TO: CHOKE POINT WORKGROUP
FROM: EXECUTIVE DIRECTOR'S OFFICE
SUBJECT: CHOKE POINT OPTIONS
DATE: JUNE 10, 2012

INTRODUCTION

The ED Office updated the WAC on May 8, 2012 regarding progress on the goal of achieving 3,000 cfs North Platte River capacity at the NWS minor flood stage in North Platte. Two general approaches were presented for increasing capacity at flood stage towards the 3,000 cfs objective:

1. Institutional options that may provide a basis for NWS to increase flood stage from the existing 6.0 feet (capacity of approximately 1,560 cfs) to 6.5 feet (capacity of approximately 2,400 cfs).
2. Engineering the river to increase capacity at flood stage.

The WAC supported an expenditure of $150,000 from the 2012 approved PRRIP budget to implement some of the institutional options (i.e., flood-proofing projects). A Choke Point workgroup was formed at the May WAC meeting consisting of Econopouly, Taddackin, Steinke, Goltl, Shafer, and Kent Miller, which will consider other options to engineer additional capacity through the Choke Point to the full 3,000 cfs capacity objective.

This memorandum summarizes the institutional options, including flood-proofing projects supported by the WAC at the May 2012 meeting. Potential engineering options are also described for fully meeting the Program's objective of 3,000 cfs capacity at NWS minor flood stage. After review of this memorandum, the Choke Point workgroup will be asked to provide input for the best approach for achieving the 3,000 cfs capacity objective.

INSTITUTIONAL OPTIONS

Institutional approaches would be focused on minimizing flood impacts, which may provide a basis for NWS to increase flood stage to 6.5 feet (approximately 2,400 cfs capacity), as discussed with the NWS in a meeting with ED Office staff on May 7, 2012. Institutional options are to buyout potentially affected properties, or to implement various flood-proofing projects to minimize flooding impacts.

FLOOD PROOFING PROJECTS

The ED Office met with NWS staff in North Platte on May 7, 2012 to discuss the factors influencing the North Platte flood stage, and to discuss potential flood-proofing projects that may provide a basis for NWS to increase minor flood stage to 6.5 feet (capacity of approximately 2,400 cfs). NWS identified the following key factors influencing flood stage at North Platte:

1. The primary area of concern for flooding that impacts NWS flood stage is from about three miles upstream of Highway 83 to 2 miles downstream of Highway 83. The developed area along North River Road west of Highway 83 is the primary focus of concern for potential impacts on structures.
2. Flood stage is equal to the stage where flow initially overtops the channel banks, but is not based on stage when high ground water levels cause flooding. Flow has been observed by NWS to overtop channel banks at the Cody Park boat ramp at a stage of 6.1 feet, but no structures are

affected at this stage. Properties along North River Road are initially impacted at a stage of about 6.5 feet.

3. NWS sets flood stage to the nearest whole or half-foot increment, thus rounding down the observed 6.1-foot impacts at the Cody Park boat ramp to a 6.0-foot minor flood stage.

The ED Office has met with the City of North Platte and Lincoln County regarding potential flood-proofing projects since the fall of 2011. Three potential projects described below came out of the meetings with the City and County. The ED Office discussed these projects with the NWS on May 7th, and the NWS indicated that an increase in minor flood stage to 6.5 feet may be possible following completion of the flood-proofing projects described below. Increasing flood stage to 6.5 feet would result in 2,400 cfs capacity (Figure 1). There is no guarantee that NWS will raise flood stage if the following projects are completed. However, the projects would result in local perception of the Program making progress towards reducing flood impacts in North Platte, and if nothing else will develop local goodwill towards the Program at a fairly low cost.

