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*Managing Water in the West*

# Whooping Crane Data Analysis Methods Summary

*Photo credit Mark Peyton, CNPPID*

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2008

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**BUREAU OF RECLAMATION**
**Technical Service Center, Denver, Colorado**
**Sedimentation and River Hydraulics Group**

# Whooping Crane Data Analysis Methods Summary

**Prepared for:**

**The Governance Committee**
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**Bureau of Reclamation**
**Technical Service Center**
**Denver, Colorado**

**April 2008**

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# I. Introduction and Background

The Governance Committee (GC) of the Platte River Program (Program) contracted with different consultant groups to take field observations and measurements on Whooping Crane (WC) use in the Platte River study area between Overton, Nebraska and Chapman, Nebraska downstream of Grand Island (Figure 1). These observations from years 2001 to 2006 were combined with observations from the U.S. Fish and Wildlife Service (FWS) over the same period. The GC contracted Western EcoSystems Technology, Inc. (WEST, Inc.) to analyze the Whooping Crane observations and later contracted with the Bureau of Reclamation, Sedimentation and River Hydraulics Group (SRH) at the Technical Service Center, to aid WEST, Inc. with the reduction of the Whooping Crane hydraulic data. Three transects, an upstream, middle and downstream transect, were measured and recorded at every WC-use site using stadia surveys. The surveys were collected within a few weeks to a couple months of the crane observation. The hydraulic parameters estimated from the WC transect surveys can help the Program determine if specific habitat conditions are favored by the WC in their migratory stops along the Platte River.

The contract between the Governance Committee and the Reclamation SRH Group was divided into two phases. The first phase was a pilot study to determine the most feasible of three methods to estimate the hydraulic parameters at the crane use sites, on the day the crane stopped at the site. Methods and conclusions from Phase I are attached in electronic format, in Appendix A. After determining method in Phase I and receiving GC approval of the method selection, the hydraulic parameters for all crane use sites are estimated in Phase II. This summary report describes methods and results of Phase II data reduction.

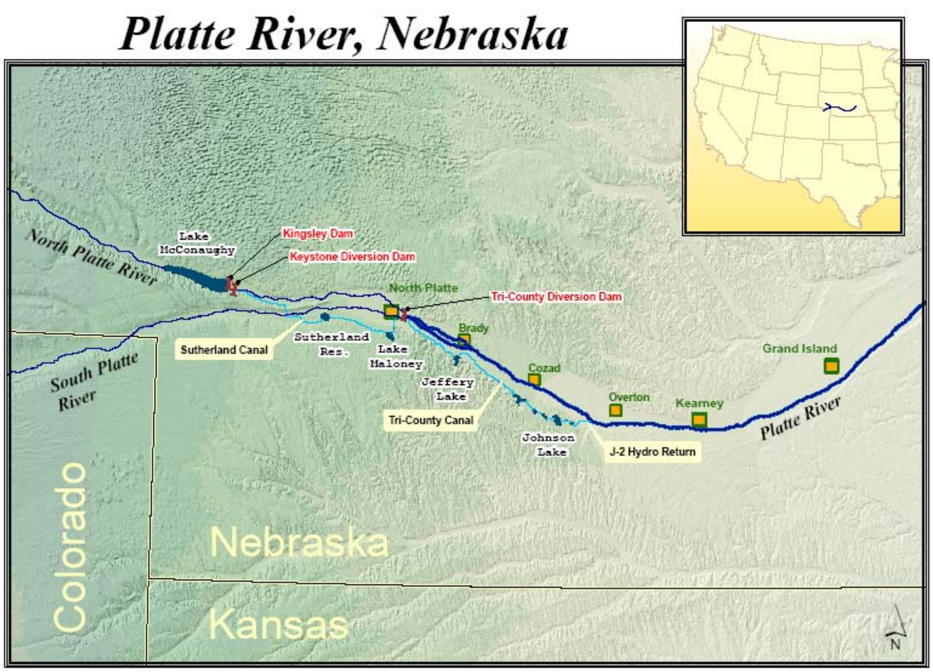


Figure 1 Location Map

## 1.1 Challenges of Hydraulic Data Reduction

Two pieces of information, needed to calculate the hydraulic parameters for the WC studies, were not available from the transect surveys. They are the slope and the partial flow in the transect at the WC use site. In the braided Platte River the flow is divided between multiple channels in a cross section. The water surface and hydraulic parameters for a specific channel or transect (segment of the cross section) is dependent on the flow in that transect and the downstream slope. The total flow for the river is known from US Geologic Survey (USGS) gage data, however the partial flow at a transect where the crane stopped has to be estimated based on the geometry of the entire floodplain. The percent of flow conveyed in a transect is unique to each longitudinal location along the river, and unique to the selected location of the transect within the floodplain cross section. The slope of the Platte River is relatively consistent at 0.0012 ft/ft, however local conditions can cause this value to vary by as much as a third (.0008 ft/ft at J2 outlet). Because the transect surveys are not tied into vertical control or tied to adjacent transects, the slope can not be calculated from the stadia survey data.

