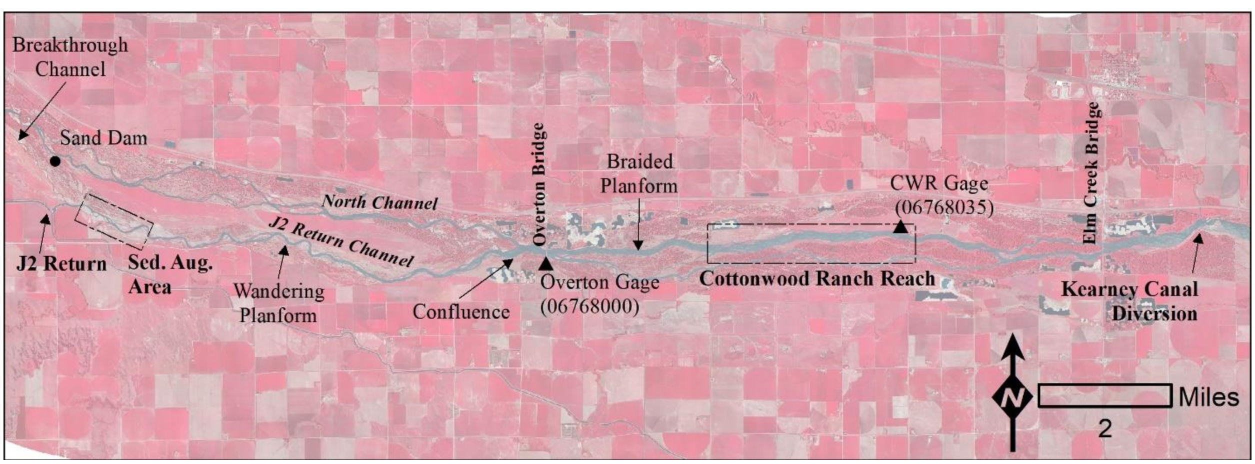
TO: Governance Committee (GC)
FROM: Executive Director's Office (EDO)
SUBJECT: Sediment Augmentation Implementation
DATE: June 5, 2023

The EDO is currently completing an analysis of the sediment augmentation management experiment that began in 2017. That analysis will be presented to the Technical Advisory Committee (TAC) and subjected to Independent Science Advisory Committee (ISAC) and third-party peer review later this year. In the meantime, we are seeking GC guidance on continuing sediment augmentation operations in late summer this year as review is ongoing. This memo provides a brief background on the purpose of the augmentation experiment, preliminary findings, and potential options for 2023 and beyond.

Why are we conducting a sediment augmentation management experiment?

Extension Science Plan Big Question 3 asks if sediment augmentation is necessary to create and/or maintain suitable whooping crane habitat in the future. More specifically, clear water hydropower return flows entering the south channel of the Platte between Lexington and Overton (hereafter J2 Return Channel) resulted in incision and narrowing in that reach. We hypothesized that annual sand augmentation of 60,000 to 80,000 tons may be necessary to supply sediment in sufficient quantities to stabilize channel incision and prevent it from progressing downstream past the Overton bridge and negatively impacting whooping crane habitat suitability.[1] Alternative hypotheses include the need for more/less sediment and/or alternate augmentation locations, as well as the hypothesis that incision is progressing slowly enough that it does not pose a threat to downstream habitat.

To answer this question, the Program initiated a full-scale sediment augmentation management experiment in 2017 involving mechanically augmenting 40,000 – 60,000 CY (60,000 – 80,000 T) of sand into the channel immediately downstream of the J2 Return each year. A combination of transect surveys and LiDAR data are being analyzed to evaluate channel response to the increase in sediment supply. Preliminary findings (along with a map of the augmentation evaluation reach and features) follow.



Overview map of sediment augmentation evaluation reach and features.

[1] The narrow, incised reach of the J2 Return Channel does not meet minimum habitat suitability requirements for whooping crane roosting habitat. If impacts progress downstream past the Overton bridge, habitat suitability at the Cottonwood Ranch habitat complex will be negatively impacted.