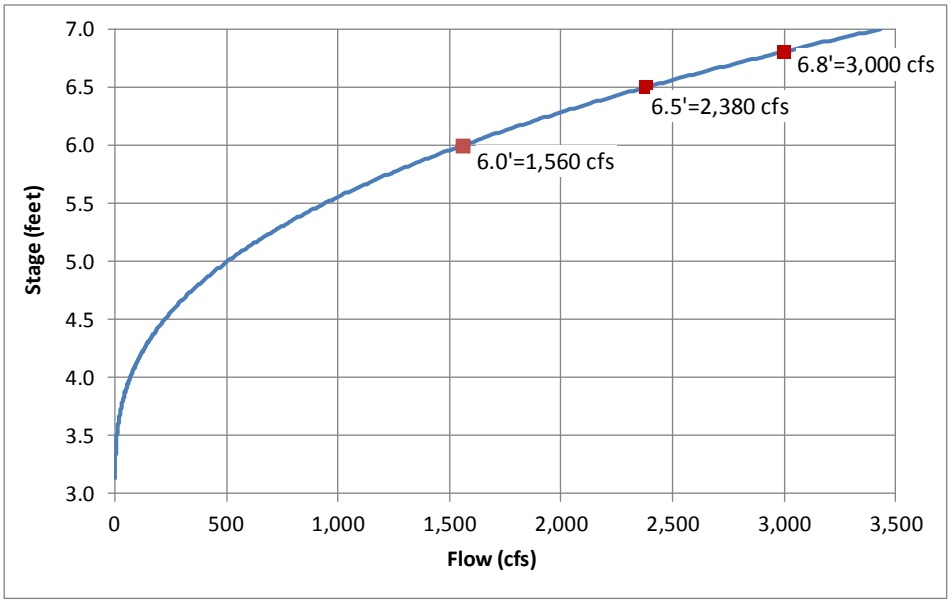

Figure 1. Rating Curve for North Platte River at North Platte Gage

A. Re-Activation of the State Channel

The 'State Channel' was created by the Nebraska Department of Roads (NDOR) around 1970 to direct flow in the 'North River Road Channel' into the 'State Channel' and towards the North Platte River (Figure 2). A berm along the east side of the channel was created to direct flow into the State Channel. A 1993 aerial photo shows a sandy area at the head of the State Channel (red box in Figure 2), suggesting that the berm was breached at this location in the early 1990s. Breaching the berm effectively cut off the State Channel, and resulted in flow continuing east in the North River Road Channel towards the structures along North River Road.

Re-activation of the State Channel would direct high flows from the North River Road Channel into the State Channel, reducing flood impacts to structures along North River Road. Partial re-activation of the State Channel was achieved in May 2012 through Weed Management Area disking at the head of the State Channel partially funded by the Program, with flow naturally clearing disked material and diverting down the State Channel. Flow distribution between the State Channel and the North River Road Channel could be controlled with installation of a check structure and small culvert. The culvert would allow a small amount of flow to continue east in the North River Road channel without flooding North River Road properties, and high flows could be diverted back to the North Platte River via the State Channel.

