REVISED FINAL

PILOT SCALE MANAGEMENT ACTION TECHNICAL MEMORANDUM

Prepared for

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

July 2012

Prepared by

The Flatwater Group, Inc.
In association with
HDR Engineering, Inc. and Tetra Tech, Inc.

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY BLANK

1. PILOT STUDY OBJECTIVES

1.1 Background Information

In November 2010, the *Sediment Augmentation Experiment Alternatives Screening Study Summary Report* (The Flatwater Group, Inc. et al. November 2010) (Screening Study) was prepared for the Platte River Recovery Implementation Program (the Program). The Screening Study identified, developed, and evaluated alternatives to test the Program's Tier 1 sediment augmentation hypothesis: *Average sediment augmentation near Overton, Nebraska, of 185,000 tons/year (t/y) under the existing flow regime and 225,000 t/y under the flow regime proposed by the Governance Committee achieves a sediment balance to Kearney, Nebraska*. This hypothesis, referred to as Priority Hypothesis Sediment #1 in Program documents, is based on modeling performed by the Bureau of Reclamation (BOR). The Screening Study evaluated the sediment deficit reported by the BOR as well as a number of potential sediment augmentation alternatives and identified several areas of uncertainty that affect the design of a sediment augmentation program. The Screening Study recommended implementing a pilot-scale experiment to reduce uncertainties associated with sediment volume, material size, and augmentation location. The Program entered into a contractual agreement with The Flatwater Group, Inc. (TFG) team for the sediment augmentation pilot scale management action (Pilot Study) on June 3, 2011, which includes both the Management Action and a Monitoring Plan.

Modeling was conducted as part of the Screening Study to verify the results of the BOR model. Results from the Baseline Model simulation were evaluated to assess the magnitude, distribution, and characteristics of sediment loading along the project reach (between the Lexington and Odessa bridges) under existing conditions. The results confirmed a significant sediment imbalance along the project reach. In general, the results indicate that the overall sediment deficit in the project reach is approximately 150,000 tons/year (t/yr). Several sediment augmentation alternatives were developed and evaluated in the Screening Study for their ability to reduce the 150,000 t/yr sediment deficit.

The Screening Study concluded that although a significant reduction in the sediment deficit could be realized, it is unlikely that any of the alternatives would be 100 percent effective in eliminating the sediment deficit at Cottonwood Ranch Complex. Modeling performed for the Screening Study indicated that approximately twice the deficit amount of material, using readily available material at local sand pits, may need to be added to fully account for the deficit. Screening Study modeling results also suggest that in addition to material size and volume of material, the augmentation technology and the location are significant factors in achieving sediment balance. Therefore, the Screening Study recommended implementing a 2-year pilot-scale management action to reduce uncertainties associated with sediment volume, material size, and augmentation locations. This pilot-scale action will allow the Program to evaluate identified augmentation measures and compare physical actions with predicted model results (evaluated in the Monitoring Plan).

1.2 Objectives of the Pilot Study

The objective of the Pilot Study is to collect data associated with the means and methods for sediment augmentation in order to provide a foundation for the design of the full-scale sediment augmentation project. Therefore, the Pilot Study has two primary components, first is the "Management Action" that is comprised of all of the activities required to introduce sediment to the river. Second is the "Monitoring Plan" that is comprised of the activities associated with the collection and evaluation of the data from the implementation of the Management Action. It is anticipated that data and results from the Year 1 monitoring will inform Year 2 Pilot Study management actions.

Several uncertainties related to sediment augmentation were identified in the Screening Study though not all of the uncertainties can reasonably be evaluated during the Pilot Study. For example, evaluating the effects of reducing some but not 100 percent of the sediment deficit on providing habitat will likely take much longer than the timeframe associated with the Pilot Study to assess. In addition, the cost associated with the commercial acquisition of sediment can be influenced by factors outside the control of the Pilot Study. A better understanding of the timing and difficulty of obtaining permits is being gained by the Program as permits are obtained for a variety of Program actions. Therefore, the following sediment augmentation uncertainties will be evaluated during the Pilot Study:

- Testing to determine the optimal particle size
- Technology to produce the optimal particle size
- Timing and duration of annual augmentation activities
- Optimal location and windrow/sand plug configuration for augmentation
- Potential for adverse downstream effects

Data will be collected as prescribed in the detailed Monitoring Plan to address the uncertainties (see Appendix A). The Monitoring Plan will be implemented to accomplish two purposes. First, data will be collected and used to verify that the Pilot Study has no adverse effects on adjacent property owners. Second, data will be collected to help determine if the sediment placement technology is effective, if the location chosen is appropriate, and if the material used is sufficiently suitable for sediment augmentation purposes. The data will be evaluated to determine if the physical response of the Platte River is substantially different than the response expected based on the sediment transport model and historical data. The monitoring activities will focus on stage and bed elevation change to identify trends that indicate how the river is responding including whether the river may be responding in unexpected ways.

The Pilot Study and associated Monitoring Plan will also provide short-term data on sediment transport, dispersal, and any resulting influences on channel morphology and riverine processes. Implementing the Monitoring Plan will provide data necessary to test the Tier 1 sediment hypothesis on a preliminary basis.In addition, the sediment transport model developed for the Screening Study will be updated based on the data collected during the Pilot Study.

1.3 Pilot Study Management Action Design

The Screening Study recommended designing and implementing Alternatives 6 and 8 for the pilot-scale management action. Alternative 6, as described in the Screening Study, is as follows:

> Sediment would be produced on site using sand pit dredge operations established on the Cook Tract/Dyer Property. A sand pit or pits would be created as a result of this operation, which could provide a future habitat benefit. This alternative would use two sand pump locations on Program properties (Sand Pump Sites 2 and 3), supplied by material from the onsite sand pit operation established on the Cook Tract/Dyer Property. In addition, a sand pump location would be established on the OS&G property (Sand Pump Site 4), supplied by sediment obtained from the existing OS&G sand pit operation. It should be noted that while OS&G was selected for the purposes of this evaluation, other locations may be available to establish a sand pump delivery location that would likely produce the same results.

Project constraints necessitated slight variations in Alternative 6 from the way it was described in the Screening Study. In order to evaluate the means and methods of placing the material in the river, it was determined that a pilot scale management action would reduce the potential for the development of adverse flow conditions while still allowing the Program to evaluate augmentation methods identified in the Screening Study. It was estimated that augmenting approximately two-thirds of the predicted total sediment deficit of 150,000 t/yr in the project reach would provide enough information to inform the Program whether to implement the full-scale sediment augmentation project. To accomplish this half of the material (50,000 tons) will be mined from and placed into the river at the Cook Tract/Dyer Property. Existing sandpits on the property will be expanded to allow for a more rapid mobilization time. All of the pumped material will be obtained and placed on the Cook Tract/Dyer Property. The OS&G location will not be used as either a source or placement location under the Pilot Study. The operation will be established on the Cook Tract/Dyer Property so that the specific discharge location can be varied to prevent excessive buildup of material in the channel.

Alternative 8, as described in the Screening Study, is as follows:

> Sediment would be produced on site using sand pit dredge operations established on the Cook Tract/Dyer Property. A sand pit or pits would be created as a result of this operation, which could provide a future habitat benefit. Dozers would be used to push the material to the desired locations in the channel from stockpiles along the south bank. Access points to the river would need to be constructed to allow dozer access from the high bank down into the river channel. Dozers would be used to push material into the river at OS&G. Material stockpiles and access points would be created on the north bank on the OS&G property. Material at this location would be supplied from the existing OS&G sand pit operation. It should be noted that while OS&G was selected for the purposes of this evaluation, other locations may be available to establish a delivery location that would likely produce the same results.

Under Alternative 8, the primary focus of the evaluation during the Pilot Study is how the dozer-supplied augmentation material affects the sediment deficit. Cottonwood Ranch Complex was identified as a logical area to evaluate bulldozer options since the Program has been conducting bulldozer operations at the site for several years. The other half of the material (50,000 tons) will be dozed into the river at the Cottonwood Ranch Complex. The source of the material will not be from an offsite sandpit operation (Cook Tract/Dyer Property or OS&G) but rather from existing material present in sandbars in the river channel. It is noted that the sandbar material is only infrequently inundated and mobilized under the current flow regime. There is sufficient material present at the site to conduct the Pilot Study and using existing material in the sandbars will reduce the cost of the Pilot Study by eliminating the need to haul material to the site. Bulldozing the sandbars will also benefit the Program by potentially creating additional sandbar habitat at the Cottonwood Ranch Complex.

2. MANAGEMENT ACTIONS

As stated, the objective of the Pilot Study is to collect data to help reduce the uncertainties concerning the means and methods for the full-scale sediment augmentation project by testing and evaluating the performance of sediment augmentation using both sand pump technology and mechanical placement. The Pilot Study will introduce sediment to the Platte River to offset a portion of the sediment deficit. The Program will solicit bids from qualified local contractors to complete the management actions. One or more contractors will be selected from the bids submitted to complete the management actions based on the design completed by the TFG team. There are two distinct management actions that will be implemented. These management actions may be conducted either concurrently or at different times within the overall design timeframe. The first management action will generally consist of the contractor establishing a sand pit operation on Program property (Dyer Property) upstream of the Overton Bridge. The operation will be established by expanding an existing sand pit on the Dyer Property (Figure 2-1) and discharging (pumping) sediment into the river. The second management action consists of using earth-moving equipment to push sediment into the river from existing sand bars in the river at Cottonwood Ranch Complex. The contractor will be responsible for determining the means and methods used to complete the work in accordance with the design and contract documents. The contractor will be responsible for all day-to-day operations while completing the management actions. The design team will be responsible for monitoring the contractor and verifying compliance with the design documents. The impact triggers will be used by the TFG team to make decisions during implementation of the management actions. The specific management actions are more fully described below in Sections 2.1 and 2.2.