## 1.2 Phase I- Selection of Data Reduction Method

The GC initially contracted SRH to consider three methods of estimating the water surface elevation at a crane use site using transect surveys from 10 sites. The water surface elevation is estimated for the day a WC was observed, in comparison to the water surface elevation noted on the day when a survey crew returned to obtain a stadia transect-survey at the approximate WC use site. Decoy data was used in Phase I whenever it was available since this data included two transect surveys, surveys when the decoy was originally placed and a transect survey at a later date. Two decoy sites in the Overton Reach, four decoy sites in the Kearney Reach, and four WC sites from the Grand Island Reach (no decoy data is available downstream of the Grand Island gage) were selected for the phase I comparison of methods. Three methods of estimating the difference in water surface between the survey date and WC use date were considered:

- USGS Gage- compute the differential in water surface between the dates at the closest USGS gage station and assume it is the same water surface differential at the Whooping Crane use sight;
- Manning's Equation and Q Ratio (Manning's) - a flow ratio is computed comparing the closest USGS gage flow for survey day, to a computed flow conveyed in the transect on survey day using the Manning's Equation. The ratio is then used to estimate flow in the transect on the WC use day. Finally, Manning's Equation is again used to back-calculate the water surface elevation on WC use day from the estimated Q in the transect;
- HECRAS- use the model to compute transect water surface differential between the dates based on the model dividing flow between the transect conveyance channel and any additional channels in the floodplain as shown in full cross sections.

The basic HECRAS method of dividing flows between channels did better in the 10 test cases than the Q ratio approach used in the Manning's Method. The HECRAS steady flow model used 58 surveyed cross sections, providing better opportunity for a match then the single cross sections associated with the 4 gage sites in the USGS Gage Method. HECRAS was recommended in Phase I November 6, 2007 summary report as the primary method of data reduction, while the USGS Gage method, which is readily available from USGS gage readings, was recommended for quality control purposes. Based on these results, the GC approved the use of the HECRAS method for analyzing 2001 to 2006 Whooping Crane observations.

# 2.0 Phase II – Methods

In January 2008, the GC approved and funded Phase II, data reduction by SRH using the method recommended in Phase I. Three hydraulic parameters are required for each transect, at each WC use site, and measured at the flow on the WC use day. The three parameters are water surface differential between survey day and WC use day, wetted top width of the transect, and hydraulic depth of the transect (flow area divided by wetted top width). Normally there are three transects at each site. The same parameters were also requested for 15 sites upstream and 15 sites downstream of the WC use site for a comparison to sites not chosen by WC. At the time the cross-section spacing of the model was approximately one every 0.1 miles, so 15 sites represented approximately 1.5 miles.

## 2.1 Assigning River Miles

The first task was to translate crane use locations and transect surveys from UTM coordinates to river miles, to enter cross sections into the HECRAS model. The Army Corps of Engineers river mile designations were used and the distance between the downstream river mile marker and the transect UTM or UTM's was added to the value from the river mile marker (Figure 2). The river mile was reported to the 1/1000 of a mile.

Several other rules that were followed to assign river mile are listed here:

- the river mile measurement is a straight distance between two points, with the exception of the last rule in this list;
- in most cases measure from the downstream river mile, but flag any exceptions where distance is measured from the upstream river mile marker;
- if there are two transect end points, the distance ends at the intersection of the transect line;
- project the end of the transect line to the intercept if it does not initially intersect the river mile distance measure;
- if there is only one transect end point on a single channel, project a transect line perpendicular to flow and measure the distance to this intersect:
- if there is only one transect end point in a reach with multiple channels, project a transect line perpendicular to the outer river banks, and measure the distance to this intersect;
- if there is only one transect end point, but it is adjacent to a transect with two end points, project the transect parallel to the adjacent transect; and
- if there is more than one transect line and the transect lines intersect each other before intersecting with the river mile distance measure, curve river mile distance around the bend.

Maps showing the locations of the WC use sites can be found in Appendix B. The numbers for each crane use site correspond to GIS numbering by SRH shown in the excel spreadsheet "Profilemiles worksheet" in Appendix D. Also listed on this spreadsheet are the river miles for the crane use sites and for the transects.