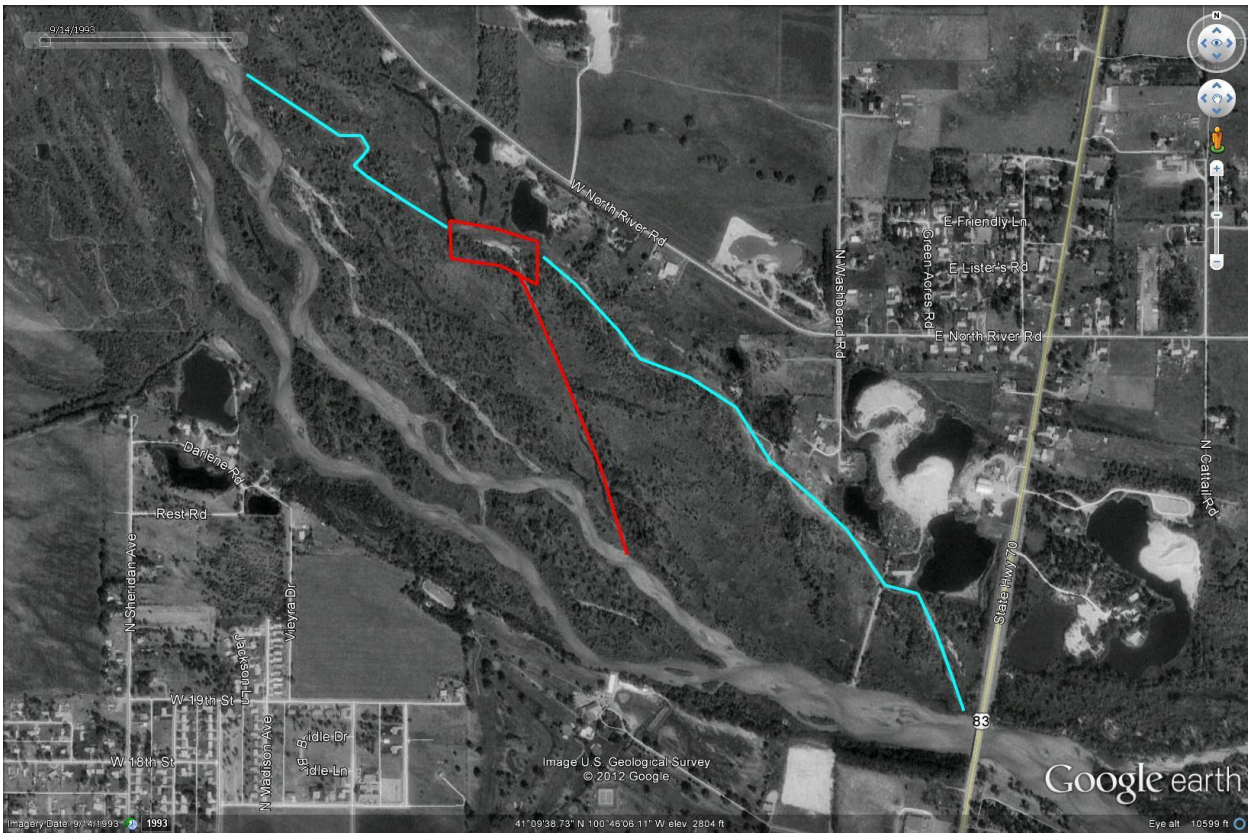

Figure 2. September 1993 Aerial Photo Showing State Channel (red) and North River Road Channel (blue)

B. Existing Drainage and Gravel Pond Outlet

Effective use of an existing natural drainage near North River Road (yellow line in Figure 3) could reduce flooding from high ground water levels. The drainage slopes to the east, crosses under Highway 83 via an existing culvert, and flows to a gravel pond east of Highway 83. There is no existing outlet on the gravel pond, and a new outlet would prevent flooding problems from simply being shifted from the North River Road area to the gravel pond east of Highway 83.

The location of the outlet would be chosen based on a) optimal pond water surface elevation to prevent flooding at the gravel pond property, and b) ability to drain water towards the North Platte River. The outlet would include a check (e.g., flap gate) to prevent North Platte River water from flowing into the

gravel pond during high river stage. A pump may also be needed near the outlet, which would be used to lower the pond water surface during high river stage when the outlet may not be effective. A potential outlet location is shown as the orange line in Figure 3, and was based on a field reconnaissance by the ED Office.

Figure 3. 2010 Aerial Photo with Proposed Gravel Pond Outlet/Pump (orange) and Existing Drainage (yellow)

C. Whitehorse Creek Drainage

The effectiveness of an existing road ditch along the north side of North River Road and East Hall School Road has been minimized as a result of about 12 driveways west of Highway 83. Culverts were not installed under the driveways, and as a result high ground water is trapped behind the driveways and cannot drain effectively to the east via the existing road ditch.

The objective of the Whitehorse Creek Drainage alternative would be to drain high ground water to the east via the existing road ditch and east to the North Platte River via Whitehorse Creek. The 0.25-mile of road ditch west of Highway 83 and the 1.5-mile of road ditch east of Highway 83 may also need to be cleaned of debris (orange line in Figure 4). There may be a high point along the road ditch delineating the drainage boundary between the Whitehorse Creek and North Platte River basins. As a result, the existing road ditch will be surveyed and limited road ditch excavation and/or installation of a small pipe may be needed to optimize ditch flow to the east.

Figure 4. Whitehorse Creek Drainage

D. Cost Estimates for Flood-Proofing Projects

Reconnaissance-level cost estimates indicate a total budget of approximately $151k (Table 1). The WAC supported an expenditure of $150k towards these projects during the May 2012 WAC meeting. Cost estimates will be refined to design-level estimates based on surveying and engineering work to be completed in 2012.

Table 1. Reconnaissance-Level Cost Estimates for Flood-Proofing Projects

Alternative	Cost Estimate
Construction	
A. State Channel	$20,000
B. Gravel Pond Outlet	$26,000
C. White Horse Creek Drainage	$30,000
Construction Total	**$76,000**
Surveying, Engineering, Permitting	$75,000[1]
Total	**$151,000**

Notes:

[1] Based on a fee estimate provided to the ED Office by TC Engineering, a North Platte firm that has completed similar work for the Program in the past. Actual cost may be different and will be negotiated with the contractor selected to do the work.