The Program anticipates that with the appropriate flows, the introduced sediment will have the potential to prevent continued degradation of the bed and banks. Sediment augmentation will help support those physical processes that help create a braided river system that will form sandbars to create the type of habitat desired by the target species, as well as other waterfowl and wildlife species.

2.1 Pumping

The contractor will establish a sand pit mining operation using the western-most existing sand pit on the Dyer Property (Figure 2-1). The sand pit will be expanded to the west while extracting sediment augmentation material. Material will be mined and processed (screened until the desired gradation is achieved) until 50,000 tons of acceptable material has been produced. Material that is outside the desired gradation will be separated and stockpiled separately onsite. Augmentation material will be directly pumped to the river as a sand-water slurry using sand pumps provided by the contractor. Figure 2-2 below shows a typical sand pumping operation. If direct discharge is not feasible, the augmentation material will be temporarily stockpiled prior to being pumped into the river also using sand pumps provided by the contractor.

It is anticipated that sediment will be added to the river starting in the spring of 2012, weather permitting, and prior to threatened and endangered species migration and nesting timeframes. Initial rates of sediment introduction will be in the range of 75 tons per hour. The rate of sediment introduction can be varied based on results of downstream monitoring so that excessive buildup of sediment does not occur. Depending on the rate of pumping and the number of hours per day worked, it is estimated that the augmentation of 50,000 tons of material at the Cook Tract/Dyer Property will take one to two months. Sediment will be introduced at various flows depending on the flow in the channel at the time of discharge. Augmentation rates and volumes can be adjusted to accommodate various flow regimes. Flows in the south channel are almost exclusively dependent on return flows from the Central Nebraska Public Power and Irrigation District's J2 return; therefore, in most instances, a good estimate of expected flows in the channel can be obtained.

During times of abnormally low flow, sediment augmentation may be halted to avoid excessive buildup of sediment and potential associated adverse effects. The specific flow rate below which augmentation is not feasible is not known, however, comparing potential flows sediment discharge rating curves may give an indication of a lower flow threshold for sediment augmentation. In addition, the monitoring program developed for this project will be used to advise when augmentation will cease.

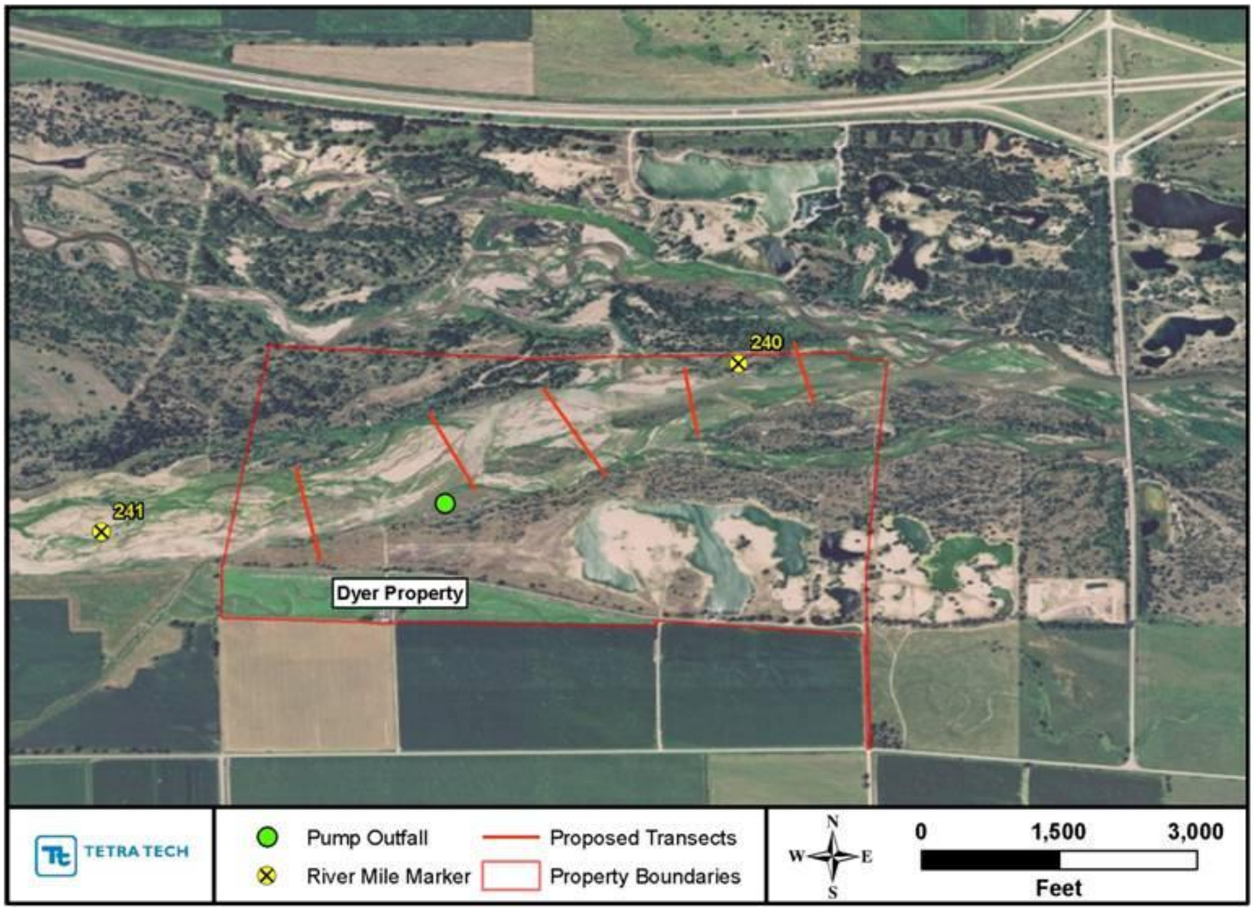


Figure 2-1. Dyer Property

Figure 2-2. Typical Sand Pump Operation

2.2 Mechanical Placement

The contractor will use dozers or other earth moving equipment to remove 50,000 tons material from the upper layers of sediment present in existing sand bars within the river channel at Cottonwood Ranch Complex (Figure 2-3). A typical bulldozer is shown in Figure 2-4. Vegetation will be stripped from the sandbars prior to introduction of the material into the river. Temporary stockpiles may be created during the operation to improve efficiency of sediment introduction into the river. The configuration of the pushed material in the river will generally follow the design requirements and will be such that the sediment can be effectively entrained in the river. The configurations will be adjusted by the design team as necessary based on field observations and effectiveness.

The work at the Cottonwood Ranch Complex is expected to occur in the spring of 2012, weather permitting, and prior to threatened and endangered species migration and nesting timeframes. The Monitoring Plan (see Appendix A) will include measurements of channel cross sections starting in the vicinity of the sediment introduction to a point downstream through the Elm Creek Complex and monitoring of downstream suspended sediment loads as part of the Program's system-wide and Kearney Canal water quality monitoring programs. The Monitoring Plan will also include monitoring of changes in bed material gradation during the Pilot Study.

