Platte River Recovery Implementation Program
1-D Hydraulic Model
Keystone Diversion to North Platte
Draft Scope of Services

TASK SERIES 100 – PROJECT SCOPING AND KICKOFF

Objective: Develop and finalize project scope for the 1-D Hydraulic Modeling (Project) and conduct Kickoff Meeting with Platte River Recovery and Implementation Program (Program) Executive Director's (ED's) staff, Adaptive Management Working Group (AMWG) members, and other interested parties.

Activities:

Task 101 - Develop Draft Scope of Services and Estimated Fee

- Work with Program staff to finalize approach to work efforts, tools to be used in the analyses, data sources and types.
- Review past and current data collection and modeling efforts.

Task 102 – Project Kickoff Meeting and Site Visit

- Conduct kickoff meeting with Program ED staff, AMWG members, and peer reviewer to review Draft Scope, gather input, identify data sets and contacts and get consensus on approach.
- Finalize key milestone dates, project timeline and delivery dates and compile into a project schedule.
- Conduct site visit on Platte River from Keystone Diversion to North PlatteNebraska.

Task 103 – Develop Final Scope of Services and Final Fee

- Incorporate comments from Kickoff Meeting into Draft Scope and Estimated Fee.

Deliverables:

- Draft and Final Project Scope documents.
- Agenda for meetings and meeting minutes.

Key Understandings:

- Draft model to be completed by August 1, 2011.
- Project completion anticipated in October 1, 2011.
- Meetings will be hosted at the ED office in Kearney, Nebraska.
- The scope and fee estimate format will be consistent with past and current efforts and will include a man hour breakdown by discipline with associated billing rates.
- Peer Review of 1D model to be completed by Golder Associates and is not included in this Scope of Services.
- Kickoff meeting to last one (1) day, and the site visit will take one and a half (1.5) days.

Information/Service Provided by Program Staff:

- Equipment for site visit.
- Data from ongoing Program data collection efforts.

- Coordination with Golder Associates for kickoff meeting attendance.

Meetings/Travel:

- One meeting with Program Staff to finalize Project Scope, Fee, and Schedule.
- One joint Kickoff meeting with Program ED staff, AMWG, Golder Associates, and others as deemed appropriate.

TASK SERIES 200 PROJECT MANAGEMENT AND MEETINGS

Objective: To plan and manage HDR Services, coordinate all efforts of the Project Team, maintain project document control system, and manage communications between project participants, internal and external.

Activities:

Task 201 – Project Management

- Coordinate and direct the activities of the Project Team.
- Coordinate work and solicit input from Program ED staff.
- Prepare a Project Guide containing concise summary of key project information including the Quality Assurance/Quality Control Plan.
- Monitor and control Project budget and schedule.
- Develop monthly project progress reports.

Task 202 – Project Meetings

- Conduct progress and coordination meetings to make Program staff aware of Project progress. Anticipate monthly project coordination meetings via conference call with Program ED staff and AMWG members on technical issues.
- Attend one (1) Technical Advisory Committee (TAC) meetings to brief TAC members of Project status.
- Attend one (1) Governance Committee (GC) meeting to present results.

Task Deliverables:

- Monthly invoices and project progress reports including updated project schedule.
- Meeting minutes.
- Presentation materials for TAC project briefings.
- Presentation materials for GC project meeting.

Key Understandings:

- Draft meeting minutes and Progress Reports will be done in Microsoft Word format.
- Final meeting minutes and Progress Reports will be submitted in PDF format.
- Management of HDR subcontracts is included.
- TAC and GC meetings will be held in Kearney, NE.

Information/Service Provided by Program Staff:

- TAC meeting dates and agendas.
- GC meeting date and agenda.

Meetings/Travel:

- Monthly project coordination conference calls.
- One (1) TAC meeting.
- One (1) Governance Committee meeting.

TASK SERIES 300 EXISTING INFORMATION GATHERING AND REVIEW

Objective: Collect and review relevant existing information and data from ongoing Program data collection and modeling efforts and identify information gaps and needs.

Activities: **Task 301 –Existing Information Gathering and Review**

- Review hydrologic data/reports from ongoing projects sponsored by the Program and other basin water users applicable to this reach.
- Review topographic mapping (including LiDAR).
- Obtain and review NDOR and county bridge as-builts.
- Obtain and review NDNR rating curves.
- Obtain and review Hydraulic Structure as-builts.
- Obtain land use coverage data set from Program.

