also want to discuss consensus between similar test types (multiple mean based tests identify a nonstationarity in the same year).

Applies to all nonstationarity analyses

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Non-concurred**

Currently we define both a "strong" and "robust" test result. We would need further clarification on how adding the definition of "consensus" would add to the current discussion.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

As documented in the 2018 USACE Nonstationarity Detection Tool User guide, the strength of a nonstationarity can be determined by the level of consensus and robustness between the various tests. Basically, if there is a consensus and the results are robust, then the nonstationarity may be considered strong. You may want to include a discussion of both consensus and robustness to clarify why the nonstationarity is strong, but the added discussion won't impact the final analysis.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

| 9299150 | Climate | 5.2.8 Lower Missouri | 26 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Again, just wondering if "lower Missouri" naming convention should be consistent with the gage flow frequencies being updated as part of the project (downstream of Gavins). Can still separate between NWO and NWK if needed. Example: Lower Missouri - NWO

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

We modified the section headers to reflect the change to the names on the basin map ("Lower Missouri-NWO" and "Lower Missouri-NWK").

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9299156	Climate	5.3 Summary NRNI Nonstationarities	35	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Include discussion about what may have contributed to the specific change points. For example, the 1930's were characterized by severe drought. Is the sudden change from widespread drought conditions contributing to the nonstationarity detection?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Concurred**

The 1941 change point, which persists across all n-day flow durations, may be a result of the severe drought in the Missouri River Basin during 1930s. Due to the magnitude and scale of the drought the impacts could be potentially result in a nonstationarity for the NRNI data. Other nonstationarities do not have such a clear hydroclimatic event which can be presented as a potential cause.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

The addition of Table 6 includes this explanation. Thank you!

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Aug 25 2021

Current Comment Status: **Comment Closed**

9299164 section	Climate	5.3 Summary NRNI Nonstationarities	36	End of page and

Comment Classification: **Controlled Unclassified Information (CUI)**

Does using daily flows averaged over multiple day periods also influence this analysis? In other words, how would this analysis vary if the annual maximum daily NRNI flow was used to represent a given year rather than the N-Day flows?

May want to do a quick sensitivity analysis with a centrally located gage for the MO River downstream of Gavins.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Non-concurred**

Using single day peaks is not advised for a river this large, especially with a synthesized dataset like the NRNI flows. If this analysis was to include tributary rivers then perhaps a 1-day peak flow may be appropriate for that system.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021 Current Comment Status: **Comment Closed**

9299167   Climate 6.0 Monotonic Trend Analysis   37   n/a
Comment Classification: **Controlled Unclassified Information (CUI)**

(R,2021). This reference is missing from the references section

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**
added reference

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299169   Climate 6.1 USGS Annual Peak Instant. Streamflow (1975-2016)   n/a
Comment Classification: **Controlled Unclassified Information (CUI)**

Add in text reference and caption for the table. May also be beneficial to include the slope of the trendline to have an idea as to the magnitude of change at the gage location.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**
Added to text.

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021 Current Comment Status: **Comment Closed**

9299171   Climate 6.2 Mean Projected Annual Maximum Monthly Streamflow   n/a
Comment Classification: **Controlled Unclassified Information (CUI)**

(Document Reference: Table 17)

Trend Direction - May be beneficial to include the slope to see the magnitude of change and differences between the different analysis periods (earlier, later). Even if there is a statistically significant trend, the rate of increase may be relatively small for the design lifetime of projects.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Non-concurred**
slope presented in Table 18

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Open Comment**

I still don't see slope values added to the table (Table 8) pertaining to this analysis (6.2 Mean Projected Annual Maximum Monthly Streamflow) or summarized in Appendix D for the HUCs. Table 18 only contains the description of Sens Slope.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

1-2   Backcheck Recommendation **Close Comment**

Slopes still not included, but won't impact the final results/analysis.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Jan 27 2022

Current Comment Status: **Comment Closed**

9299173   Climate 6.2 Mean Projected Annual Maximum Monthly Streamflow   38   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Insert caption and cross reference within the document text for the HUC4 figure.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021 Revised Jun 25 2021.

1-0   Evaluation **Concurred**

Added to text

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299193   Climate 6.4 GHCND Climate Trends   43   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Recommend including slope units in the table so it is easier to understand the temporal time frame. Example (mm/yr, etc.)

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021 Revised Jun 25 2021.

1-0   Evaluation **Concurred**

Added units to tables.

Submitted By: Daniel Hamill (6036464240) Submitted On: Jul 02 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9299214 | Climate | Figure 39 | 47 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

It would be nice to include additional precip gages in the northwest portion of the basin to see if the decreasing precip is a regional trend or isolated to the one gage.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Non-concurred**

Agreed a full analysis with every available climate station in the watershed would be worthwhile. However this was outside the current scope and the sites provided were based on NWO recommendations.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9299237 | Climate | 7.0 Vulnerability Analysis (HUC 4) | 47 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

ATRs usually like a discussion about how these vulnerabilities specifically relate to the project or what is being done in the project to address the vulnerability. Include a discussion about measures already implemented or possible measures that could be included to improve flow frequency resiliency to climate change. You may want to include a table in the report similar to Table B-1 in ECB 2018-14.

How is climate change being incorporated into the updated flow frequencies? Will the flow frequency updates still be relevant in 10 years? 20 years? (the "design" lifetime of this project).

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Concurred**

Agreed, Table B-1 is very useful for planning studies. Currently there are not alternatives or measures considered in the update of the flow frequency study. We don't know of any way to include a table like B-1 with this study.

Added text:

The update to the Lower Missouri River Flow Frequency values will not directly incorporate climate change. The update will follow existing guidance and will used the results of this analysis as needed to appropriately discuss the limitations and future flow frequency updates.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Jan 27 2022

Current Comment Status: **Comment Closed**

| 9299259 | Climate | 7.0 Vulnerability Analysis (HUC 4) | 47 | Figure 40 |

Comment Classification: **Controlled Unclassified Information (CUI)**

The vulnerability assessment does not discuss HUCs in the NWK district. Include a discussion related to the NWK HUCs since most of the gages updated as part of the Lower Missouri Flow Frequency Study are located in NWK.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Concurred**

Changed to:

Notably, both wet scenarios predict vulnerabilities in the Lower Missouri River Basin.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Open Comment**

Appendix G and Section 7.0 still do not include any analysis of the HUCs located within the Lower Missouri River - NWK boundary. Update the report and Vulnerability Assessment discussion to include these HUCS since they are included within the jurisdiction of the project.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

1-2 Backcheck Recommendation **Close Comment**

NWK HUCs are now included in the vulnerability assessment discussion. Thank you and great work!

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Feb 02 2022

Current Comment Status: **Comment Closed**

| 9299268 | Climate | 7.0 Vulnerability Analysis (HUC 4) | 48 | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

"cumulative 568-Flood Magnification factor".

Provide a brief description of what this is and what may contribute to this factor based on the literature review (increased precipitation/temperature).

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Non-concurred**

Description already included:

The flood magnification factor indicates an increased risk of flooding that might result in energy spills at hydropower plants.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299280   Climate   7.0 Vulnerability Analysis (HUC 4)   48   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

"... result in energy spills at hydropower plants."

What are other implications of increased flood risk rather than just the application to hydropower plants (levees, sedimentation/scour, etc.)?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Non-concurred**

Based CoP guidance for these reviews we need to keep the discussion as concise as possible. Expanding upon the VA results could be especially given the large domain of the current study. A an explanation of the vulnerable indicators is provided. Other implications should be handled in a quantitative analysis.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299331 Climate   8.0 Summary   53   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Still need some discussion about how the updated flow frequencies are related to climate change…or what can be done to reduce the impact of climate change on the increased flood risk, even if it isn't included as part of this project.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

We will recommend to include to the NWO team to include this discussion in the main report.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Jan 27 2022

Current Comment Status: **Comment Closed**

9299354   Climate   Appendix C: Mean Projected Annual Maximum Monthly Flow   77   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

May want to organize the figures from upstream to downstream

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0   Evaluation **Concurred**

Noted.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299360 Climate Appendix C: Mean Projected Annual Maximum Monthly Flow 77 n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

If the intent is to include all MO River Basin HUCs for the projected annual maximum monthly flow figures, several are missing: HUCs 1002, 1003, 1005, 1007, 1008, 1009, 1015, and 1028.

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Non-concurred**

Our intent was only to include the main-stem HUCs. Inclusion of all HUC4s in the watershed doesn't necessarily add to the discussion or inform the results of the NRNI data.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

It is still unclear as to why those HUCs were left out. I only say that because there are several other HUCs that are associated with tributaries (not the main-stem) that were included in the analysis.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

9299365 Climate Appendix C: Mean Projected Annual Maximum Monthly Flow 88 Figure 94

Comment Classification: **Controlled Unclassified Information (CUI)**

Recommend organizing the figures from upstream to downstream

Also, if the intent is to include this type of figure for all HUCs in the MO River Basin, several HUCs are missing including: 1002, 1003, 1005,1007, and 1008.

These missing HUCs are inconsistent with the previous comment . . . is there a reason why different HUCs were included for these figures?

Submitted By: Erin Reinkemeyer (8163892332). Submitted On: Jun 25 2021

1-0 Evaluation **Concurred**

Noted on organization.

Again, including projected data for all HUC4s in the watershed does not add to the discussion.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-0 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Erin Reinkemeyer (8163892332) Submitted On: Sep 03 2021

Current Comment Status: **Comment Closed**

| 9322146 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

See the attached report with recommended edits to address a lot of these comments. Editorial comments included as well.

Note that this not all comments are addressed in the attached report. Additional formatting work is also required.

This was a HUGE study area and I love how some of the data was presented visually in figures! The author(s) have a strong statistical background and were very detailed. However, some of the results were difficult to process due to the large amount of detail in the main body of the report. See my recommended edits.

(Attachment: missouri_qualitativeCCreport_draft_Apr2021_JPC.docx)

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021 Revised Jul 12 2021.

1-0   Evaluation **Concurred**

We accepted many of the proposed changes in the revised document.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 10 2021

1-1   Backcheck Recommendation **Close Comment**

Many of the proposed changes were accepted. Only issue was the change in the focus of business lines included in the assessment. My open comment addresses this issue with a deletion of a sentence in the introduction and the addition of another. Should be a quick fix.

Thank you.

Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322158 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Document should clearly state that the overall purpose for the climate change analysis is to better understand possible future without project conditions and if future projects will need resilience built into their designs.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommended text added to report attached to Comment 9322146 (first comment) of this review.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Adopted suggested edits into main body of the report.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 06 2021

1-1   Backcheck Recommendation **Close Comment**

Text excepted. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322160	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Most important climate variables that could impact future projects along the Missouri River should be clearly stated and included in both the observed and projected sections of the literature review. Precipitation and temperature are included in the observed and projected documentation, but streamflow needs more development.

Basis. ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Clearly state that important climate variables include temperature, precipitation, and streamflow (see recommended text in reviewed document). Observed and projected trends in temperature and precipitation are documented but stream flows are not. I have added at figure from Norton et al., 2014 to the edited report I provide in another comment. This figure shows statistically significant stream flow trends for the Missouri River basin.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

We have reorganized the observed and projected trends sections to clearly address temperature, precipitation, and streamflow. The streamflow section was expanded to include the Norton et al. 2014 analysis.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 10 2021

1-1   Backcheck Recommendation **Close Comment**

Figure and text added. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322161	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Precipitation and temperature are included in the observed and projected documentation, but streamflow needs more development.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies,

Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Add additional information on the observed and projected trends in stream flow. I have added at figure from Norton et al., 2014 to the edited report I provide in another comment. This figure shows statistically significant stream flow trends for the Missouri River basin. Also refer to figure 1 noting that there is more uncertainty in the stream flow projections (low consensus in literature projections in Figure).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Reorganized the projected trends section to clearly address streamflow. Made reference back to Figure 1 to indicate there is low consensus among scientific literature.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 10 2021

1-1 Backcheck Recommendation **Close Comment**

Comment addressed and closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322162 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

[Critical/Flagged.]

Concern. The business lines considered in the assessment are not clearly stated in the introduction of the document. The flood risk reduction, navigation, ecosystem restoration, water supply, regulatory, and emergency management business lines are of importance.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Adopt recommended text in document attached to a later comment in these ProjNet comments. Make sure your Vulnerability Tool assessment includes results from all business lines.

I have added recommended text in the report attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Accepted and merged suggested changes into the main document.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Open Comment**

Based on your other comment that flood mitigation is the focus of the Missouri River Flow Frequency Study, I recommend you state something like the following at the end of paragraph two of the introduction:

"While the Missouri River has many authorized purposes, flood mitigation (and navigation?) are the focus of the Missouri River Flow Frequency Study."

Remove the text stating that "For this reason the business lines considered include: Flood risk reduction..."

This will help clarify for future projects up front that this document does not meet all their climate change assessment requirements.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

1-2 Backcheck Recommendation **Close Comment**

Text added. Apologies on the critical flag. I did not mean for this to be a critical comment.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Sep 02 2021

2-0 Evaluation **Concurred**

Added text to Section 1.0.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Sep 01 2021

Backcheck not conducted

Current Comment Status: **Comment Closed**

9322163   Climate n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. More background on the Missouri River Basin and its seasonal high flow cycles should be included to help focus the analysis. More background information on the MR basin and its historic flooding cycles will help in future reviews. ATR reviewers will not have site-specific knowledge or time and funding to gather it.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Add more background information on the Missouri River Basin and its typical flow cycles. The river has two large pulses of flow in March and May. The March pulse is due to plains snowmelt and the May pulse is due to mountain snowmelt. In addition to these snowmelt cycles, the mainstem is vulnerable to heavy rainfall within its large drainage area. Based on this information, winter, spring, and summer seasons are the most important as changes in precipitation and temperature could produce significant impact.