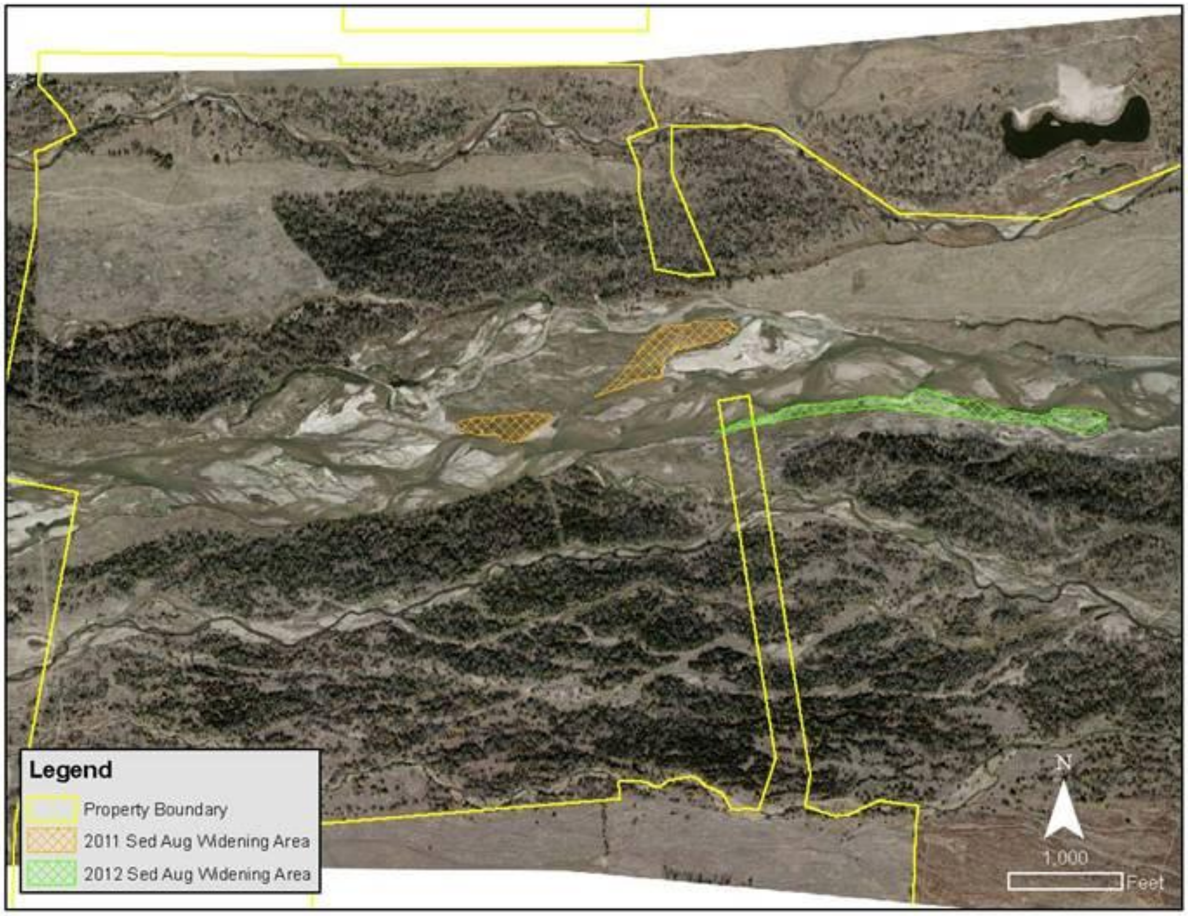


Figure 2-3. Cottonwood Ranch Complex

Figure 2-4. Typical Bulldozer

3. PROJECT EVALUATION

The performance of the Pilot Scale Management Action will be evaluated through monitoring to determine the best approach for Year 2 of the Pilot study and ultimately for the full-scale sediment augmentation project. The data collected as part of the Pilot Study will be used to address the uncertainties associated with the feasibility of implementing the full-scale sediment augmentation project. In turn, the results from a full scale implementation of the sediment augmentation project could assist with addressing the uncertainties listed above in Section 1.2.

3.1 Performance Indicators

The Pilot Scale Management Action will be evaluated on both a short- term and a long-term basis. Performance indicators have been identified to assist in this evaluation. Although similar indicators are used to evaluate both long and short term performance, how the indicators are used is different. The short term evaluation focuses on prevention of adverse effects or threshold effects whereas the long term evaluation looks at whether the action is meeting project goals or benchmarks.

Performance indicators were established to evaluate the implementation of the Management Action, as well as the eventual long term performance of the full-scale sediment augmentation project. The performance indicators are:

- Stage-discharge relationship
- Bed elevation

- Bed and bar gradation

To evaluate short term effects (during the Management Action), a threshold or "impact trigger" was established for each performance indicator for the implementation of the Pilot Study Management Action. The impact triggers were established to assist in identifying potential negative effects of the Management Action to adjacent property owners. These triggers will be used to help determine whether the Management Action implementation should continue or whether the Management Action should be stopped and/or modified. Modification could include both a change in implementation rate and location. The impact triggers were developed on a local basis; that is, within one mile of the implementation location. The impact triggers were developed for the Pilot Study in conjunction with Program staff. Consistent with the principles of adaptive management, the triggers can and likely will be revised as the Pilot Study proceeds.

Long term effects will be evaluated using a benchmark for each performance indicator listed above. The benchmarks were established to evaluate the long term Management Action performance, and will be based on data collected during and after the Pilot Study. For example, cross sections (bed elevations) taken as part of the Management Action will be evaluated against historical or predicted natural river processes by using the Overton Bridge rating curve (stage-discharge relationships). The benchmarks were developed on a reach scale basis (extent of several miles). A complete listing of data to be collected as part of the Pilot Study, as well as data collected for other Program activities are listed in Appendix A – Pilot Scale Monitoring Plan.

A sediment-transport model was developed as part of the screening study. This model will become the baseline to evaluate impact triggers and performance benchmarks. The sediment-transport model results for dry, normal, and wet simulations of the pilot augmentation will be used in conjunction with historical stage-discharge gage data as a basis for comparing measured changes in stage during the Pilot Study. This comparison will involve the following steps (see Figure 2-5):

1. During data collection, the cumulative water volume at the Overton gage, starting at the beginning of the Management Action, will be compared with the cumulative water volume used in the simulations to determine the hydrologic classification (dry, normal or wet) of the actual pilot study hydrology.

2. The measured stage-discharge data at the Overton gage during the dry, normal, and wet years will be plotted and a power function will be fit to the data. A scatter plot of the resulting differences between the measured and best-fit line will then be prepared for each hydrologic classification. These difference plots represent the range of natural stage fluctuations expected for each type of hydrologic classification.

3. The model results for each simulation will be reviewed to determine the simulation day when the maximum amount of aggradation was indicated at the Overton gage during the augmentation period. The predicted geometry on this day of the simulation will then be extracted and inserted into the calibrated steady-state hydraulic model.

4. The hydraulic model developed in Step 3 will be executed over a range of discharges, and the resulting water-surface elevations at the Overton gage will be compared to the water-surface elevations predicted by the model for existing conditions. Since the model for existing conditions represents the model geometry at the start of the sediment-transport simulation, the difference between the water-surface elevations predicted by the two models represents the predicted maximum change in stage at the gage over the range of modeled flows.

5. The predicted maximum change in stage for the range of modeled flows will be added to the scatter plot of measured differences developed in Step 2 for the appropriate hydrologic classification. This line represents the predicted maximum envelope for change in stage.

6. The observed stage during the pilot study at the Overton Gage will be compared to the stage predicted by the most recent gage rating curve to determine the observed change in stage that has occurred since the beginning of the pilot study. This data point will be added to the plot that was updated in Step 5 using the reported discharge at the time of the measurement.

7. The following Stage-Change Classes were developed for this study, and will be assigned to the observed Management Action stage-change data point as follows:
    - Stage-Change Class I – The observed Management Action data point falls within the scatter of the measured gage data, indicating the Management Action has not had a significant effect on the stage.
    - Stage-Change Class II – The observed stage-change data point falls outside of the scatter of the measured data but is less than the predicted maximum envelope (Step 5), indicating the Management Action has significantly affected the stage but are within the levels predicted by the model.
    - Stage-Change Class III – The observed stage-change data point is greater than the predicted maximum envelope (Step 5), indicating the Management Action has significantly affected the stage beyond the levels predicted by the model.

8. The predicted maximum envelope for change in stage (Steps 3 through 5 at the Overton gage) will also be computed at each of the monitoring locations. Because there is no information at the monitoring locations with which to develop the historical stage change scatter set, the historical stage change information at the Overton gage will be applied to determine the Stage-Change Class at these locations. For example, assume the analysis at the Overton gage for a given flow in a normal year indicates that Stage-Change Class I occurs for changes in stage between -0.5 feet (lower band of historical data) and +0.5 feet (upper band of historical data). If the observed stage change for this given discharge at the monitoring location is between -0.5 feet and +0.5 feet, and the pilot study occurs during a normal hydrologic year, then a Stage-Change Class I would be assigned to that observation. If however, the observed stage change for this given discharge is between +0.5 feet and the predicted maximum envelope at the monitoring location, then a Stage-Change Class II would be assigned to that observation.

Similar to the Stage-Change Classes, Mean Bed Elevation[1] Classes were developed to assess the measured bed elevation versus the modeled and historical data for use in evaluating the performance indicators. They are:

- Mean Bed Elevation Class I – The observed Management Action data point falls within the scatter of the measured gage data, indicating the Management Action has not had a significant effect on the mean bed elevation.

[1] Mean bed elevation will be calculated by identifying the toe of the bank on either side of the active channel at each transect, calculating the cross sectional area between these points below an arbitrary reference elevation, dividing the cross sectional area by the width between the points, and then subtracting the resulting average height from the reference elevation.

- Mean Bed Elevation Class II – The observed mean bed elevation data point falls outside of the scatter of the measured data but is less than the modeled maximum increase in mean bed elevation indicating the Management Action has significantly affected the mean bed elevation but is within the levels predicted by the model.
- Mean Bed Elevation Class III – The observed mean bed elevation data point is outside the scatter of the measured gage data, and is greater than the modeled maximum increase in mean bed elevation change, indicating the Management Action has significantly affected the mean bed elevation change beyond the levels predicted by the model.

Several methods for measuring the performance indicators have been identified to quantitatively assess the Pilot Study's effectiveness in meeting project objectives. The measurement methods are:

- Pressure Transducers and Gage Readings
- Topography and Bathymetry Surveys
- Photographic Documentation
- Bed-and-Bar Material Sampling

The location, method, and instrumentation to be used for each performance indicator are detailed in the Pilot Study Monitoring Plan. The impact triggers and performance benchmarks for each performance indicator, as well as the measurement method are described in Table 3-1:

Table 3-1 Pilot Study Performance Indicators

Performance Indicator	Measurement Method	Impact Trigger	Performance Benchmark
Stage Discharge Relationship	Pressure Transducers and Gages	Stage-Change Class II or III	Stage-Change Class I
Bed Elevation	Topographic and Bathymetric Surveys	Mean Bed Elevation Class II or III	Mean Bed Elevation Class I
Bed Elevation	Photographic Documentation	Visual evidence of sediment accumulation: excessive, acceptable, none or negative (degrading) as compared to prior photos	Average reduction in degradation over reach
Bed and Bar Gradation	Bed-and-Bar Material Sampling	N/A	Median diameter within ± 0.2 mm of model results; and change in median diameter of -0.2 mm as compared to historic data

Evaluating the short-term and long term performance of the impact triggers with respect to the performance benchmarks, respectively, will be used to make decisions during and after the Management Action. Decision criteria and corresponding actions for each impact trigger and performance indicator is described in detail in Section 5. Decision Criteria. The sediment transport models that were developed for the Pilot Study will be used to assist with evaluation. For example, the models will be updated and recalibrated based on the measured cross section data during and after the Year 1 Pilot Study Management Action. The updated model will become the baseline for the Year 2 Pilot Study Management Action.