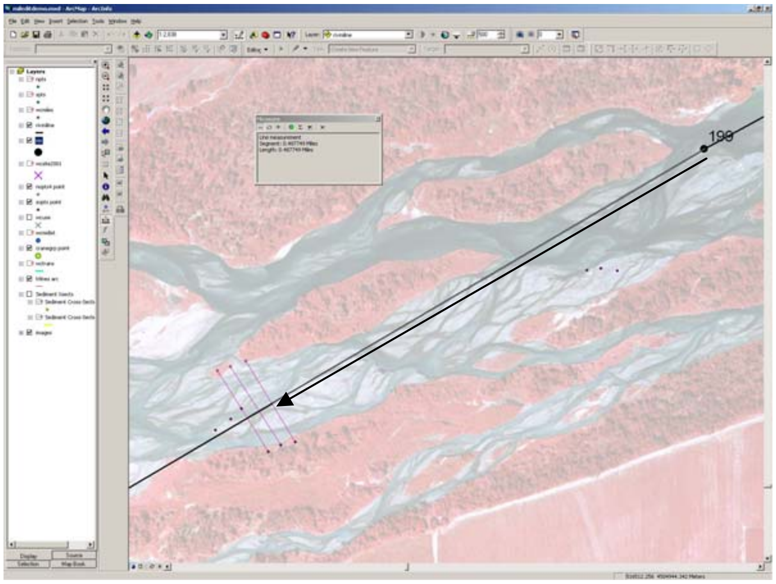

Figure 2- River mile assigned to the transect was measured from the downstream river mile to the intercept of the transect.

## 2.2 Constructing Geometry Files

The transect survey data had to be extended with additional points across the floodplain to construct a cross section, so that the total flow in the Platte River could be distributed across all channels at this cross section. The transect data was collected using stadia survey methods where a survey rod and a survey level with upper, middle and lower crosshairs are used. Through simple geometry, the reading from the upper and lower cross hairs are converted to distance between the level and the rod, while the middle cross hair provides an elevation reading relative to the current setup of the level.

WEST, Inc provided the rod reading, upper stadia reading, lower stadia reading, stadia interval and distance data with the distance between the level and the rod computed. The profile ID, use site ID, and transect description for each transect were also provided. SRH first assigned a river mile to the transect using GIS as described in the previous section. In the next step the distance from the level was converted to transect stationing, and the rod readings were converted to a local elevation (the level was assigned the same elevation for every setup). Finally, the transect was inserted into an adjacent floodplain-width cross-section.

### *2.2.1. Reducing Stadia Survey Data*

To compute the station and elevation for each point in the transect, the following steps were completed for each transect:

1. The distance in meters was converted to distance in feet.
2. Since the distance variable provided is the distance between the level and the rod reading, and the level was often rotated 180 degrees to take readings in both directions, one end point was assigned station zero.
3. The stationing for all other survey points was computed by adding the difference between two readings to the previous station.

4. The location of the level setup was estimated by looking for two small distance values where the measurements first decreased then increased (where level was swiveled 180 degrees).
5. The middle-stadia reading was converted to a local elevation by subtracting the reading from an elevation assigned as 10 feet.

### *2.2.2. Inserting a WC-use Transect into a Cross-Section*

After reducing stadia distances and rod readings to station and elevations, the transect data was placed within a copy of an adjacent cross section existing in the model.

1. The closest existing HECRAS cross-section to the surveyed transect for a WC-use site is selected based on river mile.
2. The existing cross section is copied and assigned the same river mile as the WC-use transect.
3. The copied or WC cross section is labeled with the WEST, Inc. date and profile ID in the comment line of the HECRAS cross-section file.
4. The thalweg of the copied cross section is initially assigned an elevation based on a slope of 0.0012 ft/ft with respect to the original cross section. All elevations in the copied cross section are adjusted based on the same elevation adjustment used for the thalweg.
5. The local elevation of the transect thalweg is replaced by the thalweg elevation of the WC cross section, and the elevation of all other points in the transect are adjusted by the difference between the transect thalweg elevation and the cross-section thalweg elevation.
6. Through visual observation, the beginning station where the transect will be inserted into the WC cross section is recorded. This is determined by looking at the overall HECRAS channel width compared to the transect width, comparing the HECRAS elevation changes to the transect elevation changes, or by keeping the transect within the HECRAS main channel boundaries.
7. The transect stations are adjusted so that the transect station zero is now assigned the station at the HECRAS insert point and all other transect stations are adjusted accordingly.
8. The points in the WC cross section that are overlaid by transect points, are erased and replaced by the transect survey data.
9. The left and right bank stations in the WC cross section are adjusted to be the endpoints of the inserted transect.
10. Distances between cross sections were corrected to reflect the river mile locations of each cross section.