I have added some text to the recommended edits in the document attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

concur added text to main document.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 06 2021

1-1 Backcheck Recommendation **Close Comment**
Thank you. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322164	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. While the level of confidence is provided as 95% for statistical significance, it should be documented as a p-value of equal to or less than 0.05 early in the document as well.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Clearly state the p-value used to determine statistical significance in the early text. State that the p-value represents the level of risk we are willing to accept that the trends shown are accurate. Some readers will not have your strong statistical background.

I have NOT added this text to the document attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**
Added text throughout the document to document statistical significance is assessed using 95% confidence level. Also added some clarification how a confidence level relates to the uncertainty of the reported trends.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**
Text was added. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322167	Climate	n/a		n/a	n/a

 Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Text should state that the national standard settings were used in the USACE tools. Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. State that the USACE climate change tools used the national standard settings. I know this is shown in the plots, but it is good to add to the text as well as the text in the plots is small.

I have added some text to the recommended edits in the document attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Added text to main document indicating the national standard settings were used.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 09 2021

1-1   Backcheck Recommendation **Close Comment**

Text added. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322171 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Please clarify the R statistical software was used to determine nonstationarities and trends for the unregulated flows (NRNI flows). Also state why it was used opposed to the Time Series Toolbox.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Clearly note the R statistical software was used in place of the TST due to the number of simulations required for the number of gauges and volume durations as you explained on the phone.

I have added text to the recommended edits in the document attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Added suggested revisions to the main document.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Text added. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322180 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. N-day durations were used in the determination of nonstationarities and trends. This is not something typically seen and additional explanation in the text would help clarify.

Basis. Clarification

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Please clarify why n-day durations were used in the determination of nonstationarities and trends for the NRNI timeseries. I am sure there is a good reason but stating why might avoid additional questions in ATR.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Added additional text to clearly document the motivations for n-day durations. Shorter windows are for quick moving floods (rain), while longer windows are for slower moving floods (snowmelt).

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

Thank you! Nice explanation in my opinion. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322183 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Much of the text refers to strong nonstationarities as "strong change points". I have only heard of change points indicating strong nonstationarites. I have not seen the use of "strong change points" terminology in references.

Basis. Consistency with guidance and requirement documents' terminology
Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Please replace "strong change points" throughout the text with "strong nonstationarites".

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Non-concurred**

The term "strong change point" is consistent with the terminology in ETL 1100-2-3 (appendix B, b-5).

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 09 2021

1-1 Backcheck Recommendation **Close Comment**

Thanks for checking the documentation. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322184 | Climate | n/a | | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Strong nonstationaries were determined in the observed USGS records for early 1950s and 1998. However, there is no analysis on what could have created these nonstationarities.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend you look at the USGS metadata to see if an upstream dam was built or something else of significance occurred upstream of the gauge. Were these years of large runoff events (1952 is one) or droughts? Was a dam built or were upstream dam operations changed significantly? Was there a significant change in landuse or agricultural development? You could also contact someone in Division to answer this site-specific question more quickly.

Submitted By: [Jennifer Christensen](#) (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Non-concurred**

We added a statement about why the nonstationarity from 1941 may be detected but did not expand upon others. Since the USGS gage data has too many compounding potential causes we think just listing some of them is sufficient. In addition, the nonstationarities from the USGS data are not the focus of this analysis.

Submitted By: [Jeremy Giovando](#) (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Agree. We are told to be concise from CPR leadership from her on out.

The 1941 nonstationarity appears to be the strongest as it appears from upper basin to lower. Explanation in table 6 clarifies it was due to recovery from a 12-year drought.

Submitted By: [Jennifer Christensen](#) (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322185 | Climate | n/a | | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Strong nonstationaries were determined in the 1941, 1946, early 1980s, 1961, 2000 and 2009 in the unregulated record. There is no analysis indicating what could be causing these nonstationatities.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. State in the text if these were years of significant flooding, drought, land use change, or other mechanism not screened out of the regulated record to produce the NRNI record. Recommend you contact someone in Missouri River Basin Water Management Division for background information.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Added suggested table of possible explanations to main document. Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

Nice explanations! Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322186 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. I find it odd that 1952 was picked up as a strong nonstationarity in the regulated record but not the NRNI unregulated record. This was a historic year and I think should have been picked up in the nonstationarity detection analysis in both the regulated and unregulated records. This makes me have less confidence in the NRNI record.

Basis. Engineering judgement.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Please provide an explanation. If possible, please investigate adjusting the sensitivity of whatever tool was used to determine strong nonstationarities in the NRNI record or explain why the 1952 event was not identified as a strong nonstationarity. I know with the USACE nonstationarity detection tool there are slider bars to adjust sensitivity. These are used to pick up on change points for years where the author knows something changed in the record.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Non-concurred**

While 1952 was a large water year on the lower river it doesn't necessarily mean a nonstationarity would be detected.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

True. Considering the other results, it would have to likely be followed by much lower flows to trigger. Thanks for clarification. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322187 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. There is reference to the R programing language in the text but no acknowledgement in the references section or note that it is a programming language used in statistically analysis.

Basis. Clarity and understanding of the results Significance. Low (will not affect project

selection)

Probable Action to Resolve Concern. Note that R is a programming language used for statistical analysis in the text and add it to the reference section.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Added to reference section

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Aug 05 2021

1-1 Backcheck Recommendation **Close Comment**

Reference was added to the text. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322191 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. It is not clearly stated that scripting in the R software was used to run statistical tests like those in the CHAT and NSD on data not in the tools. Typically, the Time Series Toolbox (TST) would be used in this type of analysis.

Basis. Consistency of results with USACE approved Climate Assessment Models. Significance. Low (phone call clarified that will not affect the results)

Probable Action to Resolve Concern. Add text stating that scripting in the R software was used opposed to the TST due to the large amount of data analyzed. I have added some text in the report attached to Comment 9322146 (first comment). Please review before accepting.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Added additional text to the data section describing the motivations for using scripted analyses.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

Thank you. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9322194 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. It is not stated in the text that any verification was completed to compare the scripted R software results with the official climate change models. I think it is important to communicate this was completed. Verification of the scripting is documented in the appendix. However, this is not stated in the text of the main document.

Basis. Consistency of results with USACE approved Climate Assessment Models, ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. State in the climate assessment text that the scripting in the R software was verified with the official model results. State as well that verification is documented in the appendix.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Additional text was added in the main document to clearly articulate all analyses of NRNI data were completed using the R computing library.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

The following statement added to the text addresses my comment: "The methods used for our qualitative climate change assessment were consistent with the standardized tools created by the USACE Climate Preparedness and Resilience Community of Practice."

Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322195   Climate   n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. I think there is a mistake in the wording of Section 6.1. It is stated that results from the CHAT tool "do not account for regulation and agricultural depletions." The CHAT uses observed USGS gauge data, so it does account for regulation and agricultural depletions.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend rewording as: "While some differences in the trend direction did occur, it is difficult to make a strong conclusion because trends are not statistically significant. However, negative trends in the headwaters of the basin are likely due to decreases in snowpack while increases in the lower basin may be due to an increase in extreme events precipitation events in the lower basin."

I have added text to the recommended edits in the document attached to Comment 9322146 (first comment).

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Reworded the text to clarify the point that USGS streamflow data include regulation

and irrigation.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Clarifying text was added. Thank you. Comment Closed.

Submitted By: [Jennifer Christensen](#) (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322197	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. More information on how to interpret Vulnerability Analysis (VA) tool results is needed. This is important so it is understood how vulnerability in the USACE tool is defined.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend adding the following text: "When a HUC is designated as vulnerable by the USACE tool, it means that the HUC ranks within the top 20% most vulnerable HUCs of those considered in the portfolio. Just because a HUC is not identified as vulnerable in the tool does not mean that it is not vulnerable, it means instead that it is not among the most vulnerable of those considered."

I have added text to the recommended edits in the document attached to Comment 9322146 (first comment).

Submitted By: [Jennifer Christensen](#) (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Accepted changes in the main document.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Text added. Comment Closed.

Submitted By: [Jennifer Christensen](#) (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322201	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Future projects along the Missouri River will include all business lines available in the Vulnerability Assessment tool but they are not included.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Medium (could impact future project resilience to climate change)

Probable Action to Resolve Concern. Recommend adding all business line results as you have done for flood risk mitigation (with plots in the appendix). You could also clearly state that each project impacted by this climate assessment will individually do their own VA tool analysis before their project.

However, it would be better to the VA analysis for all business lines in this document opposed to having each project complete them, in my opinion. If each project had to do their own VA to complete climate assessment requirements but were confused because the climate change analysis was already complete (this document), potential impacts due to climate change would not be implemented.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Non-concurred**

While we want this CC assessment to be as useful as possible, the focus of this assessment is for the lower Missouri Flood Frequency Study. Other studies can build upon this document, but will need to complete their own analysis to ensure all possible impacts are considered.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Agree with the statement above. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322205	Climate	n/a	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. While this climate assessment is not being used to estimate risks for a specific project, developing a risk matrix for general types of future projects would help screen proposed future projects.

Basis. ER 1110-2-8159, Life Cycle Design and Performance; ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend developing a general risk matrix for possible future projects that might use the peak flow frequency information from this study in their screening and design. These types of projects could include levees, detention, ecosystem restoration, etc. Note how resiliency could be built into each of these possible future projects (i.e., accommodation for future levee raises, levee setback, etc.)

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Added generalized risk matrix to main document.

Submitted By: Daniel Hamill (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

I appreciate you adding this table. Comment Closed.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322222 Climate n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. Clarity and understanding of the results due to large amount of analysis detail presented in the report.

Basis. CPR CoP initiative to decrease the size of climate assessments, even for those with large regions. Clarity.

Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend focusing on one region analysis in the body of the report and then summarizing additional region's results. Recommend placing the additional regions' analyses in an appendix. This will help with understanding the results.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

We have made a concerted effort to be as concise as possible with the results (especially based on recent feedback from CoP leadership). More information has been moved to appendices.

1-1 Backcheck Recommendation **Close Comment**

Thank you, Jeremy. Yes, there is emphasis on making assessments concise from here on out. I will keep this in mind in future reviews.

Submitted By: Jennifer Christensen (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322225 Climate n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. After additional business lines are added to the vulnerability assessment, the narrative about the results will be cumbersome.

Basis. CPR CoP recommendations for clarity and conciseness. Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend presenting VA tool results for business lines in a table instead of text. Recommend the following information be displayed: business line, dominate indicators, wet and dry scenarios, number of vulnerable watersheds, where in basin highest vulnerability.

Submitted By: Jennifer Christensen (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Adopted suggest table in the main document.

Submitted By: <u>Daniel Hamill</u> (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Tables added. Thank you, Daniel. Comment Closed.

Submitted By: <u>Jennifer Christensen</u> (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322227	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. After additional business lines are added to the vulnerability assessment, the number of plots presented will be large. This will affect the clarity as it will be a bit overwhelming in the main document.

Basis. CPR CoP recommendations for clarity and conciseness Significance. Low (will not affect project selection)

Probable Action to Resolve Concern. Recommend moving vulnerability plots to appendix. This will help produce a clearer document for decision makers.

Submitted By: <u>Jennifer Christensen</u> (402-995-2015). Submitted On: Jul 12 2021

1-0   Evaluation **Concurred**

Reorganized the section to only include plots that have in-text references. Results from the remaining business lines are provided in tables in the main document. Added other business line plots to Appendix G.

Submitted By: <u>Daniel Hamill</u> (6036464240) Submitted On: Aug 11 2021

1-1   Backcheck Recommendation **Close Comment**

Thanks for the additional work. Comment Closed.

Submitted By: <u>Jennifer Christensen</u> (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

9322241	Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern. The dominate indicators of the vulnerability assessment are shown in Figure 40 in the pie charts but not identified and described in the text.

Basis. ECB 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects.

Significance.

Low (will not affect project selection)

Probable Action to Resolve Concern. Select the three strongest indictors driving vulnerability in the HUC (from the pie charts) and briefly describe what they represent. Refer to the fact sheets in the VA tool. Recommend you make a table of VA results as there will be a lot that needs to be summarized due to multiple business lines.

See Comment 9322225 for recommended table details.

Submitted By: [Jennifer Christensen](#) (402-995-2015). Submitted On: Jul 12 2021

1-0 Evaluation **Concurred**

Adopted suggested change into the main document.

Submitted By: [Daniel Hamill](#) (6036464240) Submitted On: Aug 11 2021

1-1 Backcheck Recommendation **Close Comment**

Comment addressed and closed.

Submitted By: [Jennifer Christensen](#) (402-995-2015) Submitted On: Aug 31 2021

Current Comment Status: **Comment Closed**

| 9526195 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Page 5, First Paragraph

a. Concern: Unclear what this paragraph is trying to convey. It reads like a loose collection of facts.

b. Basis: Technical clarity

c. Significance: Low

d. Action: I recommend reworking paragraph for conveying a clear message to start this section.

Submitted By: [Chris Frans](#) (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Modified paragraph, "The Missouri River Basin also has a history of episodic trends, drought and an overabundance of surface water (Conant et al. 2018). Tree-ring reconstructions of streamflow in the upper Missouri River Basin explain 68% of theindicate considerable streamflow variability over the last 1200 years observed streamflow records variability (Martin et al. 2019). Martin et al. (2020) reports the relatively recent "turn-of-the-century drought" which occurred between 2000 to 2010, is one of the most severe in the last 1200 years. Following this unpresented drought were substantial floods occurring in 2011 and 2019. Hoering et al. 2013 analyzed the meteorological drivers of the 2011 floods and attributed the event to a sequence of a cold-wet winter followed by late spring heavy-precipitation. Each of the events alone could have resulted in abnormally large runoff events, but they culminated in an extreme runoff year. Without being able to attribute basin runoff to a specific driver during the 2011 flood, it is harddifficult to directly link the variability to a known driver of climate change (e.g. atmospheric rivers, sea surface temperatures). In 2019, an extremely wet October through December following by large March precipitation event on areas of frozen soil resulted in several of the lower Missouri River streamgages to reach record stages. These record stages were observed for several weeks with some locations having over 270 days consecutive days above flood stage (NOAA, 2020)."

