Project Update Report

Platte River Restoration and Enhancement Project

Platte River Recovery Implementation Program (PRRIP)

SEH A-PRRIP0701.00

February 20, 2008

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I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Architect/Engineer under the laws of the State of Nebraska.

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Introduction

Purpose

Short Elliott Hendrickson, Inc. (SEH) was hired in April 2007 to complete plans and specifications for a project component previously identified in a study done by J.F. Sato and Associates (JFS) (J.F. Sato and Associates, Inc, December 1, 2005). Because there have been significant changes to the alternatives proposed in the JFS final report, this Project Update Report was prepared by SEH to document the changes, the reasons for the changes, and propose a final revised plan for the choke point project upstream of the Highway 83 bridge over the North Platte River, north of North Platte, Nebraska. This document is submitted as a report to update and describe changes from the North Platte Channel Capacity Study – Final Report, prepared by JFS.

Background

The final report (J.F. Sato and Associates, Inc, December 1, 2005) proposed a base case and two alternatives that were to be implemented into a construction project to allow flows to increase in this area. Below is a summary of the proposed solutions as described in the final report (J.F. Sato and Associates, Inc. December 1, 2005):

Base Case. The following elements are included:

1. Open State Channel
2. Extend State Channel north to existing ponds/North River Road
3. Construct road ditch along west side of Washboard Road
4. Open southern channel from road ditch to abandoned detour road
5. Remove abandoned detour road and construct ditch to main channel of the North Platte
6. Remove phragmites along opened drainages

Alternative 1. The following additional elements are added to the Base Case:

1. Improve and open the channel to connect existing culverts in Washboard Road to the existing concrete box culvert under Hwy 83.
2. Improve conveyance through the ponds to the main channel and provide overflow structure.

Alternative 2. The following additional element is added to Alternative 1:

1. Remove sand bar that is blocking the northern channel about 1,500 feet above Hwy 83 and improve the channel downstream of this point.

During the preliminary investigation and preliminary plan stages of the project, SEH met with property owners impacted by the proposed project components. It was discovered during these initial meetings that there had been limited or no contact with property owners prior to SEH starting the project. As a result of discussions with the property owners, several concerns on the impacts of the project were raised as well as some property owners conveying to SEH that they would not allow access to their property for any project. Because of the questions and concerns raised and potential property access

issues, SEH began to perform additional investigations to resolve these issues so the project could proceed. As these issues were investigated it became apparent that the original scope of work would need to be revised for the additional investigations and preparation of a report that updates the previous study done by JFS. The objective of the project remains to increase and maintain a channel capacity of 3000 cfs at flood stage in the North Platte River at North Platte, Nebraska.

The activities leading up to this final report are listed on the timeline in Table 1.

Table 1
Key project activities

Date	Activity
February 7, 2007	RFP Issued
March 23, 2007	Proposal Submitted
April 6, 2007	Contract Award Notification
April 10, 2007	Special Project meeting with key agencies during April Governance Meeting
May 15-17, 2007	Field Visit/Wetland Delineations/Base Surveys Completed
June 13, 2007	Project Update by SEH at Governance Meeting in Cheyenne, Wyoming
June 27, 2007	Agency project review meeting in North Platte, Nebraska
July 6, 2007	Wetland Permit submitted to USACE for review
July 31, 2007	Meeting with National Weather Service (NWS) staff to discuss stage elevation determination
July 31, 2007	Open house for residents impacted directly by the Project
August 8, 2007	Final Resolution of the Refuge Issue
August 21, 2007	Project Update by SEH at Governance Meeting in Denver, Colorado
September 27, 2007	Meeting with Lincoln County Weed Control Authority
September 27, 2007	Final preliminary determination of USACE permit requirements
October 9, 2007	Project Update by SEH at Governance Meeting in Kearney, Nebraska
October 13, 2007	Field Visit to walk State Channel

Project Impacts

Three key impacts to the project plan redirected the design efforts including:

- **JFS plan modifications** as a result of initial field visits and input from the U.S. Fish and Wildlife Service, Nebraska Game and Parks Commission, and residents input. This information was used to modify the project and included in the USACE permit application
- **Resident's concerns** that needed to be addressed and in some cases resulted in a slight modification to the project, and
- **Flood stage related modifications** as a result of revisiting how the current flood stage was determined based on discussion with local residents, local officials, DNR and NWS.

JFS Plan Modifications

Following is a summary of the key impacts which altered the JFS plan. This information was then used to prepare a preliminary plan that was the basis for the wetland permit submitted to the USACE on July 6, 2007 and the plan reviewed by residents at a public

meeting on July 31, 2007. The plan that was submitted as part of the permit is shown as Figure 2 in Appendix A. Following is background information on the changes:

- Changes to use existing floodplain channels per U.S. Fish and Wildlife/Nebraska Game and Parks Commission recommendation (Summary Memorandum in Appendix B). On April 10, 2007 a meeting was held in Kearney, Nebraska with key individuals from various agencies and the PRRIP to discuss the issue of whether or not construction of the project in the man-made State Channel would require an individual permit verses a nationwide permit. Representatives from the U.S. Fish and Wildlife Service (USFWS) in Grand Island and Nebraska Game and Parks Commission (NGPC) indicated that they thought if the project followed the historical natural drainage channels in the floodplain, the project would not require an individual permit. Keith Tillotson from the USACE agreed in principal that this may be correct. The resulting action was a field visit by the local agencies and SEH to identify these channels in the floodplain. These were verified by SEH during field and wetland surveys for the project done May 15-17, 2007. In discussion with the USFWS and NGPC staff they indicated their projects, for the most part, removed material in the natural channel areas and placed the excavated material at a shallow depth in adjacent areas or in adjacent non-wetland or upland areas. This allowed them to do their projects under a nationwide permit and also keep construction cost at a minimum. Based on our wetland delineation, there is limited to no upland available next to the channels targeted for improvement in the PRRIP project area; therefore, larger amounts of excavated material would need to be hauled offsite. This is a major difference between what has historically been done in the floodplain by USFWS and NGPC in other locations along the North Platte River. Due to the additional information provided by the USFWS and NGPC, permit requirements and field work, the project was modified so that if mechanical removal of vegetation and sediment will only occur in natural channels in the floodplain where the channel has degraded past its natural condition, due to sediment and vegetation growth. The excavation will be limited to shallow sediment removal to eliminate channel blockage and will not modify the channel shape as was originally proposed. This will greatly reduce costs as it relates to removal and disposal of the material.

- Removal of the State Channel as an excavated channel project**.** This was in response to the permit issue to make the project fall under a nationwide permit versus an individual permit. The State Channel is a man-made channel and based on feedback from the USACE any modifications as a result of excavation and/or sediment removal would re-establish it as an excavated channel in a wetland and thus would require an individual permit for the project to proceed. SEH agreed with the JFS study that concluded that the State Channel helps keep North Platte River floodwaters from reaching the residents and thus should be maintained if at all possible. In an effort to maintain the channel, the project was modified to include only phragmite removal in the State Channel which will help maintain flow in the channel. Vegetation removal does not require a permit from the USACE and therefore this project component should be able to move forward without any USACE permit issues.

- Removal of Washboard Road Ditch. There are major construction issues in this location due to the fact there is no current ditch. The project as originally proposed would alter a large portion of the resident's pasture. Also there are cover issues with the driveway culverts that would be required. Because of these issues, it was felt that it would be difficult to get the necessary easements to construct this portion of the project as the landowners directly impacted by the project would see no benefit.

  If all the flow is being intercepted by the State Channel before it gets to the backyards along North River Road in the floodplain and diverted back to the main channel of the river, the flooding at the intersection of Washboard Road and North River Road from direct flow from the river is eliminated. This should eliminate the need for the Washboard Road Ditch channel back to the river.

- Ditch along the abandoned roadbed The property owner indicated that they would not allow for the old roadbed to be removed. The roadbed was left for the owners to use for storing equipment or as it is currently being used as access to hunting blinds. Without this ditch location, the project as proposed will continue to direct flows down the current natural flow area and discharge closer to the bridge.

- Culvert connections between old sand pits. One of the owners of the property in this location indicated that they were not interested in construction of new culverts. They thought if a revised system is put in place, there would be future issues related to providing drainage through the area and thus cause more problems than they already have. The owner also asked the question that if we were already intercepting the flow before it gets to Washboard Road, was the increased size drainage system in the sandpit area required? It appears this is a localized issue and if the property owners do not wish to support this component of the project, it will have no impact on the two other key components, which are providing a better conveyance system in the floodplain and the removal of the sandbar blocking an upstream channel.

Resident's Concerns

During the preliminary stage of the project several specific issues were identified by the residents and are summarized below with a follow-up response which resolves the issue. Each property owned by the residents contacted as part of the project is identified in Figure 1 in the Appendix A. The information gathered as part of this effort has also influenced the final proposed project.

- What is the purpose and goal of the project?
  During many of the meetings residents would ask this question. Several purposes have been presented at various meeting based current directors' knowledge, information in the documentation, etc. If this question is asked in the future it is recommended that the information on the PRRIP website be referenced. It states:

  > In 1997, the states of Colorado, Wyoming and Nebraska and the Department of Interior came together in a unique partnership to develop a shared approach to managing the Platte River. Water

> users from the three states and conservation groups joined the effort and together, these stakeholders developed an innovative approach to better manage the Platte for the health of the ecosystem and the people that depend on it. This Program is the culmination of that planning effort and is focused on implementing this shared vision for restoration on the Platte. (Platte River Recovery Implementation Program, Adaptive Management & Collaboration on the Platte, February, 19, 2008).

- Why not do all the channel improvement in the main branch of the river by dredging?
  No additional information was collected to address this issue since this alternative was discussed in a project Memorandum prepared by JFS (J.F. Sato and Associates, 8/31/05). Per the JFS memorandum, the reason this alternative is not a recommended solution is the permit requirements (Individual 404, maybe a NEPA EA document) which would add to the already high project cost identified in the memorandum. The information in the memorandum is the recommended response to this question.

- Won't the project increase the flooding potential in my backyard?
  It was indicated to the property owners that the goal of the project has always been to reduce flooding potential in the backyards. The concern of the residents has been that any improvement near the south end of their maintained property area that looks like it is designed to carry water appears not to be a protection, but a new path for water to flood their property. There is some historical evidence that this was a flow channel during higher river flow events, but what was not well documented is the impact on the residents as it relates to various water surface elevations in the channel. To address the concern of water flowing in this natural channel and potential impact to maintain it as a channel, a monitoring program has been proposed to evaluate the impact of river flows in the existing channel and the potential impact to the residents. This effort will allow for the project to demonstrate in real time the property impacts of the flows in the river and the channel at the south end of their individual properties.

- The North Platte River Game Refuge is located in this reach of the river, won't this project's alteration to the floodplain redefine the refuge location?
  A clarification of this issue was obtained through correspondence with the Nebraska Game and Parks Commission and the Nebraska Department of Natural Resources (DNR). Records of communication with various members of these agencies are included in Appendix B. The refuge boundaries are determined based on bank flow. The bank flow cannot exceed the flood stage elevation of the river, with the key word being exceed, which indicates it is possible for the bank flow elevation to be less than the flood stage. In this location the National Weather Service has established a flood stage location that is considerably greater than the bank flow width used in determination of the refuge boundaries. However, the DNR has indicated that the bank flow boundary in this area is quite stable and will not likely change much if any in the future. The only way for the boundary to change would be creation of a new main river channel which appears unlikely due to the stability of the current system. It has always been

indicated to the residents that no system would be designed that would cause the main channel to move from its current location. The most efficient way to convey flow through the area is in the current main channels, thus there is a strong interest in keeping them open and functioning. Therefore, the refuge boundaries will not be changed as a result of his project.