4. MONITORING PLAN

The complete Monitoring Plan (see Appendix A) includes two primary components: The Field Sampling Plan (FSP) and the Data Analysis Plan (DAP). The FSP describes the nature of data that will be collected during and following the introduction of sediment. This includes river stage at selected locations, topographic/bathymetry data, photographic data, bed-and-bar materials, and water quality information. The DAP presents the methods by which collected data will be analyzed and used to make decisions about the Pilot Study's success. In addition, some of the data will be used to determine whether modifications are necessary during implementation of the Pilot Study(e.g., change in the rate of sediment introduction. The Monitoring Plan is detailed in Appendix A.

5. DECISION CRITERIA

Impact triggers were identified in Section 3 based on a series of performance indicators related to water surface elevation, bed elevation, and sediment gradations in the river. Decision criteria were developed based on the specific triggers identified for the applicable performance trigger. The decision criteria will assist the Program in using gage data, pressure transducers, and monitoring data to determining whether the Management Action has adverse effects on adjacent property owners and to assess whether the physical response of the Platte River is significantly different that the response expected based on the sediment transport model and historical data. These decision criteria will help guide the Program during implementation of the Management Action and inform decision makers whether to proceed with the action, stop the action, or modify the action or whether additional information may be needed prior to making a decision. Adjustments to the frequency of monitoring data collection may also be warranted based on the decision logic. Table 5-1 lists the decision criteria and corresponding actions based on those criteria.

The original schedule was to conduct Year 1 Pilot Study augmentation in the fall of 2011, which would allow the material to be mobilized during the spring of 2012, typically the highest flows experienced during the year. However, due to permitting coordination, it was not feasible to initiate Year 1 Pilot Study Augmentation in the fall of 2011. Assuming permits can be obtained, the Year 1 Pilot Study augmentation would begin in the spring of 2012, after whooping crane migration. It is expected that the augmented material will be entrained due to anticipated high spring flows. The discharge and mobilization of material will be monitored. Monitoring results will be reviewed, and if practical, Year 2 Pilot Study activities will commence in the fall of 2012.

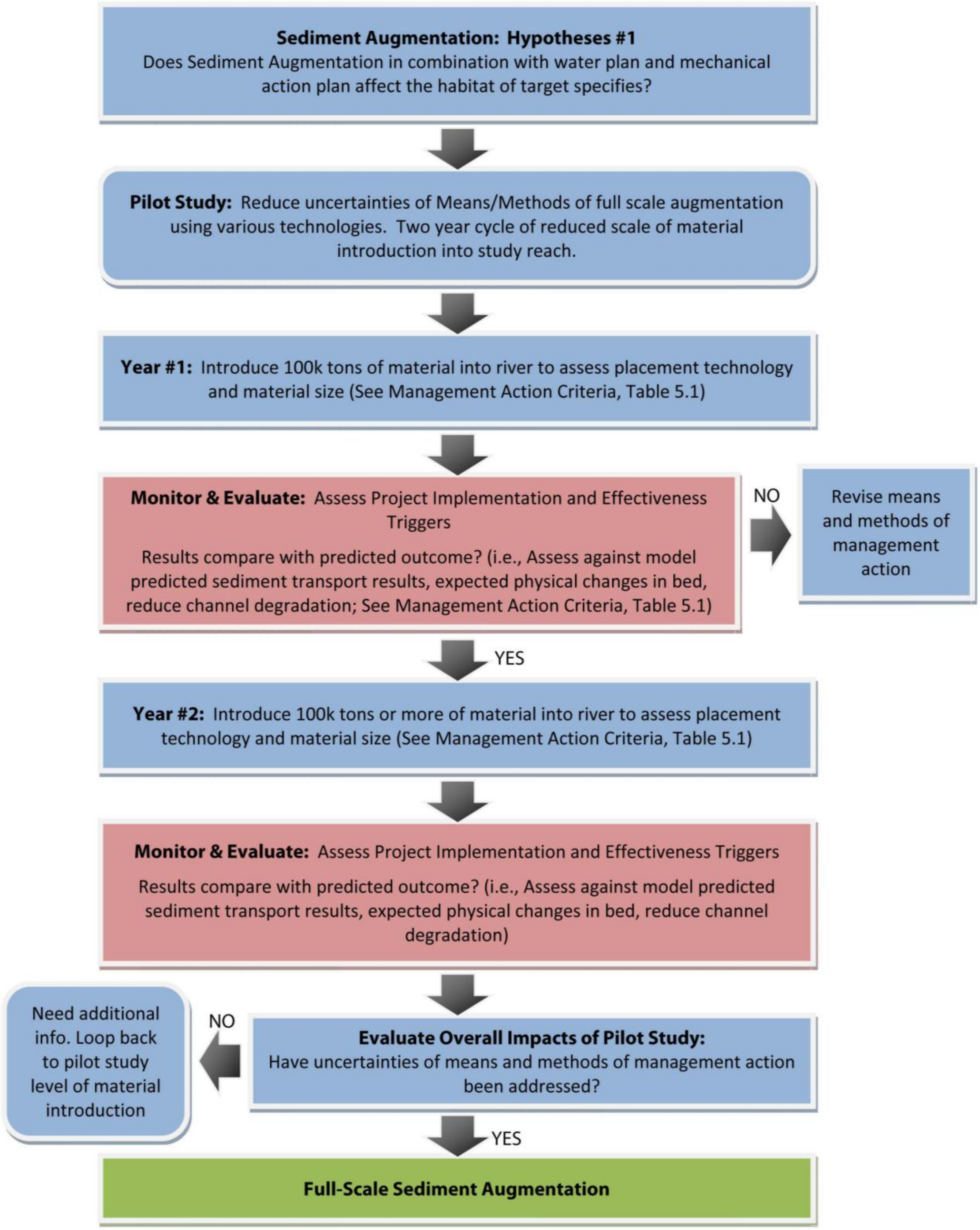
A flowchart or decision tree (Figure 5-1) describes the various actions based on the identified performance benchmarks.

Table 5-1 Decision Criteria

Decision Criteria	Action
Stage-Discharge Relationship	
Stage-Change Class II at a single monitoring location on one occasion	Increase monitoring frequency of topographic/bathymetric data to bi-weekly.
Stage-Change Class III at a single monitoring location on one occasion	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class II at a single monitoring location on consecutive occasions.	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class III at a single monitoring location on consecutive occasions.	Reduce rate of sediment introduction by 25-50 percent and increase frequency of data collection to weekly.

Decision Criteria	Action
Stage-Change Class II and III at multiple monitoring locations on one occasion	Increase monitoring frequency of topographic/bathymetric data to weekly.
Stage-Change Class II at multiple monitoring locations for two consecutive occasions	Reduce rate of sediment introduction by 25 percent and increase frequency of data collection to weekly.
Stage-Change Class III at multiple monitoring locations for two consecutive occasions	Reduce rate of sediment introduction by 50 percent and increase frequency of data collection to weekly.
Stage-Change Class II and III at multiple monitoring locations for three consecutive occasions	Stop operations and evaluate all available data. Determine need for corrective action.
Stage-Change Class I at multiple monitoring locations for three consecutive occasions	If stages are not increasing more than expected, reduce topographic data collection frequency by 50 percent.
Mean Bed Elevation	
Mean Bed Elevation Change Class I	Continue current monitoring frequency.
Mean Bed Elevation Change Class II	Evaluate corresponding Stage-Change Classification. If Stage-Change Classification II or III, incorporate Action of Stage-Change Class. If Stage-Change Class I, continue current monitoring frequency.
Mean Bed Elevation Change Class III	Evaluate corresponding Stage-Change Classification. If Stage-Change Classification II or III, incorporate Action of Stage-Change Class. If Stage-Change Class I, increase monitoring to bi-weekly.

Figure 5-1. Decision Tree for Pilot Scale Management Action



6. BIBLIOGRAPHY

HDR Engineering, Inc. and The Flatwater Group, Inc. May 2011. Sediment Augmentation Pilot Study, Cook Tract/Dyer Property and Cottonwood Ranch Complex. Section 404 Permit Application.

HDR Engineering, Inc and The Flatwater Group, Inc. August 2011. Sediment Augmentation Pilot Study, Cook Tract/Dyer Property and Cottonwood Ranch Complex. Supplemental Environmental Document.

Platte River Recovery Implementation Program, Final. 24 October 2006. Attachment 3, Adaptive Management Plan.

Platte River Recovery Implementation Program. June 2009. PRRIP Strategic Science Plan for Adaptive Management Plan Implementation 2009-2015

Platte River Recovery Implementation Program. April 2010. Monitoring the Channel Geomorphology and In-Channel Vegetation of the Central Platte River.

Platte River Recovery Implementation Program. August 2011. Response to Comments, Permit File Number 2011-01023-KEA.

The Flatwater Group, HDR and Tetra Tech, Inc. November 2010. Platte River from the Lexington to Odessa Bridges: Sediment Augmentation Experiment Alternatives Screening Study Summary Report.