### *2.2.3. The HECRAS Geometry File*

In Phase I of this study, the HECRAS geometry file from the Platte River Unsteady Flow and Bank Storage Model was used. This model constructed by Mohammed Samad was used to route flows through the Platte River study area. Only 58 surveyed cross sections were available so cross sections were interpolated every 1/10$^{th}$ of a mile to reduce instability in the model for unsteady runs. This brought the number of cross sections up to approximately 900. The same geometry file was used initially in Phase II, but modified when some of the interpolated cross sections were found to be not suitable for this application. Although the original 58 cross sections were retained, many of the interpolated cross sections were deleted or replaced by synthetic cross sections. The interpolated cross sections were deleted when the widths of the main channels and number of channels in the interpolated cross sections did not resemble the river section in plan view as observed from 1998 aerial infra-red photos. Synthetic cross sections were constructed from adjacent or similar cross sections, again based on the 1998 aerial infra-red photos. The spacing for the revised model is approximately one cross section every ½ mile, with 161 base cross sections. This number of cross sections was doubled to 334 with Whooping Crane cross sections at WC use sites.

## 2.3 Constructing flow files

A flow file was constructed for each WC use day and contained average daily flows measured at the USGS gages at Overton, Kearney and Grand Island. The files also contained average daily flows for the Overton, Kearney and Grand Island gages for the day the site was surveyed. The flow files were constructed as described below.

1. Every WC use date is identified by a unique WEST, Inc. crane GIS ID. The GIS IDs were correlated to the transect profile IDs. The IDs were first paired to the transects using UTM coordinates. If the coordinates were not the same, the IDs were paired based on the use site ID. If both of these methods did not match the GIS ID to the profile ID, the profile ID with the closest UTM coordinates was used. There were two GIS IDs that did not get flow files because there was no WC use date associated with the GIS ID's. Also, one GIS ID did not have transect survey data because the surveyors were unable to gain access to the location where the crane was originally observed.
2. Mean daily flow (cubic feet per second) and mean gage height (feet) were obtained from the USGS database for the gages at Platte River near Overton, Nebr. (06768000), Platte River near Grand Island, Nebr. (06770500), and Platte River near Kearney, Nebr. (06770200) for WC use dates and transect survey dates.
3. A constant (steady state) flow file was created for each transect. The flow file included the transect survey date flow information and the WC use date(s) flow information associated with the transect. There were three flow change locations at river mile 239.3 (Overton), 215.5 (Kearney), and 165.85 (Grand Island) that corresponded with the locations of the USGS gages. The upstream and downstream boundary conditions for all of the flow files assumed normal depth.