- Could this project redefine the legal description of my back property line?
  This issue has been discussed with a local North Platte attorney, City Administrator Jim Hawks and the attorney representing PRRIP in this matter. The legal description is always to the centerline of the river. The DNR has indicated that this appears to be a stable reach in its current condition, which is strong evidence that if left alone would not change significantly. The major concern would be if the north channel downstream of the location where it has been proposed to remove the sandbar ceases to function, this could potentially cause a new channel to develop in the floodplain over a long period of time. If the sandbar is removed, this would eliminate this concern and keep the main channel in its current location. As is the case with the refuge question, it has always been indicated that no system would be designed that would cause the main channel to move from its current location and consequently no changes to property lines are anticipated.

- Will the project affect the access to my property between the river and my yard?
  All current property access will be maintained and in some cases may need to be improved with a Texas style river crossing (rock/concrete rubble bedding to drive over). The most logical location of any access point would be at property lines so it could be maintained and then be used by both residents. No adverse impacts to access property by property owners are anticipated.

- Will the project impact my ability to use the area for hunting?
  The simple answer has always been no. The goal of this project has never been to alter the use of personal property in this location.

- How much of the phragmites on my property will be removed as part of the project?
  The original project proposed 50 feet of removal on each side of the reopened channels. There was no mention of phragmite removal in any other locations. It has been discussed with the landowners that there may be opportunities for additional removal depending on project needs (access, etc.). It would be cost effective and a potential benefit to the project if the landowners identify additional areas that may need phragmite removal If there are no project benefits, a reimbursement of the cost to do additional non-project removals could be negotiated with each owner. Since the work is part of a bigger project it should reduce their cost when compared to hiring their own contractor. Also, the method(s) and research done to complete the removals will be available to the owners in case they wish to use any successful processes (methods and chemical used) to do their own removals.

Flood Stage Related Modifications

At the agency meeting on June 27, 2007, there was extensive discussion on the elevation at the gage station and how it impacts the potential to increase flows at this location. It was agreed that in order for the flow rate to be increased to 3000 cfs, the official gage station designated flood stage would need to be restored to near what is was prior to 2002. Because the official flood station elevation designation was a key issue, SEH scheduled a meeting with the NWS to discuss in more detail how the current flood stage was determined. This was followed up by additional conversations with residents, local officials and other government agencies.

Following is a brief summary of meetings and discussion:

- Meeting with NWS.
  On July 31st, SEH and Dr. Jerry Kenny met with NWS representatives in North Platte to discuss how the flood stage was determined in 2002. The key point was that flood stage, per the NWS definition, occurs when property damage first occurs. During the flood of 2002, water was surrounding several of the homes along North River Road east and west of Washboard Road as well as along Washboard Road south of North River Road, thus property damage was occurring. The NWS then reviewed the best available information and concluded that flows in the river caused the flooding and correlated a gage station reading at the time the flooding occurred. A copy of the minutes for this meeting is included in Appendix B.

- Discussion with Jim Hawks, North Platte City Administrator
  Mr. Hawks worked as the Lincoln County Highway Superintendent in 2002. He indicated that during the 2002 flooding there was blockage of the flow from the intersection of Washboard Road and North River Road which should have flowed east to a culvert crossing located under Highway 83. This blockage was removed and the water quickly receded in the area around Washboard Road. It is very likely that this blockage contributed to the localized flooding. There was no clear indication of the source of the water, which could have been from direct rainfall or flows from the river.

- Blockage of State Channel
  The resident on Lot Area 3 (see Figure 1 in Appendix A), who is at the upstream end of the project, indicated that during the flood event of 2002, water flowed around the front of his yard along North River Road and east toward Washboard Road. He could not remember this happening prior that event. North Platte City Administrator, Jim Hawks also indicated that if you reviewed aerial photographs just prior to the 2002 event it appears some alteration to the upper end of the State Channel occurred. If the alteration included blockage of the State Channel, the water would go to the point of least resistance which is north and make an end run away from the State Channel and toward North River Road. The water would then flow east toward Washboard Road where in 2002 the outlet to the east appeared to be blocked. Currently, blockage of the upstream end of the State Channel is not present.

- HEC-RAS computer model
  A simulation of the flooding was done using a detailed HEC-RAS computer model. "The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) is software that allows you to perform one-dimensional steady and unsteady flow river hydraulics calculations, sediment transport-mobile bed modeling, and water temperature analysis" (Brunner, November 2006). The assumption and results of the modeling are included in Appendix C. The modeling and cross-sections indicate that there are many locations where there is adequate bank flow capacity for the river. However, there are two locations where the flow is near the top of the banks and could leave the river and flow into the floodplain. One of these areas is located just upstream of the State Channel. If the State Channel is able to intercept the upstream floodplain flows, these flows will be conveyed downstream to where the river flow elevation decreases to a point where the main channel can again retain the flows with limited impact to the floodplain. If the State Channel for any reason is unable to divert the water back to the river, it appears, based on the cross-sections, the river flows could flow north along the North River Road.

- Summer of 2007 Flows
  Water was near flood stage at least twice during the summer of 2007. The first time was around June 18, 2007. The river again reached near flood stage just prior to the meeting on July 31, 2007. In this location, based upon 2002 flooding history, if the river is within 0.1 feet of flood stage, the water would be near buildings or be within the maintained areas of the property owner's yards. Based on feedback of the residents at the July 31, 2007 meeting this did not occur. Drawing 1 in Appendix A, shows a channel just south of each property owner's maintained yards. If the river was near flood stage, it would be reasonable to expect water to be in this channel and flowing east. Again property owners in lot areas 3, 4, 5, 6 and 8 (see Figure 1 in Appendix A) indicated there was no water flowing in this channel. The owner of Lot 12 indicated some flow in the channel. The resident's feedback implies that during these events near flood stage in 2007, the flooding did not come close to the flooding that occurred in 2002. This would lead to the conclusion that there were other factors that contributed to the flooding in 2002.

Recommended Project Modifications

Introduction

As a result of information gathered during the preliminary plan preparation stage of the project, it is recommended the project proceed as follows:

- Island Removal per the JFS Report
- Phragmite Removal
- Installation of Staff Gages
- Monitoring Program Fall 2007 to Fall 2008Monitor controlled pulse flow in the Spring of 2008.
- Develop a Calibrated HEC-RAS Model to Help in Flow Forecast
- Revise Flood Stage Elevation

Below is a more detail description of each of the project components.

Island Removal per the JFS Report

The main channel bank to bank width just upstream of the Highway 83 bridge is approximately 470 feet wide and just upstream of the island is approximately 290 feet wide. Common sense dictates that channel bank to bank flow width through the project area should be one which is near these upstream and downstream widths or flow will leave the banks and go into the floodplain at lower flows. There is no doubt that the island proposed to be removed is starting to block the northern channel through sandbar build-up. Also, it is beginning to stabilize with phragmite and other vegetation growth and will be difficult to remove with natural flows. If the north channel is blocked, it would result in a fifty percent (50%) reduction in the total bank flow width at this point and several feet downstream. This would then force the flow to go into the floodplain. Keeping this channel open maintains the current bank to bank flow widths. The HEC-RAS computer run indicates that without this North Channel, the upstream depths in the river could increase by about ½ foot at 2000 cfs and near 1 foot at 3000 cfs. In these flat floodplain areas, this is a significant impact and should be avoided if at all possible.

Because the area around the island is considered wetland, one minor change to the JFS plan is to remove only enough material from the island that can be disposed of on-site in areas adjacent to the island. According to USACE permit office in Kearney, if the material can be distributed at a depth of around 4 inches and still maintain the current vegetation of the area, a nationwide permit could be issued. Table 2 summarizes the removal area and various depths on and around the island. The area of disposal is estimated to be 1.3 acres and at a depth of 4 inches this will allow for the disposal of 700 cubic yards. The estimated removal per the JFS report was about 7000 cubic yards. The revised plan limits the volume of excavated material to approximately 700 cubic yards and focuses on restoration of the channel to its pre-2002 state, which includes a non-vegetated sandbar. The JFS plan was a full removal of the sandbar and thus resulted in a much larger volume of excavation. Permit requirements and the focus on vegetation removal verses excavation resulted in the proposed plan and consequent reduction of excavation. Based on the HEC-RAS model and the potential for pulse flows to remove or decrease the size of the sandbar, the reduced excavation project should achieve the same project goal, which is to increase flow through this channel reach. A plan sheet of the project area is included in Appendix A.

See Table 2 below.

Table 2
Material removal on the island

Location	Depth Inches	Area Acres	Volume Cu. Yds.
Channel on north side. Currently open about 10 feet wide. Proposed plan will increase the width to 50 feet	12	0.27	441
Island. Covered with vegetation. Primary removal is vegetation and some material to recreate the sand bar	2	0.32	86
Old channel on south side. In 2007 became totally blocked. Restore to 30 foot wide shallow channel.	6	0.22	177
Summary		0.81	704

Phragmite Removal

On September 27th, SEH met with Mitch Huxoll of the Lincoln County Weed Control Authority. As a result of this meeting, it was recommended that the PRRIP work with the Authority to remove the phragmites. This was done through a contribution to Lincoln County's program to complete the specific projects identified below. The funds provided were tied to performance to assure that the monies were used to target areas requiring flow improvements in the area upstream of Highway 83. The Authority also has a program in place to obtain access to private property to complete weed removal projects. This resolved a major issue the PRRIP would have had to deal with if managing the phragmite removal project in-house.

Recommended Phragmite Removal Projects

Vegetation Removal Along the North Channel at the Island Removal Location (Fall 2007)

Since 2002, the channel downstream of the island to be removed has had the sand bars become fully vegetated with phragmites. It is recommended that this area be added to the phragmite removal area to assure this channel does not become blocked. In the 2002 aerial photographs that were provided by the City of North Platte, the sandbar islands can clearly be seen. During field visits in the late summer of 2007 the sandbars were covered completely with phragmites. Figure 4 shows the target areas for removal which is based on the 2002 aerials and thus shows the condition of the area during that time period.

Vegetation Removal Around the Sand Pits in Property Areas 2 and 3 (Fall 2007)

With the intense growth of phragmites in this area, the natural drainage from the sand pits to the State Channel could be in jeopardy. If the existing drainage system fails, there is a strong possibility that the flows would either flow along North River Road or along the backyards of the residents adjacent to North River Road. Removal of the growth in this area is needed to determine where the natural drainage patterns are in the area and verify they are not being blocked by the phragmite growth. The concern is that if the sand pits are an indication of groundwater elevation in the area during longer term high flows in the river, water levels in these areas without an outlet may become higher than historically was present.

Vegetation Removal of the State Channel and any other Potential Feeder Channels (Fall 2007)

All indications are that the State Channel is a key flow channel to protect the properties from flooding. In the JFS report this was one of the main channel improvements proposed; however, since this channel is man-made it could not be mechanically improved without an individual permit from the USACE. SEH concluded that it can be maintained as a flow channel through vegetation removal which does not require a USACE permit, so the proposed project is to make sure this channel has an unobstructed flow path back to the river. A field visit to walk the channel was completed on October 13, 2007 to determine the extent and type of vegetation removal. During the field trip, it was determined that for the most part major phragmite growth has occurred in the historic channels (those identified by the Fish and Wildlife Service and Nebraska Game and Parks) and the remaining areas have some but much less phragmite growth. It appears at this time the old channels would represent about 25% of the area in the floodplain. For the project it is estimated the area to be removed would be a 300 feet wide target area along the length of the channel and that about 25% of the area is covered in phragmite growth. The density of the phragmite growth was increased to 75% of the area for the last 550 feet of the channel upstream of the confluence of the river. The HEC-RAS model indicates that in the overall flow of the reach, the removal of the vegetation will have minimum impact, but it does assure that an alternative flow path is available to divert the water away from the yards and back into the river.