USDOI. April 2006. Platte River Recovery Implementation Program Final Environmental Impact Statement.

USDOI. September 2006. Record of Decision Platte River Recovery Implementation Program. The Secretary of the Interior, Washington.

APPENDIX A

Pilot Study Monitoring Plan

Platte River Recovery Implementation Program Sediment Augmentation Pilot-Scale Management Action Monitoring and Data Analysis Plan

July 2012

1. INTRODUCTION AND PURPOSE

The Platte River Recovery Implementation Program (PRRIP) plans to conduct a Sediment Augmentation Pilot-Scale Management Action, hereinafter referred to as the *Pilot Project*. The purpose of the Pilot Project is to test and evaluate potential methods for introducing sediment to the river and to reduce uncertainties regarding the availability and cost of the augmentation material. Two specific sediment introduction methods will be tested during the project: (1) sand pumps and (2) direct mechanical placement. The sand pumping test will be conducted at the Program's Dyer property, where approximately 50,000 tons of sediment will be mined on-site and pumped into the river (**Figures 1 and 2**). The mechanical placement test will be conducted at Cottonwood Ranch as a continuation of the grading activities that have been performed by NPPD over the past several years, and will involve directly pushing approximately 50,000 tons of additional sediment into the river from existing sand bars within the river or overbank areas adjacent to the river (**Figure 3**).

This document describes the field monitoring and data analysis that will be performed in conjunction with the Pilot Project to understand the response of the project reach to the augmented sediment and to assess the potential for adverse impacts up- and downstream from the primary project area. Because the amount of sediment that will be added to the river at the pump site during the Pilot Project is small relative to the typical annual sediment loads, the monitoring will be focused on the local area within one to two miles of the outfall. The Program and others have conducted extensive monitoring at and downstream from the Cottonwood Ranch Reach, and these activities are expected to continue during the period of the Pilot Project. As a result, no specific additional monitoring is included in this plan for the Cottonwood Ranch Reach.

2. GENERAL APPROACH

The monitoring program will follow the guidelines in the PRRIP Project-scale Geomorphology and Vegetation Monitoring Protocol (PRRIP, 2011) for collecting and analyzing the following specific data types:

- Topographic/bathymetric changes, including both the aggradation/degradation response of the river bed and lateral migration.
- Potential impacts to the water-surface elevations in the river at key locations and discharges.
- Changes in bed-material sediment sizes.

In addition to the data collected specifically for the *Pilot Project*, relevant data from other ongoing Program monitoring activities will be used to meet the objectives of the project. These activities include:

- The PRRIP Channel Geomorphology and In-channel Vegetation Monitoring of the Central Platte River Program (PRRIP, 2010).
- Nebraska Public Power District (NPPD) habitat enhancement activities at Cottonwood Ranch (NPPD, undated)
- USGS monitoring data at Cottonwood Ranch.
- Monitoring data from Elm Creek Complex FSM Experiment (Tetra Tech,2011 and data from ongoing and future monitoring activities)
- Data from the Kearney Canal Monitoring Program (EA Engineering, Science and Technology, 2011).
- PRRIP aerial photos and LiDAR data
- Stream gage data at Overton, Cottonwood Ranch North and South Channels, Kearney Canal and Odessa, and discharge information from the J-2 Return.

Clarifications and/or deviations from the Project-scale Monitoring Protocol are presented in the following sections, and a summary of the monitoring locations and activities at each location is provided in **Table 1**.

3. FIELD SAMPLING PLAN

3.1. Topography and Bathymetry

Topographic and bathymetric data for the *Pilot Project* can be divided into two general types:

1. Near-outfall surveys to understand the rate of entrainment and downstream movement of augmented material, particularly near the pump site, and
2. Downstream river surveys to monitor the overall response of the river to the augmented sediment.

All cross section surveys performed specifically for the *Pilot Project* will include sufficient points to define the bed and bank topography with sufficient accuracy to detect changes in aggradation/degradation response. The surveys will include the location of the green line, as defined in PRRIP (2010 and 2011), and the top-of-bank on either side of the channel.

3.1.1 Near-outfall Surveys

Prior to the start of pumping, a baseline bathymetric survey will be performed in the approximately 1-mile reach of the South Channel at Jeffreys Island from approximately 1,000 feet upstream to approximately 4,000 feet downstream from the proposed pump outfall (Figure 2). The survey will include five monumented cross sections of the active channel between the

Table 1. Summary of *Pilot Study* monitoring locations, types and timing.		
Monitoring Location	**Type of Monitoring**	**Timing of Monitoring**
Dyer Property Near-outfall surveys (South Channel at Jeffreys Island) – five cross sections	1. Topographic survey 2. Bed-and-bar material sampling	1. Prior to the start of pumping (baseline survey) 2. 2.Within one week after completion of pumping 3. 3.At monthly intervals over 9 months (conditions permitting)
Anchor Point (AP) 29[1]	1. Topographic survey 2. Bed-and-bar material sampling	Post-runoff survey
AP 31[1]	1. Topographic survey 2. Bed-and-bar material sampling	Post-runoff survey
AP 32	1. Topographic survey 2. Bed-and-bar material sampling	Pre-sediment augmentation survey Post-runoff survey
AP 33[1]	1. Topographic survey 2. Bed-and-bar material sampling	Post-runoff survey
AP 34[1]	1. Topographic survey 2. Bed-and-bar material sampling	Pre-sediment augmentation survey Post-runoff survey
Elm Creek Complex	1. Topographic survey 2. Bed-and-bar material sampling	Pre-runoff survey Post-runoff survey
North Phelps County Drainage Ditch Batie Drain Peterson Drainage Ditch Benson Drain South Channel of the Platte River[2]	1. Topographic or cross-section surveys at the mouth or upstream of the mouth 2. Photographic documentation of drain at time of data collection	Pre-sediment augmentation survey Post-sediment augmentation survey
Lexington and Elm Creek Platte River Bridges and in the Kearney Canal[3]	1. Instream sondes water quality measurements 2. 2. Discrete samples collected during periodic maintenance of sondes	Mid-March through November weather permitting
Overton Bridge	Water quality sampling – continuous turbidity, conductivity, temperature data; daily point suspended sediment samples	During the pumping period and for two weeks after cessation of pumping
Up to three locations near the Dyer property (two upstream, one downstream)	Stage data	1. Pre-sediment augmentation 2. Post- sediment augmentation for approximately 4-6 weeks

[1] Collected as part of the Program's System-wide Geomorphology and Vegetation Monitoring Protocol
[2] These locations provided by Tri-Basin NRD
[3] Collected as part of the Program's System-wide Water Quality Monitoring Protocol

confining banks. The cross section surveys will be repeated within one week after completion of the pumping, that is anticipated to occur over a 30- to 60-day period depending on the ultimate pumping rate, and at monthly intervals (conditions permitting) over the following nine months to provide data on the rate at which the injected sediment is entrained and moved downstream.

3.1.2 Downstream River Surveys

Post-runoff surveys are anticipated at AP 29, 31, and 33 during both years of the Pilot Project, and a post-runoff survey is anticipated at AP 34 as part of the system-wide Geomorphology and Vegetation Monitoring Program, and both pre- and post-runoff surveys are anticipated at the Elm Creek Complex FSM Experiment (Figure 1). Data from these surveys will be used to assess the downstream response of the river to the *Pilot Project.* Pre-sediment augmentation and pre-runoff surveys will also be conducted as part of this *Pilot Project* at the upstream, middle and downstream transects at AP 32 and AP 34. The first system-wide program survey will be conducted at AP 34 in July 2012. If the Pilot Project is conducted in early-fall 2012, the initial survey at AP 34 should be sufficient to define pre-augmentation conditions at this location. AP 32 was initially surveyed in 2009, and the next survey is not scheduled until summer 2013. A pre-augmentation survey and post-augmentation surveys will be conducted in the active channel at this site on the same schedule as the surveys at the pump site will also be conducted at the three primary transects at this AP 32 as part of this *Pilot Project*.

Twenty cross sections have been surveyed at the Elm Creek Complex during May and September 2011 and in May 2012, and additional, repeat surveys of these cross sections will be conducted in August 2012, May and August 2013 (**Figure 4**).

Along with the cross section surveys described above, additional surveys may be conducted at specific locations where increased sediment deposition associated with the augmentation could cause adverse impacts. These locations will be identified and visually evaluated on a case-by-case basis as data are collected during the course of the augmentation activities and post-augmentation monitoring. Specific locations where additional specific surveys may be warranted include a series of local drainage ditches and a secondary stream channel, identified by Tri-Basin NRD, that discharge into the river in the vicinity downstream of the augmentation activities (Figure 1). These drainages, all discharging into the river from the south bank, include:

- North Phelps County Drainage Ditch – Outlet located in Sec. 11, T8N, R20W;
- Batie Drain – Outlet located in Sec. 8, T8N, R19W;
- Peterson Drainage Ditch – Outlet located in Sec. 18, T8N, R18W ;
- Benson Drain – Outlet located in Sec. 18, T8N, R18W;
- South Channel of the Platte River where it diverges from the main channel in Sec. 12, T8N, R19W).

If warranted, topographic and/or cross section surveys will be conducted in the main river channel at the mouth of these drainages and at least one location upstream from the mouth.

3.2. Photographic Documentation

Photographic documentation will be collected at all survey sites in accordance with the Project-scale Monitoring Protocol (PRRIP, 2011). Additional photographic documentation will be collected during the visual observations and any curves at the locations identified in Section 3.1.