Task 302 – Identify Data Information Gaps

- Compile and evaluate information from Task 301.

Task Deliverables:

- Memorandum identifying data gaps.

Key Understandings:

- CIR upstream of North Platte is available from TPNRD for 2009. HDRwill obtain the CIR for the Platte River from Keystone Diversion to North Platte for the Project, and will also provide an electronic copy of the CIR to the Program's ED's office.
- Program LiDAR data used for Tri-County Diversion to Chapman hydraulic model is adequate for this study reach to represent existing topography.
- Hydrologic information utilized in the Conjunctive Management Model will be used to estimate tributary/canal inputs.

Information/Service Provided by Program Staff:

- Land use coverages will be provided by Program staff if available.
- Any other data deemed necessary by Program Staff.

Meetings/Travel:

- One trip to Program office to obtain Program data.

TASK SERIES 400 SUPPLEMENTAL DATA COLLECTION

Objective: Supplement existing topographic data as needed based on findings in Task Series 300 to facilitate hydraulic model development and calibration.

Activities: **Task 401 – Field Collection Plan**

- Develop a Field Collection Plan to obtain the needed data based on identified data gaps and additional information needs.

Task 402 – Data Collection

- Conduct data collection effort.

Task Deliverables:

- Technical memorandum stating methods, results of additional data collection, and raw data.

Key Understandings:

- HDR Team will get concurrence with Program ED staff on Field Collection Plan prior to implementation.
- HDR Team will coordinate with Program staff for land access and will adhere to Program protocols relative to land access.
- Supplemental data, primarily related to the subaqueous in-channel elevations, may be required upstream of North Platte. For purposes of this work effort, it is estimated that 10 new cross sections upstream of North Platte will be surveyed as needed depending on the results of model calibration. The cost associated with surveying 10 new cross sections is reflected in the fee estimate.
- Ten cross sections per week per crew can be obtained.
- Bridge geometry will be estimated based on bridge plans from the respective county and Nebraska Department of Roads. No bridge survey information will be required. If bridge surveys are required, the work associated with that effort will be provided as additional service.

Information/Service Provided by Program Staff:

- Land owner permission for cross section survey.

Meetings/Travel:

- Data Collection as needed.

TASK SERIES 500 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

Objective: Develop and calibrate a 1-D hydraulic model for the 55-mile reach of the Platte River from Keystone Diversion to the Tri-County DiversionThe model will provide a tool that can be used by Program participants to evaluate flow attenuation from Keystone Diversion to Tri County Diversion

Activities: **Task 501 - Steady state model development and calibration from Keystone Diversion (RM 365) to RM 321 (5 miles upstream of Hwy 83)**

- Identify four (4) steady-state flows for use in calibration in consultation with Program staff, including the LiDAR flow.
- Process LiDAR data.
- Develop DTM from LiDAR data.
- Develop topographic input data using DTM and HEC-GeoRAS.
- Develop Manning's "n" value input data using land use coverage polygons and HEC-GeoRAS.
- Develop flow input files and average annual reach gain/loss values based on NDNR stream gages and tributary/canal inflow estimates.

- Calibrate model by comparing predicted water-surface elevations with the measurement data and rating curves at the existing gages along the reach, measured water-surface elevations from recent surveys, and the water-surface profile developed from the LiDAR mapping that was flown.

Task 503 - Unsteady model development and calibration from Keystone Diversion (RM 365) the Tri-County Diversion (RM 310.4)

- Identify three (3) unsteady hydrographs for use in calibration in consultation with Program staff.
- Develop reach gain/loss relationship.
- Develop appropriate bank storage relationship.
- Calibrate the unsteady model by adjusting input parameters, as necessary, to match predicted hydrographs as closely as possible to measured hydrographs. The quality of agreement between the predicted and measured hydrographs will be initially qualitatively assessed by simple visual comparison of the hydrographs, and ultimately quantified using Nash-Sutcliffe Coefficients (Nash and Sutcliffe, 1970; Krause, et al, 2005; Moriasi, et al, 2007).