E. ED Office Recommendation for Flood-Proofing Projects

The ED Office recommends selecting an engineer/surveyor to complete design-level cost estimates and permitting for all three flood-proofing projects. A draft RFP for engineering/surveying/permitting of flood-proofing projects is being provided to the workgroup with this memo. Provided choke point workgroup support, the RFP will subsequently be presented to the FC at their next meeting on June 28, 2012. Depending on the time required to complete project permitting, flood-proofing projects could potentially be implemented by the end of 2013. Even if projects are completed by the end of 2013, NWS may need time to determine whether flood stage can be increased. NWS may not be able to raise flood stage until flood-proofing project benefits are tested with a naturally occurring high flow (Program flow releases are limited by the current 6.0-foot flood stage). As a result of potentially delayed flood-proofing project benefits, the ED Office recommends completing the projects as soon as possible, and simultaneously moving forward with engineering approaches described below.

PROPERTY BUYOUTS

Potentially affected properties were determined based on flood inundation modeling completed by the ED Office, and based on anecdotal flood information from the summer of 2012. The extent of potentially affected properties is overlain on the Lincoln County plat map in Figure 5, and is generally consistent with the developed area NWS identified as the primary focus for structural flooding impacts. Total assessed value (land, improvements, and buildings) for all of the potentially affected properties is $2.8 million according to the Lincoln County assessor's online database. The actual buyout amount may be higher if property owners inflate their sale price once they are aware of a buyout. Assuming a 20 percent markup, the total buyout amount would be $3.4 million. Note that these amounts only include purchase price, but additional funds would be needed to remove the existing structures following purchase of the properties by the Program. In addition to the high cost, property buyouts are likely politically unacceptable until all other options have been exercised, and SDHFs are deemed essential for successful Program implementation.