Submitted By: [Jeremy Giovando](#) (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: [Chris Frans](#) (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526196 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Page 5, Paragraph 2, Figure 3

a. Concern: The text cites a peak flow analysis. In the figure there appears to be clearly organized patterns. Some of which do not match the streamflow and precipitation trends presented later in the report. Was this referenced analysis based on regulated (observed) flow?

b. Basis: technical clarity

c. Significance: Low

d. Action: I recommend explicitly stating whether the analysis used observed or unregulated flow.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Modified paragraph, "There have been several studies of streamflow trends within the Missouri River Basin. Notron et al. 2014 provides a comprehensive trend analysis of observed peak streamflow records at 227 streamgages (Figure 3). The streamgage records were not corrected for any upstream impacts from human activities such as irrigation and reservoir regulation. "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526197 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Page 12, Paragraph 2, NRNI Data

a. Concern: The NRNI analysis is one of the more important pieces of this study. The NRNI dataset was only developed for 19 mainstem locations. Because of the mainstem only analysis, little is gained on how tributaries outside of headwater projects could be changing. The further downstream you get, the climate signal will be the same translated downstream washing out or obscuring changes from contributing tributaries.

b. Basis: technical approach

c. Significance: Medium

d. Action: If available, it would be information to include analysis outside of mainstem locations. Otherwise, the rationale for an approach for a mainstem only analysis should be described and justified.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

We agree that analysis beyond the main-stem locations is important. However, the NRNI dataset doesn't extent into any of the tributaries. Subsequent work is now underway to develop NRNI flows for each of the major tributaries in the watershed. Based on DQC comments we removed statements that would have made why the main-stem only analysis was performed. This assessment is specifically in conjunction with the Lower Missouri River Flow Frequency Study which focus only on main-stem locations below Gavin's Point Dam. The DQC commenter wanted our analysis to omit discussion of specific studies this assessment was being used. Sentence added, "Currently, only main-stem Missouri River locations have NRNI data available; therefore, our analysis is limited to these 19 locations. "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526199 Climate   n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Page 12, Paragraph 2, NRNI Data

a. Concern: The NRNI analysis is one of the more important pieces of this study. It is also the basis for the evaluation of hydrology products and reference point for calibration in potential future phases. There is no citation for the source of the information. "Mass conservation and mass balance" is vague. How are depletions defined and calculated? Are irrigation return flows included? Are groundwater interactions with irrigation activities backed out? Are corrections for reservoir evaporation effects included? What are the routing assumptions?

b. Basis: technical approach

c. Significance: High

d. Action: I recommend an appendix describing the development of the NRNI dataset if it was developed for this project. If the source of the data is from another documented study, that should be referenced and the key development pieces listed above should be summarized.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Text and reference added.

"Depletions for multiple basin development conditions are estimated by the US Bureau of Reclamation (USBR) using their Regional Depletions model (USBR 2012). This model estimates agricultural withdrawals and return flows based on ag census data, meteorological data, types of conveyance systems, etc. In areas of high groundwater usage, additional analyses are performed to remove groundwater effects on surface water. USBR reservoir effects (water stored in a reservoir and lost to evaporation) are estimated from data retrieved from USBR's Hydromet Data System. Water supply withdrawals are estimated using per capita demand assumptions and fit to a monthly

temporal pattern.

Several trans-basin diversions are also included in the USBR depletions with data coming from a variety of sources. Final USBR depletions are calculated on a HUC8 scale and a monthly time step. This data is disaggregated to a daily time step so it can be utilized in reservoir and river models and estimate NRNI flows."

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526200 | Climate | n/a | | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)** throughout text

a. Concern: The statistical methods are inconsistently described. For instance, calculating trends and significance varies. The usage of p-value hypothesis testing is defined differently throughout the text. Some of the challenge comes from using different tools that are based on different tests. Ultimately, when presenting results in later sections they are accurately described but are not consistent with text in earlier sections. The text also defines the statistics multiple times.

b. Basis: technical clarity, ETL 1100-2-3

c. Significance: low

d. Action: Recommend consistent description of statistics. Consolidating the description of statistics will also make the text more concise.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

We did not find inconsistencies in the descriptions related to p-values tests. Some verbiage was clarified in sentences describing the confidence level that we used. The repetition of our confidence level was repeated based on comments from DQC.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526201 | Climate | | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Page 17, Paragraph 2

a. Concern: This paragraph lists off a bunch of different results, which are disjointed

and hard to follow.

b. Basis: technical clarity

c. Significance: low

d. Action: I recommend revising this text for clarity. One option is to present the main findings as bullets.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

The text was modified to read, " Key results include:

- The most striking trend within the NRNI change point dataset aA 1941 change point persisted across all of the n-day durations. This trend is most apparent in the Lower Missouri River trend analysis zones (Figure 9).

- The 91-day duration resulted in the most change point years, where a fraction of the NRNI flow locations were had change points in 1941, 1946, 1961, 1984, and 1999.

- The 121-day duration time series had 84.2% (16 of 19) flow locations with a 1941 change point. Possible explanations for the change points identified in Table 5 are provided in Table 6."

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526202 | Climate | n/a | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 5.2 – locations with change points

a. Concern: It is difficult to understand where these change points are being identified.

b. Basis: technical clarity

c. Significance: low

d. Action: This could be better described in revising paragraph 1, or by adding a spatial graphic if possible to see how these are organized. Since it is sliced and diced so many ways, you will likely have to just plot one element that has the strongest spatial signal.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Maps inserted

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526203 Climate n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Table 6

a. Concern: Table 6 describes hydrological changes in time that could explain change points. This messaging and directional changes in time could be made clearer with a visual supplement.

b. Basis: technical clarity

c. Significance: low

d. Action: This would be well supplemented with a representative timeseries or two of the data. That way the reader can see what you are describing and the directional nature of these changes.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

example plot added to section 5.2 showing annotated time series for a location.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526204 Climate   n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 5.2 – last paragraph

a. Concern: This paragraph lists some limitations of the NRNI data but doesn't list potential implications on findings.

b. Basis: technical clarity

c. Significance: low

d. Action: Can you further this discussion and add potential implications of these limitations (false trends, change points from data streams coming online/offline). Maybe this text would be better in an NRNI dedicated section, or at a minimum, after trend analyses too because those could also be affected and discussed.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Text moved to Section 4.0 Data and additional information provided on implications.

"There are several sources of uncertainty in the NRNI data that could impact the climate signal within the data. First, the agricultural depletions across the time series are monthly estimates. Second, the aquifer in the Missouri River Basin is not spatially uniform and changes can lead to a transient signal in the NRNI data depending on regional depletions. Third, the available USGS streamflow records varies since the number of operational gages in the basin increased over time. Finally, land-use changes in the basin are not explicitly accounted for in the NRNI data which could impact the runoff volume and timing. As the proportion of the basin used for agricultural purposes increases, the infiltration and runoff characteristics of the basin could change. The impacts of these uncertainties could result in false change points or trends. For example, monthly depletions provide a presentative volume from the historical period. However, the error between the uniform depletion value and actual daily depletion could vary throughout the monthly timeframe. Therefore, the error in depletion estimates for the n-day time window being used for the centered moving average could also vary between water years. This could result in change points that are an artifact of temporal resolution differences between streamflow and depletion data. "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526205 Climate	n/a		n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 6.0 – last sentence

a. Concern: "The trend line in the CHAT uses linear regression fit while the trend values for the NRNI were calculated using nonparametric methods. For purposes of a qualitative analysis, the difference in methods is not substantial." There is no justification given for this statement. If outliers are present, I would expect there to a difference in detected trend presence and magnitude.

b. Basis: technical approach, ETL 1100-2-3

c. Significance: low

d. Action: I recommend providing supporting rationale for this statement.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

last statement changed to "For purposes of this analysis, the non-parametric values are discussed in the results. "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526206 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 6.2

a. Concern: Why looking at just these 5 HUCs? The other analyses in the report include sites in other areas of the basin outside of these 5 HUCs. As described it seems inconsistent to select these, and there doesn't seem to be great coverage throughout the basin.

b. Basis: technical approach, ECB-2018-14

c. Significance: low

d. Action: I recommend describing why the analysis was limited to these HUCs or providing additional analyses.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

Text added for clarification. "These HUC basins were selected to represent the various hydrologic forcing mechanisms within the Missouri River Basin, which include mountain snowmelt (HUC 1004), plains snowmelt with rainfall (HUC 1013), rainfall with some snowmelt contribution (HUC 1023), and rainfall (HUC 1024 and 1030). "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526207 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Table 9

a. Concern: It is difficult to understand trend magnitude in units cfs/year for locations of various drainage areas.

b. Basis: technical clarity

c. Significance: low

d. Action: I recommend using a different unit for trends. In this case %/year or %/decade would make the analyses more meaningful.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

values converted to %/decade

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: [Chris Frans](#) (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526208 Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 6.3, paragraph 3 (page 23)

a.   Concern: "This specific sequence in the 15-day duration time series is not statistically significant but could indicate 15-day peak flow durations are not appropriate for monotonic trend analyses in this reach". I don't think that you can conclude that the method is not applicable for a single reach because the results are inconsistent. I don't agree that the analysis is inappropriate. Could point to change in local flow in the reach, or an issue with NRNI local flow calc. The mainstem only approach makes this challenging.

b.   Basis: technical clarity

c.   Significance: low

d.   Action: I recommend that you interrogate the reason for difference and strike text.

Submitted By: [Chris Frans](#) (2067646701). Submitted On: Dec 15 2021

1-0   Evaluation **Concurred**

text changed to "This specific sequence in the 15-day duration time series is not statistically significant which could potentially be caused by uncertainties in the development of the NRNI data for this reach. "

Submitted By: [Jeremy Giovando](#) (509-540-6498) Submitted On: Jan 26 2022

1-1   Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: [Chris Frans](#) (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

| 9526209 | Climate | n/a | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Comment: Figures 12 and 13

a.   Concern: It is hard to tell which symbols are filled. Can't tell where in the mainstem analysis does it flip in trend significance?

b.   Basis: technical clarity

c.   Significance: low

d.   Action: Consider improving visual clarity.

Submitted By: [Chris Frans](#) (2067646701). Submitted On: Dec 15 2021

1-0   Evaluation **Concurred**

We did spend considerable time on these figures trying to find a scaling. The current paneled plots seem to be the best solution for showing limited data points across a large domain. We did shift Figure 12 to landscape and enlarged while Figure 13 is made slightly larger.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526210 Climate   n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 6.4

a. Concern: This is a good analysis to include because it supports the earlier findings, increasing overall confidence in the results. The mechanisms of the temperature trends have been fairly well described in the literature, linking with irrigation practices.

b. Basis: technical clarity

c. Significance: low

d. Action: Consider adding addition explanation of climate trends.

Mueller, Nathaniel D., et al. "Cooling of US Midwest summer temperature extremes from cropland intensification." Nature Climate Change 6.3 (2016): 317-322.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**
Text and reference added. "These decreasing trends could be related to cropland intensification. Mueller et al. (2016) suggests that increased cropland results in create evapotranspiration on hotter days which reduced maximum temperatures through latent heat flux and increased precipitation. "

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526211 Climate   n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Section 8.0 Paragraph 2

a. Concern: The end of this paragraph is confusing and isn't supported with report content. " ...but future projections have a low consensus with variable directions." The literature review (Figure 2), CHAT results, and VA outcomes all

showed increasing flood risk.

b. "Some of the uncertainty in streamflow projections is because large volumes of runoff are cannot be attributed to an individual driver. Rather, large runoff years are related to a sequence of independent meteorological events." This is really confusing, I am not sure what the message is.

c. Basis: ECB-2018-14, technical clarity

d. Significance: medium

e. Action: I recommend revising this paragraph to reflect report content and for clarity.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

last two sentences removed.

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

9526212 Climate n/a   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Table 16

a. Concern: The table includes "slower moving storms" and "Longer periods of low flow from extended drought periods". This report does not present observed or projected evidence (literature or data) for these triggers and associated hazards, but are found to be likely.

b. Basis: ECB-2018-14, technical clarity

c. Significance: medium

d. Action: I recommend adding literature or analyses that support these statements to the body of the report or removing them from the table.

Submitted By: Chris Frans (2067646701). Submitted On: Dec 15 2021

1-0 Evaluation **Concurred**

citations added for references to increased precip to the basin

Submitted By: Jeremy Giovando (509-540-6498) Submitted On: Jan 26 2022

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Chris Frans (2067646701) Submitted On: Feb 01 2022

Current Comment Status: **Comment Closed**

2.0. ATR – Main Report

Displaying 54 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number

10085250   Hydrology   Main Report, Page15 Glossary of Important Terms   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Need additional terms in glossary – and spelling out of Acronyms. Basis: Report Clarity

Significance: Low

Action Needed to Resolve: Add definitions for the following terms:

- Expected and Computed Probability
- Expected Moment Algorithm (EMA)
- Depletion
- Period of Record (POR)

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Additional terms have been added and defined in the glossary. Care was taken to spell out acronyms in report.

Submitted By: [Kellie Bergman](#) (402-995-2308) Submitted On: Mar 21 2023

1-1   Backcheck Recommendation **Close Comment**

The Glossary of Important terms has expanded and includes the terms suggested.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

10085252   Hydrology   Main Report, ES-1 and Table ES-1   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Unclear what the "undeveloped" time series mean? Basis: Report Clarity

Significance: Low

Action Needed to Resolve: Does undeveloped mean that a time series was developed for land use returned to agriculture or prairie? Has reservoir operation been removed from mainstem? From tributary reservoirs? More definition is needed. Does this title mean Unregulated or Undeveloped. Consider renaming the figure.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

The term undeveloped was removed from the report. Unregulated is the correct term. It is also defined in the glossary.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 21 2023

1-1   Backcheck Recommendation **Close Comment**

The text has been corrected, and notation added to the Glossary of Terms.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

| 10085254 | Hydrology | Main Report, Table ES-1 and ES-2 | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Title incorrectly indicates that the table show curves. It shows the AEP values for various frequencies. Half of the table is yellow highlighted. Why?