50 Foot Wide Area Upstream of Highway 83 Bridge Adjacent to the North Bank (Additional Area 1 Project)

One of the key functions of the river is to maintain a bank to bank flow width which is available during higher flows. Prior to phragmite growth on the banks of the river, the banks could be eroded away during higher flows that helps maintain a wider channel during other flows. The phragmites area now acts as an anchor to the banks and diminishing the historical dynamic system of bank changes. As the banks become more stable and cannot be naturally altered to accept more flow during higher flows, the water needs to move to other locations, which is the floodplain, and possibly into properties. The impact of the loss of 10 feet of bank to bank flow width on the river system was modeled and the results are summarized in Appendix C. The model shows that if the bank to bank flow is decreased by 10 feet on each side in the areas where there are no islands (total of 20 foot reduction) and 10 feet on each side of the channels around the islands (total of 40 foot reduction) it can raise the water surface over 2 feet for both the 2000 cfs and 3000 cfs in some locations.

Area Upstream of the Highway 83 Bridge (Additional Area 2 Project)

The discussion with the Weed Control Authority indicated they have a strong interest in getting rid of all phragmite growth in Lincoln County. The concern with this project is that the initial removal effort will be effective, but if phragmiteses are left in other nearby areas, they can come back and re-vegetate in the area which was mitigated in the fall of 2007. PRRIP should consider a more extensive removal upstream of the area to complete a major phragmite removal. The key to the phragmite removal project components is that if the PRRIP does the initial removal, the future long-term maintenance cost should be the responsibility of the Lincoln County Weed Authority.

A rough estimate was made to determine the amount of phragmite areas which would need to be removed in the project location. This was based roughly on the 2002 City aerial photographs of the area which unfortunately do not clearly show the extent of phragmite growth. Since it is known the entire area is not yet covered with phragmites, assumptions on the amount of phragmite growth in the total measured area was made. For a final determination of area to be removed, more detailed information will need to be obtained. This is only intended to be a preliminary estimate. Table 3 summarizes the amount of area assumed removal required for the project this year and in the future.

Installation of Staff Gages

It is proposed that staff gages be installed at key locations to monitor the flow elevation in the yards and the relationship to that at the gage station. The biggest unanswered question continues to be what really happens in the floodplain of the river as the flows leave the banks. Resident eyewitness accounts do not support the relationship between the current flood stage and the extent of the flooding that occurs when it reaches this elevation. The only way to make sure we have an accurate measure of the relationship between the gage station, flood stage, and flow upstream of the bridge is to monitor the flows and water surface elevations at a number of locations. SEH would work with the residents to determine the best location for the staff gages based on access and to ensure they are located to best collect the necessary information. A driven steel post with a USGS Style C Staff Gage (two lengths for a gage height of seven feet) can easily be placed in several locations. Local surveying firm TC Engineering can tie these gages into the 1929 datum. The gages can be installed in fall 2007 or spring 2008.

Monitoring Program from Fall 2007 through Fall 2008

The gages have no value if they are not read on a regular basis. If normal flows are in the river, a once per week reading is anticipated. As flows increase, a daily reading may be required. This could be a volunteer program done by the property owners, which is verified by TC Engineering staff, City staff, or Nebraska Game and Parks staff. Our recommendation would be weekly normal readings done by residents verified once per month by Nebraska Game and Parks staff. During high flows, stages would be read by residents, reviewed by Game and Parks, or other local government staff and verified by SEH and TC Engineering during the peak of the actual flood event. This information could be posted on a webpage for review. It is recommended that the SEH contract scope be modified to convert some of the project construction monitoring fees to this program (primarily use TC Engineering and other local support agencies).

See Table 3 below.

Table 3
Phragmite Removal Summary

Location	Total Area (Acres)	Estimate Percent Phragmites	Estimated Removal Area (Acres)	Comments
State Channel	13.5	34%	4.6	Part is 300 foot wide (Assume 25% phragmites) and part near river is 200 foot wide (Assume 75% phragmites)
North Channel Downstream of Island	8.9	100%	8.9	Width varies between 50 feet where there was no sandbar in 2002 to 150 feet where sandbars were visible in 2002. Sand bar areas are assumed to be all phragmites thus 100 foot sand bar width plus 50 foot additional clear zone for a total width of 150 feet. Other areas are 50 feet clear area from river.
Area around Sand Pits Near Substation	16.2	77%	12.5	% based on total area (100% phragmites) minus the pit water area (0% phragmites)
Fall 2007 Project Area Summary			26	
North Bank of the River Bridge to 5900 Feet Upstream.	12	100%	12	Assume 100 foot removal area from river bank and exclude area near State Channel discharge since area is already accounted for.
Additional Area 1 Project Area Summary			12	
South Bank of River Bridge to 5900 Feet Upstream	14	100%	14	Assume 100 foot removal area from river bank.
Island Areas	44	50%	22	Excludes some areas which are part of North Channel downstream of island area
Private Area North of River	132	25%	33	Area 100 feet from river (area is already accounted for in North Bank of River calculations) up to manicured portion of yards from bridge to near 69+00
Additional Area 2 Project Area Summary			69	

Monitor Controlled Pulse Flow in the Spring of 2008

In the spring of 2008 it is anticipated a pulse flow in the reach will be approved and can occur sometime in March and April. The anticipated daily increase is about 300 cfs per day until a targeted maximum approved flow rate is achieved. The goal would be to reach at least 2000 cfs. Prior to each day's flow event the HEC-RAS model will be ran using the daily targeted total flow rate and the water surface elevations estimated. When the daily flow rate stabilizes, the monitoring gages will be read and compared to the modeling results. If adjustments are needed to the model they will me made and then used to predict the next day's water surface elevation. It is hoped that through this

process the flow reaches the 2000 cfs the model calibration as stabilized and the model is accurately predicting the next days flood elevations. By doing real time prediction, monitoring, and calibration it is anticipated that the model will be able to predict the impact of flows when they reach the targeted flow rate of 3000 cfs. Besides the model calibration, the monitoring program will aid in the calibration of the gage station located near the Hwy 83 bridge and thus establish the flood stage for this reach based on a controlled flow situation.

Develop a Calibrated HEC-RAS Model to Help in Flow Forecast

The key to the program's long term success is to have a model that can, as accurately as possible, predict the impacts of various flow increases on the properties. With enough monitoring data, the HEC-RAS program developed for this area can be calibrated to help in these predictions. The program can also be used to predict various channel modifications that may be needed to improve the channel capacity if the flows do not reach 3000 cfs without damage to property. Improvement such as sediment removal in the main channel or impact of phragmite growth can be analyzed. It is recommended that the SEH contract be modified to include this change in scope. It is recommended that some of the project construction monitoring fees be used for this effort.

Revise Flood Stage Elevation

Based on the SEH investigation into how the flood stage was determined, it appears with the improvements proposed, including a monitoring program; the flood stage can be modified to a higher elevation. The proposed gage installation and monitoring program should be presented to the NWS with the idea that the system will be monitored and if sufficient evidence is provided, the flood stage can be adjusted.

Project Costs

The costs were revised to update them based on the project modification discuss in this report. A summary of the cost is included in Table 4 with a detail estimates included in Appendix B. Island Removal, Installation of Staff Gages and Phragmite Removal are construction project costs and thus are outside the scope of the SEH engineering services contract for the construction project except for coordination of the effort. The other items could be considered engineering services which would require a review of the scope of the SEH contract and then a determination needs to be made if additional fees are required for the work and the SEH contract modified or if work should be done under a new RFP for the project.

See Table 4 below.

Table 4
Estimated Project Costs

Item	Cost Estimate	Comments
Island Removal per the JFS Report	$43,900	Original JFS cost was around $60,000. Biggest difference and why the cost are close in spite of significantly less excavation in revised plan is their assumption of $7.00 CY for excavation and based on local contractors input we used $25.00.
Phragmite Removal	$39,700	Includes the cost estimate to spray all phragmite areas identified in Table 3. It does not include cost to physically remove the phragmite after they have been sprayed. A breakdown by smaller project areas is provided in Appendix B.
Installation of Staff Gages	$ 6,300	Includes labor and material. SEH coordination cost is assumed to be part of current contract for construction services.
Monitoring Program Fall 2007 to Fall 2008	$29,300	Labor costs for SEH and TC Engineering
Monitor Controlled Pulse Flows in the Spring of 2008.	$ 0	Cost assumed to be part of Monitoring Program Fall 2007 to Fall 2008 labor costs.
Develop a Calibrated HEC-RAS Model to Help in Flow Forecast	$ 9,000	Input new stage/flow information and adjust model as need and rerun any target flows.
Revise Flood Stage Elevation	$ 7,800	Meetings and field visits with NWS as well as time to survey any key house or building elevations.

References

J.F. Sato and Associates, Inc., December 1, 2005, “Final Report, North Platte Channel Capacity Study for the Water Management Committee North Platte Cooperative Agreement”, Littleton, CO

J.F. Sato and Associates, Inc., 8/31/05, Memorandum to Clayton Derby, WEST, Inc., “Preliminary Review NE Channel Capacity Study”,NE Channel Capacity Study, page Alt 5-1, Littleton, CO.

Brunner, Gary W., November 2006, “HEC-RAS, River Analysis System User’s Manual, CPD-68, US Army Corps of Engineers Hydrologic Engineering Center (HEC), Davis, CA.

Platte River Recovery Implementation Program, Adaptive Management & Collaboration on the Platte, February, 19, 2008, http://platteriverprogram.org/default.aspx

Appendix A
Figures

Figure 1 – Project Location and Site Map.

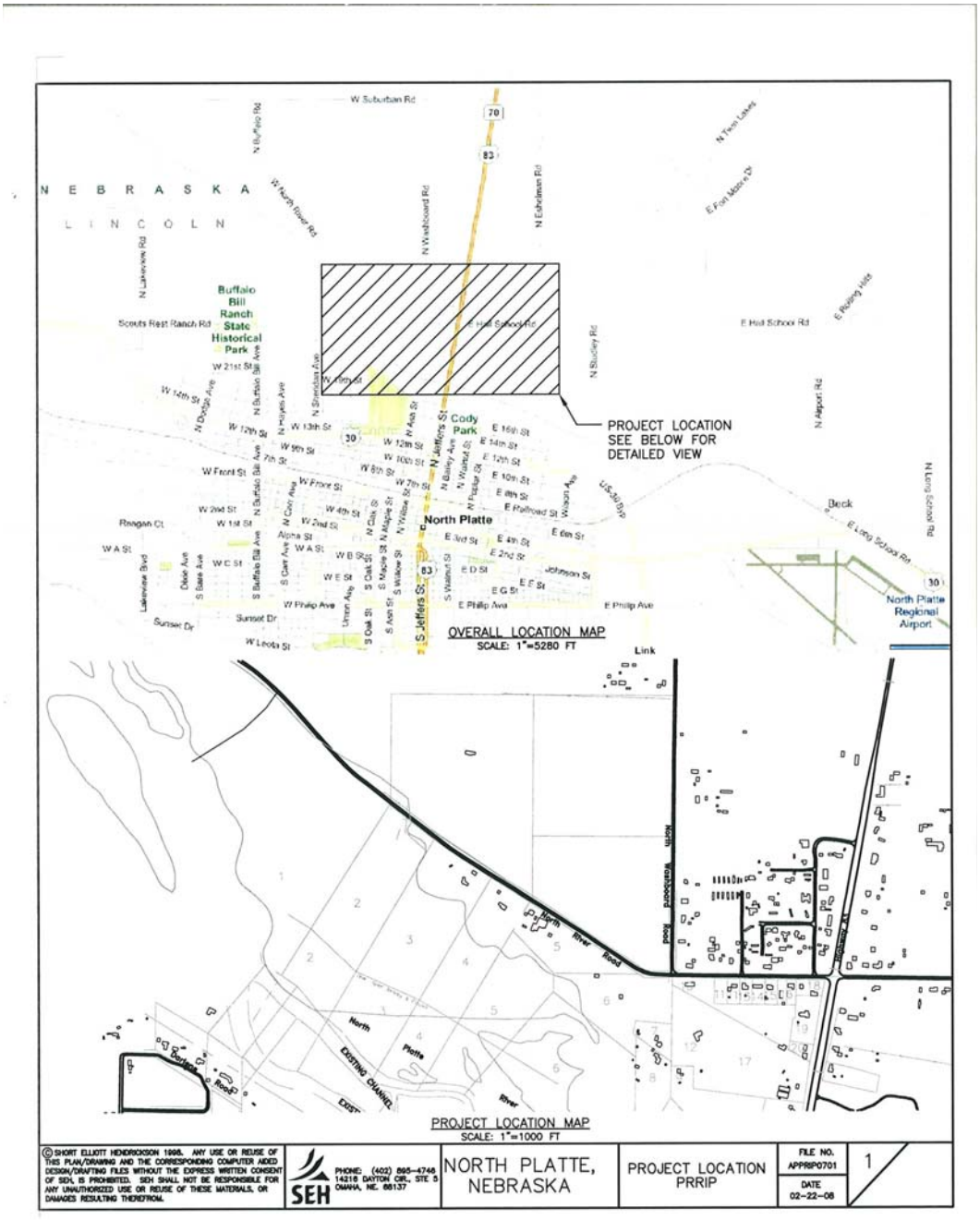

Figure 2. Project as Presented in Permit.