## Table 1 – Description of Cross Sections

| River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 239.3 | 2002 | 215.317 | WC | 199.548 | WC | 187 | 1989 &1998 | 179 | 1989 | 166.742 | WC |
| 239 | 2002 | 215 | Synthetic from 215.012 | 199.529 | WC | 185.984 | WC | 178.4 | 1989 | 166.72 | WC |
| 238.46* | Interpolated | 214.542* | modified interpolated | 199.515 | WC | 185.980* | Interpolated | 178.033* | Interpolated | 166.71 | WC |
| 237.2 | 2002 | 213.979* | modified interpolated | 199.511 | WC | 185.965 | WC | 177.483* | Interpolated | 166.632 | WC |
| 237.006 | WC | 213.510* | modified interpolated | 199.502 | WC | 185.957 | WC | 177.383 | WC | 166.609 | WC |
| 236.99 | WC | 213.040* | modified interpolated | 199.5 | 2002 | 185.756 | WC | 177.365 | WC | 166.59 | WC |
| 236.979 | WC | 212.477* | modified interpolated | 199.488 | WC | 185.749 | WC | 177.347 | WC | 166.569 | WC |
| 236.63 | WC | 212.008* | Interpolated | 199.154 | WC | 185.735 | WC | 177.344 | WC | 166.556 | WC |
| 236.607 | WC | 211.538* | Interpolated | 199.142 | WC | 185.517* | Interpolated | 177.318 | WC | 166.544 | WC |
| 236.588 | WC | 211.069* | modified interpolated | 199.129 | WC | 185.262 | WC | 177.3 | Surveyed | 166.536* | Interpolated |
| 236.5 | Copied 234.5 | 210.6 | 2002 | 199.043* | Interpolated | 185.241 | WC | 177.285 | WC | 165.990* | Interpolated |
| 235.5 | Copied 234.5 | 209.8 | 1998 | 198.495* | Interpolated | 185.053* | Interpolated | 177.184 | WC | 165.9 | Surveyed |
| 234.5 | Syn from 235.027 | 209.523* | Interpolated | 197.947* | Interpolated | 184.628 | WC | 177.174 | WC | 165.85 | Surveyed |
| 234.461* | Synthetic | 208.969* | Interpolated | 197.4 | Surveyed | 184.61 | WC | 177.158 | WC | 165.8 | Surveyed |
| 233.8 | 2002 | 208.764 | WC | 197.023* | Interpolated | 184.593 | WC | 177.095 | WC | 165.523* | Interpolated |
| 232.512* | Interpolated | 208.751 | WC | 196.458* | Interpolated | 184.497* | Interpolated | 177.0678 | WC | 164.969* | Interpolated |
| 232.052* | Interpolated | 208.739 | WC | 195.8 | 1998 | 184.306 | WC | 177.067 | WC | 164.516 | WC |
| 231.5 | Surveyed | 208.6 | 2002 | 195.53* | Interpolated | 184.288 | WC | 177.06 | WC | 164.507* | Interpolated |
| 230.8 | 2002 | 207.9 | 1998 | 194.9 | Surveyed | 184.266 | WC | 177.048 | WC | 164.492 | WC |
| 230.6821 | WC | 207.2 | 1998 | 194.445* | Interpolated | 184.034* | Interpolated | 177.044 | WC | 164.474 | WC |
| 230.666 | WC | 206.871 | WC | 193.9 | Surveyed | 183.965 | WC | 176.531 | WC | 164.046* | Interpolated |
| 230.65 | WC | 206.857 | WC | 193.524* | Interpolated | 183.949 | WC | 176.518 | WC | 163.492* | Interpolated |
| 230.533* | Interpolated | 206.842 | WC | 192.961* | Interpolated | 183.937 | WC | 176.505 | WC | 163.425 | WC |
| 230 | 2002 | 206.6 | 2002 1998 | 192.585* | Interpolated | 183.716 | WC | 176.49* | Interpolated | 163.417 | WC |
| 229.744 | WC | 206.194 | WC | 192.022* | Interpolated | 183.71 | WC | 176.04* | Interpolated | 163.403 | WC |
| 229.733 | WC | 206.164 | WC | 191.427 | WC | 183.699 | WC | 176.033 | WC | 163.03 | 1989 |
| 229.7202 | WC | 206.144 | WC | 191.408 | WC | 183.556 | WC | 176.029 | WC | 162.557 | WC |
| 229.535* | Interpolated | 206.127 | WC | 191.4 | Syn from 190 | 183.535 | WC | 176.005 | WC | 162.536 | WC |
| 229.071* | Interpolated | 205.94* | Interpolated | 191.39 | WC | 183.522 | WC | 175.5 | Surveyed | 162.511 | WC |
| 228.7 | 2002 | 205.56 | WC | 191.004 | WC | 183.478* | modified | 175.2 | Surveyed | 162.476 | Copied 162.2 |

