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Planning Assistance to States (PAS)

Technical Assistance Study Report for the Lower Eau Claire River & Lake Altoona, Wisconsin

May 2024

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1.0 Project Context

Since construction of the Altoona Dam in 1938, sediment transport from the Lower Eau Claire River (LECR) has resulted in sedimentation and formation of a delta at the upstream (east) end of Lake Altoona. This sediment delta, along with deposition immediately upstream in the LECR, has prevented and negatively impacted water quality and recreation on Lake Altoona.

This Planning Assistance to States (PAS) report aims to assist the Lake Altoona Rehabilitation and Protection District (LARPD) in preparing for future study and implementation of practices to reduce sediment transport from the LECR to Lake Altoona. This PAS report is limited in scope to the following two phases:

1. Literature and data review to obtain the following:
    a. All existing data, reports and models for the Lower Eau Claire River and Lake Altoona, Wisconsin, from study partners and
    b. Any other sources of information deemed useful for the study.
2. Development of a study strategy for future work based on information obtained in Phase 1. Goals for the future study are expected to be:
    a. Determination of sediment transport mechanisms impacting Lake Altoona
    b. Development of an enhanced modeling tool for the non-federal sponsor to use for planning applications related to sediment reduction and management efforts.

2.0 Lake Altoona and the Lower Eau Claire River Watershed

2.1 Lake Altoona Overview

Lake Altoona is in Eau Claire County, Wisconsin and lies within the City of Altoona and the Towns of Seymour and Washington. Lake Altoona was formed by construction of the Altoona Dam on the LECR in 1938. The Lake Altoona Watershed totals approximately 813 mi^2 and comprises two subwatersheds: the Lake Eau Claire Subwatershed (597 mi^2) and the LECR Subwatershed (216 mi^2). The LECR Subwatershed is shown in Figure 1. The entire Lake Eau Claire Subwatershed is controlled by the Eau Claire Dam, which was constructed in 1937, and forms Lake Eau Claire approximately 26 river miles upstream of the Altoona Dam. Two reservoirs – Dells Mill Pond on Bridge Creek and Fall Creek Pond on Fall Creek – in the LECR Subwatershed control a combined 73 mi^2 (Simons, Li & Associates [SLA], 1988), leaving approximately 143 mi^2 (18 percent) of the Lake Altoona Watershed uncontrolled by dams upstream of Lake Altoona.

Lake Altoona has been identified as “highly eutrophic” by the Wisconsin DNR (2024) and is listed on the EPA Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs) list as impaired due to excessive algal growth, which is fueled by elevated phosphorus concentrations within the lake. Excessive sediment delivery to the lake delivers particulate phosphorus to the lake and contributes to algal growth. Extensive algal blooms are common in Lake Altoona during the growing season and have contributed to beach closures (West Central Wisconsin Regional Planning Commission, 2017).

Lake Altoona has experienced relatively high sedimentation rates since construction. Between 1938 and 1966, sediment deposited at a rate that would have completely filled the lake within 150 years (SLA, 1988). In recent decades, sediment deposition in the delta at the upstream end of Lake Altoona, and the lowest portion of the LECR above Lake Altoona, has significantly impacted access and recreational opportunities on Lake Altoona. This has led to more intensive, and expensive, management of sediment by the LARPD, largely through dredging of sediment in the LECR. The goal for the LARPD is to minimize sediment transport into the LECR/Lake Altoona delta and, when needed, to manage excess sediment efficiently and cost-effectively in this area.

2.2 Lower Eau Claire River Subwatershed

2.2.1 Land Cover and Soils Data

A summary of land cover (derived from the 2021 National Land Cover Database [NLCD]) for the Lake Eau Claire Subwatershed, the LECR Subwatershed, and the combined Lake Altoona Watershed is presented Table 1. Forest is the largest land cover in the Lake Altoona Watershed, though it constitutes less of the LECR Subwatershed (37%) than the Lake Eau Claire subwatershed (50%). Cultivated areas constitute about one-third of each subwatershed, with pasture/hay making up another 13 percent in the LECR Subwatershed. The remaining 13 to 17 percent of the subwatersheds is made up of developed, wetlands, open water, and other (barren, shrub/scrub, and grassland/herbaceous land covers).

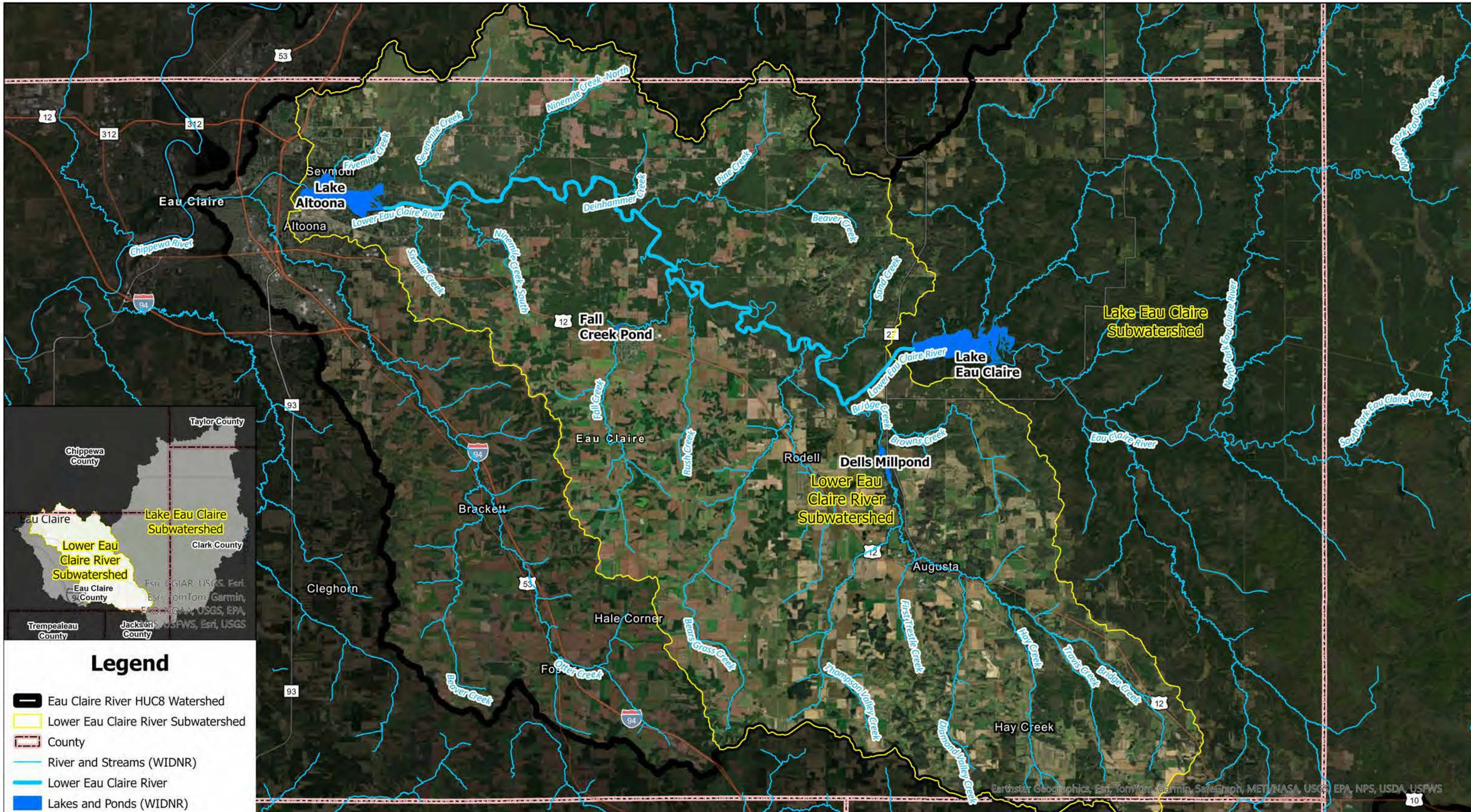

Figure 1. Lower Eau Claire River Subwatershed

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Table 1. 2021 National Land Cover Database Data Reclassified and Summarized by Subwatershed

Watershed (area)	Reclassified 2021 NLCD Land Cover						
	Forest	Cultivated	Pasture/Hay	Developed	Wetlands	Open Water	Other
Lake Eau Claire (596.5 mi^2)	50%	35%	2%	4%	6%	1%	2%
Lower Eau Claire River (216.4 mi^2)	37%	33%	13%	7%	5%	1%	4%
Total (812.9 mi^2)	47%	35%	5%	5%	6%	1%	2%

SLA (1988) reported land cover in the LECR Subwatershed as 57 percent cropland, 17 percent woodland, 11 percent pasture, 11 percent miscellaneous, and 4 percent urban. NLCD 2021 data suggest there has been a net conversion of approximately 20 percent of the LECR Subwatershed from cropland and hay/pasture to forest since the SLA report. It is unclear if this represents real land cover change or a difference in methodology.

SLA (1988) reported that 80 percent of the soils in the LECR Subwatershed are fine sand or finer.

2.3 Lower Eau Claire River

The Lower Eau Claire River (LECR) runs approximately 26 miles from Lake Eau Claire to Lake Altoona and is the primary tributary to Lake Altoona. Slopes along the LECR channel generally range from 2 to 5 ft per mile, with a steeper section of approximately 13 ft per mile in the vicinity of Big Falls (river mile 10). There are 12 major tributaries within the LECR Subwatershed, with slopes ranging from 10 to 50 ft per mile (SLA, 1988). Major tributaries include, from upstream to downstream, Bridge Creek, Bears Grass Creek, Fall Creek, and Beaver Creek.

SLA (1988) reported that the bed and bank material of the LECR are predominantly fine gravel and medium sand. Figure 2 is taken from SLA (1988) and shows the particle size distribution for a total of 14 channel sediment samples collected by Finley (1976) and SLA (1988). SLA samples were all taken from the channel bed, while the Finley samples are of unknown origin within the channel. The leftmost (finest grain size) sample in Figure 2 is an SLA sample taken from the Lake Altoona delta and is almost all fine sand and finer. The remaining samples are predominantly medium sand or coarser, with several being 40 to 60 percent coarse sand or larger particles. As the upland soils in the LECR Subwatershed are predominantly fine sand (or finer), it is expected that there would be little overlap in the sediment size distributions of wash load and bedload that settles in Lake Altoona.

Sediment transport can be characterized by three main mechanisms within a stream or river: wash load, suspended load, and bedload (Turowski et al., 2010). Wash load is the transport of particles that are small enough that they are “washed” through a channel and are not found in measurable quantities in the channel bed. Bedload relates to particles that are coarse enough that they cannot be suspended and are instead transported by saltation (rolling, sliding, etc.) along the channel bed. Suspended sediment load carries those particles that are too coarse to be considered wash load and too fine to be considered bedload. These particles are carried in suspension (e.g., by turbulent forces) and may be carried great distances without interacting with the channel bed.