Basis: Report Clarity Significance: Low

Action Needed to Resolve: Table ES-1 should be renamed. The preceding text needs to explain if this table is "Undeveloped" or "Unregulated" data and what went into creating that data set. The Tables ES-1 and ES-1 show AEP estimates at different frequencies, not curves. Are these the final recommended AEP values? Add a better definition of what the curves represent.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

I will call it unregulated flow and rename as such.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

1-1   Backcheck Recommendation **Close Comment**

The titles in Tables ES-1 and ES-2 have been modified and more clearly represent the data shown in them.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

2-0   Evaluation Concurred

The ES was modified to summarize background and methods. The tables were updated to reflect final recommended AEP values.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 15 2023

Backcheck not conducted

Current Comment Status: **Comment Closed**

| 10085255 | Hydrology | Report Section: Main Report, Section 1.2 First Paragraph | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: It is unclear what gages were used to generate the unregulated dataset. Is the unregulated portion on the main stem only, or was regulation removed from the tributary reservoirs as well?

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: Add detail to the description of how the unregulated dataset was developed. Were Water Management operational changes over time considered in

the unregulated dataset production? Add a note where to find the details of the unregulated dataset production.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Report was updated. Historical incremental flows based on historical gage data were routed downstream from Landusky, MT to Hermann, MO via the Missouri River ResSim Model. ResSim removes regulation effects of only the modeled reservoirs. The tributary reservoir effects were removed when depletions and tributary reservoir holdouts were added back to the model at each gage location. Estimates of depletions and tributary reservoir holdouts not in the ResSim model were estimated by the USBR.

Submitted By: Ryan Larsen (402-996-3861) Submitted On: Mar 16 2023

1-1   Backcheck Recommendation **Close Comment**

The text has been expanded as described above, to relay how the unregulated dataset was prepared.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

| 10085257 | Hydrology | Main Report, Section 1.2 First Paragraph | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: "These data sets were developed both by use of an HEC-ResSim model and HEC-RAS flow routing" needs some additional clarification

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: Are there other modeling differences between holdouts? Do you use control points or SWE conditions in the logic sequence of the ResSim model? Or is this discussion meant to be in simplified terms since it is in the Scope section. Provide a reference to what section the detail is covered in.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation Concurred

Report updated. The regulated dataset was developed by simulating reservoir operations based on the 2018 Missouri River Master Manual. The unregulated and regulated datasets could also be routed from Gavins Point downstream to Hermann, MO via

HEC-RAS models. The HEC-RAS routing used the ResSim unregulated and regulated flows at Gavins Point as the upstream boundary condition.

Submitted By: Ryan Larsen (402-996-3861) Submitted On: Mar 16 2023

1-1   Backcheck Recommendation **Close Comment**

Additional text has been added to describe how the regulated and unregulated datasets were routed (both RAS routing and ResSim as boundary conditions.)

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

| 10085259 | Hydrology | Main Report, Section 1.2 Second Paragraph | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: "This relationship was used to transform the unregulated flow frequency from the Bulletin 17C analysis into expected values from the regulated stream" needs some additional clarification

Basis: Report Clarity and Correctness Significance: Medium

Action Needed to Resolve: The term "expected value" with regard to frequency estimates indicates that perhaps an adjustment was made to a computed curve to account for the asymmetry of the uncertainty distribution. If that I not the intent of the sentence, modify the terms used in this sentence, such as "This relationship was used to transform the unregulated flow frequency into a regulated frequency estimate."

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

This paragraph was just poorly worded before. Changed to:

"This relationship was used to transform the unregulated flow frequency from the Bulletin 17C analysis into a regulated flow frequency. "

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

1-1 Backcheck Recommendation **Close Comment**

The "expected value" terminology has been replaced and clarified.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

| 10085262 | Hydrology | Main Report, Section 2 | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The Basin description should include an overview and discussion about regulation in the basin in the main stem and tributaries.

Basis: Report Clarity and Correctness Significance: Medium

Action Needed to Resolve: Regulation is a significant complexity in this basin. Add a section on regulation on the main stem and the tributaries.

How significant is the storage? Do they rank in the top storage for Dams in the US? The Basin Description could use a basin map w/ labeled rivers, reservoirs and gages.

Regulation is an important aspect in the study and the need for water accounting, carry over storage from year to year, availability of water for water supply or distraction purposes. Also allows some relief from droughts in the lower miss. (And impacts lower miss in the winter when the MO Basin moves into winter releases.)

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added text and maps about dams and regulation.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 15 2023

1-1 Backcheck Recommendation **Close Comment**

A new "Basin Regulation" section has been added as section 2.2. It is very helpful to have visual and textual context to the complex regulated system addressed in this Frequency study. Great addition.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

10085263	Hydrology	Main Report, Section 2.1	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The Watershed Characteristics discussion is good, but needs a map for reference. Basis: Report Clarity and Correctness

Significance: Medium

Action Needed to Resolve: Consider adding a figure (maybe a relief basemap) that shows the physiographic divisions are described if they are pertinent to the flow frequency analysis and discussion.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added a relief basemap with physiographic divisions to the report as Figure 2-1.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 16 2023

1-1 Backcheck Recommendation **Close Comment**

Figure 2-1 was included to help with report clarity on the physiographic divisions of the watershed. This is very helpful.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

Current Comment Status: **Comment Closed**

10085266	Hydrology	Main Report, Section 2.3 Climate Assessment	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The Qualitative Assessment was completed and reviewed for this study, but the

hydrology report does not weave the findings into the text. The Climate Assessment should also be an appendix to this work.

Basis: ECB 2018-14

Significance: High.

Action Needed to Resolve: How do the literature conclusions, NonStationarity Tool findings, and CHAT trends relate to the constructed time series in this project? Were the timeframes associated with dam construction or regulation changes detected with the Climate Assessment? Are there trends in the observed period that would indicate that Climate Change is impacting the watershed? Add the Climate Assessment as an appendix to this study.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

The ATR reviewed climate assessment is included as Appendix J and will be made available to the reviewer for backcheck. The climate change section of the report has been expanded significantly to address these specific questions. A numbered summary list is provided in Section 2.6 - this is a new section location for the climate assessment

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Open Comment**

Concern: Section 2.6 The term "NRNI" Flow Locations... NRNI is not defined in the main report. Spell out the acronym before it is used. (The definition is in the Climate Appendix but not the main report.)

Concern: Section 2.7 The land cover figures and graphs in Figure 2-7 represent the entire country. The statement "Figure 2-7 presents a plot showing historic land cover... which confirms most row crop production had been in place by 1898." is misleading. Looking at the figures for 1900 and 1950, about 1/4 of the state of SD converted to cropland. Perhaps data clipped to Missouri River would give a more accurate depiction of land use change with the Missouri River watershed.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

2-0   Evaluation Concurred

Concern 1: Good catch, thank you. No Regulation No Irrigation = Unregulated. Added the acronym here and the cross reference to unregulated.

Concern 2: I had trouble finding a basin specific study unfortunately with the land cover change research done clipped to the basin. After reviewing, and cross referencing to current land cover from the basin from the 2018 Missouri River Master Manual, I have taken the approach of retaining the figures but clarifying the text, using similar observations as suggested in your response. Please backcheck the text (see track changes). We do also include a recommendation to consider research to further the understanding of land-use changes on streamflows in the Basin (see Section 7.5).

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

2-1   Backcheck Recommendation **Close Comment**

Concern 1 has been resolved. The acronym NRNI is now spelled out in Section 2.6, Number 4.

Concern 2 has been resolved by the addition of text to describe the land use changes specific to the Missouri Basin. Section 7.5, (Recommendation number 6) also suggests that additional analysis be done to look closer at land use and management changes to the hydrologic response of the watershed.

Submitted By: Ann Banitt (6512905541) Submitted On: Jun 02 2023

Current Comment Status: **Comment Closed**

10085269   Hydrology   Main Report, Section 2.3 Climate Assessment.(Paragraph 2) n/a   n/a
                 Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The statement made says that "Climate models showed big differences between natural flows and peak flows during extreme years".

Basis: ECB 2018-14

Significance: Medium

Action Needed to Resolve: The "climate model" is not descriptive of what model was run. Are the climate model outputs part of the CPR Tools and associated outputs? Is it a different climate model? What was the spatial domain? What number of projections were simulated, what RCPs? what epochs the statements refer to? Etc. Additional caveats should be added to qualify the type of Climate Model, simulation parameter sets and the outputs from the Climate models. Climate model outputs are likely unregulated time series and have been "mildly calibrated" in certain regions of the country to gages for the historic(observed) period. The time step of simulation may also affect the peak flows, as daily averaged precipitation forcing would likely affect the outcome of runoff especially in steeper terrain. The goal of the CPR Tools is to assess for trends (relative differences/trends) through the observed period, and how that may be different in the future. There is a lot of uncertainty in projected climate.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Section 2.6 now has a ppg at the end summarizing the uncertainties associated with the projections and directs to the Appendix for details on the models used.

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1 Backcheck Recommendation **Open Comment**

Section 2.6 discusses some uncertainties with historic peak estimates and development in the basin, but does not comment on the uncertainties of the climate projections as the response suggests.

Submitted By: Ann Banitt (6512905541) Submitted On: May 03 2023

2-0 Evaluation Concurred

I had added Bulletin 17C analysis at three representative gages to Section 3 (for Omaha early spring period which drives the extreme frequencies, and Kansas City and Hermann) using the 1941 change point from the analysis to shorten the systematic records, and a second shorter period of 1967. The overall impacts on flow frequency of trying to shorten the period for this 1941 change point are inconsistent along the river,

-9% at Hermann, little change at KC, to +6% at Omaha for 1% AEP compared to the adopted systematic period. Removing the 1930's drought did not appear warranted. As such, we treated uncertainty from climate change as being within the bounds of hydrologic uncertainty for the existing conditions. Also added a little text on the background for the in-depth climate assessment scope for future conditions. See the updates at the end of Section 2.6 for the added information to cross reference this sensitivity analysis conducted for the change point.

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

2-1 Backcheck Recommendation **Close Comment**

Some sensitivity analyses were run for 3 gages in the early spring period that drives the extreme frequencies.

Ultimately the uncertainty from climate change were determined to be within the bound of hydrologic uncertainty for existing conditions.

Submitted By: Ann Banitt (6512905541) Submitted On: Jun 02 2023 Current Comment Status: **Comment Closed**

| 10085274 | Hydrology | Main Report, Section 2.3 Climate Assessment. | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: It Is unclear of the statements in the final paragraph relate to the current conditions and recent trends, or projected future simulations from the climate model. Basis: ECB 2018-14

Significance: High.

Action Needed to Resolve: Be specific about what "analysis" is being discussed. What was the model? What was period of simulation? How many projections were being simulated? What time window or epoch are you comparing? What are the parameters that are relevant to the study purpose and how are they affected by climate change? (Precip, Air Temp, Evapotranspiration, Discharges) etc.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

The numbered list in section 2.6 addresses the period of assessment and which parameters were affected.

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1 Backcheck Recommendation **Close Comment**

Section 2.6 descriptions have been enhanced to provide specifics on what parameters were reviewed, the importance to the study and more specifics about that analysis that was performed.

Submitted By: Ann Banitt (6512905541) Submitted On: May 04 2023

Current Comment Status: **Comment Closed**

| 10085277 | Hydrology | Main Report, Section 2.3 Climate Assessment. | n/a | n/a |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: What are the results from the Vulnerability Assessment?

Basis: ECB 2018-14

Significance: High.

Action Needed to Resolve: Is this basin vulnerable for the Flood Risk Business Line? What are the sensitive factors?

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Item #6 in Section 2.6 identifies the risk to the FRM business line and which factors.

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Close Comment**

The summary of the Vulnerability Assessment in Section 2.6 has been enhanced specifically to call out dominant indicators for flood risk reduction.

Submitted By: Ann Banitt (6512905541) Submitted On: May 04 2023

Current Comment Status: **Comment Closed**

| 10085278 | Hydrology | Main Report, Section 2.3 Climate Assessment. | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: What are the conclusions from the Climate Assessment? Basis: ECB 2018-14

Significance: High.

Action Needed to Resolve: Is there an indication that climate change is already driving changed discharges or seasonality in the watershed? Is there a thought that the regulation would need to change for drier months? Impacts from Temperatures, drought, water use by plants/humans/animals during drought conditions? Seasonality Shift (less snowpack?) or earlier ice out. Less ice cover?

Other impacts from Climate?

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Discussion in section 2.6 identifies what changes are seen seasonally from the analysis. No change to system regulation are currently begin considered. However, the results of the in-progress future flows study may cause that to be a consideration in the near future.

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Close Comment**

The climate assessment now summarizes the seasonal changes in the watershed. Discussion on the watershed vulnerability may help drive project adaptation in the future.

Submitted By: Ann Banitt (6512905541) Submitted On: May 04 2023

Current Comment Status: **Comment Closed**

| 10085280 | Hydrology | Main Report, Section 2.5 Water Resources Development | n/a | n/a |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The section does not address how has watershed management changed in the watershed an how has that impacted runoff.

Basis: Report Clarity and thoroughness Significance: Medium.

Action Needed to Resolve: Explain how watershed management has impacted runoff. Ie Conversion from Prairie and forest to cultivated cropland also has an impact on runoff. Drain Tiling also has an impact on lower flows (extending the back end of the hydrograph) and Ditching changes the routing efficiency of the watershed. Is this change evident in the stationarity explored In the climate assessment?

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

Evaluation **Concurred**

Section 2.6, right after the numbered list discusses the uncertainties in the source data.

Every effort was made in the B17c process to remove depletions/holdouts to get a 'non-developed' flow data set, eliminating the impacts of the watershed changes. Section 2.7 and following have been added to address basin development

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 06 2023

1-0 Backcheck Recommendation **Close Comment**

A section on basin development has been added, and provides a much more robust description on the changes that the watershed has experienced.