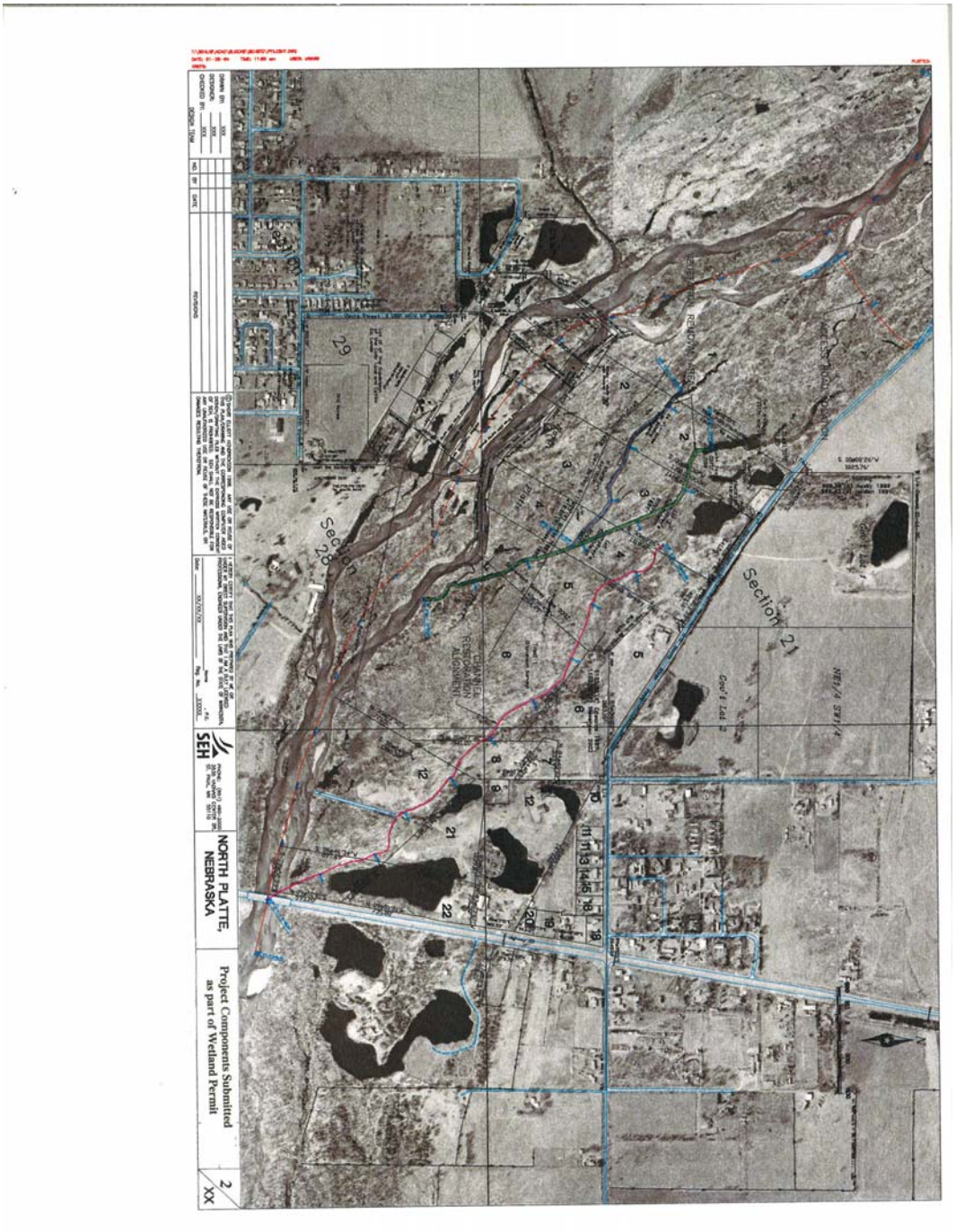

Figure 3. Proposed Project

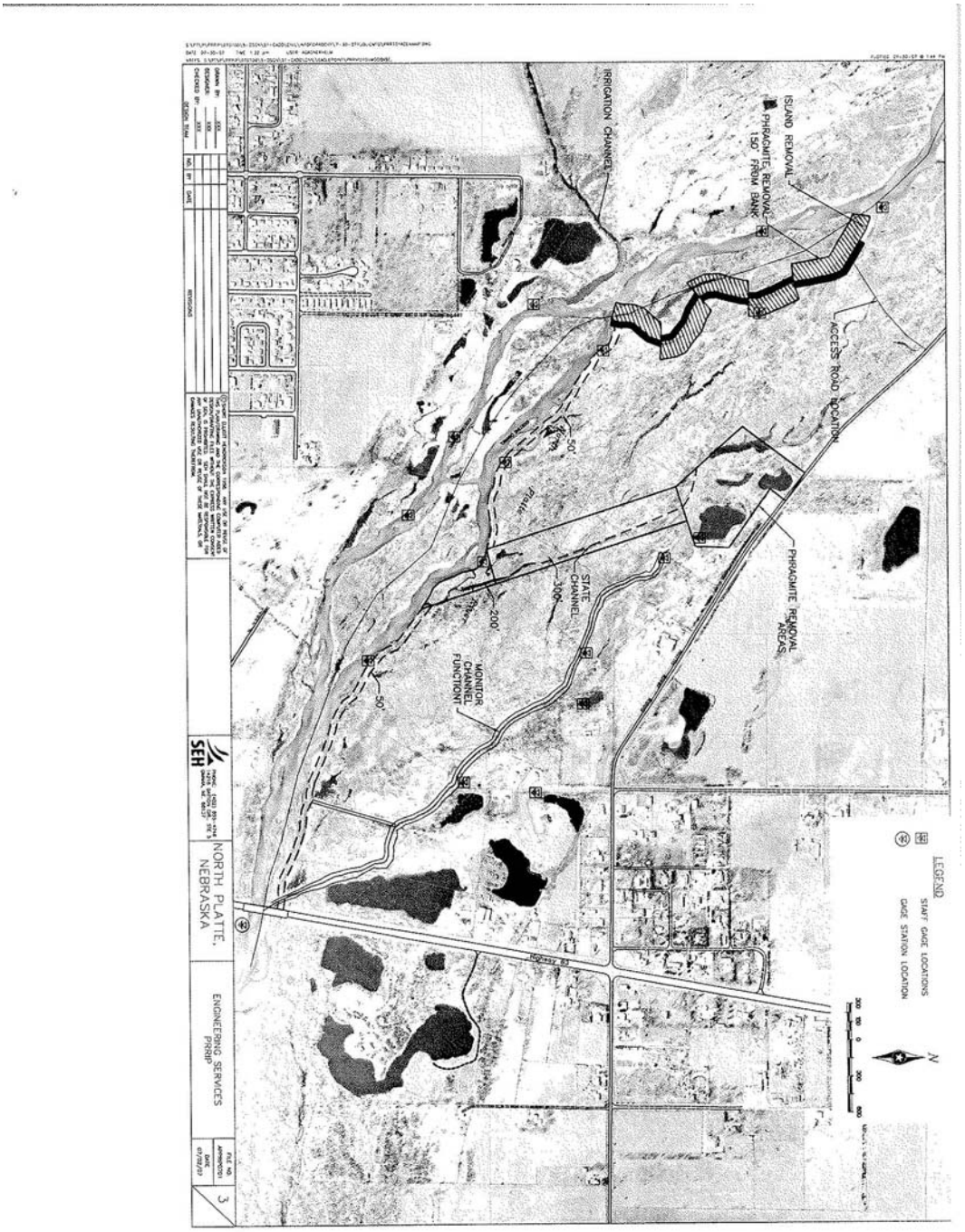

Figure 4 - Sandbar Removal Project

Appendix B

Supporting Documentation
Detailed Cost Estimates

RECORD OF CONVERSATION ON REFUGE ISSUE

Conversation With: Brian Dunnigan **SEH File No.:** A-PRRIP0701.00

Co/Org: Nebraska Department of Natural Resources **SEH File Loc:**

Phone No.: 402.471.3934 **Owner's File No.:**

Fax No.: **Date/Time:** 8/08/2007 Around 2:15: p.m.

Subject: North Platte State Game Refuge boundary determination **By:** Rocky Keehn

Conversation Type:

☐ In Person ☐ At SEH ☐ At Site Other:

☒ Telephone ☐ Incoming ☐ Outgoing

Items Discussed:

Mr. Dunnigan was contacted to get additional information on how the Refuge Boundaries on the North Platte River near the Highway 83 Bridge were determined. He had been provided background information via email prior to the phone conversation.

Brian indicated that the original refuge boundaries for the location in question are based on bank river flows. The bank river flows were determined by reviewing aerial photography from 1993, 1999 and 2003 and other available technical information. This included both periods of low flows and high flows. Based on these maps the river banks appeared to be very stable and had not move much if at all during the 10 years of history of the mapping and thus a consistent river bank location could be mapped and used as the basis for the determination of the refuge boundaries.

The other key issue that Brian clarified is the reference to flood stage in the statue. The statue states "the banks of the river means the banks of the river which are the elevation of ground which confines the water at a level not exceeding flood stage". Mr. Dunnigan indicated the key words are "not exceeding" which allows for the bank flow determination to be set at an elevation or flow width that is less then the NWS or other agencies determined flood stage. We discussed the fact that in this location the banks of the river flow width appear to be less then the NWS determined location of the flow width during flood stage.

Brian also indicated there was a very comprehensive PowerPoint presentation on the DNR website for the Garden County Game Refuge that would help answer some of the technical question related to determination of the boundaries. (Note: after the call looked up the site and it is a good summary and can be found at - http://www.dnr.ne.gov/StateGameRefuge/GardenCounty/GardenCoStateGameRefuge.pdf). He also indicate he would provide information from their GIS database on the location of the Refuge

that can be included on any maps or plan sheets prepared for the project.

We discussed the project in general and what aspects of the proposed project could potential impact the current banks of the river. Brian indicated that if a new excavated channel were to be constructed through the floodplain that is connect to or potentially could connect to the existing river, it could in theory create a new river channel and thus the banks of the river change. His understanding of the project was that we were only doing minor or limited modifications to existing channels in the floodplain which I confirmed was the case. We both felt that if the project is limited to flow improvements of existing channels and no apparent connection is made to the main river channel, it is unlikely the project will alter the river banks. I indicated to Brian that the focus of our project was to assure that the project channel will not move and that the flow increases would be incremental and at levels that could be monitored to track flow pattern changes. If it appears the project impacts the bank flow channel, changes could be made to assure the channel remains in its current location as a result of the project.

Follow-Up Required:

Send a copy of the Record of Conversation for his review. Provide any maps or reference to the Refuge Boundary location for DNR review. Request a copy of the GIS mapping of the area to be used for our project maps and plans.