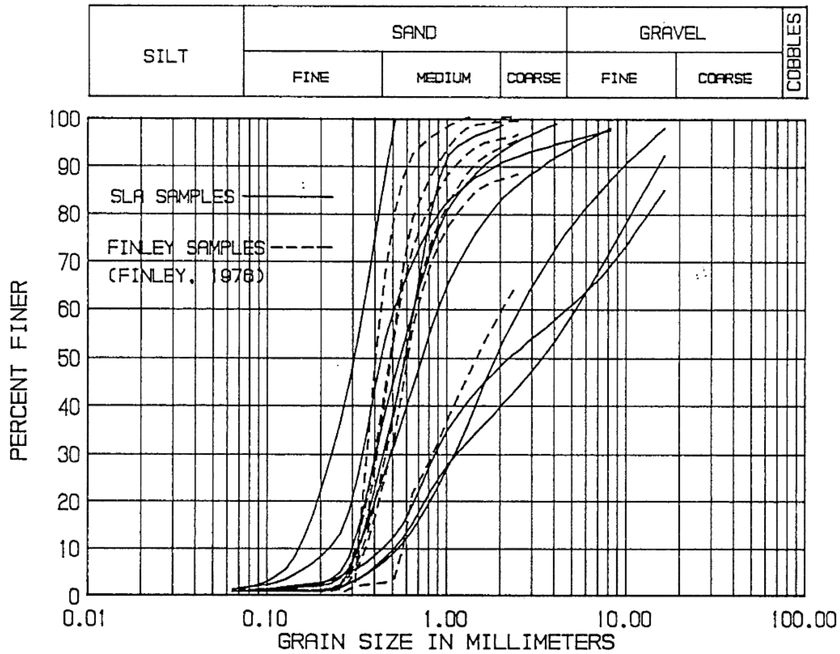

Figure 2. Lower Eau Claire River Channel Sediment Sample Particle Size Distributions (taken from Simons Li & Associates, 1988)

The particles transported by each of these mechanisms at any given time depend on both the sediment supply and the hydraulic regime in the river. For example, a river with only a very coarse sediment supply would not be expected to transport a wash load under typical conditions. Instead, it's sediment would be transported largely as bedload. Sediment transport will generally increase with higher channel velocities; as velocities increase, larger particles may be mobilized as bedload and some particles formerly transported as bedload may be transported as suspended load.

Due to the coarse nature of bedload sediments, and the rapid settling of these particles within a reservoir, it is expected that minimal or no bedload in the LECR would originate in the Lake Eau Claire Subwatershed. Furthermore, any fine sediments that remain suspended in upstream reservoirs and are transported to the LECR may also remain suspended in Lake Altoona, ultimately passing over Altoona Dam. For these reasons, it is expected that sediment input from controlled portions of the watershed is relatively minor compared to sediments originating within the LECR Subwatershed or within the LECR itself.

Given the predominant soil types in the LECR Subwatershed (mostly fine sand or finer) and the bed and bank materials in the LECR (medium sand and coarser), it is expected that under typical flow conditions bedload would largely be sourced from bed and bank materials and that wash load (and fine suspended load) would largely be sourced from upland sediment sources or from Lake Eau Claire. Ongoing work to address upland sediment loading to the LECR is being completed by the Eau Claire County Land Conservation Department and other partners in the watershed. Thus, the remainder of this report will focus largely on bedload sediment sources within the LECR Subwatershed.

3.0 Previous Studies

Literature review focused on three studies: the mid-1970s Finley study, the 1988 Simons, Li & Associates (SLA) report and the 2015 Lake Altoona Sedimentation Study Project Report by Zika and Trombly. SLA (1988) cited three 1975 quarterly reports by Finley and a final report from 1976. None of the Finley reports were available for review at the time this report was written. Thus, all information from Finley reports comes from discussion in the SLA (1988) and Zika and Trombly (2015) reports and all references to the Finley reports are cited here simply as Finley (1976) to correspond to the date of the final report.

The Finley and SLA studies focused on observed sedimentation within Lake Altoona (i.e., measured loss of storage volume) and estimates of sediment loading (in terms of bedload and wash load) delivered by the LECR and remaining in Lake Altoona. Bedload estimates provided by Finley (1976) and SLA (1988) were derived through hydraulic modeling exercises. Due to the coarse nature of bedload, it was assumed that all bedload delivered to Lake Altoona would remain in the lake. Estimates of wash load were then made based on the difference between the observed filling rate of Lake Altoona and the calculated bedload. This estimate of wash load would be only the portion of wash load that is retained in the lake and would not reflect any fine materials that remain suspended long enough to be transported over the Altoona Dam.

The Zika and Trombly report (2015) provided an updated estimate of bank erosion from bank erosion hotspots along the LECR. The report also provided valuable context for work that had taken place since the 1988 SLA report and proposed potential paths forward, both in terms of data collection efforts and sediment management practices.

3.1 Finley (1976)

The 1976 Finley study was not available for review, but study outcomes were discussed by SLA (1988) and Zika and Trombly (2015). Finley reported measured mean annual volume loss within Lake Altoona of approximately 111,000 cubic yards (cy) since construction of the Altoona Dam in 1938 (SLA, 1988). Zika and Trombly (2015) clarified that this average rate of deposition reported by Finley was based on a 1966 bathymetric survey of Lake Altoona and thus this mean annual rate of 111,000 cy per year was valid only for the period 1938 to 1966.

Finley used three empirical methods to determine mean annual bedload transport rates to Lake Altoona and reported estimates of 107,000, 103,700, and 90,500 cy. Finley's final estimate of mean annual bedload was 90,500 cy. SLA noted that the Finley's methodology appeared to rely on a five-year average of instantaneous peak flow measurements at Lake Altoona.

Finley estimated mean annual wash load to Lake Altoona using the Universal Soil Loss Equation (USLE) at 20,576 cy per year. Though details are lacking on Finley's implementation of the USLE, it is assumed that erosion, sediment transport factors, and trapping efficiency (of wash load sediment within Lake Altoona) were chosen to produce a wash load estimate equal to the difference between the observed mean annual sedimentation (111,000 cy) and bedload (90,500 cy). Finley's loading estimates suggested bedload constituted approximately 82 percent of the annual deposition in Lake Altoona.

Zika and Trombly (2015) reported that Finley (1976) estimated that of the mean 111,000 cy deposited in Lake Altoona each year, 21,000 cy were deposited in the delta and the remainder (90,000 cy) were deposited in the rest of the lake.

3.2 Simons, Li & Associates (1988)

The SLA study included field reconnaissance of the LECR and divided the LECR into four distinct geomorphic reaches:

1. Reach A immediately downstream of Lake Eau Claire (river miles 22.5 to 25.7)
2. Reach B (river miles 13.9 to 22.5)
3. Reach C (river miles 9.5 to 13.9)
4. Reach D immediately upstream of Lake Altoona (river miles 2.5 to 9.5)

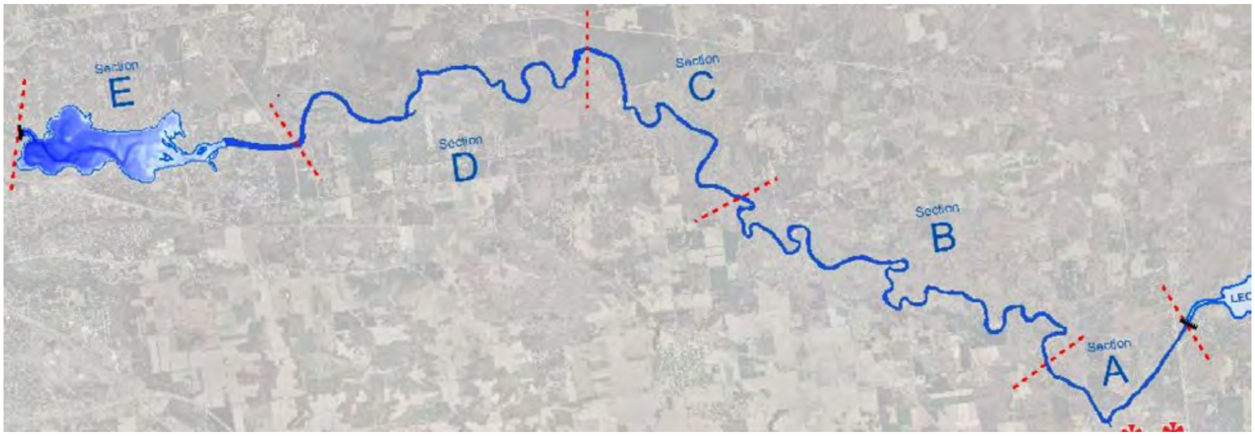

Figure 3. Lower Eau Claire River Channel Reaches (taken from Zika and Trombly, 2015)

Hydraulic reaches (1 through 4) were also identified and roughly correspond to Reaches A through D listed above. Figure 3 shows reaches as identified in Zika and Trombly (2015), with flow from right to left (east to west) from Lake Eau Claire through LECR to Lake Altoona. It is assumed that reaches D and E in Figure 3 correspond to Reach D in SLA (1988). SLA summarized the geomorphic reaches as follows:

Reach A: very stable and bedrock-controlled
Reach B: least stable reach, with evidence of channel migration and bank erosion
Reach C: very stable and bedrock-controlled
Reach D: less stable reach, with evidence of channel migration and bank erosion

SLA conducted a sediment-continuity analysis of the LECR reaches, relying on flow-duration statistics derived from the 1943-1955 USGS gage 05366500 Eau Claire River Near Fall Creek, WI near County Road K, an HEC-2 hydraulic model, sediment transport relationships, and sediment rating curves for each reach.

SLA concluded that there was negligible sediment transport through the Eau Claire Dam and geomorphic Reach A, due to the bedrock control within that reach. Therefore, Reach B was considered as the upstream source of bedload and was identified as “undoubtedly the largest source of sediment due to bank erosion in the watershed.” The authors also concluded that the sediment transport capacity of Reach C was much greater than the supply of sediment from Reach B into Reach C and that little new sediment would be mobilized in Reach C. Thus, sediment loading from Reach B would be transported through Reach C and delivered to Reach D. Their analysis determined that Reach D was an aggradational reach due to sediment supply exceeding sediment transport capacity. Annual bedload supplied to Reach D was estimated to be 59,450 cy, while the bedload transport capacity of Reach D was estimated at 32,244 cy.

Thus, it was estimated that 32,244 cy would be transported through Reach D to Lake Altoona and the remainder of the bedload (27,206 cy) would aggrade in Reach D.

The authors' estimate of 32,244 cy for mean annual bedload delivered to Lake Altoona is reported as an unbulked volume. Unbulked sediment loads reported by SLA assumed a unit weight of 165 lbs/ft^3 and are used to represent sediment transported within a stream. Bulked sediment volume is the volume occupied by sediment after it has settled within Lake Altoona and has a lower unit weight (90 lbs/ft^3 in the SLA study) due to voids in the resulting sediment/water matrix after deposition. In this case, the mean annual bedload of 32,244 cy of unbulked volume corresponds to 59,114 cy unbulked volume within Lake Altoona. SLA noted that when combined with Finley's estimate of wash load (20,576 cy), SLA's more sophisticated estimate of bedload did not produce enough total load to match the observed 111,000 cy per year total load to Lake Altoona. To remain consistent with the observed deposition in Lake Altoona of 111,000 cy per year, the wash load would have to be 51,886 cy per year.

SLA reviewed Finley's methodology for estimating wash load and developed low, medium, and high estimates based on varying gross erosion rates. The low, medium, and high wash load estimates were 53,254, 70,854, and 88,454 cy per year, respectively. The authors noted uncertainty in the estimation of both the bedload and wash load estimates but were satisfied that the estimated wash load of 51,886, as calculated by difference, was consistent with the low estimate of wash load as calculated using the USLE. These estimates suggest a much lower percentage of the total load settling within Lake Altoona is from bedload (53 percent) than Finley's estimate of 82 percent.

The main goal of the SLA report was to analyze the effectiveness of potential bank stabilization and protection within geomorphic Reach B (above Big Falls). The authors concluded that even if bank erosion in Reach B could be reduced by a significant amount, which the authors described as unrealistic, the "highly erodible non-cohesive sand and gravel" in the Reach B channel bed would be eroded instead. They also noted that "no physical limitation" on such erosion is known to exist in Reach B." Furthermore, the authors noted that even "if the sediment supply to Reach D were reduced to less than the current sediment transport capacity of the reach," they would still expect Reach D to scour out deposited sediment and continue to deliver a similar bedload quantity to Lake Altoona as identified in their sediment transport analysis (59,114 cy per year).