What have we learned about historical degradation in the J2 Return Channel prior to augmentation?

The J2 Return began clearwater hydropower returns in 1942. By the early 2000s, the channel immediately below the return incised 16 – 18 feet, with magnitude decreasing in a downstream direction away from the return. Based on the minimum elevation of 4 repeat transects from 1989-2002 upstream of Overton Bridge, incision slowed since the early 2000s. There has been a large increase in meandering in the upper half of the reach where slope has fallen below 0.001 ft/ft. We interpret the shift from incision to lateral migration to be caused by the channel dropping below the slope threshold to maintain a straight braided channel, causing it to transition to a wandering planform. The increase in meandering and associated increase in lateral erosion along outer bends (which now comprises >50% of total erosion) coincides with the decrease in downstream incision that occurred prior to sediment augmentation.

Overall, we assess that over the 15 years prior to full-scale sediment augmentation implementation, incision slowed in the J2 Return Channel in response to increasing sediment inputs from lateral erosion[2] in the upper portion of the reach that transitioned to a wandering planform.

What have we learned about the J2 Return Channel during the sediment augmentation management experiment?

Mechanical augmentation operations began in 2017 and full-scale augmentation of 40,000 – 60,000 CY occurred annually from 2018 – 2021.[3] Calculation of year-to-year volume change in the augmentation area indicates most augmented material was mobilized downstream out the augmentation area annually. Annual comparisons of volume change downstream of the augmentation area found that lateral erosion did not decrease during the augmentation period, remaining stable at approximately 60,000 CY per year. Bed erosion did decrease by 20,000 – 40,000 CY (45%-60%) from the pre-augmentation period. This roughly equals the annual increase in sediment transported out of the sediment augmentation area (36,000 CY) during augmentation operations.

The decrease in bed erosion occurred in the first 3-miles downstream of the augmentation area. Bed elevations in that segment were stable to slightly aggradational. However, incision was observed farther down the J2 Return Channel. In 2019 a 6,000 ft reach of pronounced bed erosion (thalweg incision averaged 1.3 ft) occurred mid-way down the reach likely due to April & July flood flows conveyed from the North Channel to the J2 Return Channel upstream of Jeffery Island (breakthrough channel). The incised area has been stable since 2020 and may be recovering slightly.[4]

Overall, we assess that the annual augmentation volume was sufficient to offset approximately half the bed erosion in the J2 Return Channel Reach but had no effect on lateral erosion.

What have we learned about sediment balance downstream of Overton during the sediment augmentation management experiment?

A specific gage analysis for low to moderate flows at the Overton Bridge indicates channel degradation at the bridge prior to 2013 followed by slight channel aggradation since. At the Cottonwood Ranch

[2] Bed armoring and sediment inputs from a breakthrough channel west of Jeffery Island likely also contributed the slowing rate of incision.

[3] Full-scale augmentation also occurred in 2022 but remote sensing data was not available in time to include in this analysis.

[4] Breakthrough channel is complicating factor in J2 Return Channel evaluations. Contributed a substantial amount of water and sediment prior to 2020. Has since been completely disconnected. Now no flow or sediment across Jeffery Island.

(CWR) stream gage located at the downstream end of the CWR habitat complex, the channel was slightly aggradational during the period of 2005-2015 and has been stable since.[5] Thalweg and volume change analyses indicate a dynamic channel with a high degree of spatial and temporal variability during the augmentation period. Spatially, the reach from the Overton Bridge to CWR was stable to slightly aggradational, the CWR reach was slightly degradational, and the reach from CWR to the Kearney Canal diversion structure was aggradational during augmentation years. Temporally, the channel bed was net aggradational in years of lower flow and net degradational in years with higher flows. When compared to the pre-augmentation period and normalized for discharge, we observed no major difference in bed erosion during the pre- and post-augmentation periods downstream of Overton Bridge. The one substantial difference we did observe was substantial lateral erosion that occurred because of the prolonged peak flow event in 2015 which increased mean channel width by more than 200 ft. Channel widths have remained stable since.