Please contact the writer if errors are contained in this record, or if relevant information has been omitted.

c: [Click to type cc's OR delete this line]

SEH MINUTES

Platte River Recovery Implemenation Program -
July 31, 2007
3:00 p.m.
NWS Office, 5250 E. Lee Bird Drive, North Platte, NE 69101

Meeting Chair: Rocky Keehn, P.E.

Minutes by: Rocky Keehn

Present: Rocky Keehn, Project Manager SEH; Jerry Kenny, Ex. Director Platte River Recovery Implementation Program (PRRIP); Kenneth Roberg, NWS – North Platte, NE Office; Brian Hirsch, NWS – North Platte, NE, Office, Meteorologist-in-charge

Copies to: Rocky Keehn, Jerry Kenny, Kenneth Roberg, Jim Hawks, City Administrator, North Platte NE.

The purpose of the meeting was to discuss how the flood stage and other flood related information was determined in the 2002 letter which set the elevation for flood stage at the gage station located just downstream of the bridge. Meeting was at the request of Rocky Keehn. SEH through it local consultant TC Engineering, provided two 1" = 200' maps of the project locations to NWS prior to the meeting. One was an aerial map and one a contour map.

Kenneth Roberg with the National Weather Service, North Platte was the author of a September 9, 2002 memo which established the flood stage elevation for the project site and thus was contacted by SEH to attend a meeting to discuss the events that occurred in 2002. Brain Hirsch, with the North Platte NWS office, also attended the meeting to participate in the discussion of how flood stages are determined in a specific location and the potential role of the NWS in the PRRIP project. Mr. Roberg had available his notes from the 2002 flood as a reference for our discussion and briefly reviewed them with those in attendance. He also provided additional background information on the site visits and flooding that occurred during the event in summer of 2002.

NWS staff indicated the gage station is maintained and owned by the Nebraska Department of Natural Resources (DNR). The DNR determines the elevation and

corresponding flow relationship at this location. The NWS uses the information to aid in their flood forecasting, but has no control over the elevation to flow relationships determined at the gage station or it's operation.

NWS staff indicated Flood Stage is based on the location at which property damage is about to occur and thus a corresponding elevations can be determined. Existing information, field reconnaissance and maps are reviewed to determine which structure(s) or property features are first threaten during a rise in the flow in the river. Once the extent of flooding is known and which property features are threatened, nearby gage stations are used to correlate the flooding extents to known reference points. The historic elevation of the gage at which this event occurred is reviewed and then the appropriate flood stage elevation is determined at a corresponding gage station and thus appropriate anticipated flooding events occur in the river when this elevation is reached.

Mr. Hirsch indicated the gage station at Highway 83 is not located in the ideal spot since it is downstream of the bridge. The ideal location would have been upstream of the bridge. If the gage station was upstream of the bridge there would be more of a direct correlation between the gage station elevation and the properties without the influences of the downstream structures.

Mr. Kenny provided a brief overview of the PRRIP program and its purpose which is focused around increase surge flows in the Platte River to improve habitat of endangered species downstream of North Platte. Mr. Keehn then provided an overview of the purpose of the project which is allow for increased flow rate through this area without causing flooding. The project focus is floodplain channel improvements which will try and recreate flow patterns that were in the area prior to the appearance of invasive plants such as Phragmites.

Mr. Keehn indicated that the contour map provided to NWS was in the 1988 datum and not the 1929 datum used at the gage station. This would explain the elevation discrepancy that Mr. Roberg noted when he was looking at the flooding areas in 2002 and their relationship to the gage station elevation. Mr. Keehn indicated that SEH has converted the 1988 contour map to 1929 datum and all future modeling and construction plans will be done using the 1929 datum which is the same as that gage station. The question on the actual conversion value came up, but Mr. Keehn was not sure of the exact value. He will provide that information to Mr. Roberg via email at a later date.

For this project, Mr. Keehn indicated that SEH would like to generate a map which roughly shows the extent of the flooding during flood stage. This would be based on current property uses, elevation of the land in the area and a HEC-RAS computer model that is being developed for the river upstream of the gage station. Once this map is generated Mr. Keehn would like it to be sent to the NWS staff in North Platte for a general review. If everyone is in agreement on the general width of the river during flood stage, it can be marked in the field for the property

owners to see and monitor. The reason for the NWS review of the SEH generated information is to make sure if a property owners contacts the NWS with questions on the staked location of the flood stage extents, NWS can indicate that they have reviewed the maps and are in general agreement with the locations marked in the field. Mr. Keehn indicated that as part of the project effort elevation gages may also be installed in backyards with markings that are tied into the gage station. This would allow property owners to quickly review the relationship between any water on their property and the gage station stage information on the NWS website.

It was agreed that SEH will prepare a map showing the general location of the extent of flooding during flood stage based on property location, general discussion at this meeting, HEC-RAS model results and conversation with the property owners. This map will be sent to NWS for a general review. The purpose of the review is such that if the property owners question the SEH determination of the extent of flooding, the NWS is in general agreement of the information thus eliminating any conflicting interpolation of the flooding expected during flood stage. NWS will have on file in their office the same reference map used by SEH to mark in the field the anticipated the extent of the flooding during flood stage. Some type of corresponds is expected from the NWS to SEH and the PRRIP that indicates they are in general agreement with the anticipated extent of the flooding during flood stage.

It was also discussed that by staking the anticipated extent of the flooding during various flood events, the flows could be monitored and better understanding of the conditions at which flooding occurs could be determined. This information could then be used to revise the current flood stage elevations if appropriate.

No date was determined when this mapping would be available for review.

SEH believes that this document accurately reflects the business transacted during the meeting. If any attendee believes that there are any inconsistencies, omissions or errors in the minutes, they should notify the writer at once. Unless objections are raised within seven (7) days, we will consider this account accurate and acceptable to all.

If there are errors contained in this document, or if relevant information has been omitted, please contact Rocky Keehn, P.E. at 402.659.3531.

rjk
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Installation of Staff Gages

Staff Gage Unit Cost Estimate

Item	Quantity	Unit	Unit Price	Total
7 ft of USCS Style C Staff Gage (requires two 3.5 feet pieces)	1	Each	$60.00	$60
Installation Labor Person 1	0.5	Hour	$45.00	$23
Installation Labor Person 2	0.5	Hour	$30.00	$15
Hardware for Gage Station	1	Each	$15.00	$15
T-Posts	1	Each	$15.00	$15
Sub-total				**$128**
Contingency			**35%**	**$45**
Total				**$172**

Installation of Staff Gages

Item	Quanity	Unit	Unit Price	Total
Mobilization	1	LS	$1,000.00	$1,000
Intalled Staff Gages	15	Each	$175.00	$2,625
Equipment Rental	1	LS	$1,000.00	$1,000
Survey Staff Gage into dataum	4	Hr	$100.00	$400
Sub-total				**$5,025**
Contingency			**25%**	**$1,256**
Total				**$6,281**

Island Removal per the JFS Report

Item	Quanity	Unit	Unit Price	Total
Mobilization	1	LS	$2,000.00	$2,000
Access Road	1	LS	$5,000.00	$5,000
Clear and Grubb	2	Ac	$1,500.00	$3,000
Excavate, move and level	703	CY	$25.00	$17,575
Erosion Control	1	LS	$1,000.00	$1,000
Revegetate	1.3	Ac	$500.00	$650
Sub-total				**$29,225**
Contingency			**50%**	**$14,613**
Total				**$43,838**

Phragmite Removal

Location	Quanity	Unit	Unit Price*	Total
State Channel	4.6	Acre	215	989
North Channel Downstream of Island	8.9	Acre	215	1913.5
Area around Sand Pits Near Substation	12.5	Acre	215	2687.5
Sub-total				**$5,590**
Contingency			**10%**	**$559**
Fall 2007 Total Cost				**$6,149**
North Bank of the River Bridge to 5900 Feet Upstream.	12	Acre	215	2580
Sub-total				**$2,580**
Contingency			**50%**	**$1,290**
Additional Area 1 - North River Edge Removal - Total Cost				**$3,870**
South Bank of River Bridge to 5900 Feet Upstream	14	Acre	215	3010
Island Areas	22	Acre	215	4730
Private Area North of River	33	Acre	215	7095
Sub-total				**$14,835**
Contingency			**100%**	**$14,835**
Additional Area 2 - Total Phragmite Removal in area - Total Cost				**$29,670**
Total Cost of Phragmite Removal All Projects				**$39,689**

* Assumes only applications by helicopter

Monitoring Program Fall 2007 to Fall 2008				
TC Engineering Staff	112	Hr	$85.00	$9,520.00
SEH Engineering Staff	112	Hr	$130.00	$14,560.00
TC Surveying/Field Staff	48	Hr	$65.00	$3,120.00
			Sub-total	**$27,200**
			Contingency **10%**	**$2,720**
			Total	**$29,920**

* Assumption Engineering - 1 day per month for 8 months (March 1 to October 31) to check on system
* Assumption Engineering - Monitor 3, 2 day storm events in additonal to monthly checkup
* Assumption on Field Staff - 2 days of time for checks during 3 - day storm events

Develop a Calibrated HEC-RAS Model to Help in Flow Forecast				
SEH Staff Engineer	40	Hr	$90.00	$3,600.00
SEH Senior Engineer	24	Hr	$150.00	$3,600.00
			Sub-total	**$7,200**
			Contingency **25%**	**$1,800**
			Total	**$9,000**

Revise Flood Stage Elevation				
SEH Engineering Staff	40	Hr	$130.00	$5,200.00
TC Surveying/Field Staff	16	Hr	$65.00	$1,040.00
			Sub-total	**$6,240**
			Contingency **25%**	**$1,560**
			Total	**$7,800**

Appendix C
HEC-RAS Model Report
HEC-RAS Model Report Figures

HEC-RAS Summary Report
Platte River Restoration and Enhancement Project
Platte River Recovery Implementation Program (PRRIP)

SEH A-PRRIP0701.00

October 7, 2007

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Architect/Engineer under the laws of the State of Nebraska.

Prepared by: Rocky J. Keehn, PE

Date: 10/7/2007 Reg. No.: E- 11199

Reviewed by: Brad T. Woznak, PE, CFM

Short Elliott Hendrickson, Inc.
14216 Dayton Circle, Suite 5
Omaha, Nebraska 68137-5566
402.895.0746