Task Deliverables:

- Calibrated model for the Platte River from the Keystone Diversion to Tri-County Diversion, including topographic input data.
- Digital terrain model and HEC-GeoRAS application for input of topographic data and export of simulation results.
- Technical report describing model development and calibration.

Key Understandings:

- The hydraulic model will be developed and executed using the most recent version of HEC-RAS, currently version 4.1. Although HEC-RAS version 4.2 is under development, it is not anticipated that it will be available during the course of this project.
- DTM will be based on LiDAR information only, no subaqueous information will be generated in DTM format.
- HEC-GeoRAS will be used to facilitate the use of the available mapping to import the topographic and roughness data.
- If land use coverages are not available, land use coverage polygons using Program CIR photography will be developed for use in assigning Manning's "n" values for the overbanks.
- Manning's "n" values will be based on past and on-going studies on the Platte River, including hydraulic models previously developed for the Program, experience in similar rivers, and review of standard references (Arcement and Schneider, 1989; and Barnes, 1967) for the Lexington to Chapman Reach.
- Three (3) steady state flows will be selected in consultation with Program staff. In addition, the model will be calibrated for the low flow condition when the LiDAR mapping was flown.
- Steady state calibration will be achieved by adjusting Manning's roughness coefficients within the range of physically reasonable values for sand-bed

channels and the variable overbank vegetation conditions that occur in the model reach. Where appropriate, encroachments and ineffective flow areas will be used to account for the effects of abrupt changes in channel geometry that cause flow separation or ponding, and to prevent flow in areas that are below the computed water-surface, but separated from the primary channel and are, therefore, not effective in carrying flow. Although it would be possible to vary the main channel roughness coefficients (i.e., n-values) from cross section to cross section and with discharge to achieve more precise calibration to observed water-surface elevations, this level of resolution does not typically result in a more robust model because of the temporal variability in conditions at any given location, particularly in a sand bed channel such as the Platte River. It is, therefore, standard practice to specify the main channel "n" on a reach-by-reach basis, based on physical conditions that can be observed in the aerial photography and the site visit, and this approach will be used for this project. The scale of the reaches will be determined during model development, but is likely to be on the order of several to tens of miles per reach. Aside from the effects of in-channel vegetation and obstructions, it is anticipated that the main channel n-values will be relatively consistent along the reach. In general, the calibration objective for the steady-state model will be to minimize the differences between measured and predicted water-surface elevations, with the average difference less than a few tenths of feet, no consistent trend of over- or under-predicting along the length of the reach, and maximum differences of less than 1 foot. Relatively large differences could be caused be inaccuracy in the measured water-surface elevation, changes in the bed and/or roughness conditions between the time of the surveys and the observed water-surface elevation, and hydraulic controls or other factors that are not accounted for in the available data. As a result, additional effort using the available data will not improve the calibration nor the overall robustness of the model, and the model will be considered to be adequately calibrated. The fee estimate for calibration is based on a level of effort for a project engineer of 1 hour/mile. Should the calibration exceed this it will be negotiated as an additional service.

- Average cross section spacing will be in the 1,500 ft to 2,000 ft range.
- Split flows around well vegetated, permanent to semi-permanent islands will be incorporated into the model using the Split Flow Optimization option in HEC-RAS.
- Three (3) hydrographs will be used to calibrate the unsteady model using post-1996 gage data, and will be selected in consultation with Program Staff.
- For the unsteady model calibration, it may be necessary to reduce the cross section resolution and make minor adjustments to the input parameters. Since the roughness and other input parameters in the steady-state model will have already been calibrated to observed water-surface elevations, additional adjustments to these parameters to achieve calibration in the unsteady model will be avoided. Additional parameters and input data that will be considered for adjustment in the unsteady model include hydraulic

conductivity, assumed groundwater levels, weir or conveyance coefficients, the Theta Implicit Weighting Factor, and the Flow and Submergence Stability Factors. Because of the length and variability of the modeled reach, the inherent uncertainty in the lateral inflows and losses along the reach, numerical limitations of the routing model, precise matching of the time and magnitude of flows at the various gages along the reach will not be possible. The model will be considered to be adequately calibrated when the predicted hydrographs have similar shape, peak flow and general temporal trends as the measured hydrographs at the gages. The fee estimate for calibration is based on a level of effort for a project engineer of 2 hours/mile. Should the calibration exceed this effort, it will be negotiated as an additional service.