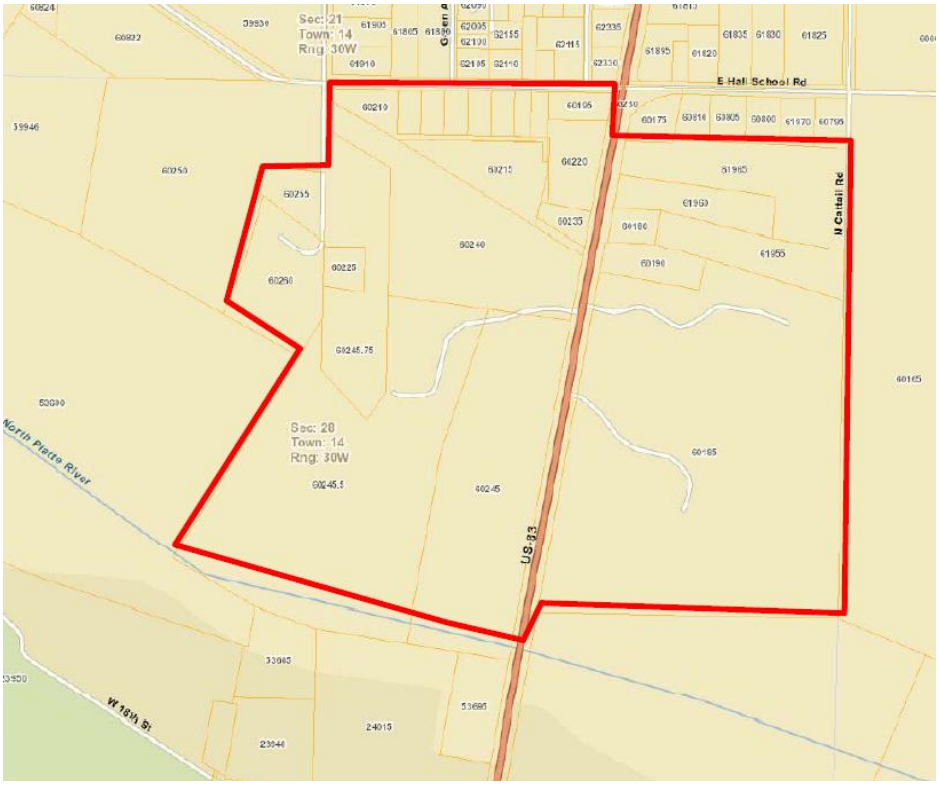

Figure 5. Estimated Extent of Property Buyouts

ENGINEERED ALTERNATIVES TO GET TO 3,000 CFS CAPACITY

Engineering approaches would be more costly than the flood-proofing projects described above, but are the only way to fully meet the Program's 3,000 cfs capacity objective. The degree of engineering necessary to achieve 3,000 cfs capacity would be greater for the current flood stage of 6.0' than it would be if NWS raises flood stage to 6.5' after completion of the three flood-proofing projects described above. Potential engineering approaches to be considered are:

1. Existing or new infrastructure to divert water from North Platte River to South Platte River to circumvent the North Platte Choke Point issue (e.g., additional capacity through NPPD's system).
2. Additional storage in existing canals/reservoirs on CNPPID's system available for releases to the central Platte River.
3. Dredge material from the North Platte River to provide additional capacity, and potentially modify North Platte River channel dimensions to maximize sediment transport capacity.
4. Install sediment collector(s) on the North Platte River to reduce sediment input and potentially induce "natural" dredging.

The first two options are provided as alternatives to North Platte channel capacity maintenance. Additional capacity in NPPD and CNPPID systems was explored in the PRRIP Water Management Study (WMS) for contributing 2,000 cfs for 3 days (12,000 AF) for short-duration high flows (SDHF). Although these alternatives were screened out during the WMS, workgroup input is requested as to whether it is appropriate to revisit these concepts at this time for a portion of the additional needed

capacity. For initial discussion purposes, each option is presented in terms of maximum capacity needed if this were the only engineered solution moving forward. However, potential for combinations of projects should also be considered after initial screening by the workgroup.

1. North Platte River to South Platte River Diversion

Diverting water to the South Platte River would provide an alternative to increased capacity through the North Platte River. Considering the long-term trend of reduced North Platte River capacity, the South Platte River approach may be a sustainable alternative to a perpetual effort to maintain North Platte River capacity over time.

Initial discussion points for the workgroup regarding the design of a diversion to the South Platte River:

- Is there any capacity within the existing system and/or does a new diversion need to constructed?
- 2009 Flow Routing planning spreadsheet assumptions regarding system capacities should be verified. The Flow Routing spreadsheet could then be used to determine whether there is any potential for additional Program capacity using existing infrastructure.
- Is there potential to design a new diversion to provide benefit to the Program and NPPD?
- Where should additional capacity be located? A diversion from Sutherland may be more cost effective than additional capacity diverted at Keystone.
- Water could be delivered to the South Platte River near Paxton or Sutherland to minimize construction costs. Deliveries could also be routed through NPPD's system if the economic benefits of power generation would offset the additional upfront construction costs associated with a longer pipeline and potentially new/upgraded South Platte siphon.
- Diversion capacity would need to range from approximately 1,440 cfs (assuming 6.0' flood stage) to 620 cfs (if NWS raises flood stage to 6.5 after completion of flood-proofing projects described above), plus system losses.
- A sponsorship agreement with NPPD should be considered, and NPPD should provide input as to how the design of additional capacity could benefit both the Program and NPPD.

2. Existing Storage on CNPPID's System

The Program, CNPPID, and DNR are currently planning a new J-2 Regulating Reservoir project within the CNPPID system capable of contributing 2,000 cfs for 3 days (12,000 AF) to a SDHF. Potentially, additional Program water could be stored in existing CNPPID system storage prior to an SDHF release, and subsequently released during an SDHF to make up for North Platte capacity less than the 3,000 cfs objective. While this concept was previously presented during the PRRIP WMS and determined to be undesirable by CNPPID, it is being included here for comprehensiveness. Initial discussion points for the workgroup regarding this option:

- 2009 Flow Routing planning spreadsheet assumptions regarding system capacities should be verified. The Flow Routing spreadsheet could then be used to determine whether there is any potential for additional Program capacity using existing infrastructure.
- The additional capacity was estimated with the 2009 Flow Routing planning spreadsheet to be up to 2,400 cfs for 3 days (14,000 AF) to achieve a 3-day SDHF of 8,000 cfs at Overton (Figure 6).