3.3 Zika & Trombly (2015)

The Zika and Trombly report provides the most recent summary of the state of the LECR and Lake Altoona. The authors' goals were to provide updates to previous analyses, determine if there had been fundamental changes since the 1988 SLA report, provide new insight, and suggest new strategies for both cost-effective sediment management and potential future studies.

A list of key dates related to Lake Altoona, its sediment loading issues, and past sediment management projects is included in Table 2. This table was adapted from Table 2 in Zika and Trombly (2015) and expanded upon with recent information.

The loading estimates from Finley (1976) and SLA (1988) considered total sediment volume retained in Lake Altoona. Zika and Trombly instead focused their analysis on direct measurements of bank erosion from 43 major bank erosion areas and compared their estimates to similar bank erosion estimates provided by Finley (1976) and Ayres (1979). The period for the Finley and Ayres studies was 1938 to 1975, while the Zika and Trombly study considered the

period 1999 to 2013. Zika and Trombly's methodology consisted of a volumetric calculation of the loss of bank (e.g., recession of the bank, measured perpendicular to the bank) over a period of years times the area of the face of each bank. It is assumed that Finley and Ayres used a similar methodology for their estimates and that the calculated bank erosion volumes are roughly equivalent in volume to bulked sediment (90 lb/ft^3 as defined by Finley, 1976). Zika and Trombly cited total annual bank erosion values of:

1) 56,027 cy from 16 sites from Finley (1976)
2) 122,000 cy from 21 sites from Ayres (1979)
3) 20,743 cy from 43 sites from the Zika/Trombly study (2015)

Table 2. Key Dates Relating to Lake Altoona and Sediment Management (adapted from Zika and Trombly, 2015 and expanded)

Year	Action	Cost	Outcomes
1938	Construction of Altoona Dam	Unknown	
1943-present	USGS operation of stream gage near County Road K	Unknown	
1966	Bathymetric survey	Unknown	Initial annual filling rate of 111,000 cy determined
1975	Establishment of Lake Altoona Rehabilitation and Protection District	Unknown	Raised funds to perform initial studies
1975-1981	Three studies focused on sediment management	Unknown	Recommendation to dredge
1983-1984	Installed riprap on south side of LECR near lake inlet	Unknown	Riprap failure
1988	Simons Li & Associates Study	Unknown	
1995	1,000 willow trees planted to minimize erosion on LECR banks	Unknown	Beavers cut down trees following planting
1996	First dredging and establishment of hydraulic dredging infrastructure	$1,500,000	410,000 cy removed and sand trap created
2001	Sediment trap cleaned	$345,000	80,000 cy removed
2001	Bathymetric survey	Unknown	
2008-2010	Second dredging/sediment trap cleaned	$1,800,000	200,000 cy removed
2011	Sediment trap cleaned due to major 2011 storm	$472,000	55,000 cy removed
2013	Lake bathymetric survey	Unknown	
2016	Dredging	$1,140,000	214,000 cy removed
2018	Installation of stage monitoring equipment at County Roads G and K	Unknown	
2021	Lake bathymetric survey	Unknown	
2022	Dredging of sand trap	$300,000	30,000 cy removed
2022	Period channel bathymetric surveys began	Unknown	
2023	Channel bedload sediment collector obtained	Unknown	
2023 (spring)	Dredging of sand trap	$300,000	30,000 cy removed
2023 (December)	Sediment trap cleaned	$400,000	60,000 cy removed

Zika and Trombly's estimates of mean annual erosion were lower for the common sites measured in earlier studies. Furthermore, Zika and Trombly actually considered additional erosion sites that were not included in the earlier studies, further underscoring how much lower

their estimate of total mean annual erosion was than the earlier estimates. Other than the difference in time period analyzed, there is no clear explanation for the discrepancy in the three studies' estimates. Potential factors impacting erosion rates could include a combination of differences in climatic conditions, conversion of cultivated and hay/pasture areas to forest, and hydrologic response.

The reported mean annual bank erosion of 56,027 cy from Finley may be useful in that it can be compared to the total mean annual bedload from Finley (90,500 cy). A comparison of these estimates does not have a specific physical basis due to potentially complicated sediment transport dynamics, but it is worth pointing out that Finley's estimate of bank erosion *at the source* is 62 percent of their estimate for bedload delivered *to the lake*.

Zika and Trombly's bank erosion methodology appears to give no consideration for bank erosion from areas outside the 43 areas of interest. While these 43 sites likely represent the areas of highest bank erosion rates on a per-stream-mile basis, the remaining streambank miles not considered may collectively contribute significant sediment loads to the LECR.

Zika and Trombly appear to have adopted the reaches from the SLA (1988) report, as shown in Figure 3, with the exception of splitting the lower portion of SLA's Reach D into a shortened Reach D and a new Reach E.

Zika and Trombly state that before settlement, the area was virgin forest and would have had a relatively low sediment supply to the LECR: "The low supply of sediment to the river meant that the riverbed was continually scoured down to bedrock, boulders, and cobble." Zika and Trombly also cited evidence from recent dredging in the LECR "that this [bedrock, boulders, and cobble] is the nature of the sub-floor of the river beneath aggraded sand" and noted that Finley (1976) reported "the subsurface structure is composed largely of pre-Cambrian granite with numerous outcrops all along" the LECR. It is assumed that any information about bedrock, boulders, and cobble underlaying deposited sediment that was gleaned from recent dredging references Reach E as this is the only area where dredging is known to have taken place.

Regarding the SLA (1988) conclusion that reducing bedload to Lake Altoona by controlling erosion in Reach B was unlikely to be successful, Zika and Trombly noted that "glacial sands over which the river runs are estimated to be 200 to 300 feet deep" and that there "would virtually be an unlimited supply of sediment from which to draw," even if attempts at slowing/stopping bank erosion were successful in Reach B. It is assumed that the reference to deposited sediments being 200 to 300 feet deep is referencing only Reach B and not Reaches D or E.

Figure 4, which was taken from Zika and Trombly, shows the volume remaining in Lake Altoona at different points, as determined from bathymetric surveys, along with various sediment deposition rates within the lake. For example, the storage shown for 1938 (16,262,400 cy) is the storage immediately after construction of Altoona Dam. The storage in 1966 is that corresponding to that year's bathymetric survey and the mean annual rate of volume loss between 1938 and 1966 is equivalent to 111,000 cy. The value reported in 1975 can be ignored as it was an extrapolation of the earlier sedimentation rate and is not based on a bathymetric survey. The three lowest lines in the figure (labeled 7.2 TAY, 5.2 TAY, and 4.3 TAY along the x-axis) show different extrapolations corresponding to complete filling of Lake Altoona based on different gross erosion rates (varying wash load deposition rates). The 4.3 TAY line intersects the x-axis at about the year 2085 and corresponds to complete filling of the Lake by that year at a continued 111,000 cy per year.

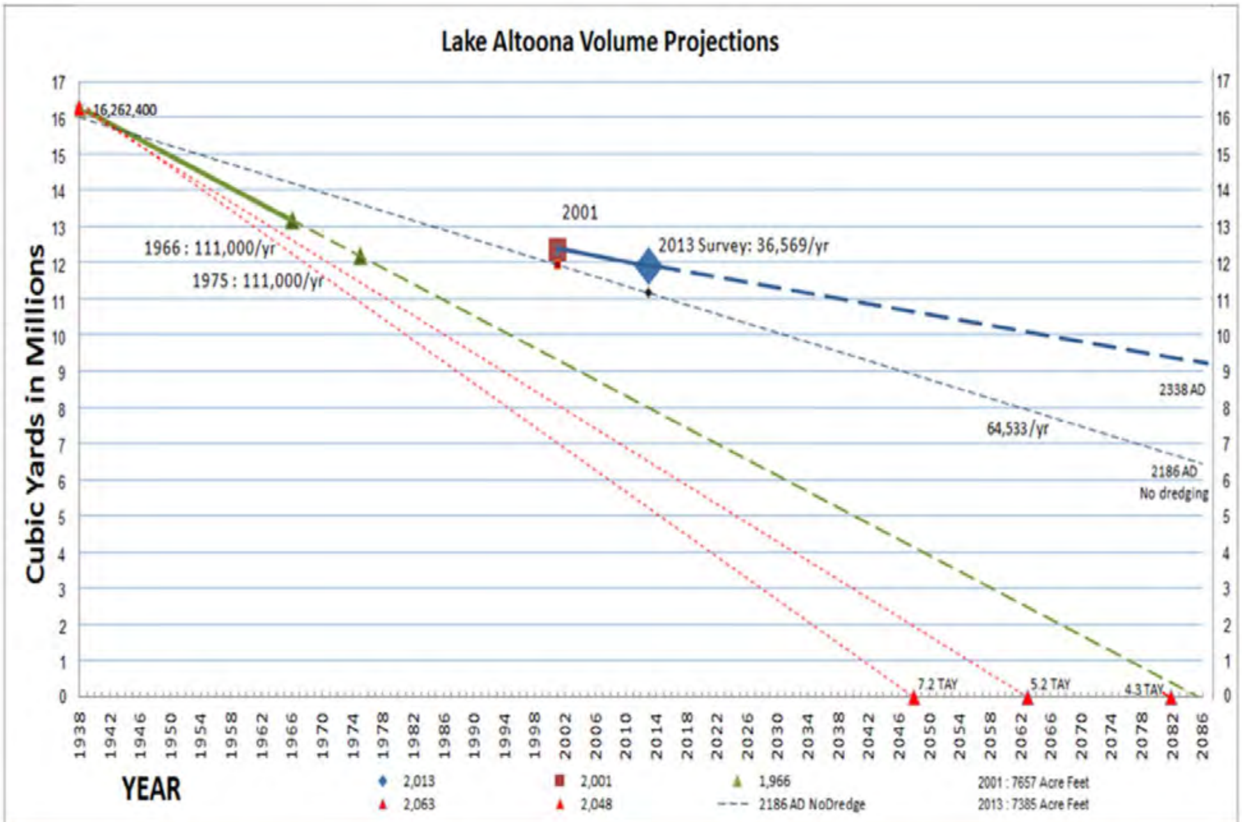

Figure 4. Summary of Bathymetric Surveys and Deposition Rates (taken from Zika and Trombly, 2015)

It is not clear if a mean annual sedimentation rate was calculated for the period between the 1966 and 2001 surveys. However, drawing a line between the 1966 survey volume point and the 2001 survey volume point suggests a mean sedimentation rate of approximately 22,000 to 35,000 cy/yr, depending on whether the high or low point shown for 2001 is used.

Zika and Trombly stated that the figure “shows that from recent bathymetry measurements the total sediment arriving in Lake Altoona is 64,533 cy/yr.” It is assumed that this is the calculated sedimentation in Lake Altoona between the 2001 and 2013 bathymetric surveys.

Zika and Trombly appear to present two differing rates of mean sedimentation in Lake Altoona for present day (prior to 2015):

1) 36,569 cy per year
2) 64,533 cy per year

Zika and Trombly reported that dredging done between 2001 and 2013 reduced sediment deposition in the lake by 43 percent. Because 29,719 cy is 43 percent of 64,533 cy/yr, it seems possible that the actual deposition within the lake was assumed to be the difference between these two amounts (36,616 cy) due to the mean annual dredging of 29,719 cy. It is unclear if the 64,533 cy is the observed sedimentation between 2001 and 2013, or if perhaps this value is what the sedimentation would have been without dredging. Similarly, no discussion was given regarding the two points show in Figure 4 for both 2001 and 2013.