Overall, we assess that sediment augmentation did not appear to influence sediment balance downstream of Overton Bridge. This should not be interpreted as a negative finding as the reach continues to be dynamic but generally stable and the increase in channel width that occurred during the pre-augmentation period has been maintained.[6]

What is our overall assessment of the performance of the sediment augmentation management experiment?

Augmentation operations reduced annual bed erosion in J2 Return Channel by approximately 20,000 – 40,000 CY (45%-60%) which is consistent with the 35,000 CY increase in sediment transported out of the augmentation area following augmentation operations. The relative importance of this reduction in bed erosion is difficult to assess given the obscuring effect of the large volume of lateral erosion in the wandering reach that appears to supply sufficient sediment to slow the downstream progression of incision. If augmentation operations cease, we would expect bed erosion in the J2 Return Channel to return to pre-augmentation levels but we are unable to predict short term changes in the rate of incision because:

1) The absence of detailed thalweg elevation data during the pre-augmentation period (no Topobathymetric LiDAR) prevented a detailed analysis of thalweg incision rates immediately prior to augmentation.
2) The confounding effect of a breakthrough channel across Jeffery Island that contributed flow and sediment to the J2 Return Channel prior to 2020. That channel has now been completely blocked to protect utility infrastructure.

Long-term channel evolution with and without augmentation is also uncertain. Will meander bends in the wandering portion of the J2 Return Channel continue to migrate and supply sufficient lateral erosion to forestall downstream incision or will the reach stabilize and downstream incision increase? Will the elimination of flood flows (and associated sediment) across Jeffery Island reduce the potential for episodic incision events or will the elimination of the external sediment supply accelerate baseline incision?

[5] NPPD and then PRRIP channel widening occurred upstream of this gage annually until ~2012
[6] Whooping crane habitat suitability in the CWR reach is being maintained at the highest level in 60-70 years.

Regardless of these uncertainties we can say with confidence there is a substantial sediment deficit in the J2 Return Channel that continues to impact channel form. At present the impacts (in terms of narrowing and planform change) have not progressed downstream of the Overton Bridge but may at some unknown point in the future. As such, mechanical augmentation at the upper end of the J2 Return Channel theoretically reduces future risk to downstream habitat but near- and long-term benefits are difficult to quantify and weigh against the annual cost of augmenting sediment. Alternatives that allow for sediment replenishment without annual mechanical augmentation may be the best long-term solution. As such, we recommend exploration of alternatives such as retrofitting of the Jeffery Island Sand Dam to pass sediment into the south channel in a controlled manner.

What should we do in 2023?

The Extension Science Plan contemplates the potential for a second cycle of sediment augmentation research prior to the end of the Extension. We anticipate a recommendation on future research will emerge from the committee and independent review process later this year. However, that process will not conclude prior to the annual augmentation window in late summer. We budgeted for full-scale augmentation this year but are seeking GC guidance on 2023 implementation as well as general feedback on future direction. Three potential alternatives are described below:

Continue full-scale augmentation: This is a low-risk alternative as it continues operations at current levels. However, it does provide limited learning potential as outcomes will likely be similar to those observed since 2017. Augmentation cost is expected to be on the order of $200,000, which is slightly lower than 2022 but substantially higher than 2017-2021.

Pause augmentation: Pausing for a year (or more) would save money and provide the potential to learn about the progression of incision without augmentation.[7] However, learning does come with the risk of increased channel incision, especially if drought conditions ease and clear water hydropower returns increase.

Double the amount of augmentation: Doubling the amount of annual augmentation (for one or more years) would be one avenue of increasing management contrast for the purpose of maximizing learning potential. Specifically, it would allow the Program to assess our ability to offset and/or begin to reverse bed erosion in the J2 Return Channel by augmenting enough material to offset the entire volume of bed erosion in the reach. This learning potential must be balanced against annual cost which will likely exceed $400,000.

[7] Lack of Topobathymetric LiDAR during the pre-augmentation period limits our ability to assess thalweg change during that period.