- Use of Jeffrey and Johnson lakes for Program storage and releases may be limited because of adverse impacts of rapid drawdown such as bank slumping and reduced recreational opportunities.
- Need to determine what the maximum release volumes are for Jeffrey and Johnson lakes without adverse impacts, what improvements could be made to reduce adverse impacts, and whether there are times of year where some level of drawdown would be acceptable if certain improvements were made. A maximum drawdown of 6,000 AF was assumed for Johnson Lake in the 2009 SDHF planning tool spreadsheet. This volume should be confirmed, and a similar maximum needs to be determined for Jeffrey Reservoir. Are there any improvements that could be made to maximize the potential regulating storage in Central's system (e.g., reservoir bank stabilization)?
- Maximum releases rates from the Jeffrey and J-2 returns were assumed to be 1,250 cfs and 2,000 cfs, respectively, in the 2009 SDHF planning tool spreadsheet. With the combined total release rate of up to 3,250 cfs, a new or improved return to the Platte River does not appear to be needed. Rather, the issue appears to be that additional storage volume may be needed to avoid adverse impacts of rapid drawdown on Jeffrey and Johnson lakes.
- CNPPID should provide input on the viability of this option, and whether they would reconsider Program use of existing storage within their system.

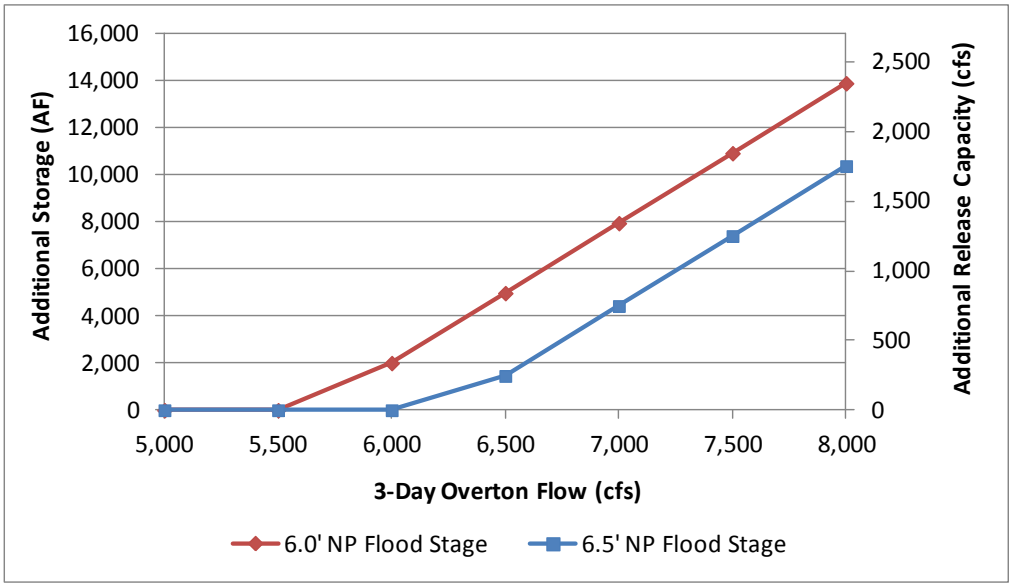

Figure 6. Additional Storage and Release Capacity for a Range of 3-Day SDHF Flow Magnitudes (assumes 2,000 cfs J-2 Regulating Reservoir release and 2,000 cfs J-2 return; calculated with SDHF planning spreadsheet, which accounts for system capacities and transit losses)

3. North Platte Dredging

North Platte River hydraulic and sediment transport models previously created for the Program were used to simulate sediment transport budgets and dredging alternatives to achieve the 3,000 cfs capacity Program target. Sediment modeling indicates depositional conditions for the North Platte River within the model reach (5 miles upstream of Highway 83 to 5 miles downstream of Highway 83).

Approximately 9,600 yd^3/year of deposition occurs within the reach with the greatest impact on flood stage (i.e., 2 miles from Highway 83 to the UPRR Bridge) (Table 2). Hydraulic capacity could be increased by dredging material that has accumulated in the channel over time. However, dredging may need to be repeated periodically to maintain capacity.