HEC-RAS Summary Report

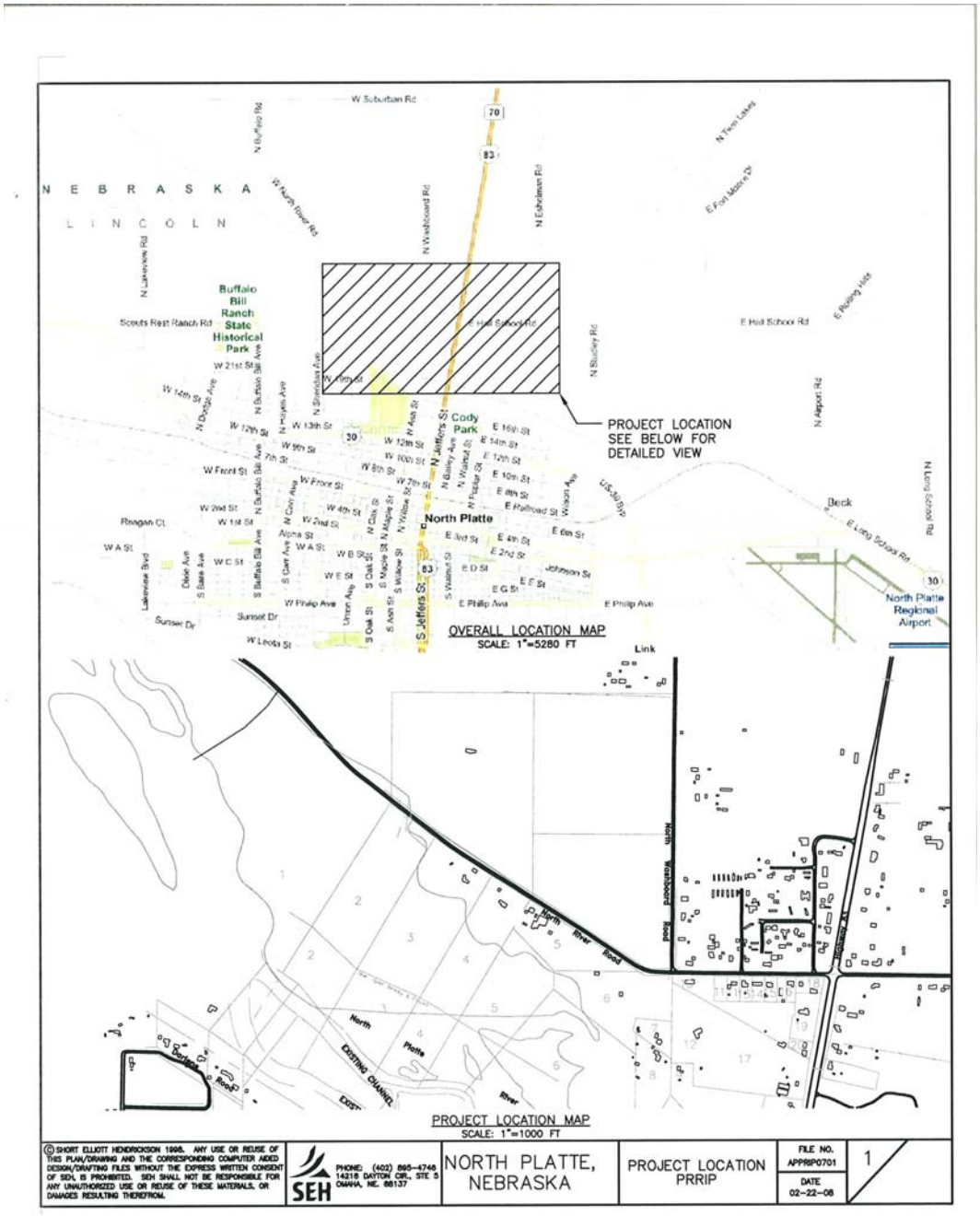
Platte River Restoration and Enhancement Project
Platte River Recovery Implementation Program (PRRIP)

Background

A detailed HEC-RAS model was created for the area upstream of the Highway 83 Bridge on the North Platte River north of North Platte, Nebraska. The main concern with the previously done FIS study information provided by the City was it only included two cross-sections in the project reach area. This would not provide enough detail to look at the relationship between the main channel potential of overbank flow into the floodplain and the flows in the floodplain itself. Also, based on the SEH field visits and reviewing charts showing Mannings n-values for various types of channels, the n-values in the City's program appeared to be composite values since only the main channel n and left and right overbank floodplain-values were used. These n-values did not show the variability that exists in the adjacent floodplains (dense cover, less dense areas near the houses and in the hay fields, etc.) and did not break out the islands in the middle of the river. Also, for this project cross-sections were created at key locations of houses, buildings, and property lines to aid in determining the extent of the flows without having to interpolate between cross-sections.

The City contour maps were in the 1988 datum and the FIS and gage station downstream of the Highway 83 Bridge were on the 1929 datum. SEH converted the City contour map using the raw elevation information in the 1988 maps into a new 1929 datum based contour map. This map was then used to cut new cross-sections at key points in the river. SEH used the bridge as a base station of 10+00 which differs from the original FIS study cross-section locations. Figure 1 shows the project location and lot numbers. Figure 2 shows the location of the cross-sections. Table 1 shows the River Station used in the model, the SEH cross-section identifications, and the reason the cross-section was cut.

Figure 1 - Project Location and Site Map



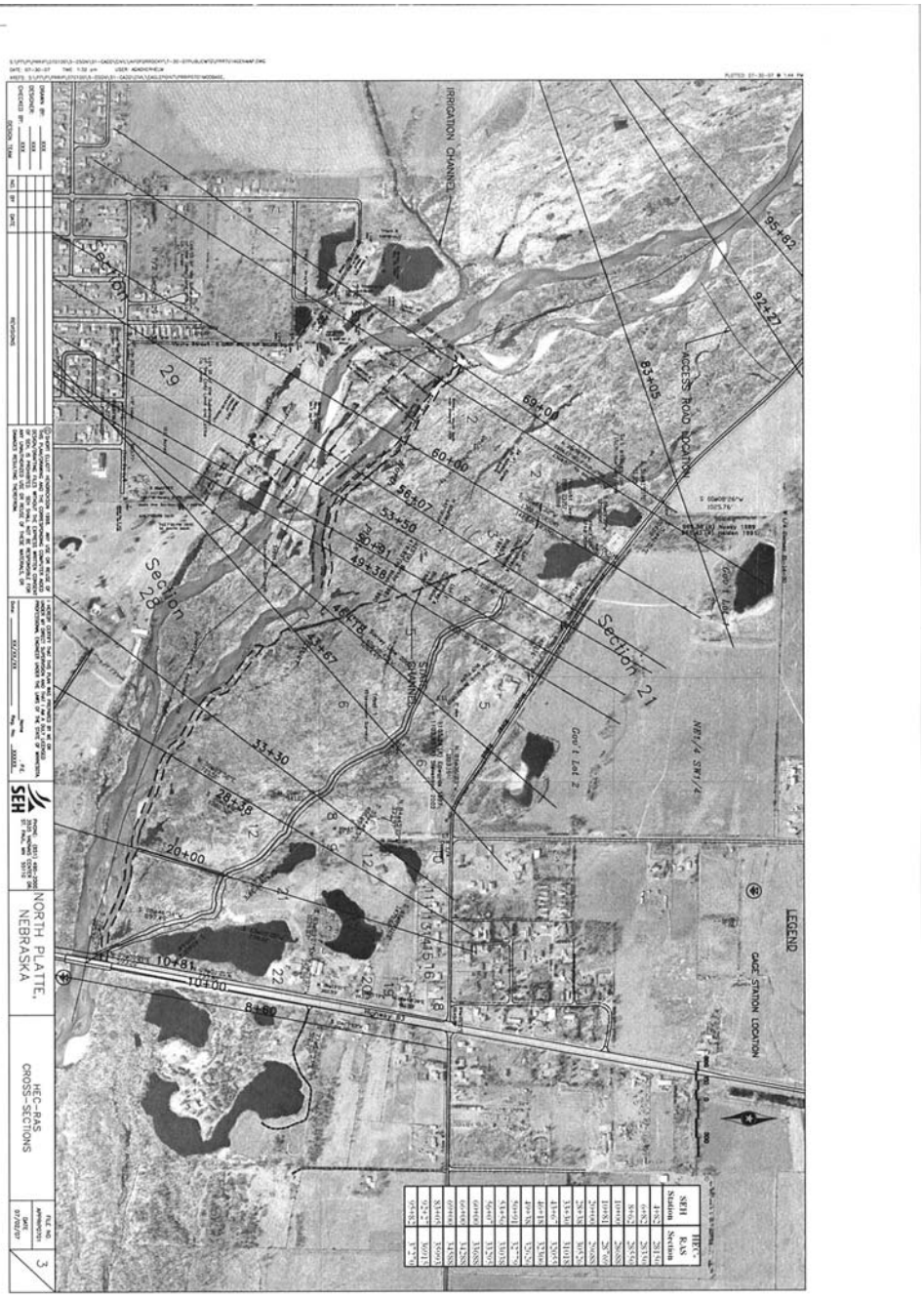

HEC-RAS CROSS-SECTIONS
NORTH PLATTE, NEBRASKA
SEH
LEGEND
GAGE STATION LOCATION
IRRIGATION CHANNEL
ACCESS ROAD LOCATION
Section 21
Section 28
Section 29
NE1/4 SW1/4
Gov't Lot 2
95+82
92+27
83+05
69+09
60+00
56+07
53+50
50+91
49+38
43+67
33+30
28+38
20+00
10+81
10+00
8+80

Table 1
River Station used in HEC-RAS Model

SEH Station	HEC-RAS Section	Purpose of the cross-section
4+82	28150	Copy of 862 which was used as the assumed starting elevation of the river to allow the model to stabilize before it reached the gage station.
6+82	28350	Copy of 862 which was a transition cross-section to help stabilize flows prior to reaching the known gage station elevations
8+62	28550	Gage Station Location and Downstream Bridge Cross-Section. Was used as the match point for the water surface elevations based on the stage discharge curve for the gage station.
10+00	28688	Bridge Centerline
10+81	28769	Upstream Bridge Cross-Section
20+00	29688	Location of Old Road Bed on North Side of the River
28+38	30526	Through Lot 12 Buildings
33+30	31018	Through Lot 8 Buildings
43+67	32055	Through Lot 6 Buildings
46+18	32306	Lot Line between Lots 6 and 5
49+38	32626	Through Lot 5 Buildings and Lot Line between Lots 5 and 4
50+91	32779	Through Lot 4 Buildings
53+50	33038	Lot Line between Lots 4 and 3
56+07	33295	Through Lot 3 Buildings
60+00	33688	Lot Line between Lots 3 and 2
66+00	34288	Lot Line between 1 and 2
69+00	34588	Copy of 6600 at flow break between main river & irrigation channel
83+05	35993	Intermediate cross-section between upstream end of project and residential areas
92+27	36915	Located at upstream tip of island to remove
95+82	37270	Upstream cross-section near potential breakout point

Program Assumptions

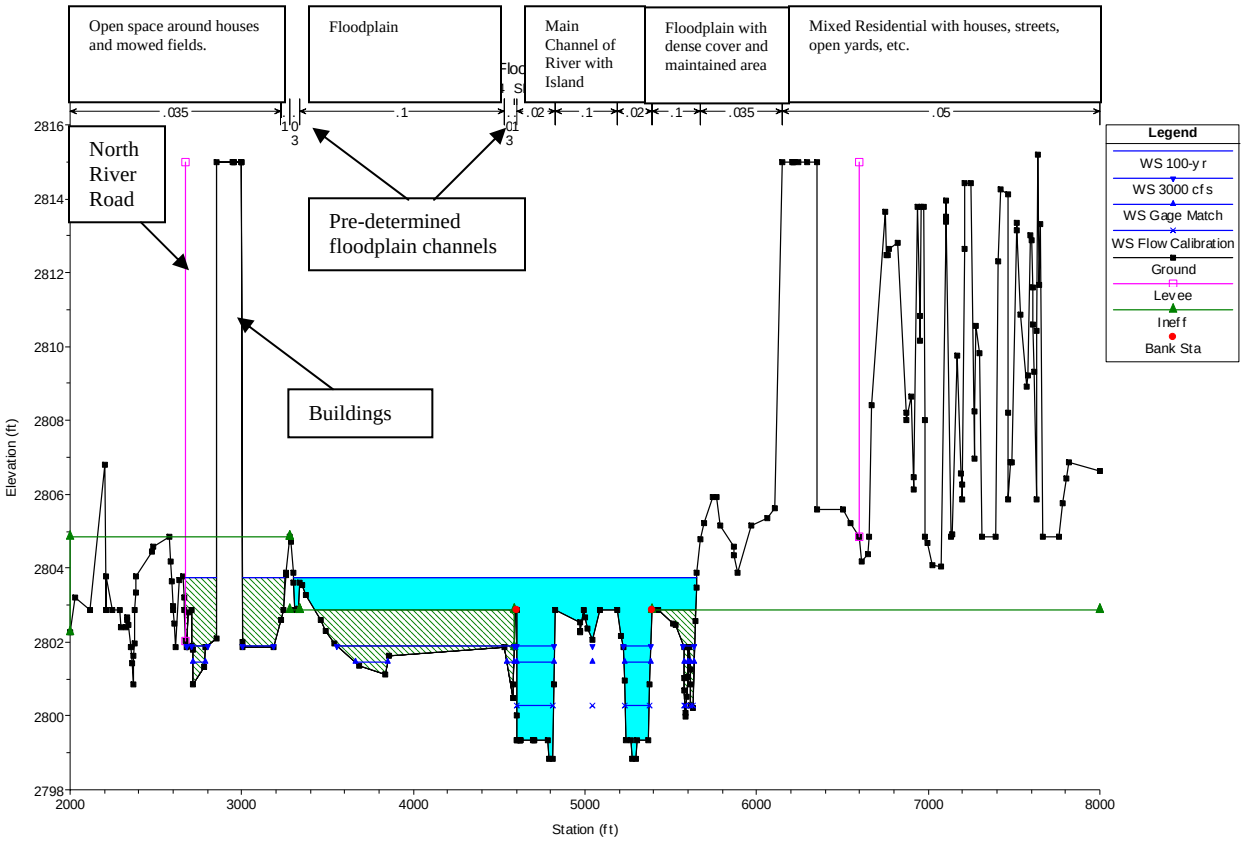
Based on n-values in Chow Handbook of hydraulics, information presented in the help screens in HEC-RAS and field observation n-values were determined for the channel and adjacent surrounding floodplains. These are summarized in Table 2.