- Modeling split flows for the unsteady simulation may result in model instabilities. The most effective method for eliminating these instabilities is to incorporate artificial pilot channels into the secondary channels that permit a nominal amount of flow under conditions when the secondary channel would not actually carry flow. Using this approach, the artificial flow in the pilot channel must be sufficiently small so overall hydraulic conditions are minimally affected yet allow for model stability.
- Although characteristics of the flow splits are important in understanding the local hydraulic conditions that are key to evaluating habitat, they often have insignificant effects on the hydrograph routing characteristics of the reach. As a result, it may be necessary to maintain an unsteady version of the model, in which certain problematic flow splits that do not affect the hydrograph routing characteristics are eliminated, and a steady state version that includes all of the locally-important flow splits. Subreaches and parallel channel will be added as necessary to represent flow splits.
- Computed actual reach gain/loss and tributary inflows will be used for calibration. The reach gain/losses will be calculated using gage data in an Excel spreadsheet. This will serve as an approximation of the bank storage. The bank storage tool developed for the Program's model from Tri County Diversion to Chapman will be used to estimate bank storage.

Information/Service Provided by Program Staff:

- Input on steady state and unsteady hydrology to be used for calibration.

Meetings/Travel:

- Milestone meetings to be coordinated with TAC meetings listed in Task Series 200.

TASK SERIES 600 MODEL TRANSITION AND SUPPORT

Objective: Transfer all model-related files to Program staff, and transition control and ownership of the model to the Program. Provide as needed support to Program staff for up to 6 months.

Activities:

- Transfer all input data and model files to the Program following Task Series 500, Model Application Workshop.

- Provide support to Program staff for up to 6 months, including phone calls, emails, and short meetings.

Deliverables:

- Final model files including all input data and input files used in model development and calibration.

Key Understandings:

- All input data and model files will be transferred to the Program, and the model will become Program property to be used and modified as necessary for Program purposes.

Information/Service Provided by Program Staff:

- Desired format of model related files.

Meetings/Travel:

- None.

Exhibit "B" Budget
Platte River Recovery Implementation Program
1-D Hydraulic and Sediment Transport Modeling