| River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description | River Station | Node Description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 228.502 | WC | 205.549 | WC | 191 | Syn from 190 | 183.264 | WC | 174.6 | Surveyed | 162.254 | WC |
| 228.224 | WC | 205.533 | WC | 190.955 | WC | 183.248 | WC | 173.97* | Interpolated | 162.234 | WC |
| 228.206 | WC | 205.468* | Interpolated | 190.944 | WC | 183.238 | WC | 173.52* | Interpolated | 162.223 | WC |
| 228.053* | Interpolated | 205.386 | WC | 190.879 | WC | 183.2 | 1989 | 172.8 | Surveyed | 162.2 | 1989 |
| 227.5* | Interpolated | 205.38 | WC | 190.8676 | WC | 183.195 | WC | 172.7 | Surveyed | 162.011* | Interpolated |
| 227 | Copied 227.5* | 205.317 | WC | 190.856 | WC | 183.178 | WC | 172.6 | 1989 1998 | 161.951 | WC |
| 226.5 | Synthetic | 205.151 | WC | 190.529 | WC | 183.167 | WC | 172.4 | Surveyed | 161.936 | WC |
| 225.469* | Interpolated | 205.101 | WC | 190.516 | WC | 183.016* | modified | 172.1 | Surveyed | 161.923 | WC |
| 225.1 | 2002 and 1998 | 205.081 | WC | 190.501 | WC | 182.55 | WC | 171.47* | Interpolated | 161.539* | Interpolated |
| 224.3 | 2002 | 204.997* | Interpolated | 190.5 | Syn from 190 | 182.534 | WC | 171.02* | Interpolated | 160.973* | Interpolated |
| 224 | 1998 | 204.703 | WC | 190.22 | WC | 182.5197 | WC | 170.48* | Interpolated | 160.501* | Interpolated |
| 223.5 | Copied from 222.5 | 204.684 | WC | 190.204 | WC | 182.5 | Surveyed | 170.3 | 1998 1989 | 160.030* | Interpolated |
| 223 | Copied from 222.5 | 204.665 | WC | 190.19 | WC | 182.1 | Surveyed | 170.026* | Interpolated | 159.464* | Interpolated |
| 222.545* | Interpolated | 204.5 | 2002 | 190 | Syn from 189.957* | 181.9 | 1989 1998 | 169.479* | Interpolated | 159.086* | Interpolated |
| 222 | 2002 | 204.367 | WC | 189.792 | WC | 181.85 | Surveyed | 169.023* | Interpolated | 158.520* | Interpolated |
| 221.541* | Interpolated | 204.355 | WC | 189.771 | WC | 181.485* | Interpolated | 168.75 | 1998 1989 | 158.049* | Interpolated |
| 220.991* | Interpolated | 204.34 | WC | 189.762 | WC | 181.423 | WC | 168.512 | WC | 157.483* | Interpolated |
| 220.533* | Interpolated | 204.144 | WC | 189.648 | WC | 181.409 | WC | 168.492 | WC | 157.2 | Surveyed |
| 219.8 | 2002 | 204.135 | WC | 189.634 | WC | 181.396 | WC | 168.475 | WC | | |
| 219.518* | Interpolated | 204.119 | WC | 189.616 | WC | 181.029* | Interpolated | 168.466* | Interpolated | | |
| 218.955* | Interpolated | 204 | 2002 | 189.3 | Surveyed | 180.782 | WC | 167.9 | Surveyed | | |
| 218.485* | Interpolated | 203.488* | Interpolated | 189.027* | Interpolated | 180.767 | WC | 167.85 | 1998 | | |
| 218.016* | Interpolated | 203.3 | 2002 | 188.3 | 1989 | 180.752 | WC | 167.504* | Interpolated | | |
| 217.828* | Interpolated | 202.475* | Interpolated | 188.03* | Interpolated | 180.425 | WC | 166.986* | Interpolated | | |
| 216.983* | Interpolated | 202.2 | 1998 | 187.97 | WC | 180.412 | WC | 166.936 | WC | | |
| 216.044* | Interpolated | 201.2 | 1998 | 187.962 | WC | 180.398 | WC | 166.926 | WC | | |
| 215.5 | Syn from 215.012 | 201.011* | Interpolated | 187.95 | WC | 180.3 | Surveyed | 166.91 | WC | | |
| 215.349 | WC | 200.538* | Interpolated | 187.4 | 1989 &1998 | 180.1 | Surveyed | 166.905 | WC | | |
| 215.33 | WC | 199.972* | Interpolated | 187.3 | 1998 | 179.5 | 1989 | 166.9 | Surveyed | | |

## 2.4 Quality Control on Model Construction

The 4.0 beta version of HECRAS was used for this study. After construction of the flow and geometry files, the HECRAS output was reviewed using the water surface profile. When abrupt changes in the water surface occurred at a cross section(s) the geometry file was reviewed. Often the slope of the WC cross sections was adjusted to match the slope of upstream and downstream cross sections. The distance between cross sections and the location of the left and right banks were also checked. An incorrect distance would steepen or flatten the slope altering the water surface elevation. The location of the left and right banks has a large effect on the results of the study.

### *2.4.1. Locating the Left and Right Bank*

HECRAS will compute variables such as total width of wetted surface for the floodplain cross section and will also compute the variables for the distance between the left and right bank. This study considered the area within the cross section that was used by the cranes so the assignation of left and right bank, which defined the limits of the computation of desired variables, is a key factor in computing meaningful results. The left and right banks of WC cross sections are defined by the end points of the surveyed transect, but selecting the left and right banks on base cross sections was more subjective. The WC use cross sections are to be compared to base cross sections not used by the cranes on the same day therefore the assignment of right and left bank should be consistent. Roughness coefficients are also set by the right and left banks. The model automatically assigns higher roughness values outside the right and left bank and a smaller roughness value to the area between the banks. If the flow corridor between the right and left bank is relatively narrow, the cross section could have a high average roughness value creating an abrupt change in water surface. During quality control the roughness values of the cross sections were reviewed and the left and right banks (areas of lower roughness) were occasionally adjusted to better represent existing conditions or balance the roughness between adjacent cross sections.