Zika and Trombly proposed several potential mitigation options in their report:

1) Dredging delta and channel
2) Multiple sediment traps upstream
3) Change dredging method from hydraulic to mechanical dredging
4) Apply stream flow reduction strategies
5) Use energy reduction in specific expanded flood plain areas like zone B
6) Sediment disposal/storage options

The first three mitigation options were essentially to optimize dredging operations by considering changes to the number and location of sediment traps and to the method of dredging (hydraulic vs. mechanical). Mitigation options 4 and 5 involve enhancing and/or restoring floodplain connectivity for stream energy and sediment transport reduction. Mitigation option 6 was focused on finding a market/use for the dredged material.

Zika and Trombly also made recommendations for future studies and ongoing work:

1) Use of LiDAR data to determine erosion hot spots and historical trends
2) Regular scheduling of lake bathymetric maps
3) Establish river stage continuous monitoring site and calibrate for discharge rate (flow)
4) Determine river transported sediment type and size distribution
5) Establish relationship for stream discharge rate vs. sediment transport rates to predict lake sediment loading
6) Coring to characterize lake sediment
7) Subsurface profiling of river channel
8) Create accurate elevation map of riverbed, backwater, and potential aggradation sites
9) Identify best locations for upstream sediment traps and catchment basins
10) Identify and design reconnectivity and improved habitat projects

Recommendation 1 would involve expanding the analysis done for the period 1999-2013 by Zika and Trombly to earlier period (1938-1972 and 1972-1999). Recommendation 2 is for regularly scheduled bathymetric mapping of Lake Altoona as an incremental measure of historical sedimentation in the lake.

Recommendations 3, 4, and 5 deal with in-stream monitoring of the LECR. First is a recommendation for river stage monitoring to create a discharge record. Second is a recommendation for sediment transport monitoring in LECR. The third recommendation is to establish a relationship between stream discharge and sediment concentration or transport.

Recommendation 7 proposed coring lake bottom sediments to collect data about layers of sediment that have deposited since 1938. These data could provide insight about both spatial trends within the lake and temporal trends over time. Recommendation 8 proposed to gather information about the depth and characteristics of sediment, and depth to layers such as cobble or bedrock, within the LECR.

Recommendation 8 is a suggestion to improve mapping of riverbed and riparian sites that could be used for potential enhancement and/or restoration of floodplain connectivity for stream energy and sediment transport reduction. Recommendation 9 calls for an analysis to select candidate locations for sediment traps and/or catchment basins. Recommendation 10 was for an analysis and design of floodplain re-connectivity and habitat improvement projects.

3.4 Additional Studies

Two additional studies were reviewed for information about sediment transport in the LECR and impacts on the storage and water quality in Lake Altoona. The studies reviewed were Limnological Analysis of Lake Altoona, Wisconsin by James, Barko, and Eakin (James et al., 2000) and Phosphorus Loading Model for Lake Eau Claire and Lake Altoona by Freihoefer and McGinley (Freihoefer and McGinley, 2009).

The James et al. (2000) report focused on water quality in Lake Altoona and included an examination of phosphorus fluxes from the LECR, within Lake Altoona, and over the Altoona Dam. A lake eutrophication model was developed to understand the importance of external and internal phosphorus loads and to model phosphorus management scenarios. The report found residence times of greater than 15 days during periods of "nominal inflow" and residence times often dropped to less than 1 day during periods of peak inflow.

The report included the following periods of monitoring data collection:

1) LECR stage at County Road K from November 1999 to November 2000
2) Bridge Creek stage near WI Highway 27 from April 2000 to November 2000
3) Fall Creek stage at the Fall Creek Dam from April 2000 to November 2000
4) Lake Altoona pool elevation data (obtained from Eau Claire County Parks and Forest Department)
5) Water quality samples from tributary inflows and the Altoona Dam were collected during storms and bi-weekly and were analyzed for the following constituents:
    a. Total suspended sediment (TSS) concentration
    b. Particulate organic matter (POM) concentration
    c. Total nitrogen (TN) concentration
    d. Total phosphorus (TP) concentration
6) Water quality samples within Lake Altoona were collected bi-weekly during the ice-free period for various parameters, including:
    a. Water temperature
    b. Total phosphorus (TP) concentration
    c. Soluble reactive phosphorus (SRP) concentration
    d. Secchi disk transparency

Six sediment cores were also collected from Lake Altoona and were analyzed in the laboratory for release of soluble reactive phosphorus (SRP) from the sediment. The authors noted the presence of algal blooms, including the blue green *Aphanizomenon flos aquae*, which are driven by both externa and internal phosphorus loads to Lake Altoona.

The authors noted that only 30 percent of the TSS load from the LECR was retained in Lake Altoona during the study period. The authors did not consider bed load in their analysis.

Freihoefer and McGinley (2009) developed a Soil and Water Assessment Tool (SWAT) model for the entire Eau Claire River Watershed. The SWAT model was developed to reflect the hydrology and sediment and nutrient loads that occur through the Eau Claire River Watershed and was calibrated to available monitoring data. The model was also used to develop sediment and phosphorus reductions strategies to improve water quality throughout the watershed.

The SWAT model employed relevant data collected as part of the James et al. (2000) study, including stream gage and TSS and TP concentration collected on the LECR at County Road K, Bridge Creek near WI Highway 27, and Fall Creek at the Fall Creek Dam. Monitoring data on

Bridge and Fall Creeks were only collected in 2000 and included daily discharge measurements for 5 months and 48 samples of both TSS and TP. Data on the LECR was collected in each of the years from 1996 through 2003. A total of 19 samples of TSS and TP were collected at the LECR site.

The SWAT model was developed for the six-year period from 1998 to 2003. Average phosphorus loads to Lake Altoona were estimated to be approximately 62,000 kg/yr. Suspended sediment results were not discussed in detail, but the authors stated that "suspended sediment delivery in the Eau Claire River Watershed was approximately 4,150 metric tons per year." This annual load appears consistent with the monthly values reported at the LECR site (Figure 27 in Freihoefer and McGinley [2009]) for December 1999 through October 2000. Using the bulked sediment unit weight of 90 lb/ft^3 from SLA (1988), this annual TSS load corresponds to approximately 3,765 cy, a relatively small volume compared to the estimates of 22,000 to 111,000 cy of total deposition in Lake Altoona reported for earlier time periods in other studies.

4.0 Lake Altoona and the LECR Today

4.1 Sedimentation in Lake Altoona

The initial rate of sedimentation in Lake Altoona was determined to be approximately 111,000 cy per year (1938 to 1966). Recent bathymetric surveys show that the sedimentation rate within the lake has slowed, with mean annual estimates after 1966 ranging from approximately 22,000 to 64,533 cy. Estimates range widely on how much of this sedimentation is attributable to both bedload and wash load. No explicit estimates were reported for suspended sediment, except by Freihoefer and McGinley (2009), though their estimate of annual suspended sediment load was less than 4,000 cy. The original mean annual bedload estimate (1938 to 1966) was 90,500 cy/yr, with a more recent estimate of erosion from key bank erosion sites by Zika and Trombly (1999 to 2013) of just 20,743 cy. Note that while this estimate from Zika and Trombly is not a true measurement of the actual bedload, Zika and Trombly did note that a significant portion of the bedload reported by Finley (1976) was attributable to bank erosion from major bank erosion sites.

Estimates of wash load deposited in Lake Altoona have been based on assumed rates of erosion from upland areas in the LECR Subwatershed, upland sediment characteristics, assumed sediment delivery ratios, and/or assumed trapping efficiency within Lake Altoona for sediment that becomes detached at the field scale. While literature values are available to make these estimates, there is a wide range of error, and to date the only published estimate of suspended sediment loads is that by Freihoefer and McGinley (2009). Wash load estimates range from 20,576 to 51,886 cy/year (Finley, 1976 and SLA, 1988), though both estimates were calculated by difference between the measured sedimentation rate of 111,000 cy/yr and the respective studies' estimate of bedload delivered to Lake Altoona.

4.2 Sedimentation in the LECR

The SLA (1988) study provided hydraulic modeling estimates of the sediment transport capacity of reaches B, C, and D in the LECR. SLA (1988) found that Reach B is a significant source of sediment in the LECR and Zika and Trombly (2015) noted that there is "virtually an unlimited supply of sediment from which to draw." Reach C was found to be a bed-rock stabilized reach that would produce little erosion, but had sediment transport capacity sufficient to transport essentially all of the bedload received from Reach B and transport it to Reach D. Reach D was

found to be an aggradational reach as the amount of sediment it can move is less than that received from reach C, which ultimately originates largely in Reach B. The results of the hydraulic modeling performed by SLA (1988) are consistent with what has been observed in the LECR and the Lake Altoona delta over the past decades: continued sediment deposition that prevents access to the LECR from adjacent parcels, limits recreational traffic between Lake Altoona the LECR, and ultimately diminishes recreational enjoyment on the water.

4.3 Dredging of LECR and Lake Altoona Delta

The LARPD has coordinated several efforts to dredge the LECR in Reach E and the Lake Altoona delta. A summary of all known dredging since 1996 is included in Table 3. A total of 1,079,000 cy have been dredged since 1996 at a total cost of $6,257,000.

Table 3. Summary of Dredging Since 1996

Year	Dredge Volume (cy)	Cost	Average Cost ($/cy)
1996	410,000	$ 1,500,000	$ 3.66
2001	80,000	$ 345,000	$ 4.31
2008/2010	200,000	$ 1,800,000	$ 9.00
2011	55,000	$ 472,000	$ 8.58
2016	214,000	$ 1,140,000	$ 5.33
2022	30,000	$ 300,000	$ 10.00
2023 (spring)	30,000	$ 300,000	$ 10.00
2023 (December)	60,000	$ 400,000	$ 6.67
Total	**1,079,000**	**$ 6,257,000**	**$ 5.80**

4.4 Sediment Bedload Collector

The LARPD has obtained a 30-ft wide sediment bedload collector, with the hopes that the collector can be installed in the bed of the LECR (Reach E) to provide a more sustainable approach than dredging by reducing costs and allowing for continuous removal of sediment.

There have been challenges with installing and operating the 30-ft collector. The US Army Corps of Engineers Saint Paul District and Engineer Research and Development Center (ERDC) are involved in a pilot study, with a smaller 12-ft collector, to test whether a collector will work in the LECR. If successful, the plan would be for LARPD to install and operate the 30-ft collector in lieu of dredging.

Note that while this PAS project is occurring in parallel with the sediment collector pilot study, the pilot study is a separate project. Any information or outcomes learned from the ongoing sediment collector pilot study will be incorporated as appropriate when preparing for and completing any future work, including the work proposed in a possible Phase 3 of this project.

4.5 Monitoring

There are two active continuous stream level monitoring gages on the Eau Claire River – one on the LECR at the County Highway K bridge, and another on the Eau Claire River upstream of Lake Eau Claire near the County Highway G bridge. Both gages have been in operation since 2018 and provide approximately 6 years of continuous stage data for the LECR and Eau Claire River above Lake Eau Claire.

There is also a USGS streamflow gage (USGS 05366500 Eau Claire River Near Fall Creek, WI) just upstream of the County Road K bridge. This site has annual peak streamflow data (one data point per year) available from 1943 to present and daily streamflow data available for the period 1942 to 1955.

Since the spring of 2022, there have been ongoing bathymetric surveys taken of the LECR sediment trap (near the boat ramp approximately 1.5 miles upstream of Lake Altoona) to understand the dynamics and timing of the sediment trap filling. These surveys are typically done several times, with several weeks between surveys, following cleaning of the sediment trap. As-built surveys of the sediment trap were first collected on June 18, 2022, by LARPD volunteers. USACE provided support by processing these data and recommending improvements to improve data collected in future surveys. Figure 5 shows as-built conditions of a sediment trap with dimensions of roughly 600 ft x 55 ft.