Submitted By: Ann Banitt (6512905541) Submitted On: May 04 2023

Current Comment Status: **Comment Closed**

| 10085284 | Hydrology | Main Report, Section 3 Unregulated Flow Frequency | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Organization of the discussion between District efforts. Basis: Report Clarity

Significance: Low

Action Needed to Resolve: Organization of frequency analysis is upstream to downstream for Omaha, but downstream to upstream for Kansas City. Consider reorganizing material so it moves sequentially either downstream to upstream or in reverse.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Moved Omaha district section after Kansas City section and reverse order of gages.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Update: switched this back to the order as suggested in your comment, report is organized upstream to downstream. Several sections were added for other comments throughout Section 3. Flood history information generally flows best downstream to upstream (as development moved from east to west), as such I referred the reader forward in the report often to mitigate that impact.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

2-1 Backcheck Recommendation **Close Comment**

The report sections have been re-worked to get an organized summary in hydrologic order. Additional figures were added and organized appropriately.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status**: Comment Closed**

10085285 Hydrology Main Report, Figure 3-1   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Figure 3-1 shows control points, but does not include a few rivers (James? Papio?) or reservoirs/dams that are associated with the analysis.

Basis: Report Clarity Significance: Low

Action Needed to Resolve: Suggest modifying Fig 3-1 or add a figure that shows the reservoirs in the watershed. (Suggest an Ohio Watershed Figure example attached: Uses bar graphs overlayed with their watershed figure to show the magnitude of storage and location in reservoirs through the system.)

(Attachment: AMBExample_WatershedWideStorage.jpg)

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023 Revised Jan 26 2023.

1-0   Evaluation **Concurred**

Figure 3-1 has been updated (same as Figure 1-1, also updated, may eventually remove the duplicate in Section 3). The map was expanded slightly, and labels improved where they do not block tributary names (where you can see more of the James, which is significant). Major and moderate sized tributaries are labeled. Papio refers to four small dams on little creeks near Omaha totaling 53 sq miles as denoted in the footnote for Table 3-1, as such it is not labeled here. For Figure 3-1, we wanted the focus to be on the study gages (note not all are control points, I renamed to gages), so we have left that is without expanding to the dams.

To more completely address the comment we expanded section 2.2, text was added, several figures showing drainage areas, dam locations and sizes, a summary of operations, etc.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Close Comment**

Figure 3-1 now includes labels that are clearly marked for the rivers. The description and mapping for reservoir locations and storage have been expanded as well.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085287   Hydrology   Main Report, Table 3-1   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Several aspects of this table are unclear or confusing.

1. Drainage Area reporting is confusing. Are there supposed to be notes associated with the a, b, c, d, e, f, superscripts? Are notes missing? It is unclear what is meant by "Dams Above" or "Dams Below"? What does area below dam mean, if the location is a town (not a dam).

2. Clarify that the last two columns report Pertinent "Discharges" with a unit cfs. Basis: Report Clarity

Significance: Medium Action Needed to Resolve:

1. Reporting Drainage Area (square miles)

For each Location, perhaps it would be clearer to report Regulated or Unregulated drainage area at each Gage Location?

2. Reporting Discharges (cfs)

Perhaps the Maximum USGS discharges attribution should be handled in footnotes to the table. referencing the historic floods with the reference for the discharges.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

The table headings were altered during formatting and have been edited to resolve. The "total drainage area" column is still as it was. The other two columns were labeled on the top line as "drainage area", and bottom line as "regulated" on the left side and "unregulated" on the right side. These two columns add up to the total drainage area and are cumulative instead of incremental. For example at Gavins Point Dam (sometimes also referred to at the Yankton, SD gage), there is an unregulated drainage area of 0 sq miles (area below the dams) and the regulated drainage area equals total area. At Hermann, the regulated drainage area is the sum of drainage areas upstream of all dams included in the footnote (including the mainstem dams), whereas the unregulated area is the total area minus the regulated.

Regarding superscripts: the letters indicate which dams were added to the cumulative total "regulated" drainage area. The numbers indicate which year between 1993, 2011, and 2019 produced the highest USGS flows at each gage. Notes were added to further clarify.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 15 2023

1-1   Backcheck Recommendation **Close Comment**

The headings in the table have been clarified and additional notes have been added below the table for clarification of watershed drainage and reservoir facilities.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085288 Hydrology Section 3.1 following Table 3-1.   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Tributary reservoirs and drainage are discussed briefly, but it is not clear if the tributary flows are converted to an unregulated series too.

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: It would be helpful to have a figure and/or a topology diagram (example attached) on how tributaries fit together with the river network.

(Attachment: 0_Example_Minnesota_River_Topology_Diagram.pdf)

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Figure 5-1 shows the ResSim schematic and the modeled tributaries. Most of the

tributaries in the Missouri River Basin are not modeled individually. The flows of all tributaries between computation points in the ResSim model are lumped into a total incremental reach inflow, so those tributaries would not have unregulated flow estimates at a tributary gage. Since the Kansas and Osage River Basins have modeled reservoirs, all computation points on those 2 tributaries would have unregulated flow estimates.

Submitted By: Ryan Larsen (402-996-3861) Submitted On: Mar 16 2023

Backcheck not conducted

2-0   Evaluation **Concurred**

See also the expanded Section 2.2, and the new Section 3.2 regarding time series flow development.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

2-1   Backcheck Recommendation **Close Comment**

The discussion has been expanded on what was "unregulated" flow vs what locations simply input historic time series or are computed local flows. (sections 2.2 and 3.2)

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

| 10085290 | Hydrology | Section 3.2 Seasonality | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: It would be illustrative to show the delineation of calendar year and annual flow variation. Basis: Report Clarity

Significance: Low

Action Needed to Resolve: SSP has some new plotting functions to illustrate seasonality. It would be interesting to see the differences for gages that are processed as a mixed population versus the gages that were analyzed with all-season series.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

This would be nice but currently it is lower priority.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 10 2023

Backcheck not conducted

1-0   Evaluation **Concurred**

See added plots to new Section 3.2 (timeseries) showing the upper and lower decile flow ranges (middle 80% of flows) for each day of the year at four representative gages, unreg and regulated series. And maximum / minimum dailies at St. Joseph and Kansas City. I also added some commentary on these plots in Section 3.3.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Close Comment**

The team has prepare some plots that help depict variability across the watershed at

key gage. The impact of seasonality and mixed population analysis woven into the discussion in Section 3.3.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085293 Hydrology Table 3-2 Conversion Percentage   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The write up at the end of Section 3.2 indicates that the seasonal curves and seasonal adjustments would be made at Rulo and St Joseph as well.

Basis: Report Consistency Significance: Low

Action Needed to Resolve: Verify the consistence on which gages include the seasonal analysis and what is represented in Table 3.2.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

We entered the same value in both columns for consistency as suggested. This was explained in the text and will be more clear to the reader now with the table edited as suggested. Note this is now in Section 3.4 in the updated report.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

1-1 Backcheck Recommendation **Close Comment**

The seasonal adjustment for Rulo and St Joseph were defined in Table 3.2 and a sentence for clarity was added in section 3.4

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085295 Hydrology Section 3.4   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Section 3.4 needs additional discussion on the 2 daily datasets for frequency analysis: Unregulated and Regulated dataset. Also include specifics on what reservoirs are included in the "adjusted dataset" when the homogeneous dataset was created.

Basis: Report Clarity

Significance: Low

Action Needed to Resolve: Confirm that the regulated data set for observed and for today's rules and regulation and withdrawals. It may be helpful to include a timeline that shows the sequence of regulated structures that came online, the help realize what projects are reverse-routed to derive the unregulated series.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

We have done a lot of reorganizing of Section 3 entirely so the numbers are off now. But we added Section 3.2 to explain the time series development. UNREG is no

development (depletions), no dams. REG is development and dams with current rules.

We struggled a little bit about how much of the 100+ page report from the 2018 EIS to reproduce. Ultimately tried to give a short summary and explain the things we did after that report, and provided a link to the document which is on the USACE MRRP website (on Omaha's public site).

Submitted By: Chance Bitner (816-389-3482) Submitted On: Mar 21 2023

1-1 Backcheck Recommendation **Close Comment**

The documentation of the data sets and the application has been reworked and additional description has been added to clarify the work flow and considerations of the technical analysis.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

Current Comment Status: **Comment Closed**

10085297	Hydrology	Section 3.4 2nd paragraph	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The Kansas City District Flow Frequency Analysis was mentioned but needs a reference to locate the material.

Basis: Report Organization and Clarity Significance: Low

Action Needed to Resolve: Add a reference and location (ie Section X.X or Appendix X)

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Struck: "Kansas City District Flow Frequency Analysis Section" and replaced with "Section 3.8" (based on the revised section numbering). All content relevant to all 10 gages was moved up to Section 3.5.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

1-1 Backcheck Recommendation **Close Comment**

The report text in Section 3.8 has been clarified.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: Comment Closed

10085299	Hydrology	Section 3.4 3rd paragraph	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Regional Skew values were mentioned in this paragraph. The Missouri River Basin is very large, and two skew values were adopted for the early and late seasons.

Basis: Flow Frequency Analysis Methods Significance: Medium

Action Needed to Resolve: Do you have any generalizations on skew behavior for different geographic regions/terrain etc? The following notes are taken from HEC Training (Faber) 2019 Do any of these characteristics jive with the watersheds you are analyzing?

Large positive skew – Steep Slopes

Low basin infiltration Fast Conveyance

Point downstream of 2 or more tribs with similar timing. Fan-shaped basins One or more rare events in short record

Mixed Populations

Large Negative Skews Low Ave basin slopes

Large areas controlled by lakes/swamps High Channel Losses

High infiltration rates

One or more very low events.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Non-concurred**

There was no watershed analysis in this skew smoothing. We shouldn't have used the word "regional". All we did was smooth skew along the streamline.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0   Evaluation **Concurred**

We have adjusted the report to clarify that we are smoothing the statistics to make sense up and down river for the hydrology **between** major tributaries (which are defined in the report). Other than mixed populations upstream of KC, which are hopefully clear in the report, we do not have any of the items you list here. We also discuss limited guidance for mixed populations in applying regional adjustments.

In addition to trying to clarify, I've added this text below to address some of these points you raise here (and the section it references to the report):

"Smoothing was done to help ensure gages with similar hydrology are producing reasonably consistent results. As all gages except Yankton, which is just downstream of Gavins Point Dam, are located along the federal navigation channel, velocities tend to be uniform throughout the reach. Although local variations are present, average slopes tend to also be uniform, decreasing only slightly from just over a foot per mile to approximately 0.8 feet per mile at the mouth. Additional discussion on smoothing compared to the 2003 UMRSFFS is included in Section 3.5.1."

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 04 2023

2-1   Backcheck Recommendation **Close Comment**

The skew was smoothed, but no regional analysis was completed. The text has been updated and clarified.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: Comment Closed

10085301 Hydrology Section 3.4 3rd paragraph   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The Sentence, "Generally a downward trend in skew was found when plotted

against river mile as distance from the mainstem dams increased" should be reviewed. Perhaps the logic is reversed.

Basis: Report clarity and correctness Significance: Medium

Action Needed to Resolve: Provide some thought to the correctness of the sentence above with regard to the notes below:

Trend in skew went down as the river mile went down. That would be consistent with the concept from the HEC Course ... Larger pos skew in steep slopes. Negative skews where basin slopes are lower. Perhaps you could review what the terrain is doing between RUNE and WVMO? Are there backwater impacts that affect the stage at any location? (ie where stages are used w/ rating curves to determine discharges, there may be an impact to the flow records).

For unregulated condition, the locations of the dam shouldn't matter. Is it more tied to the slope of the basin slopes nearing the Mississippi River Valley?

Perhaps is Herman near the river Valley edge where there is more slope/ relief? Or perhaps is getting some backwater impact from the Mississippi River?

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Non-concurred**

"Generally a downward trend in skew was found when plotted against river mile as distance from the mainstem dams increased." is equivalent to the following.

"Trend in skew went down as the river mile went down. That would be consistent with the concept from the HEC Course ... Larger pos skew in steep slopes. Negative skews where basin slopes are lower."

I don't see the inconsistency, but I could be missing something. Submitted By: [Ilya Poluektov](#) (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0   Evaluation Check and Resolve

The slope of the Missouri River is pretty consistent, usually around a foot per mile or just under below the dam. Flattens to roughly 0.8 feet per mile in the lower river. I do not believe this is a major factor in the trend as much as where the water is coming from and how that changes across 520,000+ sq miles. The basin produces a lot more flow per square mile from tribs in Iowa, Missouri, eastern Nebraska and eastern Kansas, eastern SD than it does further west (aside from mountain runoff) for two reasons: more rainfall, and lower infiltration rates.

We have a good description of this in Section 2.1, which we also enhanced. And as per a related comment, I've added some information on slopes to Section 3.5 also (noting the sections have been renumbered).

I tried to rephrase: "Generally, as distance downstream from the dams increased, and as drainage area increased, skew tended to decrease. This was more pronounced when plotting the early spring season." [noting we added a plot vs drainage area].

See also the Hermann Section (3.8.6 in the updated report). I added some discussion of the St. Charles, MO gage, which can be impacted by Mississippi River backwater at times, but it wasn't obvious on the rating curve for Missouri River floods. Hermann is nearly 100 miles upstream and with the slope of 0.8 ft/mile (nearly double the MS below the confluence, the backwater does not make it to Hermann).

Generally the River is leveed from Omaha to the mouth. Portions of the river valley downstream of Kansas City are overall pretty narrow compared to the reach upstream of St. Joseph, aside from at Waverly. This is also now in the report.