3.3. Bed-and-bar Material Sampling

Bed-material samples will be collected at each site during each survey following a modified version of the System-Wide Monitoring Protocol (PRRIP, 2010). The protocol calls for at least three samples from the channel bed at each cross section plus a set of three samples that are composited to form a single sample from the head of a typical sand bar in the vicinity of the transects. For purposes of this Pilot Project, the bed samples will be collected at the monitoring cross section upstream from the pump outfall at the Dyer Property, and at the most up- and downstream of the four transects downstream from the outfall. A sample will also be collected from the head of a typical bar in the vicinity of the upstream transect, and samples will be collected from the head of at least three typical bars in the reach encompassed by the four downstream monitoring cross sections. In addition to the samples in the vicinity of the pump outfall, bed samples will also be collected at the most up- and downstream cross sections during each survey at AP 32 and AP 34. The gradation of the samples will be analyzed by a qualified soils laboratory following procedures specified in ASTM Standard D422.

3.4. Sediment-transport and Water-quality Measurements

Data from the System-wide and Kearney Diversion Water Quality (WQ) Monitoring Programs (PRRIP, 2010 and 2011) will be used to the extent possible to monitor downstream bed and suspended sediment loads. These data include individual bed and suspended sediment loads at Overton and Kearney from the System-wide monitoring program. The data also include both the continuous data from sondes located at Lexington and Elm Creek on the Platte River and in the Kearney Canal just downstream from the diversion structure, and discrete, depth-integrated samples that will be collected during maintenance of the sondes from approximately mid-April through November and at four other times during the year to capture various environmental conditions (i.e., storm events, pulse flows, etc.) as part of the Kearney Diversion WQ Monitoring Project Program.

3.5. Stage and Stage-Discharge Rating Curves

Pressure-transducer stage recorders will be installed at least one month before the start of augmentation at the right end of the monitoring cross section upstream from the pump outfall at the Dyer Property and at a suitable location in the vicinity of the Todd Brown property. A staff plate that is visible from the shoreline will also be installed at each location and tied to the horizontal and vertical control being used for the transect surveys. The transducer at the Brown property will also be equipped with a telemetry system that will permit designated Project and/or Program staff to remotely monitor the stage, and the data from both transducers will be manually downloaded at periodic intervals in conjunction with the cross section surveys. A discharge measurement will also be made at the transducer upstream from the pump outfall during each cross section survey for purposes of establishing a stage-discharge rating curve.

4. DATA ANALYSIS PLAN

4.1. Topography and Bathymetry

Pre-*Pilot Project* (baseline) topographic and bathymetric survey data will be overlaid onto the most recent PRRIP 2011 LiDAR data for comparison of changes since the LiDAR data were collected. The subaqueous portions of the data will also be used to refine the LiDAR surfaces for use in the models. Transect data from the subsequent field sampling events will be overlaid onto the previous transects and surfaces to assess changes associated with the *Pilot Project* activities and subsequent flows. Where appropriate, the hydraulic and sediment-transport models will be updated with the new data and measured bed elevation changes from baseline conditions will be compared to historical and model-predicted bed elevation changes and evaluated against the proper time scale (e.g., annually). In the short term (i.e., during augmentation activities), positive changes in bed elevation may indicate an adverse accumulation of sediment and trigger a temporary stop action or modification until possible impacts to downstream property owners can be evaluated. Over the long term, no change in bed elevation or decreases in degradation will be an indicator of the effectiveness of the augmentation project.

Localized survey data collected at locations of interest will also be compared to baseline topographic and bathymetric data and LIDAR data if possible. Data collected in the vicinity of the drainages identified by Tri-Basin NRD will be compared to CNPPIDs historical maintenance records.

In addition to the above analysis, the bar topography data from the System-wide and Elm Creek Complex FSM Experiment monitoring programs and available LiDAR data that are collected during the *Pilot Project* will be obtained and evaluated to assess changes in bar height and elevation of the green line and any potential relationship of those changes with the sediment augmentation activities. If sufficient data are available, changes in bar height will be evaluated following the analytical procedures in Tetra Tech (2011).

4.2. Bed-and-bar Material

Laboratory sieve analysis data will be plotted as standard grain-size distribution curves, and the key statistical parameters (e.g., D_{50}, D_{84}, D_{16}, gradation coefficient) compared by location and by subreach-average between successive surveys to assess changes in bed gradations. Changes in gradations of material in the river may be an indication of whether the augmented material is settling out or flushing through the system.

4.3. Discharge and Stage Data

Continuous discharge and stage data to be used in the analysis will be obtained from the relevant active stream gages (**Table 2, Figure 5**). As noted in Section 3.5, stage recorders will be installed at the monitoring cross section upstream from the pump outfall and in the vicinity of the Todd Brown property. The data from the stream gages, in conjunction with the discharge data from the J2 Return and with the discharges estimated from the rating curve at the monitoring cross section upstream from the pump outfall will provide a record of flows passing through the reach during the Pilot Project. The stage recorder at the upstream monitoring cross section and Todd Brown property will also be used to assess whether the augmentation is having an adverse effect on river stage.

Data from the USGS gages that will be used in the analysis include the published, real-time stages and discharges and data from the flow measurements that are used to develop the gage rating curve. The measurement data will be used to assess the variability in stage about the current rating curve, and also to perform a specific gage analysis to understand the long-term trends in the stage-discharge relationship at the gages.

Table 2. Active stream gages in the vicinity of the Elm Creek Complex.						
Gage Number	Gage Name	Location		Start of Discharge Records	Agency
		Latitude	Longitude		
06768000	Platte River near Overton	40°40’57”	99°32’26”	10/1/1930	USGS
06768025	Platte R, So.Ch, Cottonwood Ranch nr Overton	40°40;44”	99°29’21”	4/18/2009	USGS
06768035	Platte R, So.Ch, Cottonwood Ranch nr Overton	40°41’08”	99°26’20”	5/23/2001	USGS
06768020	Spring Creek near Overton	40°42’26”	99°33’34”	4/1/1996	USGS
06769000	Buffalo Creek near Overton	40°44’04”	99°30’20”	7/1/1949	USGS
06769525	Elm Creek near Elm Creek	40°44’04”	99°23’53”	3/21/1996	USGS
06770000	Platte River near Odessa	40°43’44”	99°15’20”	10/1/1938	USGS (WY38-WY04)/NDNR (WY04-present)
06770200	Platte River near Kearney	40°39’29”	99°05’20”	1/27/1982	USGS
73000	Kearney Canal from Platte River	40°41’19”	99°20’29”	8/31/2005	NDNR

4.4. Sediment Transport

The suspended-sediment data from the various sources discussed above will be obtained and plotted to assess direct pumping-related impacts and any residual effects that persist after cessation of pumping. Sediment-transport parameters can be evaluated against permit-required conditions.

5. REPORTING

Monitoring and data analysis reports will be prepared within 60 days after completion of the last data collection event during each year of the *Pilot Project*. These reports will describe the data collection procedures, key issues encountered during the data collection, and results from the data comparisons to assess changes over the intervening periods. The results will also be presented at one Technical Advisory Committee (TAC) meeting and at the PRRIP Adaptive Management Annual Reporting Session that is typically held in late-January or early-February.

6. FIELD SAFETY

Field safety will be emphasized at all times during the data collection events. Safety procedures will follow guidelines in the Project-Scale Monitoring Protocol and sound safety practices when working in and around active rivers. This includes the use of field personnel with appropriate experience and training and appropriate field safety equipment. A key safety factor within this reach is the Kearney Diversion Structure. The field crew leader will be responsible for ensuring that data collected in the vicinity of the structure is performed in a safe manner, including identification of areas in the river near the structure within which it is potentially unsafe to work. Data will not be collected in these areas. The crew leader will also be responsible for identifying the nearest medical facility and having on-hand emergency telephone numbers at all times while crews are working at the site.

7. REFERENCES

EA Engineering, Science and Technology, Inc., 2011. Kearney Canal Water Quality Monitoring Protocol, submitted to Platte River Recovery Implementation Program, April, 8 p.

Nebraska Public Power District, undated. Platte River Transect Monitoring Procedure, provided by Jim Jenniges, 5 p.

Platte River Recovery Implementation Program, 2011. DRAFT Project-scale Geomorphology and Vegetation Monitoring, April 22, 19 p.

Platte River Recovery Implementation Program, 2010. Monitoring the Channel Geomorphology and In-Channel Vegetation of the Central Platte River, Final Protocol, April 23, 24 p.

Tetra Tech, Inc., 2011. Platte River Recovery Implementation Program Elm Creek Adaptive Management Experiment Geomorphology and Vegetation Monitoring and Analysis Plan, April 25, 11 p.