Table 2. Sediment Budget for North Platte River between Highway 83 and UPRR Bridge

Modeled Sediment Parameter	Value	Unit
Sediment Input at Hwy 83	142,000	tons/yr
Sediment Out at UPRR	130,000	tons/yr
Sediment Deposition between Hwy 83 and UPRR	9,600	yd^3/yr

Notes:
[1] Material density assumed to be 1.3 tons/yd^3

Several dredging alternatives have been simulated by the ED Office to determine the optimal location and depth of dredging. General observations of dredging approaches are:

- Dredging should occur in the main channel, and not on side channels. Dredging of side channels results in decreased flow velocity (and sediment transport capacity) in the main channel without any reduction in sediment load. The result would be sediment deposition and decreased capacity in the main channel.
- Dredging the main channel between Highway 83 and the UPRR Bridge (about 2 miles) would maximize the longevity of increased capacity.
- The longevity of 3,000+ cfs capacity increases with volume of dredged material (Table 3), because of a decrease in water surface elevation (WSE) corresponding to the lower channel bottom. Larger dredge volume also results in a larger area available for sediment to fill in without a substantial increase in WSE.
- Uniform channel width would provide slightly greater longevity of 3,000+ cfs capacity (e.g., jetties to maintain 150' width, or bank dredging narrow areas to 300' width) as a result of uniform sediment transport capacity, but the cost may outweigh the benefits.

Table 3. Dredging Alternative Summary

Alternative	3,000 cfs Longevity (years)		Dredge Volume (yd^3)	Cost[1] (millions)	Ratio of Cost/Yrs Longevity[2]
	6.0' Flood Stage	6.5' Flood Stage			
A: existing variable width, dredge 1.25' Hwy 83 to UPRR, existing slope	3.0	8+	112,000	$0.78	$0.26M/yr
B: 150' channel, dredge 1.25-3 feet Hwy 83 to UPRR, uniform slope	3.7	8+	151,000	$1.1	$0.29M/yr
C: 300' channel, dredge 1.25' Hwy 83 to UPRR, existing slope	5.4	8+	230,000	$1.6	$0.30M/yr

Notes:
[1] Dredge cost estimate assumes $5 per yd^3 for dredging, plus $2 per yd^3 to haul away material. Based on CNPPID's dredging cost of $4 per yd^3 with a 25 percent markup, plus an additional $2 per yd^3 to haul off material.
[2] Millions of dollars per years of 3,000+ cfs capacity at 6.0' minor flood stage.

The WAC and/or GC needs to determine:

1. What cost is reasonable and achievable considering Program funding limitations? Cost of dredging would be +/- $1 million, and may need to be repeated periodically to maintain capacity.
2. What longevity of 3,000+ cfs capacity at minor flood stage is necessary to provide a long enough time period to test Program hypotheses related to target flows and SDHFs?

Dredging methods practical for the area between Highway 83 and the UPRR Bridge will influence the feasibility and cost of dredging (Table 4). The estimated $1 million dredging cost was estimated assuming dredging would be completed with a floating barge similar to CNPPID's operation at the Tri-County Diversion (TCD). However, shallow water (i.e., 1 to 1.25 feet for flows of up to 700 cfs outside of irrigation season) may be suitable for some approaches but not for others. The most feasible approaches are likely the portable pump dredge and potentially dewatering followed by material excavation via trackhoe or hydraulic scraper.

Table 4. Potential Dredging Approaches for the North Platte River

Dredging Approach	Advantage	Disadvantage
Floating barge similar to CNPPID at TCD	High capacity	Not feasible in shallow water found downstream of Hwy 83
Drag lines	High capacity	High cost; access issues
Dewater and dozers	Low cost	Not feasible to push wet/heavy sediment up and out of channel
Dewater and trackhoe	Low cost, efficient in NP conditions	Access issues
Dewater and hydraulic scraper pulled by tracked cat	Low cost, efficient in NP conditions	Access issues
Portable pump dredge	Efficient in NP conditions, limited access issues	Shallow water limitations??

4. Install Sediment Collector(s)

Sediment collector(s) could be installed to remove a portion of the North Platte River sediment load that has led to deposition and reduced hydraulic capacity over time. Sediment collectors are a potentially more sustainable alternative to dredging, because if designed properly they will prevent the need for repeated dredging operations. A demonstration project is currently underway on Fountain Creek north of Pueblo, Colorado. The Fountain Creek demonstration project has largely been successful, but the question remains whether a sediment collector would be feasible for the width and sediment properties of the North Platte River (Table 5).