FYI, in the 2003 study, we actually had the opposite of what you are saying, negative skews upstream and positive downstream. I added this to the new section 3.5.1. I didn't check until after we were done, but the skew used at Hermann of 0.04 matched the station skew from the 2003 study.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1   Backcheck Recommendation **Close Comment**

The team has fully assessed the impacts of skews, and the smoothing necessary to produce frequency profiles that do not cross.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085304 Hydrology Figure 3-2.   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The figure is interesting, but the station abbreviations are not universal. Basis: Report Clarity

Significance: Medium

Action Needed to Resolve: Provide a list of station names and the abbreviations in a legend or General Note for these figures.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Thank you, an explanation of station names was included for these figures and elsewhere in the report where they were not defined.

Submitted By: Kellie Bergman (402-995-2308) Submitted On: Mar 15 2023

Backcheck not conducted

2-0   Evaluation **Concurred**

I updated the plots to just use the names instead.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 05 2023

2-1   Backcheck Recommendation **Close Comment**

Figures 3-4 through 3-8 eliminate the gage station abbreviations and include full gage names instead.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085305   Hydrology   Figure 3-3.   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The Figure title and plot titles and axis labels need to be adjusted. Basis:

Report Clarity

Significance: Medium

Action Needed to Resolve: Several changes are recommended:

- The title on the Early Spring says "annual" MKC to HEMO ... yet the graph is for the Early Spring? Clarify the titles in both plots.

- The Y-axis on both early and late spring plots say "Mean". (Mean flow?) cfs? Kcfs? Add a unit on the Y axis

- The X axis is river mile. Specify the zero point in the Figure footnote. Ie River mile 0.00 Is at the confluence with the Mississippi River (?)

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Instead of updating the plots I added explanatory text in the paragraph above to say that it was logs and "The statistics were separated into the early and late spring season from Gavins Point to St. Joseph, but are annual from Kansas City to Hermann. " Also added text into the paragraph above to keep the caption from being too long that river mile zero is the confluence.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 15 2023

Backcheck not conducted

2-0   Evaluation **Concurred**

I went ahead and updated the plots, please check.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 04 2023

2-1   Backcheck Recommendation **Close Comment**

Chronology plots now include brackets and notation for the "season" that the data represents.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: Comment Closed

10085306	Hydrology	Section 3.5 Omaha Flow Frequency Analysis	n/a	n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Were any change points identified in the climate assessments? If so, were they cross walked with the results in the frequency analysis?

Basis: ECB 2018-14

Significance: Medium

Action Needed to Resolve: Ensure the team doing the frequency analysis was aware of the finding from the Qualitative Climate Assessment and apply any adjustments for observed change points etc.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

Change points are now discussed in Section 2.6 #4. Detail review is included in the full report in Appendix J.

Submitted By: Paul Boyd (402-995-2350) Submitted On: Apr 05 2023

1-1   Backcheck Recommendation **Open Comment**

Appendix J title should be corrected to "ECB 2018-14" Climate Assessment. (The ECB is incorrectly labeled.)

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

1-2   Backcheck Recommendation **Close Comment**

The reference(Spelling) to the ECB 2018-14 has been fixed.

Submitted By: Ann Banitt (6512905541) Submitted On: Jun 02 2023

2-0   Evaluation Concurred

Thank you, I have this fixed on the page that denotes where the appendix goes and table of contents. I think the document itself for the appendix was ok, but I did tweak the title page a bit also.

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

Backcheck not conducted

Current Comment Status: Comment Closed

10085309	Hydrology	Section 3.5 Historic Flows	n/a	n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: For the unregulated frequency analysis, were any adjustments needed for the historic flows?

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: It appears that the historic flows were from the very early period. However, it should be noted if any reservoirs were online, and if any adjustments to the flows were made to establish the unregulated condition. Describe why the historic flows were not defined with an uncertainty interval, rather than lumping with the perception threshold as shown in figures 3-6, 3-8,3-11, 3-13 etc.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation Non-concurred

We didn't have a good basis to assign flow ranges to the historical floods. We could have perhaps gone with 20% arbitrarily but it was doubtful it would have improved the analysis. Small reservoirs were coming online in various parts of the basin but it was judged that their contribution was minimal. Perception thresholds were used for the majority of floods to simplify the EMA data and because a perception threshold would keep us from pretending to know more than we actually know with the lower historical floods.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 15 2023

1-1   Backcheck Recommendation **Close Comment**

The team reviewed the available information for the gages and made a decision to use a lumped perception threshold to simplify the EMA data, as there was much uncertainty with the lower historical floods.

Submitted By: <u>Ann Banitt</u> (6512905541) Submitted On: May 18 2023

2-0 Evaluation Concurred

NOTE we reorganized and have a new Section 3.6 that addresses historical peaks and I expanded on some of the things in your comment and Ilya's response there. See also new Section 2.7, including a section where I discuss differences in routings and implications for events that pre-date land being converted into crop production. I put emphasis on the Kansas River basin, which dominated the 1844 flood, due to the importance of 1844 in the gages from KC to the mouth. I did not find a justification to adjust values beyond uncertainty with the rating curves.

When I used uncertainty bands it was largely based on how wide the estimates for 1844 at Hermann were as discussed for that gage in Section 3. I added notes about sensitivity to using the values as ranges (which I mostly did as informed by the ranges of estimates for 1844 at Hermann and UMRSFFS data). E.g. see St. Joseph, where I added detail and chronology about using points vs ranges. Several other gages where I varied estimates. Also considered a separate earlier analysis in tables for KC, Boonville, and Hermann, which was input differently. What I found: so long as in the ballpark, the results are not very sensitive to the method of inputting historic peaks.

We expanded Section 2.2 of the report and I added statements to the end of Section 3.6 (very end) to summarize that the historic peaks do not need adjusted.

Submitted By: <u>Chance Bitner</u> (816-389-3482) Submitted On: Apr 07 2023

Backcheck not conducted

Current Comment Status: Comment Closed

10085310	Hydrology	Section 3.5 Flow Frequency Analysis Results	n/a	n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The last sentence of the first paragraph point to Tables 5-6 to summarize the unregulated flow frequencies. Table 5-6 doesn't exist.

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: Recommend including summary tables for unregulated 1) Expected and

2) Computed flow frequencies within Section3.5. Kansas City has their unregulated frequency estimates summarized in Section 3.6.

Submitted By: <u>Ann Banitt</u> (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

I can't find the reference to Table 5-6. Unregulated flow frequencies are listed together in one table for both districts at the end of the unregulated flow frequency section.

Submitted By: <u>Ilya Poluektov</u> (4029952356) Submitted On: Mar 15 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Note I found a few references like these and cleaned them up during my edits. Report renumbering of tables and figures will also be done in final editing stages as we added a lot of content following the ATR and TRG comments.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1 Backcheck Recommendation **Close Comment**

Editing/Cleaning has been done - and will continue through report completion.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

| 10085311 | Hydrology n/a n/a | Section 3.5.1 Figures 3-6 through 3-25 Omaha Flow Frequency Analysis |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The figures do not indicate if they are generated for regulated or unregulated data. Basis: Report Clarity

Significance: Medium

Action Needed to Resolve: Title of all Plots and frequency curves should indicate regulated or unregulated flow

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

We will update the plots with help from RTI with formatting.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 17 2023

1-1 Backcheck Recommendation **Open Comment**

Future check will be needed to close

Submitted By: Ann Banitt (6512905541) Submitted On: May 19 2023

2-0 Evaluation Concurred

Yes thank you, caught several where this wasn't included (especially those in sections that have been significantly updated since the last version). Please see track changes.

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

2-1 Backcheck Recommendation **Close Comment**

The team has scrubbed through the figures and titles to make sure that they were notated correctly to avoid confusion in future interpretation.

Submitted By: Ann Banitt (6512905541) Submitted On: Jun 02 2023

Current Comment Status: **Comment Closed**

| 10085314 | Hydrology | Section 3.5.1 | | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Include a description of the difference of computed and expected probability.

Explain that the expected frequency adjustment is made on the computed mixed population curve. Be careful of the work "Computed in the Figure legends"

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: The Legend Title in Figure 3-9 and similar flow frequency plots in Section 3.5.1 say "Computed and a date"... but that may be confusing. Not sure if that could be change to Analysis Date?

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

I added a sentence about computed and expected probability in the report text.

Submitted By: [Ilya Poluektov](#) (4029952356) Submitted On: Mar 17 2023

1-1   Backcheck Recommendation **Close Comment**

Expected Probability is included in the Glossary of Terms. The Introduction in Section

3.1 also describes what is presented in the report vs what would be needed if a full risk analysis was done with HEC-FDA. Computed flow frequency curves will be provided in a stand-alone document.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

10085315	Hydrology	Section 3.5.1	n/a	n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Include a description of the difference of computed and expected probability.

Explain that the expected frequency adjustment is made on the computed mixed population curve. Be careful of the work "Computed in the Figure legends"

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: The Legend Title in Figure 3-9 and similar flow frequency plots in Section 3.5.1 say "Computed and a date"... but that may be confusing. Not sure if that could be change to Analysis Date?

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

This comment is a duplicate of 10085316 and will be addressed in comment 10085316.

Submitted By: [Kellie Bergman](#) (402-995-2308) Submitted On: Mar 15 2023

1-1   Backcheck Recommendation **Close Comment**

Duplicate Comment.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 17 2023

Current Comment Status: **Comment Closed**

| 10085316 | Hydrology | Section 3.5.1 | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Include a description of the difference of computed and expected probability.

Explain that the expected frequency adjustment is made on the computed mixed population curve. Be careful of the work "Computed in the Figure legends"

Basis: Report Clarity Significance: Medium

Action Needed to Resolve: The Legend Title in Figure 3-9 and similar flow frequency plots in Section 3.5.1 say "Computed and a date"... but that may be confusing. Not sure if that could be change to Analysis Date?

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added this sentence "The expected probability adjustment fits the flow frequency curve through the mean of each quantile rather than the median. "

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 10 2023

1-1 Backcheck Recommendation **Close Comment**

A description explaining the difference in expected and computed frequency has been added to the text.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

1-2 Backcheck Recommendation **Close Comment**

A description explaining the difference in expected and computed frequency has been added to the text.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: Comment Closed

| 10085317 | Hydrology | Section 3.6 | n/a | n/a |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Section title does not indicate that the Flow Frequency is for unregulated. Basis: Report Clarity

Significance: Medium

Action Needed to Resolve: Modify Title of Section 3.6 to indicate the frequency curve preparation is for unregulated flows

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added "unregulated"

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 10 2023

1-1 Backcheck Recommendation **Close Comment**

The titles for the unregulated frequency analysis have been edited.

Submitted By: Ann Banitt (6512905541) Submitted On: May 17 2023

Current Comment Status: Comment Closed

| 10085322 | Hydrology | Report Section: Sections 3.5 | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Chronology plot of the systematic record, historic observations and assumed flow ranges (ie EMA Plots)...incorporation of historic data could be processed in different ways. Were sensitivities to setting perception thresholds, or flow intervals compared for the historic events?

Basis: Reasonableness of Frequency Curve Estimate Significance: Medium

Action Needed to Resolve: Provide documentation on how the historic event data was incorporated into EMA within SSP. What is the sensitivity to placing an interval threshold on the historic observations rather than lumping the full period (prior to systematic events) into a singular perception threshold? It is best practice not to overlap the interval data.

(Attachment: AMBExample_Freq_HistoricData-IntervalandThresholds.JPG) Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

Plots are shown that demonstrate how historical events were entered into EMA. Flow frequency curves are not sensitive to flow ranges.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Yes I did a fair amount of this, please see the narratives for Hermann, Boonville, KC, and St. Joseph. Our first cut for the Kansas City gages was very similar to the Omaha approach where we input point values straight from old reports. Based on feedback from our technical review group, I decided to switch to showing ranges where I felt that could be supported, and also did a fair amount to verify values and incorporate uncertainty with estimates and revised accordingly. For the four gages referenced, I found little difference in results for this added work (see the sensitivity analysis tables, clarified what the series were in the table footnotes 1 and 2). Further I did sensitivity to perception thresholds for the longer periods as shown in the tables and discussed especially for Hermann and Boonville (found similar things also in the past when doing this for KC for the KC levees project). I added a description of this to the summary in section 3.6.

FYI, we also initially showed 1yr gaps around the historical peak values if that is what you mean by no overlap. We were informed by HEC that we are not supposed to do it that way, so while the intervals do touch, they do not overlap.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Mar 21 2023

2-1 Backcheck Recommendation **Close Comment**

The team coordinated the historic period representation in the SSP frequency analysis to ensure they characterized the uncertainty reasonably.

Submitted By: Ann Banitt (6512905541) Submitted On: May 19 2023

Current Comment Status: Comment Closed

| 10085324 | Hydrology | Kansas City District Unregulated Flow Frequency Analysis Results Summary Table 3-10 | n/a | n/a |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Expected Values for AEP are provided in the table. Perhaps the computed flow should be shown as well in a second table. Future studies in the watershed may specifically incorporate/model uncertainty in their models, and then would need the computed values.

Basis: Best Practice Frequency Studies. Significance: Medium

Action Needed to Resolve: Update Table 3-10 title to include the "Expected" Flow Frequencies. Add another table for computed flow frequencies.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

We agree and have this on our to-do list, as we do also need flows from the study for input into HEC-FDA for feasibility studies. I have added the computed unreg flows at the end of Section 3. Ultimately, we may move these to Appendix A to help reduce confusion. For the regulated, our plan is to just do that with the WAT, which will require re-adjusting the weights. That part is in progress (will update the response and or confirm this is added before asking the reviewer to close this comment).

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

1-1 Backcheck Recommendation **Open Comment**

The Tables clearly show that Expected Flow Frequencies are shown. Computed flows are included in Table 4-8.

Consider adding a note to each table indicating where the computed frequencies are published within the report. Perhaps the note should highlight the definition for computed and expected probabilities.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

2-0 Evaluation **Concurred**

A footnote referencing the reader from one table to the next was added as suggested.

For the second part of this, I found it easier to do this in the text in Section 3.9 introducing these tables. As such I moved the text introducing the computed probability figure up and then added a quote from the SSP manual which explains the difference between expected and computed after that and before the tables.

Note, I also carried this comment to Tables 6-10 and 6-11 for the regulated frequencies and referred the reader back to Section 3.9 if additional details are desired.