### *2.4.2. Drawdown Water Surface at Sets of WC Cross Sections*

Where three or more WC cross sections were located short distances apart, the water surface often exhibited a drawdown or abrupt change in water surface. The drawdown could be caused by a large difference in the water conveyance between adjacent cross section. If the flow corridor was narrow in one WC cross section and large in another WC cross section, a backwater effect can be created. A difference in roughness or change in bed elevation can also create a backwater effect, and the closer the cross sections are to each other, the more sensitive the water surface is to differences between adjacent cross sections.

Each water surface drawdown at multiple WC cross section sites was investigated for the factors above. The effect could not always be removed in a feasible manner and can still be detected in some of the water surface differentials reported in the output tables at WC use sites. If two water surface differentials are high and one is low at a set of three transects, the higher values may reflect some backwater but are probably closer to actual conditions than the third value exhibiting the drawdown effect. This error may be reduced by using an average of the three values for the change in water surface between WC use and transect survey dates. To avoid this false condition of the 1-dimension model, created by irregular spacing in the cross sections, it may be beneficial to use only one or two WC cross sections instead of a group of three.

### 2.5 HECRAS Runs and Output Tables

An individual HECRAS run was simulated for each flow file. All the HECRAS runs used the same geometry file[1]. A single flow file could produce multiple sets of information for different GIS ID's if there were multiple stops by cranes at a transect (see section 2.3). For each simulation, HECRAS output tables were created with the water surface elevation (ft), the top width of the main channel (ft), the top width of all the channels in the cross section, hydraulic depth in the main channel (ft), flow in the main channel (cfs), velocity in the main channel (ft/sec), area of the main channel active flow (square feet), and the left and right station of the channel (ft). The main channel is the flow area bounded by the left and right station. A second HECRAS output table was created for each simulation that calculated the change in water surface from the transect survey date to the WC use date.

The results from the two HECRAS output tables for each simulation were then consolidated in a single excel file. The excel file contains one worksheet for every unique GIS ID. The individual work sheets contain the GIS ID, date of the crane use and transect survey, nearest cross sections to the crane use, the USGS flow information for the gage affecting the cross sections, the USGS gage height difference between the transect survey date and the WC use date, the output table from the HECRAS simulation, and the HECRAS water surface elevation change from the survey date to the WC use date. The last sheet in the excel file summarizes the variables from the WC-use cross sections.

[1] There was one exception. The 2002 output file was missing the cross sections for one crane siting day, so the three WC cross sections were added to the geometry file. The output for this day has three additional cross sections.

# 3.0 Limitations and Recommendations

The results provided in the output tables should be regarded as good estimates of habitat hydraulic conditions, rather than precise measures of field conditions. The word "estimate" is used in place of the words "field measure" due to several limitations associated with the data collection which in turn made it necessary to make several assumptions within the data reduction procedure.

It should be noted that the HECRAS Platte River Model used in this report was constructed specifically for reducing hydraulic data at Whooping Crane use sites. Therefore, it may not be an appropriate model for flood studies. It was necessary to impose false left and right bank stations and use roughness values that are more applicable at lower and annual flow ranges. These assigned conditions can not be expected to simulate an accurate water surface elevation at high flow conditions.

## 3.1 Limitations of Data

The elevations of all data points were surveyed relative to the level setup at each individual transect. The transect surveys are independent of even immediately adjacent transect measurements from this survey, and can not be related directly to any previous surveyed cross sections or topography mapping. There was also no benchmark established so there is no means of going back at a later date and upgrading the data. The lack of vertical control in the survey creates two problems: slope, a significant factor in computing hydraulic parameters, can not be calculated from these surveys; and any integration with other sources of floodplain information is approximate at best.

A second limitation is that there are no flow measurements associated with the transect survey. There is good total flow data on the Platte River from USGS gages but the transects target only one segment of the floodplain making it necessary to find means to estimate the partial flow in that transect.

The third limitation is that although stadia surveys require less advanced and low-cost equipment, the resulting measurements have a low level of accuracy in comparison to most other survey methods.

## 3.2 Limitations of Analysis

As determined in Phase I, the use of a 1-dimension floodplain model was the best of three approaches to estimating flow conveyed in the transect, however there are limitations associated with this approach.

### *3.2.1 Limited Complete Cross Sections*

The HECRAS model requires cross sections, which traverse the full width of the floodplain and include the multiple braided channels of the Platte River, rather than transects. The model has 58 cross sections (surveyed in 1989, 1998, or 2002) to represent approximately 60 miles of river. Interpolated and synthetic cross sections improve the computation but provide a lower level of accuracy.