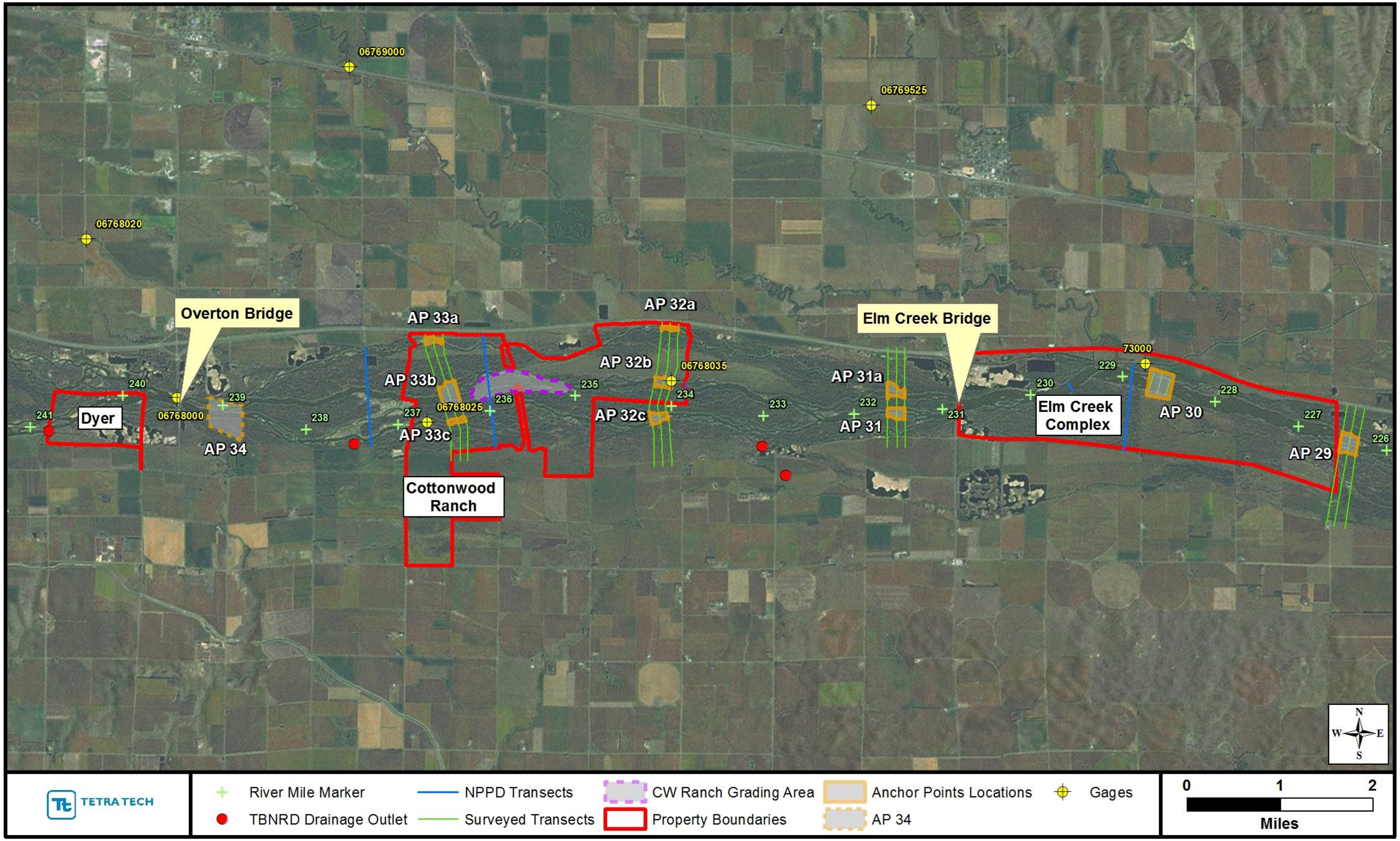


Figure 1. Overview map of the Pilot Project study reach.

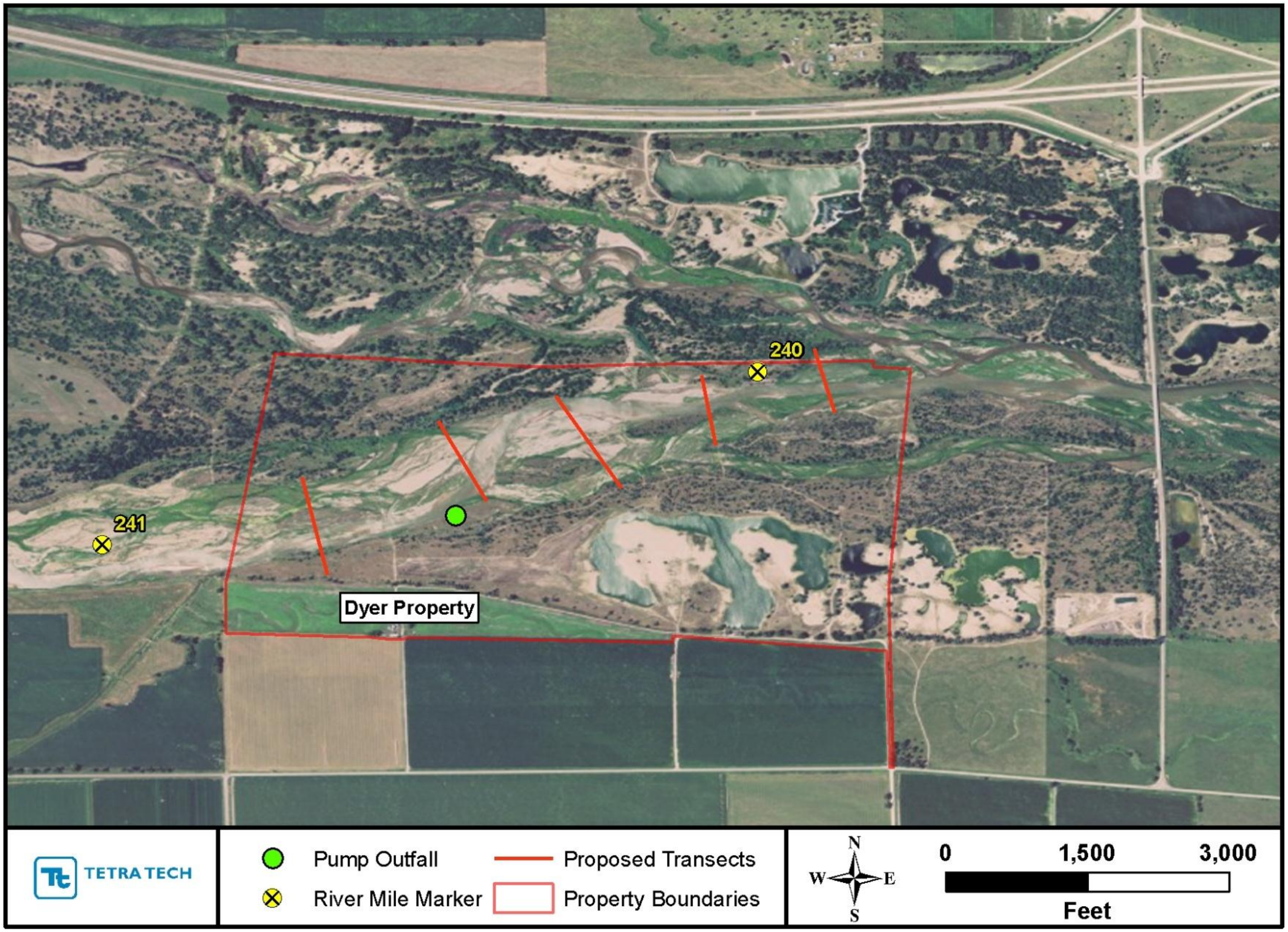


Figure 2. Approximate location of proposed pump outfall and near-outfall monitoring cross sections at the Dyer Property.