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

2-1 Backcheck Recommendation **Close Comment**

The team has taken every effort to add a definition from SSP on the difference in expected and computed probabilities, and make it clear in the report and tables where to find these 2 sets of data for future reference.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: Jun 02 2023

Current Comment Status: **Comment Closed**

10085326	Hydrology n/a	Section 3-6 All historic data (Chronology plots) in this section	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Systematic and Historic data plots are called "Chronology Plots" in the Omaha District Figures. Coordinate titles.

Basis: Best Practice Frequency Studies. Significance: Medium

Action Needed to Resolve: Update titles in the Kansas City Figures to include "Chronology Plot for Bulleting 17D EMA Input". Include a SSP screen shot that shows how the EMA data is input to the SSP model for each site that Kansas City District analyzed.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

I have changed the titles to say: "Chronology Plot for Bulletin 17C EMA Input" throughout.

I also added another chronology plot for St. Joseph to show a variation of results with historic peaks as points versus ranges. If there are specific ones missing please advise upon backcheck as I couldn't find any that were critical. Note that I didn't include each one from the sensitivity analysis but wanted to show the final adopted (and denoted that in the title if showing more than one at a gage) and a couple of the key ones with older data. Descriptions were added to table footnotes to explain the column headings also for the sensitivity analysis results, hopefully that also helps.

Submitted By: [Chance Bitner](#) (816-389-3482) Submitted On: Apr 07 2023

1-1 Backcheck Recommendation **Close Comment**

Notation has been modified to make the figures from the two Districts consistent.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: **Comment Closed**

10085328	Hydrology	Report Section: Section 3-6 Flow Frequency Plots for Hermann, Boonville, Waverly, Kansas City St Joseph and Rulo	n/a	n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Although it is helpful to have the summary table of numeric AEP Flow values, it is also good to include a plot that shows the behavior and fit of the flow frequency curves.

Basis: Best Practice Frequency Studies. Significance: Medium

Action Needed to Resolve: Include flow frequency Plots for the sites analyzed within Kansas City District Analysis.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added plots from SSP towards the end of each gage write up (we had them later in Chapter 5 etc but I agree, its better to include here and SSP gives a little different look).

Submitted By: Chance Bitner (816-389-3482) Submitted On: Mar 21 2023

1-1 Backcheck Recommendation **Close Comment**

Frequency Curve plots have been added for the Kansas City District gages.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085329   Hydrology   Report Section: Section 3-6 Tables of AEP   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The title does not specify if the Expected Probability Flows are unregulated or regulated. Basis: Best Practice Frequency Studies.

Significance: Medium

Action Needed to Resolve: Modify the title of all Tables in this Section to clarify what frequency estimates are reported.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Added "expected probability" to Table 3-16

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 10 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Note numbering has changed due to several additions and reorganization. We tried to catch this throughout.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1 Backcheck Recommendation **Open Comment**

All Tables of Flow Frequencies should indicate that they are unregulated flows.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

1-0 Evaluation **Concurred**

I have looked through, found two tables (Boonville and Hermann sensitivity, Section 3.8), and three tables in Section 4.7 where this was added for clarity. All others appeared to be labeled accordingly.

Submitted By: Chance Bitner (816-389-3482) Submitted On: May 31 2023

1-1 Backcheck Recommendation **Close Comment**

The team has scrubbed through the Tables to ensure the labels are correct and clear.

Submitted By: Ann Banitt (6512905541) Submitted On: Jun 02 2023

Current Comment Status: **Comment Closed**

| 10085330 | Hydrology | Section 3.8 Limitations of ResSim. | n/a | n/a |

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The first sentence states that the ResSim model relies on coefficient routing. The second sentence indicates that ungagged flow data is not accounted for. A thorough analysis would lump the local flow with the downstream reach or apply a correction hydrograph to account for these contributions. Understood that this section is trying to point out the complexities that the

HEC-RAS model is targeted to overcome for the study. Basis: Report Clarity

Significance: Medium

Action Needed to Resolve: There is more than 1 routing method in ResSim. Coefficient routing Is a general name, that doesn't really help define what was done in the ResSim model. Some districts call this hydrologic routing. Hydrologic routing is informed or calibrated with a hydraulic model. Hydrologic modeling can use the "ModPuls", where discharge storge curves approximate the Hydraulic modeling, but would not account for storage/looping effects that a hydraulic model can capture. Generally, a single ModPuls curve is assigned for a reach, although backwater conditions can necessitate a family of rating curves and some logic to pick which curve to assign for the given condition.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

I thought hydrologic routing was the general term and coefficient routing was the specific type used.

Additional text will be added on development of the flow time series in new Section 3.2.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 17 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Note I moved this to be part of the introduction to Section 4, as it generated comments also from the Technical Review Group and seemed out of place. This really was intended to get at the "why" behind RAS modeling to check the coefficient routing used. Please refer to the new updated text in Section 3.2 (as referenced by Ilya) combined now also with the updated Section 4.0 and let us know if this is still unclear. We did account for ungaged records, which should be clear in the report.

We also include the weblink to the report which documented the ResSim development (as mentioned in another comment).

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1 Backcheck Recommendation **Close Comment**

The introductory text from Section 4 was updated to include more detail about why the RAS model was needed for the routing and has info included about the local flows for ungaged records.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085331 Hydrology Table 3-16 Final Unregulated Flow Frequency Curves   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The title of the table does not specify if AEP estimates are "Expected" or "Computed" Basis: Best Practice Frequency Studies.

Significance: Medium

Action Needed to Resolve: It is recommended to include tables for both computed and expected so no matter the application the appropriate set of flows can be used.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

> 1-0   Evaluation **Concurred**
Added "Expected probability" to this table.

Submitted By: [Ilya Poluektov](#) (4029952356) Submitted On: Mar 10 2023

> 1-1   Backcheck Recommendation **Close Comment**
> Table 3-19 has the Expected AEP values and Table 3-21 has the Computed AEP.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085333   Hydrology   Section 4.2 Data Development   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: The term "depletions" is not defined well for the HEC_RAS model discussion in the first few paragraphs. .

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Add a description of what Deletions include. (ie water supply?, irrigation? Diversion? Other uses?) What is the source of the data that makes up the "depletions"? How accurate are the estimates for the depletions?

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

> **1-0**   Evaluation **Concurred**
> Depletions were estimated by the USBR. This text was added to Section 2.5 Water Resources Development: "Estimates of irrigation and other use depletions as well as
>
> U.S. Bureau of Reclamation (USBR) reservoir holdouts are produced by USBR's Regional Depletions Model and updated every 5 years."

Submitted By: [Christine Cieslik](#) (402-995-2304) Submitted On: Mar 22 2023

> **1-1**   Backcheck Recommendation **Close Comment**
> Depletions have been defined in the text and in the Glossary Table at the beginning of the report.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

| 10085335 | Hydrology | Section 4.2 Data Development | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Definition of the Unregulated simulation is vague. Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Add a description what time series were unregulated? Were the effects of the reservoirs In the tributaries backed out to an unregulated condition, or were only the main stem reservoirs de-regulated?

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

In addition to the mainstem, four of the tributaries: the Platte in MO, Kansas, Chariton, and Osage were also backed out to an unregulated condition. The boundary conditions/ time series that were used for the unregulated RAS are specifically called out in the Text of Section 4.2 and in Table 4-1. Additional explanation of the unregulated simulation has been added to Section 3.2 Time Series Flow Development.

Submitted By: [Christine Cieslik](#) (402-995-2304) Submitted On: Mar 22 2023

1-1 Backcheck Recommendation **Close Comment**

The text has been expanded to more clearly describe the specific time series that were "Unregulated".

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: **Comment Closed**

| 10085337 | Hydrology | Section 4.4, and Table 4-4 Notation | n/a | n/a |

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Evaluation of simulation results comments that the evaluation of results was limited to Annual peaks. Is that the annual average daily flow peak, or annual instantaneous flow peak?

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Clarify the flow estimates being compared in the Text and in the Table 4-4 Title and column headings. Also specify the simulation time step of the RAS model and the output time step.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

The HEC-RAS simulation results would be considered an instantaneous flow peak, not a daily average. The model computation timestep was 10-20 minutes, and the output timestep was 1 day. Because the Missouri, for most events, is slow rising and slow falling, this appears to capture the peak flow fairly well. The maximum value in each

year was identified from the 1 day output, and this was considered the HEC-RAS annual maximum. Modified the text in the intro paragraph of 4.4 Simulation Results,

4.4.1 Observed, Table 4-4, and Section 4.5.5 Daily Data to make this more clear.

Submitted By: Christine Cieslik (402-995-2304) Submitted On: Mar 22 2023

1-1 Backcheck Recommendation **Close Comment**

The text in Section 4.4 and 4.5 and the associated tables have been updated to indicated the flows are considered "Instantaneous".

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085338 Hydrology   Figure 4.4   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The graphic shows 2 plots for St Joseph, one for Nebraska City (none for Sioux City or Rulo). The content does not match the gage list in the Figure 4-4 title.

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Review the Figure 4-4 and ensure that the graphics match the gage list in the title.

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Good catch. These were incorrect. Figure has been fixed.

Submitted By: Christine Cieslik (402-995-2304) Submitted On: Mar 22 2023

1-1 Backcheck Recommendation **Close Comment**

The team has reviewed and ensured the figures are accurate in the report.

Submitted By: Ann Banitt (6512905541) Submitted On: May 18 2023

Current Comment Status: **Comment Closed**

10085339   Hydrology   Section 4.5.5 Daily Data   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Provide clarity by calling out instantaneous peak vs daily average peaks. Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Call out instantaneous peaks where it is appropriate

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

This has been edited to clarify that RAS was working w/ daily flows, referenced back to the table showing the peaking factors and results explained in light of that difference.

Submitted By: [Chance Bitner](#) (816-389-3482) Submitted On: Mar 21 2023

1-1 Backcheck Recommendation **Close Comment**

The caveats of average daily boundary conditions, and instantaneous midnight flow results were described in paragraph 4.5.5

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085340 Hydrology   Section 4.5.6 Computation Time.   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: where distributed compute strategies were used for Kansas City, and splitting the POR up, was there a warm-up period allotted for or a hot start?

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Provide some detail on how simultaneous runs and multiple computers were attempted for the RAS simulations. (ie Hot starts, warm up periods? Settings for boundary conditions?)

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Good comment. We primarily used this strategy for computing the ungaged inflows. We ran each decade separate with a starting day/time as the calendar year start/end (ie. Jan 1, 1930 - Dec 31 1939, Jan 1, 1940 - Dec 31, 1949). There are sometimes small discontinuities on the boundaries between the two datasets, but it is almost always during a time of winter low flows and therefore pretty insignificant. Our warmup was essentially the months of January and February, as there are no annual peaks that occur during these months (with the exception of 2017, which was not on a distributed compute boundary).

Submitted By: [Christine Cieslik](#) (402-995-2304) Submitted On: Mar 22 2023

1-1 Backcheck Recommendation **Close Comment**

The multi-compute strategies were outlined in the responses. The winter months were deemed the Start-up period for the RAS model.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085341 Hydrology Section 4.7 Comparison of ResSim and RAS Routing   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The main differences between RAS and ResSim were focused on routing methodology, and time steps and comparative flows. How about the downstream control rules for regulation? Did ResSim Logic and flow constraints at downstream control points play into the differences?

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Provide some background on ResSim logic/rules that would affect the releases from the reservoirs in the ResSim model.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

To assess the different routing methods, both RAS and ResSim were routing the same flows. The upstream boundary condition for RAS was the output from ResSim so that we could eliminate any differences caused by ResSim operations vs historical operations. That being said, there will be differences between ResSim output and historical operations, but to keep the flow frequency report focused on the flow frequency, we only reference the report that details the ResSim rules.

Submitted By: [Ryan Larsen](#) (402-996-3861) Submitted On: Mar 22 2023

1-1   Backcheck Recommendation **Close Comment**

The assessment routed both RAS and ResSim flows, but the report details the Resim rules.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 18 2023

Current Comment Status: Comment Closed

10085343 Hydrology Section 5.2 Flow Transforms for Regulated frequency n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: The flow transformation should be based on the scatter plot of the Regulated and unregulated peak flow estimates for each year. The ranking of flow pairs as described in this paragraph are not standard procedures and undermine the relationship between the unregulated and regulated response for the historic events. See RMC-TR-2021-02 Section 4.1 for more info on the flow transformation.

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Ranking the unregulated and regulated data disassociates the site's response for a given event. Usually, a line would be fitted between the scatter plot formed by the pairs of regulated and unregulated flows for each year. (It may be most appropriate to review data for the period of record that puts most weight on the data from the years with the most modern regulation and withdrawals.) Include plots for these relationships in the report.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Non-concurred**

The purpose of the transform function is to go from one frequency curve to another and this requires rank ordering of the data. It is not a problem that this dissociates the site's response.

Submitted By: [Ilya Poluektov](#) (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0   Evaluation **Non-concurred**

I looked through this guidance (which I was aware of) in detail and was unable to come up with something better than what we did for the transform method. Please refer to the expanded discussion of the guidance and how it was considered in Section 5 and 5.1, and the supplemental plot added for Gavins Point Dam (emphasis on the scaled floods).

I also included the WAT results on the plot initially but removed it since that is later in the document and we didn't want to confuse the reader here. The plateau caught from Monte-Carlo analysis, which we couldn't foresee in our transform numbers, can better account for the carryover use zone of the dams. We are also trying to be very honest about the range of analysis here, where we do not want to extend beyond 0.2% without additional work out at these probabilities, which is not in our current scope.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1   Backcheck Recommendation **Close Comment**

The analysis team feel that they did the best they could to represent the transform between regulated and unregulated flow relationships. The WAT simulations was ultimately used to determine the final frequency estimates.