Table 5. Channel and Sediment Load Comparison for Fountain Creek and North Platte River

Location	Channel Width (ft)	Sediment Load (tons/yr)	Sediment Load (yd^3/yr)	Bed Material Sediment Size (mm) D16	D50	D84	Flow[1] (cfs)
Fountain Creek near Pueblo	90-130	148,000[2]	NC[3]	1.1	2.7	7.0	210
North Platte River near Hwy 83	150-300	142,000[4]	109,000[4]	0.28	0.6	1.7	620

Notes:

[1] Average flow based on last 25 years of flow data (1986 to 2011).

[2] Source: Strategic Plan for Fountain Creek Watershed. Fountain Creek Vision Task Force. March 10, 2009. www.fountain-crk.org.

[3] Not calculated because density of Fountain Creek material is unknown.

[4] Based on sediment transport model simulation.

Streamside Systems, the manufacturer of the Fountain Creek sediment collector, recommends a two step approach for assessing the feasibility of a North Platte sediment collector:

1. Collect bedload samples over a short time frame (e.g., one week) with a small flume (2 to 4 feet in width) to determine actual bedload. This information would be useful in design of a large-scale sediment collector for the following step, and would also be useful data for refining the Program's existing North Platte sediment transport model. Cost estimate for this step would be about $7,000.
2. Design and implement a demonstration project based on bedload data from Step 1. Cost estimate for this step is hard to estimate with precision until Step 1 is completed, but may be approximately $800k for a one-year demonstration project based on costs for the project on Fountain Creek (i.e., $500k for installation, and $300k for O&M including material haul-off).

The ED Office recommends not proceeding with either of the above steps until the other engineering options have been exhausted. The primary reasoning for this recommendation is that there is more uncertainty regarding the outcome of a sediment collector than the previous options discussed, yet the costs for the alternatives are similar. While Step 1 above (bedload sampling with small flume) may provide some useful information, the utility of the bedload data may be limited based on the applicability for only one location and one flow rate.

SUMMARY AND REQUESTED WORKGROUP INPUT

The Program's ability to fully utilize Environmental Account water for target flow releases and SDHFs is limited by the current flood stage at North Platte (6.0 feet minor flood stage) with equivalent capacity of 1,560 cfs. The WAC recently supported spending $150k of approved 2012 budget to complete three flood-proofing projects. NWS has indicated the possibility of increasing flood stage if flood-proofing projects are demonstrated to reduce flood impacts. A rise in flood stage to 6.5 feet would result in flood stage capacity of 2,380 cfs. Workgroup review is requested for the attached RFP for flood-proofing projects engineering/surveying/permitting. The RFP will be presented to the FC at their June 28, 2012 meeting, pending support by the choke point workgroup.

Engineering options would be costly, but are the only way to fully achieve the Program objective of 3,000 cfs flood stage capacity. North Platte River capacity has decreased over time as a result of deposition that has filled in the existing channel. Dredging and/or sediment collector(s) would increase channel capacity by removing material from the main channel. However, the longevity of these alternatives is uncertain and additional maintenance may be needed to maintain 3,000+ cfs capacity. Additional NPPD or CNPPID capacity was previously considered in the Program's WMS, and these alternatives were screened out at least in the context of large capacities for re-regulating storage. However, it may be worthwhile to reconsider these alternatives, at least to the extent that a small amount of additional capacity could be achieved using existing infrastructure.

Workgroup input is requested on the path forward. It is assumed the Program will complete the flood-proofing projects and work to demonstrate benefits to the NWS. Although benefits of flood-proofing projects may not be realized for up to a few years, the ED Office recommends initiation of engineering/permitting for preferred engineering option(s) immediately. Workgroup input is requested regarding:

1. What combinations of engineering alternatives should be considered in detail?
2. Is additional storage available on NPPD or CNPPID systems?
3. Are the assumptions in the 2009 Flow Routing Spreadsheet appropriate? Is there any potential for improvements that would result in increased capacities in the NPPD or CNPPID systems?
4. What dredging methods are most appropriate for the North Platte River conditions, and is there available dredging cost information available to refine the dredging cost estimate?
5. Should the Program issue an RFP to develop design-level costs estimates for engineering approaches for achieving the Program-targeted 3,000 cfs capacity? If so, which engineering alternative(s) should be designed/permitted?