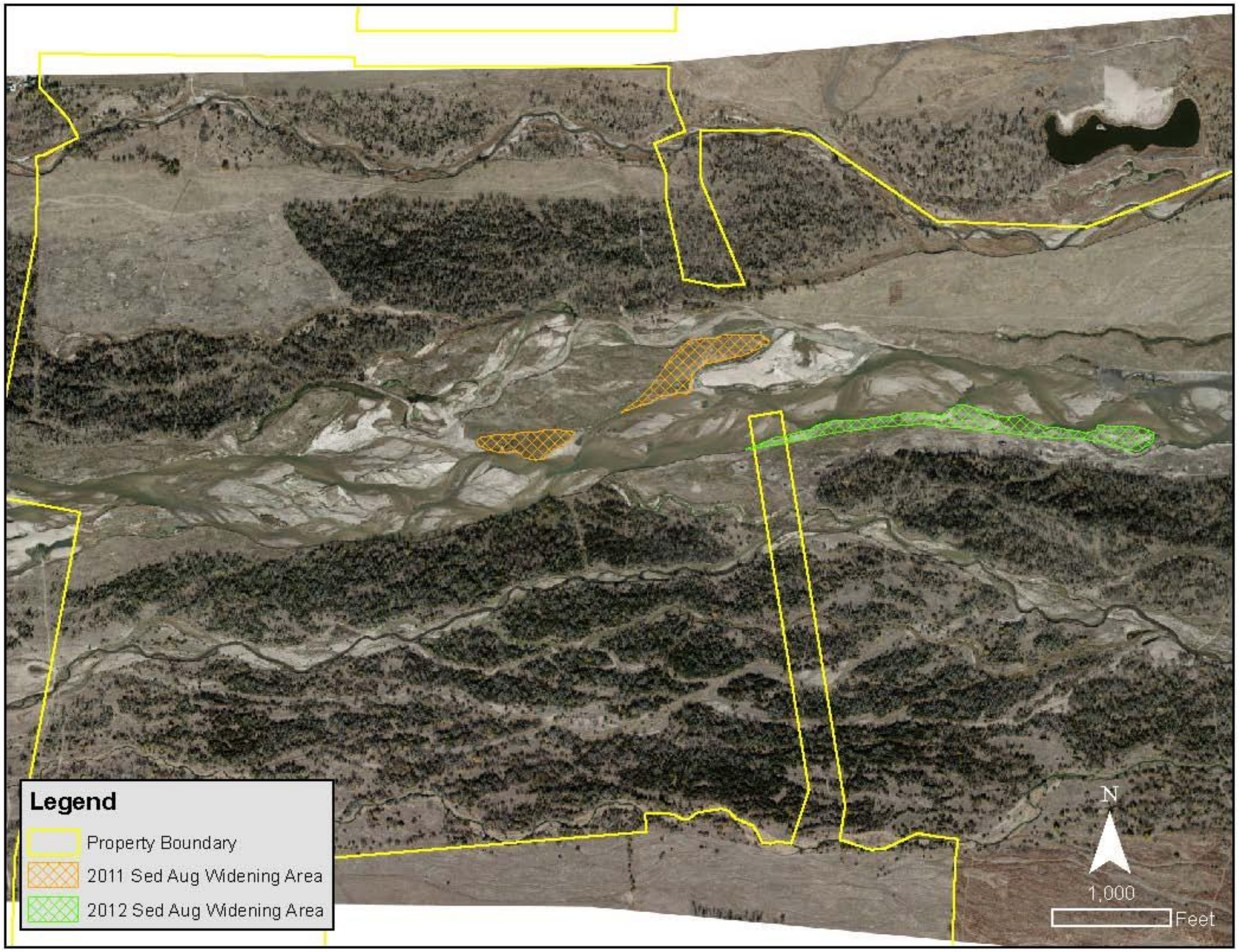


Figure 3. Proposed areas of mechanical grading to augment sediment at Cottonwood Ranch. Note: this plan was developed prior to the 2011 high flows, and may require significant modification based on changes in the bathymetry during the intervening period.

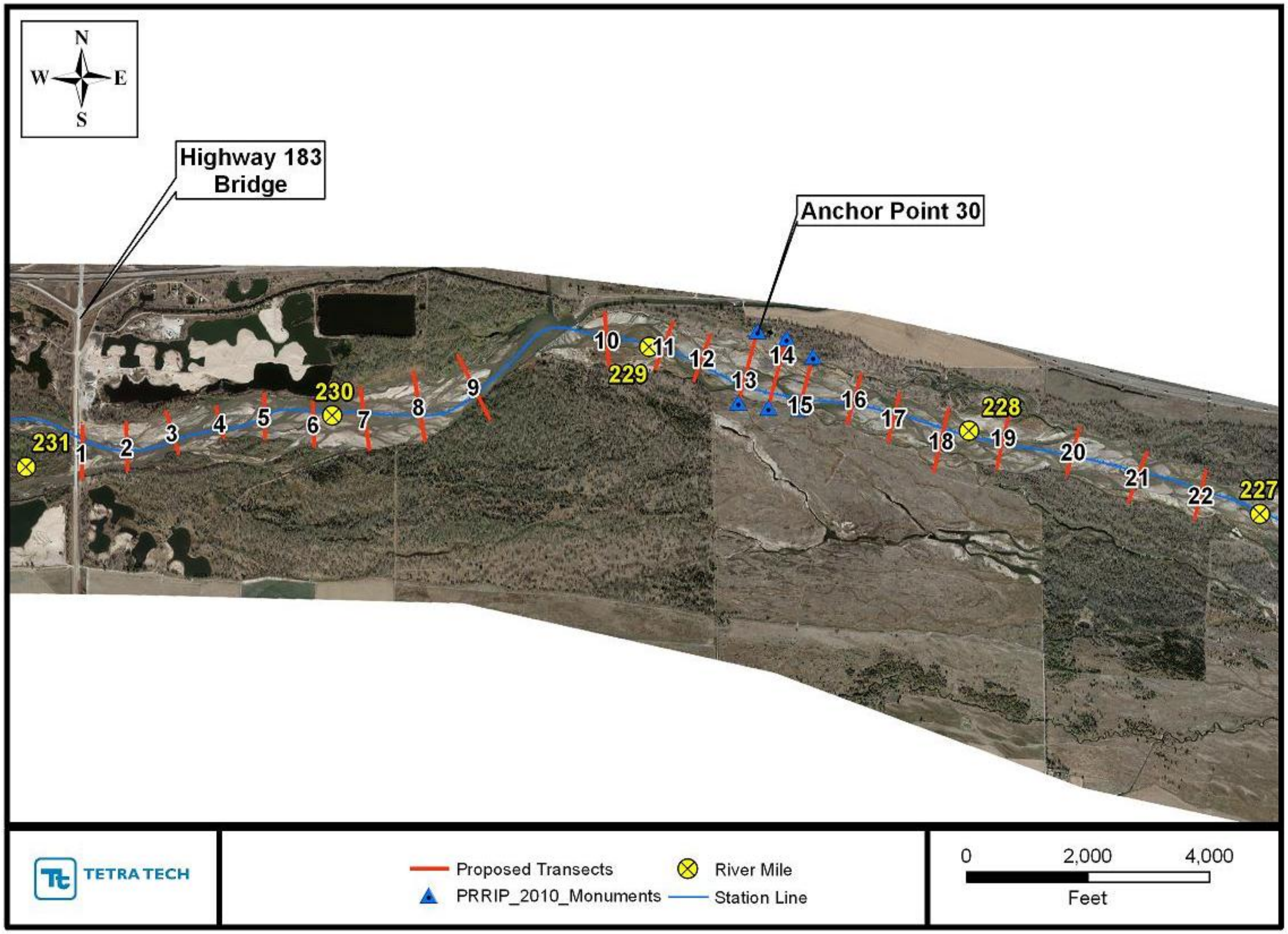


Figure 4. Monitoring cross-section layout for the Elm Creek Adaptive Management Experiment.

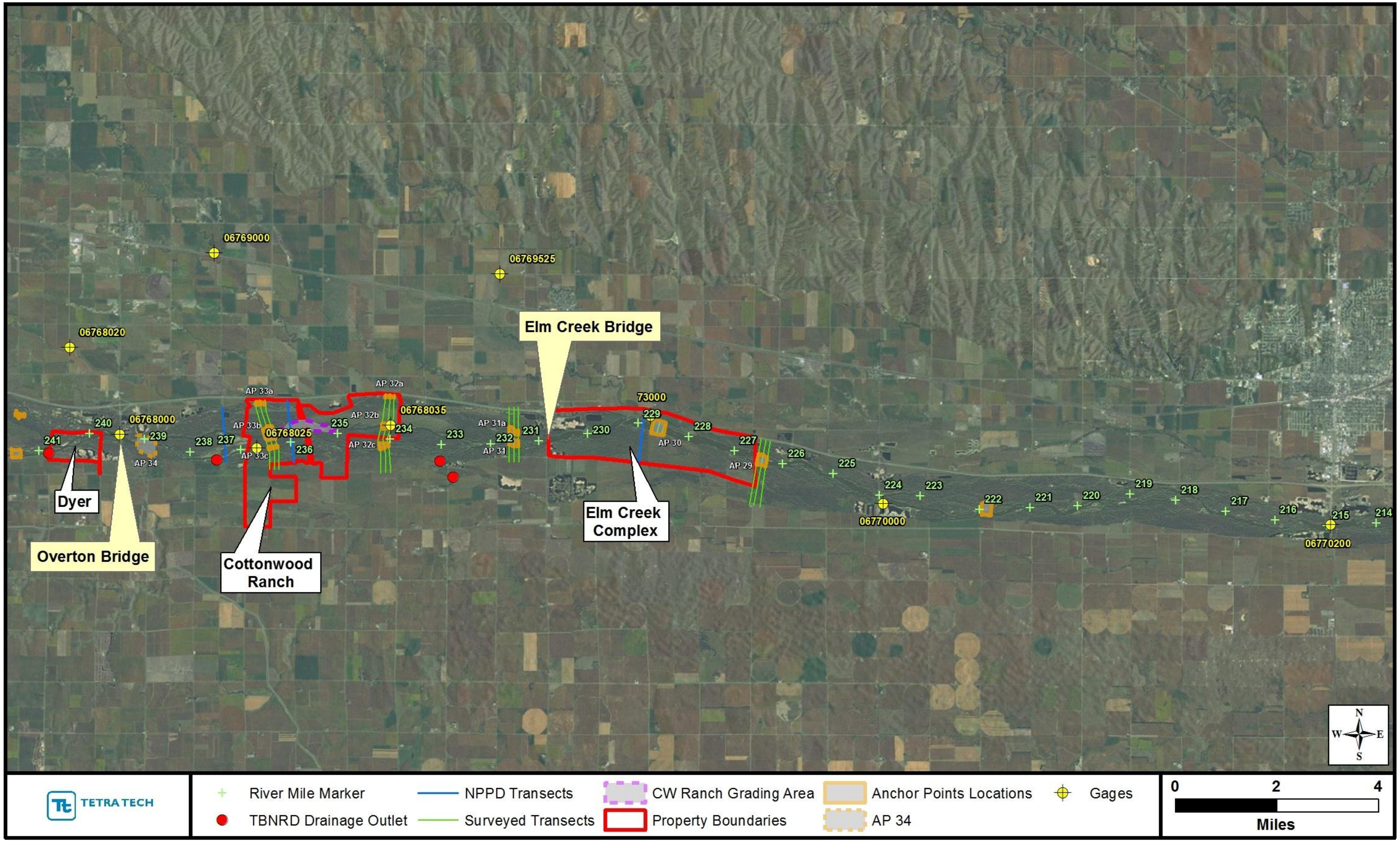


Figure 5. Location of existing stream gages in the vicinity of the project reach.