		HDR Engineering, Inc.						TetraTech						The Flatwater Group										
TASKS		Project Manager - Engelbert	Sr. Technical - Engel	Project Engineer - McCoy	Project Engineer - Schubert	Project Engineer - McConville	Clerical	QA/QC - Fullerton	Sr. Technical- Mussetter	Sr. Technical- Harvey	Project Engineer - Trabant	Project Engineer - Morris	Project Engineer - Brown	Sr. Technical- Riley	Project Engineer - Cermak	Envir. Scientist - Coke	Technician - Seipel	Total Hours	Total Labor Cost	Printing	Travel	Misc.	Total Expenses [1]	Est. Total Cost
TASK SERIES 100 - PROJECT SCOPING AND KICKOFF																								
Task 101	**Develop Draft Scope of Services and Estimated Fee**	4		8	8									0				20	$2,588				$0	$2,588
Task 102	**Project Kickoff Meeting and Site Visit**	24		24	24													72	$9,888		$850		$850	$10,738
Task 103	**Develop Final Scope of Services and Final Fee**	4																4	$708				$0	$708
	Estimated Task Hours Subtotal	**32**	**0**	**32**	**32**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**96**						
	Estimated Task Cost Subtotal	$5,664	$0	$4,640	$2,880	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		**$13,184**	**$0**	**$850**	**$0**	**$850**	**$14,034**
TASK SERIES 200 - PROJECT MANAGEMENT AND MEETINGS																								
Task 201	**Project Management**	40							8					4				52	$9,452				$0	$9,452
Task 202	**Project Meetings**	32			16													48	$7,104		$300		$300	$7,404
	Estimated Task Hours Subtotal	**72**	**0**	**0**	**16**	**0**	**0**	**0**	**8**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**100**						
	Estimated Task Cost Subtotal	$12,744	$0	$0	$1,440	$0	$0	$0	$1,772	$0	$0	$0	$0	$600	$0	$0	$0		$16,556	$0	$300	$0	**$300**	**$16,856**
TASK SERIES 300 - EXISTING INFORMATION GATHERING AND REVIEW																								
Task 301	**Existing Information Gathering and Review**																							
Subtask 301.1	Collect & Review Hydro Data/Reports	2		4	2													8	$1,114				$0	$1,114
Subtask 301.2	Collect & Review Topo Mapping	2		3	2													7	$969				$0	$969
Subtask 301.3	Collect & Review Cross-Section and Thalweg Profile Data	1		3	2													6	$792				$0	$792
Subtask 301.6	Assess Utility of Geomorphology/In-Channel Vegetation Data	1		3	2													6	$792				$0	$792
Task 302	**Identify Data Information Gaps**	2		3														5	$789				$0	$789
	Estimated Task Hours Subtotal	**8**	**0**	**16**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**32**						
	Estimated Task Cost Subtotal	$1,416	$0	$2,320	$720	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		**$4,456**	**$0**	**$0**	**$0**	**$0**	**$4,456**
TASK SERIES 400 - SUPPLEMENTAL DATA COLLECTION																								
Task 401	**Field Collection Plan**	4		4										2	8			18	$2,348				$0	$2,348
Task 402	**Data Collection**													4	8	40	40	92	$7,360		$1,000	$2,500	$3,500	$10,860
	Estimated Task Hours Subtotal	**4**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**16**	**40**	**40**	**110**						
	Estimated Task Cost Subtotal	$708	$0	$580	$0	$0	$0	$0	$0	$0	$0	$0	$0	$900	$1,520	$3,400	$2,600		**$9,708**	**$0**	**$1,000**	**$2,500**	**$3,500**	**$13,208**
TASK SERIES 500 - HYDRAULIC & SEDIMENT TRANSPORT MODEL DEV. & CALIBRATION																								
Task 501	**Steady State Model Dev & Calib - Keystone to RM 321**	12	8	40	180	60			20		24		24	8	32			408	$45,786					$45,786
Task 502	**Unsteady Model Dev & Calib - Keystone to Tri-County**	16	8	40	180	80			20		24		24	4	8			404	$45,814					$45,814
	Estimated Task Hours Subtotal	**28**	**16**	**80**	**360**	**140**	**0**	**0**	**40**	**0**	**48**	**0**	**48**	**12**	**40**	**0**	**0**	**812**						
	Estimated Task Cost Subtotal	$4,956	$2,800	$11,600	$32,400	$15,400	$0	$0	$8,860	$0	$5,352	$0	$4,632	$1,800	$3,800	$0	$0		**$91,600**	**$0**	**$0**	**$0**	**$0**	**$91,600**
TASK SERIES 600 - MODEL TRANSITION AND SUPPORT																								
Task 601	**Transfer Input Data and Model Files**	4		8	8	8												28	$3,468					$3,468
Task 602	**Provide Support to Program Staff**	12		16		16												44	$6,204					$6,204
	Estimated Task Hours Subtotal	**16**	**0**	**24**	**8**	**24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**72**						
	Estimated Task Cost Subtotal	$2,832	$0	$3,480	$720	$2,640	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		**$9,672**	**$0**	**$0**	**$0**	**$0**	**$9,672**
1-D HYDRAULIC AND SEDIMENT TRANSPORT MODELING TOTAL HOURS		**160**	**16**	**156**	**424**	**164**	**0**	**0**	**48**	**0**	**48**	**0**	**48**	**22**	**56**	**40**	**40**	**1,222**						
1-D HYDRAULIC AND SEDIMENT TRANSPORT MODELING TOTAL (ROUNDED)		**$28,320**	**$2,800**	**$22,620**	**$38,160**	**$18,040**	**$0**	**$0**	**$10,632**	**$0**	**$5,352**	**$0**	**$4,632**	**$3,300**	**$5,320**	**$3,400**	**$2,600**		**$145,176**	**$0**	**$2,150**	**$2,500**	**$4,650**	**$149,826**

Exhibit "B" Budget
Platte River Recovery Implementation Program
1-D Hydraulic and Sediment Transport Modeling
Schedule

TASKS		Mar-11				Apr-11				May-11					Jun-11				Jul-11				Aug-10					Sep-11				Oct-11				
TASK SERIES 100 - PROJECT SCOPING AND KICKOFF																																				
Task 101	**Develop Draft Scope of Services and Estimated Fee**																																			
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