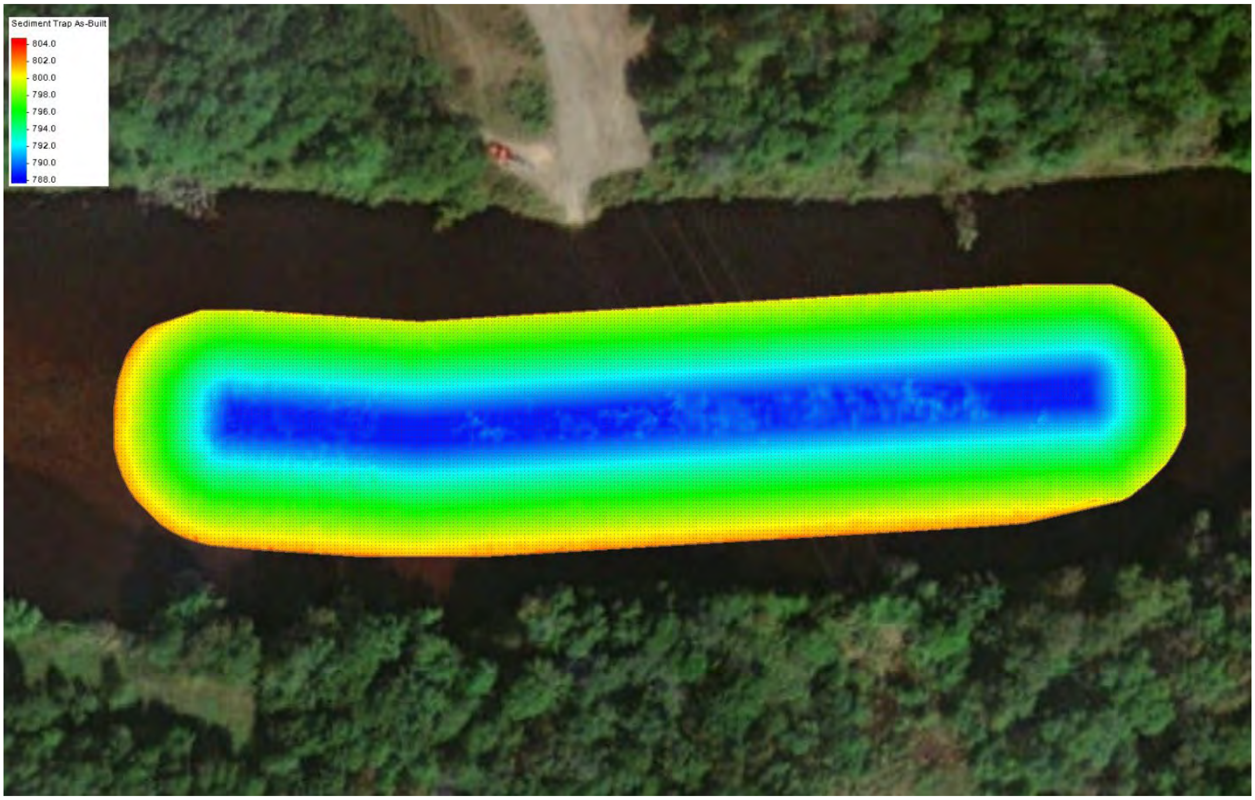

Figure 5. As-Built Sediment Trap

5.0 Future Modeling Options and Recommendations

The following sections summarize the framework of a study strategy to determine sediment transport mechanisms impacting Lake Altoona and development of an enhanced modeling tool for use in planning applications related to sediment transport and management. These sections summarize existing data, list additional data needs, and present potential modeling options for developing the final hydraulic and sediment transport model that would ultimately be used by LARPD and partners to guide future sediment analysis and management work. Appendix A of this document lays out a more formal and detailed draft scope of work corresponding to the following sections. The scope of work allows for potential inclusion of a Technical Advisory Committee (TAC) that would assist in guiding the study. The TAC would allow for input by local,

county, state, and federal government representatives, as well as other interested non-governmental entities. The TAC would provide useful guidance and expertise that would add value to the study. Appendix B of this document includes a draft budget and assumptions corresponding to the draft scope of work.

5.1 Hydrologic Data and Modeling

Stream gage and hydrologic data available include:

1) LECR – near the County Road K bridge
    a. USGS gage 05366500 Eau Claire River Near Fall Creek, WI
        i. Continuous flow record from 1942 to 1955
        ii. Annual peak discharges from 1943 to present
    b. A gage operated by the Eau Claire River Watershed Association
        i. Continuous stage data from 2018 to present (no rating curve)
2) Eau Claire River (above Lake Eau Claire) at County Road G
    a. A gage operated by the Eau Claire River Watershed Association
        i. Continuous stage data from 2018 to present (no rating curve)
3) Altoona Dam (Lake Altoona outlet)
    a. Stage and/or discharge data for an undetermined period (data availability is unknown)
4) Eau Claire Dam (Lake Eau Claire outlet)
    a. Stage and/or discharge data for an undetermined period (data availability is unknown)
5) SWAT model results (Freihoefer and McGinley, 2009)

Additional data or modeling needs may include:

1) Longer-term continuous streamflow data at the County Road K bridge
2) A rating curve for the County Road K bridge stream gage
3) An updated/extended SWAT model to provide the hydrologic basis for the hydraulic model
4) A calibrated HEC-HMS hydrologic model of the entire Lake Altoona Watershed to develop a continuous hydrograph for the LECR since construction of the Altoona Dam
5) A statistical approach to hydrologic parameters and relevant statistics (e.g., flow-duration curves or return period storms of interest)

A full hydrologic model would allow for the most realistic representation of historic and existing hydrology for use in the subsequent hydraulic model.

5.2 Hydraulic Data and Modeling

Consideration was given to a range of available hydraulic models. Ultimately, the sediment transport and management challenges present in the LECR are best suited for a one-dimensional (1-D) hydraulic model due to the characteristics of the river’s relatively narrow channel and heterogenous conditions (such as sediment and depth) across the channel. While a two-dimensional (2-D) could also be employed, it is expected that there would be little to no additional value in the model results, while there would be substantially more cost in terms of data collection, model setup, model run times, and analysis. A 2-D model would be more appropriate in a larger system, such as the Mississippi River, where there are diverse landscapes, flow regimes, and users of the river, such as barge traffic in the navigation channel

or habitat restoration in a backwater. Ultimately, the sediment problems in the LECR are driven by sediment transport that is relatively one-dimensional in its march towards Lake Altoona.

A HEC-RAS one-dimensional unsteady flow model with sediment transport is the appropriate tool for the hydraulic and sediment modeling needs of the LECR and Lake Altoona sediment problem.

Data needs for the hydraulic model are as follows:

1) Any existing hydraulic models (e.g., state or county DOT HEC-RAS models), including the existing FEMA effective HEC-2 model of the LECR just above Lake Altoona
2) Hydrologic time series (described in the previous section)
    a. LECR discharge at the upstream boundary condition, likely at the County Road K bridge
    b. Downstream water surface elevation in Lake Altoona or at the Altoona Dam
    c. Additional model output for past/future conditions or flow conditions of interest
3) Hydraulic characteristics of the LECR
    a. Channel bed/roughness characteristics (Manning's n)
4) Hydraulic details of any existing structures or bridges (e.g., pier dimensions and low chord elevations)
5) Detailed channel survey data:
    a. Longitudinal survey with adequate resolution
    b. Cross section surveys at adequate spacing and resolution (informed by channel conditions and bed materials)

5.3 Sediment Data and Sediment Transport Modeling

Sediment transport will be modeled and analyzed within the one-dimensional HEC-RAS model. Data needs for the sediment transport modeling component include bed sediment particle size distributions at multiple locations.

It is also suggested that a bathymetric survey of Lake Altoona be completed, to include sediment coring in strategic locations. Sediment coring would provide insight about the characteristics of the sediment deposited, and ultimately improve understanding of the break down between in deposited wash load and bedload throughout the Lake. Information about bed thickness throughout the lake could also be used to validate the sediment transport model.

5.4 Modeling Process and Analysis of Alternatives

The modeling process will first center on model validation. There are several potential sources of model validation. Potential long-term sediment transport simulations could be validated against observed infilling of Lake Altoona. Alternatively, more recent periods could be modeled to validate against observed infilling of the sediment trap after cleanouts.

Once the model is successfully validated, several sediment management alternatives can be developed and analyzed for their potential to reduce sedimentation in the LECR. These alternatives can be iteratively updated to reflect changes based on interim results and stakeholders' preferences.

5.5 Modeling Limitations

The sediment transport modeling as proposed will focus only on the bedload component of sediment delivered to Lake Altoona. Previous studies have produced varying estimates of the amount of suspended sediment (including wash load) that is retained within Lake Altoona. Wash load will not be considered as part of the sediment modeling for this project as other agencies and organizations are working to address the nonpoint sources of sediment originating in upland areas of the LECR Subwatershed.

5.6 Additional Future Work (Potential Phase 3b)

It is likely that additional work would be necessary to move from sediment modeling to project implementation or construction. This work has been outlined as Phase 3b (Tasks 11 through 13) in the attached draft scope of work in Appendix A. This work would likely include screening alternatives to evaluate proposed alternatives for cost, effectiveness, permitting, property/legal issues, and stakeholder acceptance. It is expected that this process would result in a ranked listing of alternatives.

Finally, it is expected that additional modeling and design work would be necessary to further develop a project or projects for potential implementation or construction. A final report would be created upon finalization of project options.

6.0 References

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Appendix A: Draft Scope of Work

Draft Phase 3 Scope of Work-Lake Altoona Sediment Management Study

Background

Lake Altoona is in Eau Claire County, Wisconsin and lies within the City of Altoona and the Towns of Seymour and Washington. Lake Altoona was formed by construction of the Altoona Dam on the Lower Eau Claire River (LECR) in 1938. The Lake Altoona Watershed totals approximately 813 mi^2 and comprises two subwatersheds: the Lake Eau Claire Subwatershed (597 mi^2) and the LECR Subwatershed (216 mi^2). The entire Lake Eau Claire Subwatershed is controlled by the Eau Claire Dam, which was constructed in 1937, and forms Lake Eau Claire approximately 26 river miles upstream of the Altoona Dam.

Since construction of the Altoona Dam in 1938, sediment transport from the LECR has resulted in sedimentation and formation of a delta at the upstream (east) end of Lake Altoona. This sediment delta, along with deposition immediately upstream in the Eau Claire River, has prevented and negatively impacted recreational access to and the water quality of Lake Altoona. Lake Altoona has been identified as “highly eutrophic” by the Wisconsin DNR (2024) and is listed on the EPA 303(d) list as impaired due to excessive algal growth, which is fueled by elevated phosphorus concentrations within the lake. Excessive sediment delivery to the lake delivers particulate phosphorus to the lake and contributes to algal growth. Extensive algal blooms are common in Lake Altoona during the growing season and have contributed to beach closures (West Central Wisconsin Regional Planning Commission, 2017).

The Lake Altoona Rehabilitation and Protection District (LARPD) was established in 1975 and since 1996 has managed repeated dredging of sediments in 1.5 miles of the LECR above Lake Altoona, as well as the Lake Altoona delta. Since 1996, at least $6,257,000 has been spent on dredging to maintain recreational access between the LECR and Lake Altoona as well as to reduce the amount of bed load reaching Lake Altoona and filling in the reservoir.