### *3.2.2 Defining Habitat Limits at All Cross Sections*

The HECRAS model makes it feasible to compute hydraulic values for a large number of WC use sites, and also makes it feasible to compare between WC use sites and sites not selected by the cranes. However to do this computation the transverse limits of the main channel, which are defined by desirable habitat, need to be specified at all cross sections in the model. The success of this comparison depends on a consistent designation of the limits of the main channel habitat. Field personnel determine these limits at the WC use site based on topography and vegetation, and with the benefit of knowing approximately where the WC stood. At sites not used by the crane, it must first be assumed the crane looked at the main channel, and then the limits of the favorable habitat in the main channel (right and left banks) are assigned in the office based on ground-surface information without knowledge of vegetation or features. This may create some noise in the results. There is also a trade-off in assigning limits when using a 1-dimension model. Narrow limits at one cross section may be more representative of the main channel habitat, but narrow limits also reduce main channel flow conveyance at that section, can impose false localized conditions on the water surface, and require more adjustment to roughness values at other locations in the cross section to account for total conveyance.

### *3.2.3 Flow Division in a River with Multiple Channels*

The method in the HECRAS model of dividing flows between multiple, *small* channels by relying on at-a-section geometry is an approximate method, but is a common approach in 1-dimension modeling. On the braided Platte with its large number of small side channels, some error can be expected. Where there are *large* flow splits with two or more large main channels, for example between Kearney and Grand Island, a more advanced modeling technique of looping flows could be employed. But the field data to verify the ratio of the split flows is not available at most locations.

### *3.2.4 Number of Transects per Site*

Oddly enough, with 1-dimension modeling, the use of three closely spaced transects may have introduced more error in the water surface computation, due to backwater and drawdown, then would result from the use of two more widely spaced transects or even a single transect at the WC-use site.

## 3.3 Recommendations for future Data Collection and Analysis

Two options for data collection standards are considered here for future data collection efforts, and they represent a range with Option 1 being the higher level of effort, and Option 2 being a minimum action effort.

### *3.3.1 Option 1 Data Collection*

The first option makes the data not only more accurate for the Whooping Crane analysis, but also makes the data useful for other aspects of the Program. Recommendations for an Option 1 standard of data collection are:

- tie the transect surveys into vertical control;
- compute slope using the transect surveys, and compare to the slope from LiDAR topography if this information is available:

- survey full cross sections across the width of the flood plain, or, if it is available, use LiDAR topography to extend the surveyed transects across the floodplain;
- use a higher-grade survey method; and
- take a discharge measurement. This action is not required with the first two actions, but the combination of actions would improve accuracy.

### *3.3.2 Option 2 Data Collection*

Option 2 is the least-cost option to slightly improve the accuracy of the Whooping Crane data collection effort. However, these actions will not make the topographic data useful to other aspects of the program. For an Option 2 level of effort:

- take a discharge measurement for all channels within the transect on the day of the transect survey, and use a ratio with the USGS gage flow to reduce data; and
- tie together the localized elevations of all three transects in a set to get a rough estimate of the longitudinal slope. The setup for the center transect could survey at least one solid point used in the upstream transect and one solid point used in the downstream transect.

A discharge measurement will take more field time but could reduce the cost of data reduction. The HECRAS model would not be needed to compute the partial flow in the transect on the day of the survey, and a Q ratio could be used to provide an estimate of flow on the day of the WC observation. See section 3.3.3 for discussion on the need for a HECRAS model in the future.

Option 1 is recommended. The accuracy of results should be higher with Option 1, the topographic data from the first option can benefit the HECRAS analysis of Whooping Crane data (see Section 3.3.3) and the topographic data can also be used to benefit other areas of the Program.

### *3.3.3 Considerations for Future Data Analysis*

Using the HECRAS model in future data analysis will depend on the future level of data collection, and WC analysis requirements. The HECRAS model was recommended for analysis of 2001 to 2006 WC data for three reasons:

1. it provides an estimate of partial flow in a selected transect;
2. the model automates the analysis process for hydraulic parameters at WC use sites; and
3. the model makes it possible to compare WC use sites to a large number of sites not used by the crane.

If both a discharge measurement and HECRAS model are used it would be expected to improve the accuracy of results of reason 1. The discharge measurement would provide verification for the HECRAS model, and the HECRAS model could be used to provide the flow estimate for WC use day. A HECRAS model should also continue to provide reasons 2. Improvements to data collection under a plan like Option 1 could improve the analysis in reason 3 by making the differences between hydraulic parameters more distinct.

## 4.0 Contents of Electronic Appendix

A. Output Tables for 2001 to 2006
B. Figures of WC use sites
C. Data files
D. GIS files
E. Downloadable execution file for HECRAS beta 4.0 from Army Corps of Engineers
F. HECRAS Geometry file
G. HECRAS Flow files for 2001 to 2006
H. Excel work files
I. Progress Reports