Submitted By: Ann Banitt (6512905541) Submitted On: May 19 2023

Current Comment Status: Comment Closed

10085344   Hydrology   Section 5.2.2 Extrapolation of Transform   n/a   n/a

Comment Classification: **Controlled Unclassified Information (CUI)**

Concern: Reservoirs on the Platte and Chariton were not modeled in Ressim. Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Explain why the reservoirs on Platte and Chariton were not modeled in ResSim. What is the impact of leaving those out?

Submitted By: Ann Banitt (6512905541). Submitted On: Jan 26 2023

1-0   Evaluation **Concurred**

The reservoirs on the Platte and Chariton Rivers do not have a significant impact on peak flows/stages on the Missouri River mainstem. There is little to no impact on leaving them out of the model.

Submitted By: Ryan Larsen (402-996-3861) Submitted On: Mar 16 2023

Backcheck not conducted

2-0   Evaluation **Concurred**

Please also refer to Section 2.2 for details. One more piece of information, as part of the Rathbun WCM revision (2016), we found that Boonville is not sensitive to Rathbun operations.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1   Backcheck Recommendation **Close Comment**

The Team has reviewed the impact of the dams that are not specifically "unregulated" for this analysis in relation to the discharges on the main stem Missouri River.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 19 2023

Current Comment Status: **Comment Closed**

10085346 Hydrology Section 5.2.2 Paragraph 2   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Provide a table that shows the peaking factors for conversion from maximum 1-day flows to instantaneous peaks. (or a reference to a table earlier in the report).

Basis: Report clarity.

Significance: Medium

Action Needed to Resolve: Add a table as described above.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

Please see section 3 and peak to daily flow ration appendix.

Submitted By: [Ilya Poluektov](#) (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0 Evaluation **Concurred**

Good comment, we added a reference back to Section 3.4 from Section 5.1 (new numbering is different). Same factors were applied as Ilya states.

Submitted By: [Chance Bitner](#) (816-389-3482) Submitted On: Apr 04 2023

2-1 Backcheck Recommendation **Close Comment**

The peaking factors are included in Table 3-2.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 19 2023

Current Comment Status: **Comment Closed**

10085348 Hydrology Table 5-1 n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Summary tables should be consistent between the two District's work products. Frequency estimates should be compared through the system by plotting the curves for the sites. Basis: Report clarity.

Significance: Low

Action Needed to Resolve: Consider plotting a summary of the discharge curves to illustrate that they do not cross. Also make these summary tables consistent. Some tables spell out gage names, others use the abbreviations. Recommend using the gage names instead.

Submitted By: [Ann Banitt](#) (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

There is no reason that flow frequency curves would not cross at different location on the stream.

Submitted By: Ilya Poluektov (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

2-0 Evaluation Check and Resolve

While I agree there are some physical reasons why curves can cross and we have seen that in the river's flood history (expanded now in the report), such as large open floodplains causing attenuation, I agree that upstream curves crossing downstream does not usually make sense otherwise as flows usually increase with drainage area.

The summary tables at the end of the section and executive summary are combined and consistent. The table that was formerly written for NWK gages plus Nebraska City has been expanded for all 10 gages and moved up and frequency curve plots added at the end of Section 3.5 which is for both districts.

We talked about this issue with Beth Faber and did plot it earlier using computed probabilities (takes a bit more work for expected plots). I did a minor amount of smoothing to minimize the NWK gages from crossing beyond the range of the analysis. However, it will be difficult to fully eliminate these "early spring", or Jan-Apr curves from crossing the single season curves. As you will see in the report, the May-Dec curves do not cross.

While Ilya did not try to prevent the Omaha District curves from crossing, overall they are not unreasonable based on additional analysis I added to the report for the range of the analysis (out to 0.2% AEP). I've added some information on this at the end of Section 3.5, and to the sensitivity analysis sub-sections for each Omaha District gage, the primary difference being the period of historic flow analysis. A few gages may be slightly conservative, but the regulated results plot reasonably well and are not sensitive to minor changes (e.g. if we were to apply more smoothing to Boonville or St. Joseph, for example, in addition to the upstream gages).

Please review the updates to the report and advise if you would like to discuss this issue with us further. As of now, we retain the previous results and add sensitivity analysis and a caveat that additional work may be required to extend the analysis, should that be needed. I also added a comparison to how the 2003 study treated the region smoothing.

Submitted By: Chance Bitner (816-389-3482) Submitted On: Apr 07 2023

2-1 Backcheck Recommendation **Close Comment**

Consistency has been addressed. The analysis team has reviewed the skew for the stations, and has even separated out the skew values for early and late spring. The early spring period presents some varying conditions where the profiles of frequency discharges could cross. The team has been thorough in reviewing the data and coordinating assumptions with Beth Faber at HEC.

Submitted By: Ann Banitt (6512905541) Submitted On: May 19 2023

Current Comment Status: Comment Closed

10085350 Hydrology   Section 5.3   n/a   n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Based on the report text it appears that the regulated peaks differed between the two Districts. The Kansas City District used USGS observed annual peak flows for the period of record vs unregulated peaks. The Omaha District plotted the

present condition- regulated flow peaks vs the unregulated peaks.

Basis: Report clarity and Methodology Correctness Significance: Medium

Action Needed to Resolve: Verify that the unregulated-Regulated Flow Transforms were consistently generated between the two studies.

Submitted By: <u>Ann Banitt</u> (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Concurred**

Transforms were consistently generated. I don't know what this comment is referring to. The Qp/Qd ratios were derived with USGS data. However, transforms were developed with unregulated and regulated flows consistently between districts.

Submitted By: <u>Ilya Poluektov</u> (4029952356) Submitted On: Mar 09 2023

1-1 Backcheck Recommendation **Close Comment**

The team has confirmed that the transforms were derived consistently between the Districts. The text has been expanded and some additional review was done after the ATR. The team has made their best judgement in producing the transforms for all sites.

Submitted By: <u>Ann Banitt</u> (6512905541) Submitted On: May 19 2023

Current Comment Status: Comment Closed

10085352	Hydrology	Section 5.4		n/a	n/a

Comment Classification: Controlled Unclassified Information (CUI)

Concern: Regulated frequency curves should be graphical and show some bends where storage and regulation take hold. Seem like the curves are averaged out too much by fitting a smooth line.

Basis: Flow Frequency Analysis Methodology Significance: Medium

Action Needed to Resolve: Review the reasonableness to present the regulated frequency curve with a smooth curve. Regulated frequency curves are generally graphical, including bends where storage and regulation rules take hold. At some point in the very infrequent, high discharge floods, the regulated and unregulated curves will meet – unless it is a really large reservoir, which might be the case.

Submitted By: <u>Ann Banitt</u> (6512905541). Submitted On: Jan 26 2023

1-0 Evaluation **Non-concurred**

Sort of. The unregulated to regulated plots are a shotgun blast because of the runoff distributions and system response variety. There wasn't a good curve that could be drawn - a smooth curve was the best we could do. Peak flows wouldn't trend back to the 1:1 line until hypothetical floods of biblical proportion at most locations. This is one of the reasons we opted for the Monte-Carlo approach as the final answer.

Submitted By: <u>Ilya Poluektov</u> (4029952356) Submitted On: Mar 09 2023

Backcheck not conducted

1.1 Evaluation **Non-concurred**

Adding to Ilya's response, and see also comment 10085343:

We have found little evidence of slope changes when looking at this at gages

downstream due to the dispersed nature of the dams, size and scale of the watershed. For the WAT, it did pick up on the shape below Gavins and that makes sense, and that was a factor in us selecting the WAT over the transform (hopefully that is more clear with changes to the title of this section and introduction, this is one method but not the adopted method). However, Gavins itself has little to no storage, and the Niobrara River enters its pool downstream of Fort Randall, providing most of the 16,000 square miles between the dams and capability to produce large peaks (e.g. 2010 and 2019 surcharge even with Fort Randall at 0 cfs). Events like these can make drawing a good relationship through wide scatter difficult even immediately below the dam.

Beyond that, even with the WAT, the shape changes are harder to see and describe. Overall the dams just make the flood peaks a little to a decent amount lower, and we do not see convergence towards the 1:1 line in most synthetic floods. From my tests, it would take a hypothetical flood similar to HMR 51/52 storms centered just right to see convergence at extreme flows. Even then I couldn't get it to transition when looking at the Kansas City gage (KC levees analysis included on the write up for the KC gage used several centering's of HMR storms). See also comment 10085343 and the additions to the report to address these items.

Submitted By: [Chance Bitner](#) (816-389-3482) Submitted On: Apr 07 2023

1-2   Backcheck Recommendation **Close Comment**

The team has thoroughly reviewed the impacts of the various dams, complexity of the watershed and then performed various sensitivities with the implementation of the WAT. The unregulated and regulated curves at some locations would not converge at high discharges except for PMF-magnitude floods.

Submitted By: [Ann Banitt](#) (6512905541) Submitted On: May 19 2023

Current Comment Status: Comment Closed

3.0.   ATR of HEC-WAT

Comments were provided through meetings, email, and word documents, and collated in the following table. The HEC-WAT reviewer signed the ATR certification.

Reviewer Comment	Response
A map would improve this description and help provide context. I do not know these station codes well and others may appreciate a reference.	Yes, a map would help. This is just a chapter in a bigger document, but there is a map in another chapter.
WAT maintains correlation from year-to-year on a defined season but generating the 'big bucket' was done with these parameters. It would help to clarify how the WAT year-to-year serial correlation was determined and does it preserve the correlation for the same boundary here? If it does not this should be discussed.	The annual serial correlation entered for WAT was computed at the same time as these seasonal correlations, and in the same way. Breaking the years, but maintaining the annual correlation, does loose a little of the remainder to early spring correlation, but not much.
From the next section, correlation applies from A to B, B to C, but does WAT's sampling recreate C to A, or another correlation? Does C to A matter?	WAT's sampling doesn't maintain C to A explicitly, but rather D to D (with D being the season for annual correlation). However, with D to D maintain, C to A ends up close. That transition matters, but less than the others.
This image does a good job illustrating the result of mixing watersheds. Text does not describe what "rnd" lines are.	RND refers to the sampled values, ie the Big Bucket. In the text, this is "...and the same color hollow diamonds show the 500 sampled values."
Does the use of normal distribution matter, in that does it influence the tails generated by this process? Is there a reason this doesn't use a uniform distribution to start with?	The Normal distribution is used for a few reasons. (a) the AR(1) process typically uses a Normally distributed error, and (b) spatial correlation is also applied using a gaussian copula, with makes use of the joint Normal distribution. So, imposing correlation in both dimensions requires use of the Normal distribution.
Does the choice of multivariate normal distribution matter in generating correlated values? It seems reasonable to use, but I am wondering if it could have an impact on the sampling of extremes.	This is a gaussian copula approach to imposing spatial correlation. If we were generating streamflow directly, I'd use Normal on log flow, or even Pearson3 on log flow. But since we're just generating U[0,1] values for bootstrap sampling, the tails are unaffected.
If we're simply using this to select from ranked historical data, why not use a uniform distribution? (This is a minor comment, I would not ask for extensive exploration of the subject)	We cannot impose correlation with Uniform, as there is no joint, correlated uniform distribution.

Reviewer Comment	Response
Re: correlation from season C to season A, would sampling that correlation or not matter to the end result?	C to A does matter and is explicitly maintained in the big bucket sampling. The first row in Table 2 is C to A, or remainder to early spring.
It would definitely matter if the 500yr big bucket is going to be used in a 'deterministic' mode. But does it have an impact on the statistics of the sampled flows for season A?	I think the question is "do we need to maintain C to A if we're just going to separate the years later in WAT sampling?" Perhaps not. But, the Big Bucket can be treated deterministically, and it was no more difficult to maintain C to A, so it made sense to do it. But season A statistics are maintained correctly either way.
This step makes me think the choice of initial distribution MN[0,1] may not be important.	Yes, that is correct. The tails are defined by the empirical sample.
In the HEC-WAT bootstrap sampling: Ordering also matters when synthetic events are added – the largest events have the most 'space' stolen from them. I am not clear how this gets applied when serial correlation is maintained in the sampling.	In the initial Big Bucket development, there were to be no synthetic events, so no stolen probability for them from larger years, and thus it was not discussed here. Synthetics were eventually added. However, the probabilities of the Big Bucket events and the synthetics were set manually, using a different method than the one automated in WAT-HS that steals probability from the largest events.
What does "good potential" mean, and how was this evaluated?	Good potential meant that the seeds generated versions of the Big Bucket that maintained the required characteristics. These were (a) maintaining and extrapolating the seasonal volume distributions effectively, and (b) maintaining the spatial and serial correlations.
These seem reasonable reproductions of the input statistics.	yes, thanks
Is this the reason for choosing a seed in the sampling process? How was that evaluated?	Yes, this was one of the two factors, along with maintaining the spatial and serial correlations. It was primarily visual, looking at the extrapolations of the seasonal volume distributions for each season, in both linear and log space, to see that the extrapolation was smooth and a reasonable extension.
Are the linear plots necessary? Removing them could make more space for log plots.	The linear plots were used for the extrapolation upward. It's not clear enough on the log plots, which were used for extrapolation downward. As you noted later, it was explained later.

Reviewer Comment	Response
What is reasonable extrapolation? The eyeball check says yes, but can you validate against a volume frequency analysis? I would like to see a fitted curve of some kind to compare the hollow points against.	Yes, that's a good idea. We did not fit probability distributions to the season volumes at this stage, and so didn't have them for comparison. However, the next version of the Big Bucket will use seasonal volume distributions to assign likelihoods to the synthetic events, and so they will be available for comparison.
I assume synthetic events added to HEC-WAT are also being used to improve the upper end of each region. How does probability sampling of these factor in, and does it alter the resulting curves for the overall volume (green)?	There was a detailed method for assigning probabilities to the Big Bucket events, the historical events, and the synthetic events in WAT in the HS probability override. It is described elsewhere but was not developed at the time this chapter was written. However, the sampling in WAT that used the synthetics provided a good extrapolation. In the updated Big Bucket, synthetic events are sampled in the Bucket, and thus are part of the extrapolation.