Study Objectives

The overall objective of this study is to identify, analyze, and prioritize alternatives for more efficiently managing bed load sediment from the LERC to Lake Altoona. It is hoped that a solution will provide a more sustainable, predictable, beneficial, and cost-effective method of maintaining recreational access to the LECR and Lake Altoona, while also minimizing transport of bed load materials to prevent excessive loss of storage volume in Lake Altoona.

The study will evaluate past and existing conditions to establish a baseline understanding of sediment transport dynamics in the LECR and Lake Altoona delta. The study will identify and evaluate alternatives for sediment management in the lower portions of the LECR. It is expected that the study area will extend from the stream gage near the County Road K bridge to the Altoona Dam, which is approximately 11 river miles. The USACE will develop a HEC-RAS one-dimension (1D) unsteady model to analyze hydraulics and sediment transport within the LECR.

Task 1: Work Plan, Schedule, Coordination and Progress Meetings (LARPD/USACE)
This task focuses on the development of a work plan to establish budget, roles, and responsibilities for the project team, including LARPD representatives and USACE; a detailed schedule with associated tasks, milestones, and final completion date; a review plan, and ongoing project coordination and progress meetings to ensure timely delivery of services.

Deliverables:
USACE:
1. Work plan
    - Within 30 business days from notice to proceed.
2. Study Schedule
    - Schedule shall identify the critical path for the project, including key tasks and milestones.
    - Biweekly schedule/progress updates.
3. Review Plan
4. Study Kick-Off and Progress Meetings
    - Kick-off meeting (Assumed to be held in-person in the Eau Claire area and 2 hours in length). 3 USACE personnel will attend (2 hydraulic engineers and 1 project manager).
    - Monthly progress meetings (Assumed to be held virtually and 1 hour in length.) At a minimum, the attendees should include LARPD and USACE. 3 USACE personnel will attend (2 hydraulic engineers and 1 project manager).
    - Detailed meeting minutes.
    - Identify & track action items discussed at progress meetings.

LARPD:
1. Attend and assist in planning the kick-off meeting, as well as monthly progress meetings

Task 2: Public and Agency Involvement (LARPD/USACE)

Stakeholder engagement will be critical for this study. LARPD will be responsible for leading stakeholder and public involvement efforts. USACE will participate in stakeholder engagement. Tasks 2 and 3 will continue through all phases of the study.

Task 2a: Identify Stakeholders (LARPD)

Identify and create a contact list of all stakeholders, including state and federal agencies, permitting agencies, elected and appointed officials, special interest, and advocacy groups. The list will be updated throughout the study, as needed.

Develop a schedule for public involvement activities, and identify what information is needed prior to those activities. Conduct an initial outreach and engagement process to better understand the study area and how the study affects the various stakeholders. Document and review stakeholder outreach participation and modify processes to meet stakeholder's needs.

The LARPD will be responsible for keeping the appropriate stakeholders informed, involved and gain the required consent and approval of the study.

Below is a draft list of potential stakeholders as an initial starting point:

State and Possible Participating Agencies:
- WI Department of Natural Resources

Federal and Possible Cooperating Agencies
- Army Corps of Engineers
- US Coast Guard
- US Fish and Wildlife Service

Local and Possible Participating Agencies
- Watershed Districts/Water Management Organizations
- Counties
- Townships
- Cities
- Towns
- Private and Public Utilities
- Media outlets and contacts

Deliverables:

LARPD:
1. Stakeholder engagement list, updated monthly or as needed.
2. Stakeholder engagement schedule.

Task 2b: Public Involvement (LARPD/USACE)

Four public engagement meetings are assumed, with all being in-person in the Eau Claire area:
1. the initial study kickoff meeting (it may be possible to combine this with the kick-off meeting listed in Task 1)
2. one progress meeting,
3. a meeting to discuss the draft study results, and
4. a meeting to discuss the final study results.

The meetings will include a formal presentation. LARPD and USACE will hold a planning meeting before each public meeting to review proposed agenda and presentation materials.

LARPD duties will include meeting attendance and preparation of meeting materials including mailing list, meeting notices, sign-in sheets, handouts, and exhibits/display boards.

USACE duties will include preparation of materials to present, meeting attendance, and presenting. USACE will also coordinate and support LARPD in preparation and compilation of meeting materials including handouts and exhibits/display boards.

After each meeting, LARPD will provide an electronic copy of the report and all materials presented. LARPD will provide a meeting summary, attendance record and record public/agency comments. LARPD and USACE will review of comments made at the meetings to help determine the best course of action based on the feedback.

LARPD will develop and maintain a webpage that keeps the public informed on the progress of the study.

Deliverables:

LARPD:

1. Attend four meetings for public engagement.
2. PDF of all exhibits, handouts, and display boards used at the meetings.
3. Electronic copy of presentations, and sign-in sheets.
4. Public Engagement meeting summary from each meeting with comments and responses recorded.
5. Study website.

USACE:

1. Coordinate and provide necessary information to LARPD in preparation for public engagement meetings.
2. Attend four meetings for public engagement.
3. Provide feedback on comments received from stakeholders relating to the hydraulic and sediment transport model.

Task 3: Technical Advisory Committee (LARPD/USACE)

The key agencies with permitting responsibilities or critical data and technical knowledge will be assembled as a Technical Advisory Committee (TAC) to advise on the study execution, and findings. LARPD will propose members for the TAC based on the input from the stakeholders. The LARPD will coordinate with the TAC, including organizing TAC meetings at key points of the study (assumed to be held virtually), conduct each meeting, and prepare detailed minutes for distribution. It is assumed there will be up to five TAC meetings, at key milestones in the study process. Three USACE personnel will attend the TAC meetings (2 hydraulic engineers and 1 project manager), with additional time included for USACE personnel for meeting preparation and post-meeting coordination. Topics presented to the TAC may include, but are not limited to, existing conditions, preliminary concepts/alternatives, impact assessment, alternative screening, feasible range of alternatives, public input meeting material, and draft report.

Deliverables:

LARPD:

1. Preliminary and final list of members for TAC.
2. TAC meeting agendas.
3. TAC meeting minutes.

USACE:

1. Coordinate with LARPD for development of TAC agendas and technical materials for TAC meetings.

PHASE 3a:

Task 4: Existing Data Collection and Review (LARPD/USACE)

The first step in the study will be to review and compile existing information to include any prior hydraulic models within the study area and identify data gaps. There is an existing HEC-2 hydraulic model of the portion of the LECR just above Lake Altoona that was developed in about 1980 for a FEMA Flood Insurance Study. There may be other hydraulic models that can be leveraged for this study effort, but they have not been identified to date.. However, some of the models or data sets might be outdated, use different methodology, or have limited survey information.

The following subtasks will be completed to collect and compile information necessary to evaluate existing conditions:

- Obtain the effective Flood Insurance Rate Map model for Eau Claire River (FEMA Model) in the vicinity of Lake Altoona from the Wisconsin Department of Natural Resources.
- Collect the most recent available LiDAR-derived digital elevation models (DEMs) for use in modeling (USACE).
- Obtain and provide all available Lake Altoona bathymetric survey data (LARPD).
- Obtain and provide all available LECR bathymetric data, as well as metadata pertaining to the conditions at time of collection (e.g., bathymetry collected 3 weeks after sediment trap was cleaned) (LARPD).
- Obtain and provide all available historical stream or dam gage information (LARPD):
- County Road G stream level (stage) data from 2018 to present.
- County Road K stream level (stage) data from 2018 to present.
- All available stage or operations data for the Eau Claire and Altoona Dams.
- Obtain and provide all sediment sample data (LARPD).
- Coordinate with USGS and Wisconsin DNR to obtain any additional information related to stream gaging, including rating curves, in the watershed (LARPD/USACE).
- Coordinate with relevant agencies to obtain any relevant hydraulic information for the study area (e.g., bridge construction plans) (LARPD/USACE).
- Compile all relevant studies of the LECR and study area, including previous hydrologic and hydraulic analyses to understand what has been studied previously (LARPD, USACE).

Deliverables:

LARPD:

1. All available existing data, as listed above.
2. Copies (digital or physical) of all available studies relevant to the LECR.

USACE:

1. Processed stream gage data (converting to stage to discharge) based on rating curves obtained from LARPD or agencies or developed through HEC-RAS modeling.

Task 5: New Data Collection (LARPD/USACE)

The existing river stage gage at County Road K (installed in about 2018) does not yet have a rating curve finalized to convert river stage readings to discharge. An optional USACE task would include collection of stream discharge measurements and development of a rating curve at the County Road K bridge. Whether developed by USACE or others, a rating curve is required to use the County Road K gage data in development of the hydrologic and hydraulic models. Note that collection of data to fully develop the rating curve over a range of flows would take multiple site visits and could take months or years to complete.

It is assumed that there is little to no detailed survey of the channel within the study area. A detailed topographic and channel survey throughout the study area is required to support development of the one-dimensional HEC-RAS hydraulic and sediment transport model. There are three options for collecting the required bathymetric survey data:

1. USACE (2 personnel working up to 10 days) conduct a full bathymetric survey of the study reach (Upstream of County Road K to the LECR delta). The detailed channel survey will include a longitudinal thalweg survey of appropriate resolution and detailed channel cross section surveys at appropriate intervals (assuming approximately every 1,000 ft) and specific areas of interest throughout the study reach. USACE personnel would collect up to 12 channel bed samples for particle size analysis.
2. LARPD and/or partners conduct a partial channel survey (deeper areas) using single/multi-beam survey equipment. Additionally, two USACE personnel (working up to 5 days) conduct a survey to capture cross section surveys of those areas not covered by the data collected by LARCP and/or partners. This would include shallower and near-bank areas. USACE personnel would collect up to 12 channel bed samples for particle size analysis.
3. LARPD and/or partners collect a full bathymetric survey using single/multi-beam survey equipment and/or traditional survey methods. This survey option would require LARPD and/or partners to collect bed sediment samples to particle size analysis. This option includes minimal remote coordination with USACE personnel but does not include any on-the-ground survey by USACE personnel.

Option: LARPD and/or partners conduct a detailed bathymetric survey of Lake Altoona.

Regardless of the survey method used in the LECR, USACE will gather the best available survey data and existing LiDAR data to create a topobathy dataset for the study area.

Collection of sediment coring data in Lake Altoona may be beneficial for hydraulic and sediment transport modeling, but also as a means to understand the depositional patterns within Lake Altoona since construction of the Altoona Dam. There are two options for performing sediment coring:

1. LARPD and/or partners perform sediment coring at points of interest within Lake Altoona
2. USACE performs sediment coring assumption one mobilization and de-mobilization of 3 USACE personnel for up to 4 days of coring at up to 12 locations within Lake Altoona. Locations would be split between the original LECR channel and overbank areas, with greater sampling density in the sediment delta area.

An optional task for sediment particle size analysis of samples collected from Lake Altoona is also included and is based on analysis of 60 sediment samples.

LARPD will coordinate survey access with landowners or agencies (e.g., Eau Claire County), as needed.

<u>Deliverables:</u>
LARPD:

1. Optional LECR bathymetric survey (partial or full)
2. Optional channel bed sediment sample collection at up to 12 locations along the LECR study area

3. Optional Lake Altoona bathymetric survey
4. Optional Lake Altoona sediment coring and sediment sample collection

USACE:
1. Optional flow measurement and rating curve development at County Road K gage
2. Optional LECR bathymetric survey (partial or full)
3. Optional channel bed sediment sample collection at up to 12 locations along the LECR study area
4. Topobathy dataset of the study area reflecting the best available topographic and bathymetric data
5. Optional sediment coring in Lake Altoona, to include sediment size analysis of up to 60 samples from up to 12 sites, data processing, and a summary of coring results
6. Optional coordination for sediment particle size analysis if the LECR bathymetric survey is conducted entirely by LARPD and/or partners

Task 6: Hydrology Development (USACE)

The U.S. Geological Survey (USGS) operates a streamflow gage (05366500) at County Road K near the upstream end of the proposed modeling reach. An annual peak flow- frequency curve for USGS gage 05366500 will be developed analytically according to methodology presented in Bulletin 17C (USGS, 2019) and HEC-SSP version 2.4.