Table 2
Manning's n-value assumed in the HEC-RAS program

Type of Channel and Description	n-value
Riverbed – Main Channel – sand and small gravel bed	0.020
Floodplain water bodies - Water flowing across sandpits	0.025
Pre-determined Floodplain Channels – Small channels that will flow during high river flows when bank elevations near river are exceeded. Has less vegetation than rest of floodplain and standing water prior to flowing	0.030
House yards – maintained yards and open space near houses or adjacent mowed or grazed fields	0.035
Residential areas outside the floodplain – flow through combination areas which include streets, houses, buildings, yards, etc.	0.050
Floodplain – area next to main channel and island areas which includes cottonwood trees, heavy grasses, wetland vegetation, phragmites, brush, and small depressions	0.100
Wooded areas in the floodplain – areas next to main channel that include more trees and less dense vegetation	0.100

For each cross-section, the type of channel was identified based on field visits and aerial photography provided by the City. The Horizontal Variation in n-values option was used in the program to model the variety of flow paths that exist across each cross-section. Since the purpose of this analysis was not to determine 100-year or high flows, the levee option was used with an assumed higher than actual elevation to define the location of North River Road on the north bank and the nearest residential street location on the south bank at each cross-section. Since this option limits the width of flow, the program would need to be revised and the levee elevations modified to the actual road heights if this model is used for 100-year flood analysis. House or building restrictions which impact the flow area were located in the model and squared off with an elevation that would estimate the height of the roof of the house and the total impact width. This eliminated this area from contributing to the flow area at each cross-section. It also clearly defined the location of key properties in each cross-section. Figure 3 is an example cross-section which demonstrates how n-values were distributed across each cross-section, buildings impacts were identified and how the levee option was used to locate North River Road and when available the most northern street location on the south side of the river.

Figure 3. Typical Cross-Section Showing n-value Horizontal Variations.



The floodplain is rather inconsistent with several small and large depressions which are difficult to determine if they contribute to the flow in the river or not. For this floodplain, the following assumptions were made for ineffective flow areas.

- Overflow into the floodplain would not occur until it reached the bank elevations of the main channel (sets the elevation of the ineffective flow area),
- Most all the areas in the floodplain below this elevation were determined to be ineffective except as described next,
- Several pre-determined floodplain channels were identified and it was assumed they would have a full cross-section effective area once the overflow occurred.

On August 16, 2007 cross-section 28+38 was surveyed and on August 21, 2007 cross-sections were taken at stations 49+38, 66+00 and 83+05 and water surface elevations were measured at stations 43+67, 53+50, 60+00, 95+82 (see Figure 2 for location of cross-sections). This information was then used to calibrate the model using a flow based on the recorded stage at the gage station located just downstream of the Highway 83 bridge on the North Platte River. The recorded stage was 4.26 feet on August 21 and on August 16 was 4.24 feet. The August 21 stage was used to determine the flow for the model calibration since it represented more data points. The flow rate for this stage is 400 cfs per information posted on the NWS website for this gage station. Information on the data obtained during this time period is included at the end of this modeling summary.

It was also observed during the field visit on August 21, 2007 that there were two sources of river flow being measured at the gage station. A portion of the flow comes from the main channel of the North Platte River upstream of station 66+00 and part of it from an irrigation channel which discharge back into the river on the south side of the river near station 69+00. There was no immediate available information on the flow rates of the irrigation channel or the main channel of the river upstream of the gage station, thus the flow split required for the model will need to be based on an assumption and then checked by the calibration run.

On August 21, 2007 the maximum depth of water averaged about 1.4 feet in all survey locations and was verified as the average maximum depth when walking across the river in several other locations. For each of the cross-sections in the program, the water surface elevation was determined based on the field data collected on August 16 and 21 by using the surveyed elevations. Where no water surface elevation was surveyed, the elevation was based on an assumed flat water surface elevation between the closest upstream and downstream surveyed locations. At each station, the minimum channel bottom elevation was assumed to be 1.4 feet below the surveyed or calculated water surface elevation. These assumed minimum channel elevations were compared to the ones surveyed at stations 28+38, 49+38, 66+00 and 83+05 and verified the minimum depth calculation based on water surface elevation.

The main channel of the river varies in depth from having small sandbars with little or no flow over them to a main flow channel with a depth of 1.4 feet. Because not all the cross-sections were surveyed and the channel is dynamic in nature it was necessary to make a general assumption on the shape of the channel bottom. For this reach, based on the field visit and surveys, the main channel was assumed to be 40 feet wide and 1.4 feet deep when there is one main channel (downstream of Station 28+40 and upstream of Station 92+27) and 20 feet wide and 1.4 feet deep where the main channel splits into two distinct channels with a large island in between (between Stations 28+40 and 92+27). From the main channel to the banks flow areas, the elevation of the bottom of the river as varied to calibrate the model. The assumed shape of the channel bottom can be seen in Figure 3.

Computer Runs

Several HEC-RAS computer runs were made including: calibration run, existing conditions for 2000 cfs and 3000 cfs and two predictive runs to evaluate proposed project components. The results of these computer runs are summarized in the following section.

Calibration

The results of the final calibrated model can be seen in Table 3. All values are consistent except stations upstream of 69+00. The method of adjusting the bottom elevation of the channel bottom outside the main channel to the bank in this area did not work as well as in the other areas. This could be due to the following items: the uncertainty of the flows in this reach because of the split flow assumption; unknown flow rates in the irrigation channel; and/or may be because in this location the channel has changed the most since the contour maps were developed. A practical assumption of the channel cross-section at cross-section 9221 was made that is within 0.2 feet of the measured flow which was assumed to be acceptable with the data available. As more calibration information is obtained and more details can be collected on the flow splits in this reach, the difference between the calibrated water surface and actual water surface will be within the targeted

difference of near 0.05 feet. The final calibrated flow split between the main channel of the river and irrigation channel near station 69+00 was 225 cfs in the main channel and 175 cfs in the irrigation channel for the initial calibration run.

Other calibration methodology used was find out if what the residents observed during the high flows in the summer of 2007 matched the model results for the 2000 cfs flow rate near what occurred. Based on what the residents indicated, the water did not reach the channel identified just south of the backyards of lots 4, 5, 6 and 8. Water was however flowing in this channel in lot 12. The model appears to show this is a possible scenario since the width of flow during the 2000 cfs would not reach the backyards of the houses if it is contained in the river. If groundwater impacts or some bypass flow upstream does not occur, this area could remain with limited water and no flow. For Lot 12 the ditch does drain one of the largest low areas in the floodplain downstream of the main floodplain interception channel (State Channel) and also has a higher potential for groundwater and possible overbank flows in this area. This could explain the reason for the water in this section of the channel during the summer of 2007 flow events. This would support the result of the modeling for 2000 cfs. There was no available calibration observation either from resident's observation or measured water surface elevation for 3000 cfs.

Table 3
Summary of Calibration Run

HEC-RAS Station	SEH Station	HEC-RAS WS (feet)	Measure Based WS* (feet)	Difference (feet)
37270	9582	2805.65	**2805.58**	0.07
36915	9227	2805.01	2805.19	-0.18
35993	8305	2804.30	**2804.19**	0.11
34588	6900	2802.66	2802.71	-0.05
34288	6600	2802.46	**2802.39**	0.07
33688	6000	2801.84	**2801.92**	-0.07
33295	5607	2801.57	2801.50	0.07
33038	5350	2801.23	**2801.20**	0.03
32779	5091	2800.99	2800.95	0.04
32626	4938	2800.85	**2800.80**	0.05
32306	4618	2800.45	2800.50	-0.05
32055	4367	2800.20	**2800.25**	-0.05
31018	3330	2799.11	2799.13	-0.02
30526	2838	2798.56	**2798.60**	-0.04
29688	2000	2797.69	2797.65	0.04
28769	1081	2796.60	2796.61	-0.01

*Bold values are based on field measurement at that station and non-bold are straight line interpolations between known values.

Current conditions 2000 cfs and 3000 cfs

After the model was calibrated for the low flow condition, the HEC-RAS model was run with flow rates of 2000 cfs and 3000 cfs. The starting water surface elevation at the gage station for flow rates in this reach can be determined from information provided on the NWS website and is summarized in Figure 4. The 2000 cfs represents a flow rate which

is based on a straight line interpolation of the 5.7 foot flood stage between the two data points provided at stage 5.0 feet and stage 6.0 feet. This is slightly higher than the current assumed flood stage flow of 1980 cfs which may have been determined from a more detailed graphic representation of the data which accounts for a more curved representation of the data. The more conservative value of 2000 cfs was used in the model since neither rate is a field verified value at the flood stage. The 3000 cfs rate represents a flow rate near the maximum target for the PRRIP in this location. Each flow rate was reduced by 175 cfs upstream of station 66+00 to compensate for the additional flow from the irrigation channel that impacts the recorded river flow at the gage station.

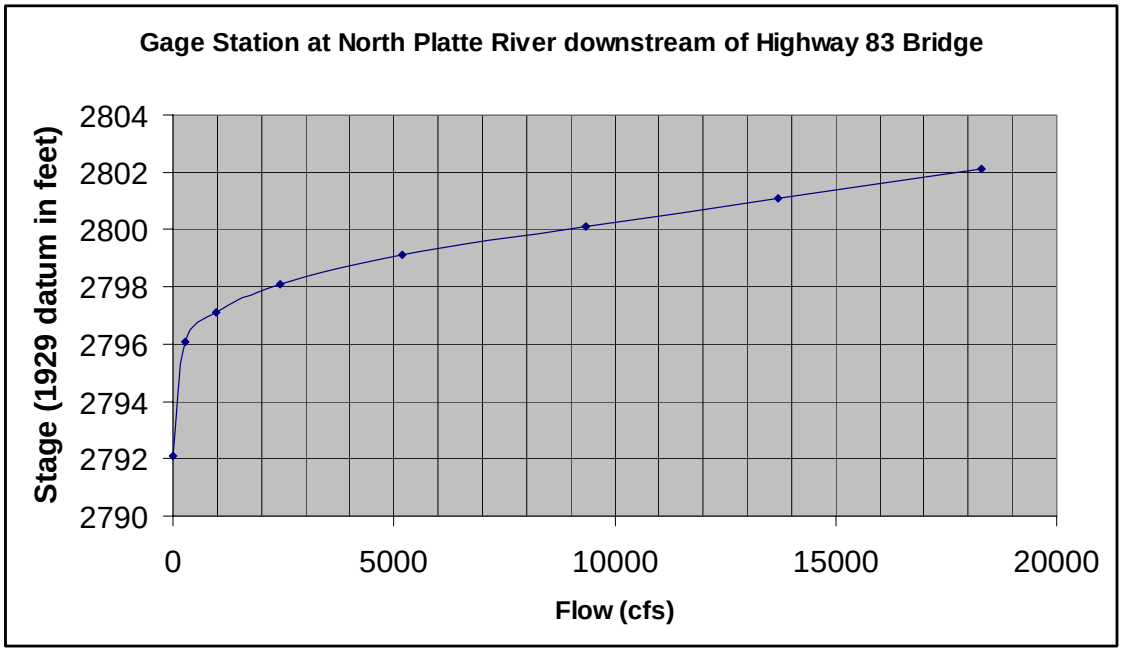


Figure 4. Gage Station Rating Curve Based on Information from the NWS Website for the North Platte River at North Platte.