Flow duration curves upstream of Lake Altoona will be developed using two methods. First, a flow duration curve will be developed using the daily discharge at USGS gage 05366500 for the period 1942 – 1955. Because the daily data at the gage were collected decades ago and may not be representative of present-day flow duration curves, a second method will be used to develop a flow duration curve. The regionalized duration curve method described in *Effective Discharge Calculation: A Practical Guide* (Biedenharn and Copeland, 2000), will be used to develop a comparison flow duration curve.

Gage	Data Type	Period of Record
USGS 05366500 EAU CLAIRE RIVER NEAR FALL CREEK, WI	Peak streamflow	1943 – present
USGS 05366500 EAU CLAIRE RIVER NEAR FALL CREEK, WI	Daily discharge	1942 – 1955
LARPD gage at County Road G	Continuous stage (unknown frequency)	2018 – present
LARPD gage at County Road K	Continuous stage (unknown frequency)	2018 – present

Option (USACE): Evaluate the existing SWAT model for the Lake Altoona Watershed (Freihoefer and McGinley, 2009) as a potential basis for hydrology used in the HEC-RAS model.

Option (USACE): Develop a HEC-HMS model of the entire Lake Altoona Watershed and calibrate HEC-HMS model to available data at the County Road G and K stream gages and the Eau Claire and Altoona Dams. The calibrated model would be used to recreate a continuous hydrograph from 1938 to present, to coincide with the existence of the Altoona Dam.

Volume-Frequency Analysis- 1-, 3-, 7-, 15-, and 30-day annual maximum volume timeseries at sites of

interest will be generated to support the development of volume frequency curves at each site. Unregulated volume frequency analysis will be conducted for the 1-, 3-, 7-, 15-, and 30-day annual maximum volume timeseries using HEC-SSP version 2.4 and methods prescribed in Bulletin 17C. Historic data will be incorporated using EMA, and low outliers will be identified using the Multiple Grubbs-Beck test. If the curves at a particular site cross, skew and standard deviation will be smoothed. The skew and standard deviation of the unregulated, annual instantaneous peak flow-frequency curve will be used as an anchor point when smoothing statistics for the 1-, 3-, 7-, 15-, and 30-day curves. After generating unregulated, volume frequency curves at Grand Forks, Oslo, Drayton, and Emerson the curves at each site will be compared to one another, and further statistic smoothing may be pursued to prevent curves crossing between sites.

Deliverables:

LARPD:

1. Optional updated SWAT model

USACE:

2. Technical Memorandum summarizing findings, that will be incorporated into the draft and final study report.

Task 7: Existing Conditions Hydraulic Modeling (USACE)

The USACE will develop a HEC-RAS one-dimensional unsteady flow model to represent the study area.

Model Geometry:

a) Incorporate model structures as necessary, to include the Country Road K bridge.
b) Cross Sections: Incorporate newly obtained bathymetric data.

Model Calibration:

a) The currently published (at time of project kick-off) HEC-RAS software version will be used for the study.
b) Calibrate to a minimum of two events (post 2018) using data from the continuous stage gage at County Road K. For this task, we assume that the available gage data at County Road K is useable for calibration.
c) Validate a minimum of 1 event not used in the calibration.

Existing Conditions Results:

a) Prepare water surface profiles for flow rates of interest.

Deliverables:

USACE:

1. Calibrated one-dimensional unsteady flow HEC-RAS model.
2. Water surface profiles at flow rates of interest (e.g., for 2, 5, 10, 25, 50, 100, and 500-year events for existing conditions.
3. Technical memorandum outlining the modeling approach and results, which will be incorporated into the draft and final study report.

Task 8: Existing Conditions Sediment Transport Modeling (USACE)

The USACE will update the HEC-RAS one-dimensional unsteady flow model to incorporate sediment transport in the study area.

Model Updates:

a) Incorporate sediment transport modeling in the one-dimensional unsteady flow HEC-RAS model

Model Calibration:

a) Calibrate to observed sediment transport following sediment trap cleanout.
b) Optional calibration to channel change based on existing HEC-2 model from about 1980
c) Optional calibration to observed Lake Altoona sedimentation since construction of the Altoona Dam (based on the option sediment core analysis in Task 5)
d) Validate a minimum of 1 event not used in the calibration.

Existing Conditions Results:

b) Analyze long-term sediment transport trends.

Deliverables:
USACE:

1. Calibrated one-dimensional unsteady flow HEC-RAS model with sediment transport.
2. Technical memorandum outlining the modeling approach and results, which will be incorporated into the draft and final study report.

Task 9: Climate Change Assessment (USACE)

Perform a climate change assessment as required by and in accordance with USACE Engineering and Construction Bulletin (ECB) 2018-14. This ECB 2018-14 assessment is intended to enhance USACE climate preparedness and resilience by incorporating relevant information about observed and expected climate change impacts in hydrologic analyses for USACE projects.

Task 10: Hydraulic & Sediment Transport Analysis of Alternatives (USACE, optional)

Development of conceptual-level alternatives should consider potential management options throughout the study area. Results of the sediment transport modeling, completed by the USACE in Task 8, will be used to guide consideration potential management options.

This optional task would involve development of up to 4 long-term sediment management alternatives. The HEC-RAS model (Task 8) would be updated to reflect each of the alternatives and a hydraulic and sediment transport analysis would be completed for each alternative. Additional refinement of the 4 original alternatives, not to exceed a total of 12 iterations across all alternatives.

Deliverables:
USACE:

1. Technical memorandum outlining the hydraulic and sediment transport results for the selected alternatives.

PHASE 3b:

Phase 3b tasks require additional detail and are not included in the budget estimate at this time.

Task 11: Screen Alternatives (TBD)

Screen and score conceptual-level design alternatives utilizing a matrix based on select criteria, including input from the stakeholders. The project team will identify and complete evaluation criteria. The criteria

may include, but not be limited to:

- Cost (both one-time and ongoing)
- Long-term viability
- Environmental permitting requirements
- Property/legal issues

Score and rank alternatives and prepare a draft report describing the alternatives considered, the process developed to evaluate them, the results of the evaluation, and the alternatives recommended to be advanced for further sediment transport modeling and/or design.

Deliverables:

1. Criteria, alternatives screening matrix, and ranking of alternatives
2. Stakeholder and TAC meeting handouts
3. Summary of comments received
4. Technical memorandum on key impacts/issues that could potentially preclude implementation of the alternatives, and recommendations on how to address them.
5. Facilitate review and concurrence on the results of the evaluation of alternatives to be advanced to Task 12.
6. Draft and Final Study Alternatives Report, which will be incorporated into the draft and final study report.

Task 12: Develop and Evaluate Projects (TBD)

Evaluate and rank projects based on the sediment transport modeling results. It is estimated that up to three projects will be moved forward into this task. Prepare a draft report describing the process used to evaluate the alternatives, the results of the evaluation, and the proposed projects recommended for advancement to the next task. Present findings to the Stakeholders and TAC for input.
Once agreement is reached on final alternatives, the hydraulic model will be updated for each project selected to be advanced. This will include all alternatives and required mitigation for each project.

Deliverables:

1. Ranking of alternatives based on the hydraulic modeling results.
2. Process to evaluate alternatives, results of the evaluation, and proposed projects recommended to be advanced.
3. Revise model geometry or design details for up to three projects.
4. Draft and Final Project Evaluation Report, which will be incorporated into the draft and final study report.

Task 13: Comprehensive Sediment Management Study Report (TBD)

A comprehensive sediment management study report will be prepared including information collected and produced in the previous tasks.

A draft report will be provided to the Stakeholders and TAC for review for one round of comments and those comments will be incorporated into the final report. The final report will be provided in pdf format. The report shall be prepared in a manner that is understandable to the general public.

Deliverables:

Draft and final study report.

References:

Biedenharn, D.S., Copeland, R.R., Thorne, C.R., Soar, P.J., Hey, R.D. and C. C. Watson (2000). Effective discharge calculation: A practical guide.

Freihoefer, A. and P McGinley (2009). Phosphorus Loading Model for Lake Eau Claire and Lake Altoona.

USGS (2019). *Bulletin 17C Guidelines for Determining Flood Flow-frequency*. Reston, VA. Accessed from https://pubs.usgs.gov/tm/04/b05/tm4b5.pdf

West Central Wisconsin Regional Planning Commission (2017). Healthy Soils & Healthy Waters: A Community Strategy for the Eau Claire River Watershed (EPA Nine Key Element Report)

Wisconsin Department of Natural Resources (2024). Lake Altoona Summary. Accessed from https://apps.dnr.wi.gov/water/waterDetail.aspx?key=16084 on March 15, 2024.

Appendix B: Draft Budget

List of Key Assumptions for the Phase 3 Draft Budget

1. 12-month duration study (October 2025 to September 2026, corresponding to FY 2026) for purposes of monthly meeting and reporting cost estimate. If the study duration requires additional time, the project administration costs would increase to account for additional meetings.
2. The cost estimate reflects only work to be done by USACE personnel; additional work may be needed by others and is not reflected in the cost estimate.
3. Initial project coordination meeting is held in person in the Eau Claire area; 3 USACE personnel attend (2 hydraulic engineers, 1 project manager).
4. 3 USACE personnel (2 hydraulic engineers, 1 project manager) attend virtual 1-hr monthly progress meetings with prep time and post-meeting coordination varying from 1 to 3 hours per person.
5. Biweekly schedule updates assume 1 hour every 2 weeks for senior engineer to update progress and 0.5 hour for supervisor review.
6. 4 stakeholder engagement meetings held in Eau Claire area. 3 USACE personnel (2 hydraulic engineers, 1 project manager) attend kick-off meeting and final meeting (2 meetings with 3 staff); assume 2 USACE personnel (1 hydraulic engineer, 1 project manager) attend the 2 intermediate meetings (2 meetings with 2 staff).
7. 3 USACE personnel (2 hydraulic engineers, 1 project manager) attend 5 virtual Technical Advisory Committee (TAC) of 2-hour duration, with prep and post-meeting coordination varying from 2 to 6 hours per person.
8. All available relevant studies, reports, bathymetric data, monitoring data (to include stream gage data, sampling, reservoir stage, and dam operations), and dredging records will be provided by LARPD or project partners.
9. The study requires the development of a rating curve for the County Road K gage; development of this rating curve will either be done by others (not reflected in the cost estimate) or by USACE personnel (reflected as an optional cost).
10. Bathymetric survey of the Lower Eau Claire River from the vicinity of the County Road K bridge to Lake Altoona will be conducted to capture data for use in the HEC-RAS hydraulic model. There are three options for collecting bathymetric data:
    a. USACE survey of up to 100 cross sections assuming 2 USACE personnel working up to 10 days, including collection of up to 12 bed sediment samples for particle size analysis
    b. Partial bathymetric survey by LARPD and/or partners to capture partial channel survey (deeper areas) using single/multi-beam survey equipment. 2 USACE personnel, working up to 5 days, would survey the remaining portions of the channel not surveyed by LARPD and/or partners to ensure full survey coverage; USACE would also collect up to 12 bed sediment samples for particle size analysis.
    c. Full bathymetric survey by LARPD and/or partners to capture full bathymetric channel survey using single/multi-beam survey equipment and/or traditional survey methods. This survey option would require LARPD and/or partners to collect bed sediment samples for particle size analysis. This option includes minimal remote coordination with USACE personnel but does not include any on-the-ground survey by USACE personnel.