The results of the model are shown in Table 4. For both the 2000 cfs flow and the 3000 cfs flow it appears that the flow can be carried within the banks of the main channel. For 3000 cfs, at SEH station 33+30 (which is downstream of the State Channel) the water surface is just above the top of the bank presenting a possibility the flow could leave the bank and travel into the floodplain. At SEH station 60+00 the area is near the top of the bank. The program does show that there are floodplain areas that are near the low flow elevation of the river and are well below these bank elevations. There is a strong possibility that ground water would raise the elevation of the water in the floodplain, but the floodplain would not necessarily be needed to convey the 2000 cfs and 3000 cfs flow areas of the river. There would be water in these areas, but should have no contribution to the main flow requirements of the river. Figure 5, at the end of the report, shows the areas of flooding during the 2000 cfs and 3000 cfs flows based on the results of the HEC-RAS model.

Table 4
Comparison of Calculated Water Surface Elevation to Bank Elevations

HEC-RAS Station	SEH Station	Left Bank Elevation	2000 cfs WS Elevation*	2000 cfs Distance WS below Bank Elevation	3000 cfs WS Elevation*	3000 cfs Distance WS below Bank Elevation
37270	9582	2808.5	2807.1	-1.4	2807.7	-0.8
36915	9227	2808.5	2806.7	-1.8	2807.3	-1.2
35993	8305	2810.0	2805.4	-4.6	2805.8	-4.2
34588	6900	2804.9	2804.0	-0.9	2804.5	-0.4
34288	6600	2804.9	2803.8	-1.1	2804.3	-0.5
33688	6000	2803.9	2803.1	-0.8	2803.6	-0.3
33295	5607	2803.9	2802.8	-1.1	2803.4	-0.5
33038	5350	2803.9	2802.5	-1.4	2803.0	-0.9
32779	5091	2803.9	2802.3	-1.6	2802.9	-1.0
32626	4938	2803.9	2801.9	-1.9	2802.4	-1.5
32306	4618	2803.9	2801.6	-2.3	2802.1	-1.8
32055	4367	2802.9	2801.4	-1.5	2801.9	-1.0
31018	3330	2800.9	2800.4	-0.5	**2800.9**	**0.0**
30526	2838	2800.9	2799.7	-1.2	2800.1	-0.7
29688	2000	2803.9	2798.8	-5.1	2799.4	-4.5
28769	1081	2800.9	2797.9	-2.9	2798.4	-2.4

* Bold indicates that the bank elevation has been exceeded.
Floodplain

Predictive Runs

The project construction activities are focused around three concepts. First is a project to maintain flow in the north channel upstream of station 69+00 by removing the island and phragmites on the sand bars downstream of the island. It has been assumed that if this channel is blocked, the water surface will increase upstream and then the path of least resistance, based on the contour maps would be to the north floodplain and into the old historic channels and into the backyards of the residents along North River Road. The impact of the channel on the overall operation of the river can be simulated by the HEC-RAS program and thus is one of the predictive runs completed. A second project component is to assure that the Phragmites in the region do not continue to block major river flow paths. If not removed, Phragmites will continue to reduce the main channels, block of side channels that currently carry flow, and block other natural channels. One of the projects proposed was a major eradication of the phragmites in the area upstream of the Hwy 83 bridge. The HEC-RAS model cannot exactly replicate the impact since the exact location of the phragmite growth is not known, but the main channel flow width in the model can be reduced (assumes phragmite growth into the channel reduces flow at each cross-section) and the impact of reduced flow width can be modeled. The final major component of the project is to maintain the State Channel and other key flow channels in the floodplain. Since the original program runs indicated the main channel could handle the required flows in the river without the floodplain channels, the State Channel is not required for the pulse flow, but is required to remove the backwater flows

from the floodplain back into the river before it goes into resident's backyards. The HEC-RAS model was created as an overall floodplain model and the State Channel width is an insignificant portion of the total flow area in relation to the main channel of the river, thus the computer model would not be a very predictive model to see the impact of not having the State Channel operating and was not modeled. A summary of the model results for the island removal and phragmite removal is in the following paragraphs.

North Channel Elimination Upstream of Station 69+00

The first option eliminated the north channel upstream of station 69+00 which is now becoming choked off by phragmites. SEH station 9582 is the cross-section just upstream of the flow split. The results of this computer run are provided in Table 5 and show that there is about a 0.4 foot rise in the water surface for 2000 cfs and 1.3 foot rise for the 3000 cfs upstream of the restriction. This water rise has the potential to push more water into the north floodplain upstream of the residents and has the potential to cause more flooding in the backyards. The model supports keeping the north channel open through removal of the island and phragmites.

Table 5
Summary of HEC-RAS for Channel Blockage at and downstream of island removal

SEH Station	2000 cfs base WS elevation	2000 cfs with north channel downstream of island blocked	2000 cfs increase/ decrease WS from base (feet)	3000 cfs Base WS elevation	3000 cfs with north channel downstream of island blocked	3000 cfs increase/ decrease WS from base (feet)
9582	2807.09	2807.39	0.30	2807.67	2808.94	1.27
9227	2806.69	2807.10	0.41	2807.29	2808.44	1.15
8305	2805.36	2805.56	0.20	2805.83	2805.77	-0.06
6900	2803.95	2803.95	0.00	2804.50	2804.50	0.00
6600	2803.78	2803.78	0.00	2804.34	2804.34	0.00

Main Channel Phragmites Removal

The second computer run was to assume all the islands in the main channel are reduced by phragmites with limited or no flow over them (high n-values) and also assumed 10 feet of bank area into the main channel of the river is lost to phragmite growth. The main channel bank to bank flow width is reduced by 20 feet where no island is present and 40 feet when an island is present since there are two channels in the river in this location. This will simulate the ultimate do nothing option of letting the Phragmites take over the reach. Table 6 shows the result of this computer run and the impact of not maintaining the current channel bank to bank flow. This has a significant negative impact up to 2-feet in some locations for the proposed pulse flow rates. If the water rises two feet in these locations it will flood the homes.

Table 6.
Summary of HEC-RAS for Main Channel Reduction due to Phragmite Growth.

SEH Station	2000 cfs Base WS Elevation	2000 cfs with Main Channel Reduction	2000 cfs Increase WS from Base (feet)	3000 cfs Base WS Elevation	3000 cfs with Main Channel Reduction	3000 cfs Increase WS from Base (feet)
9582	2807.09	2809.31	2.22	2807.67	2809.74	2.07
9227	2806.69	2809.26	2.57	2807.29	2809.70	2.41
8305	2805.36	2806.23	0.87	2805.83	2806.76	0.93
6900	2803.95	2805.88	1.93	2804.50	2806.26	1.76
6600	2803.78	2805.83	2.05	2804.34	2806.20	1.86
6000	2803.05	2805.07	2.02	2803.60	2805.49	1.89
5607	2802.81	2804.57	1.76	2803.38	2805.02	1.64
5350	2802.45	2804.42	1.97	2802.99	2804.85	1.86
5091	2802.29	2804.20	1.91	2802.85	2804.65	1.80
4938	2801.92	2804.00	2.08	2802.35	2804.47	2.12
4618	2801.58	2803.29	1.71	2802.06	2803.90	1.84
4367	2801.40	2801.93	0.53	2801.85	2802.79	0.94
3330	2800.35	2801.33	0.98	2800.90	2801.82	0.92
2838	2799.65	2800.90	1.25	2800.13	2801.44	1.31
2000	2798.83	2798.83	0.00	2799.36	2799.46	0.10
1081	2797.92	2797.92	0.00	2798.44	2798.44	0.00

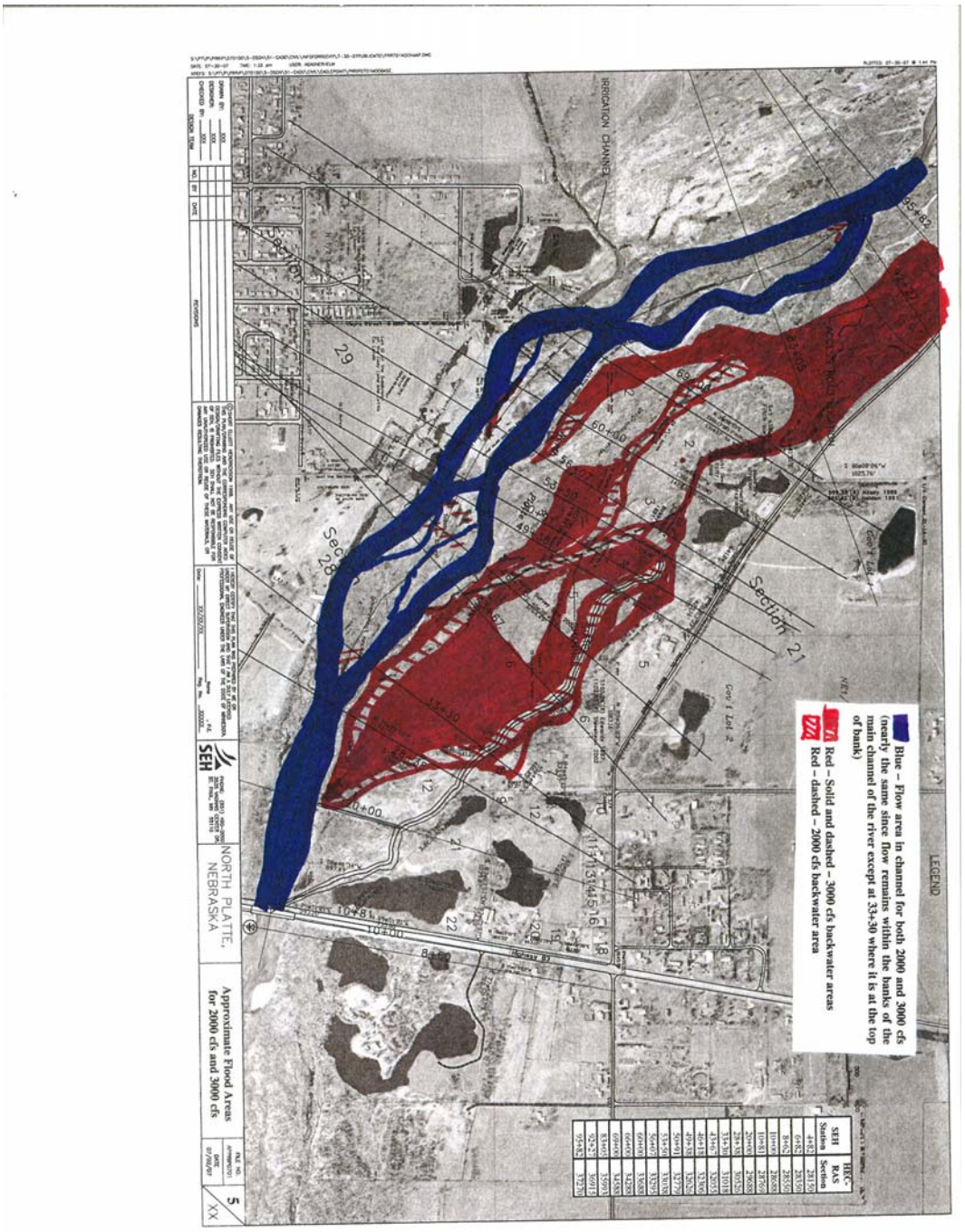


Figure 5 - Approximate Flood Area