11. Optional sediment coring within Lake Altoona could be collected to understand historical sediment deposition within Lake Altoona and the LECR delta. There are two options for obtaining sediment coring data:
    a. LARPD and/or partners perform sediment coring, with minimal remote coordination with USACE personnel.
    b. USACE sediment coring assuming one mobilization and de-mobilization of 3 USACE personnel for up to 4 days of coring at up to 12 locations. Locations will be split between the original LECR channel and overbank areas, with greater sampling density in the sediment delta area. Up to 60 sediment samples will be collected for particle size analysis. The cost estimate for this option reflects in-office preparation, data processing, and a summary of coring results.
12. An updated Lake Altoona bathymetric survey will be conducted by LARPD and/or partners and is not reflected in this cost estimate. LARPD will provide bathymetric survey results to USACE.
13. Hydrology will be developed at/near the County Road K bridge, to reflect USGS gage 05366500 and the existing nearby gage installed in 2018.
14. Hydrology will be developed for approximately the period 1980 (to coincide with the date of the known HEC-2 hydraulic model) to present.
15. The optional use of the existing SWAT model for hydrology requires additional work by others to prepare the model for use in this project. The cost estimate for this optional task assumes only limited involvement by USACE personnel for coordination regarding study needs.
16. Development of a new HEC-RAS model assumes there is no existing HEC-RAS model for the area of interest.
17. LARPD and/or partners will provide relevant hydraulic data for any hydraulic structures (e.g., bridges or culverts) in the model area.
18. The HEC-RAS hydraulic model will be calibrated to 2 observed events from the period 2018 to present and validated for 1 event from the same period.
19. The HEC-RAS sediment transport model will be calibrated to observed sediment transport following sediment trap cleanout based on availability of data from LARPD and/or partners.
20. Optional additional sediment calibration against existing HEC-2 channel bathymetry requires adequate data regarding dredging conducted since development of the HEC-2 model (approximately 1980).
21. Optional additional sediment calibration to observed deposition in Lake Altoona requires extension of hydrologic data back to the construction of Altoona Dam. This extension will only involve extension of model input parameters (e.g., rainfall) and will not include additional hydrologic calibration. Use of the SWAT model for hydrology would require additional work by others if this optional sediment work were done.
22. Optional work to analyze alternatives for long-term sediment management includes development of up to 4 alternatives and associated revision of the HEC-RAS model for hydraulic and sediment transport analysis. Additional modeling work includes up to 12 total iterations across the 4 alternatives.
23. Hydraulic model is not for design.

US Army Corps of Engineers
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Lake Altoona Phase 3 - Draft Cost Estimate
Planning Assistance to States
5/1/2024

			Project Costs (Including Labor, Travel, Other)	Optional Additional Costs
FY26	**Task 1:**	**Work Plan, Schedule, Coordination, Progress Meetings**		
FY26	Task 1: Subtask 1	Work plan development	$ 7,000.00	$ 800.00
FY26	Task 1: Subtask 2	Detailed schedule development	$ 4,700.00	$ 400.00
FY26	Task 1: Subtask 3	Quality management plan	$ 4,700.00	$ 400.00
FY26	Task 1: Subtask 4	Initial project coordination meeting	$ 13,900.00	$ 2,200.00
FY26	Task 1: Subtask 5	Monthly progress meetings	$ 29,800.00	$ 4,300.00
FY26	Task 1: Subtask 6	Biweekly progress reports	$ 19,500.00	$ 3,100.00
Subtotal Task 1			$ 79,600.00	$ 11,200.00
FY26	**Task 2:**	**Public and Agency Involvement**		
FY26	Task 2: Subtask 1	Review stakeholder list (prepared by LARPD)	$ 800.00	
FY26	Task 2: Subtask 2	Stakeholder meeting preparation	$ 6,600.00	
FY26	Task 2: Subtask 3	Stakeholder engagement meetings (4 total)	$ 14,900.00	
FY26	Task 2: Subtask 4	Stakeholder comment response	$ 11,800.00	
Subtotal Task 2			$ 34,100.00	
FY26	**Task 3:**	**Technial Advisory Committee**		
FY26	Task 3: Subtask 1	TAC meeting preparation	$ 7,400.00	
FY26	Task 3: Subtask 2	TAC meetings (5 total)	$ 5,100.00	
FY26	Task 3: Subtask 3	TAC meeting follow-up	$ 4,200.00	
Subtotal Task 3			$ 16,700.00	
FY26	**Task 4:**	**Existing Data Collection and Review**		
FY26	Task 4: Subtask 1	Obtain/review all relevant studies	$ 8,600.00	
FY26	Task 4: Subtask 2	Obtain/review existing hydraulic models & data	$ 4,000.00	
FY26	Task 4: Subtask 3	Obtain LiDAR-derived digital elevation models	$ 1,900.00	
FY26	Task 4: Subtask 4	Review channel & lake bathymetric survey data	$ 3,300.00	
FY26	Task 4: Subtask 5	Review channel & lake sediment data	$ 1,700.00	
FY26	Task 4: Subtask 6	Review stream stage/flow monitoring data	$ 3,300.00	
Subtotal Task 4			$ 22,800.00	
FY26	**Task 5:**	**New Data Collection**		
FY26	Task 5: Subtask 1	Survey data collection plan and coordination	$ 8,200.00	
FY26	Task 5: Subtask 2	Option: Flow measurements and rating curve development for County Road K gage		$ 25,000.00
FY26	Task 5: Subtask 3	LECR survey option A: Cross-section survey and bed sediment sample collection		$ 37,500.00
FY26	Task 5: Subtask 4	LECR survey option B: LARPD/partner partial channel survey w/USACE survey of channel bank areas and bed sediment sample collection	$ 19,600.00	
FY26	Task 5: Subtask 5	LECR survey option C: LARPD/partner full channel survey and bed sediment sample collection (no USACE on-the-ground survey)		$ 1,700.00
FY26	Task 5: Subtask 6	Data processing and creation of topobathy for channel & lake	$ 5,700.00	
FY26	Task 5: Subtask 7	Option: LARPD/partners perform sediment coring in Lake Altoona		$ 2,600.00
FY26	Task 5: Subtask 8	Option: USACE sediment coring at up to 12 locations in Lake Altoona		$ 30,000.00
FY26	Task 5: Subtask 9	Option: USACE obtains particle size analysis for up to 60 Lake Altoona sediment cores from up to 12 sediment cores		$ 12,700.00
FY26	Task 5: Subtask 10	Particle size analysis for up to 12 LECR channel bed samples	$ 2,500.00	
FY26	Task 5: Subtask 11	Review of sediment samples and profile data	$ 3,300.00	
Subtotal Task 5			$ 39,300.00	$ 109,500.00

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			Project Costs (Including Labor, Travel, Other)	Optional Additional Costs
FY26	**Task 6:**	**Hydrology Development**		
FY26	Task 6: Subtask 1	Development of flow record from existing data	$ 15,900.00	
FY26	Task 6: Subtask 2	Develop annual peak flow-frequency curve for County Road K gage sites	$ 14,300.00	
FY26	Task 6: Subtask 3	Develop flow duration curves from 1942-1955 gage data	$ 7,900.00	
FY26	Task 6: Subtask 4	Develop flow duration curves using regionalized method	$ 7,900.00	
FY26	Task 6: Subtask 5	Option A: Use hydrology from existing SWAT model (requires new work to be performed by others)		$ 14,700.00
FY26	Task 6: Subtask 6	Option B: Develop a HEC-HMS model of the entire Lake Altoona Watershed for approximately 1980 to present	$ 58,900.00	
FY26	Task 6: Subtask 7	Technical Reviews - DQC and ATR	$ 17,600.00	
FY26	Task 6: Subtask 8	Technical memorandum summarizing hydrologic analyses	$ 15,600.00	
Subtotal Task 6			$ 138,100.00	$ 14,700.00
FY26	**Task 7:**	**Existing Conditions Hydraulic Modeling**		
FY26	Task 7: Subtask 1	Review existing models (HEC-2, HEC-RAS, etc.)	$ 600.00	
FY26	Task 7: Subtask 2	Develop HEC-RAS model (assumes no existing HEC-RAS model)	$ 20,000.00	
FY26	Task 7: Subtask 3	Select calibration events	$ 2,900.00	
FY26	Task 7: Subtask 4	Calibrate to 2 observed events (from 2018 to present)	$ 10,600.00	
FY26	Task 7: Subtask 5	Validate 1 event (from 2018 to present) not used in calibration	$ 2,600.00	
FY26	Task 7: Subtask 6	Technical Reviews - DQC and ATR	$ 10,200.00	
Subtotal Task 7			$ 46,900.00	
FY26	**Task 8:**	**Existing Conditions Sediment Transport Modeling**		
FY26	Task 8: Subtask 1	Incorporate sediment transport in HEC-RAS model	$ 13,600.00	
FY26	Task 8: Subtask 2	Calibrate to observed sediment transport following sediment trap cleanout	$ 13,600.00	
FY26	Task 8: Subtask 3	Option: Calibrate to observed channel change from HEC-2 model		$ 12,800.00
FY26	Task 8: Subtask 4	Option: Calibrate to observed Lake Altoona sedimentation based on sediment core analysis		$ 25,600.00
FY26	Task 8: Subtask 5	Validate at least one event not used in calibration	$ 3,800.00	
FY26	Task 8: Subtask 6	Analyze long-term sediment transport based on hydrologic data from Task 6	$ 25,600.00	
FY26	Task 8: Subtask 7	Documentation	$ 8,400.00	
FY26	Task 8: Subtask 8	Technical Reviews - DQC and ATR	$ 17,600.00	
Subtotal Task 8			$ 82,600.00	$ 38,400.00
FY26	**Task 9:**	**Climate Assessment (ECB 2018-14)**		
FY26	Task 9: Subtask 1	Literature review	$ 2,100.00	
FY26	Task 9: Subtask 2	Local climate assessment: State climate summaries and trends/NSD	$ 3,200.00	
FY26	Task 9: Subtask 3	Background data assessment	$ 2,100.00	
FY26	Task 9: Subtask 4	Trend & Nonstationarity Detection Analysis	$ 4,300.00	
FY26	Task 9: Subtask 5	Projected Trends (CHAT tool)	$ 500.00	
FY26	Task 9: Subtask 6	Vulnerability Assessment Tool	$ 2,100.00	
FY26	Task 9: Subtask 7	Qualitative Residual Risk Analysis	$ 1,100.00	
FY26	Task 9: Subtask 8	Documentation	$ 3,400.00	
FY26	Task 9: Subtask 9	Technical Reviews - DQC and ATR	$ 6,900.00	
Subtotal Task 9			$ 25,700.00	
FY26	**Task 10:**	**Option: Hydraulic & Sediment Transport Analysis of Alternatives**		
FY26	Task 10: Subtask 1	Development of up to 4 sediment management alternatives		$ 8,300.00
FY26	Task 10: Subtask 2	Revise RAS model geometry for up to 4 alternatives		$ 6,400.00
FY26	Task 10: Subtask 3	RAS hydraulic and sediment transport modeling for up to 4 alternatives		$ 20,500.00
FY26	Task 10: Subtask 4	Perform up to 12 iterations (total) on up to 4 alternatives		$ 46,100.00
FY26	Task 10: Subtask 5	Prepare hydraulic and sediment transport report		$ 14,700.00
FY26	Task 10: Subtask 6	Technical Reviews - DQC and ATR		$ 14,700.00
Subtotal Task 10				$ 110,700.00
Project subtotal			**$ 485,800.00**	**$ 284,500.00**
Contingency (10%)			**$ 48,600.00**	**$ 28,500.00**
Project total (draft)			**$ 534,400.00**	**$ 313,000.00**