TO: CHOKE POINT WORKGROUP
FROM: EXECUTIVE DIRECTOR'S OFFICE
SUBJECT: FURTHER DETAIL ON INSTITUTIONAL AND ENGINEERING OPTIONS
DATE: JULY 19, 2012

INTRODUCTION

The Choke Point workgroup met June 20th to discuss an RFP for flood-proofing projects, and institutional/engineering approaches for achieving the Program goal of 3,000 cfs capacity at North Platte River (NPR) flood stage. The purpose of this memorandum is to provide an update on these activities and further information that has been developed.

The ED Office issued an RFP on June 28th to request proposals for engineering, surveying, and permitting of flood-proofing projects, and proposals are to be submitted to the Program by July 19th. This workgroup will meet at the end of July or early August to score the proposals and select a contractor by early August.

During the June 20th workgroup meeting, the workgroup narrowed down the list of institutional and engineering alternatives to consider. The workgroup identified the following approaches for further consideration:

1. Remove properties that are damaged at high flow:
    a. Buyout of properties that are affected by flooding
    b. Flood easements for properties that are affected by flooding
2. Route water around the North Platte choke point area to minimize flooding
    a. Additional NPPD system storage and/or return capacity to the NPR
    b. New infrastructure to convey water around the choke point from the NPR to the South Platte River (SPR)
3. Modify the North Platte River channel to reduce flood impacts
    a. Reduced main channel dredging with hydraulic control structures (e.g., bendway weir) to maintain high velocity flow at range of flows for a longer term solution than dredging alone

This memorandum provides additional detail collected since the June 20th workgroup meeting regarding the workgroup supported institutional and engineering alternatives. Rough order-of-magnitude cost estimates were developed or refined for each of the alternatives. Although the cost estimates can be used for an initial cost comparison, final determination to exclude/include an alternative for further consideration should not be made solely based on the current cost estimates. During the July 26th workgroup call, we will discuss whether the workgroup can make a recommendation at the August 14th WAC meeting regarding engineering options to push forward for detailed study.

PROPERTY BUYOUTS AND EASEMENTS

Previously for the May 2012 WAC meeting, the extent of property buyouts was roughly estimated based on 2011 anecdotal flooding impacts. The high cost for buyouts reported at the May WAC meeting, the potential additional costs for removal of structures, and the questionable seller willingness led the ED

Office to doubt the feasibility of property buyouts. However, the workgroup requested a more detailed evaluation of buyouts during the June 20th workgroup call so that a cost comparison with other engineering alternatives could be made using costs of roughly equivalent accuracy.

The first step in a more detailed estimate for buyouts and easements is to estimate the area of flood impacts between the existing 6.0' flood stage and 3,000 cfs. The second step is to identify combinations of buyouts and/or easements that are feasible within the flood impacts area.

Step 1 (identify flood impact area)

The primary area of flooding impacts at 3,000 cfs is the residential area along North River Road between Highway 83 and Washboard Road, and the largely undeveloped area between North River Road and the North Platte River, based on the following:

- Anecdotal impacts of 2011 flooding indicate that water was close to North River Road residences and in crawl spaces at a 6.5-foot stage.
- Hydraulic modeling indicated ground water levels would begin to come to the surface at residences along the south side of North River Road at 6.5-foot stage, and that water levels would be at or near the surface for a larger residential area along the south side of North River Road for flows of 3,000 cfs (6.8-ft stage).

Flood-proofing projects were optimistically assumed to reduce flood impacts for properties along the north and south side of North River Road (Whitehorse Creek Drainage and State Channel projects), and for the property east of Highway 83 and directly north of the river (Gravel Pond Outlet project). Based on the information above, the extent of flood impacts for flows above flood stage with and without flood-proofing projects was estimated as shown in Figure 1. NWS flood stage is based on property damage and public threat, with the highest potential to occur in developed areas. The delineation of primary vs. secondary flood impacts shown in Figure 1 was used to determine areas for the various buyout and easement scenarios described below.

Step 2 (buyouts and easements combinations)

Program land acquisition is based on a willing seller/buyer assumption. The ability to buy out properties and obtain easements will vary depending on interest of current owners. Thus separate buyouts and easements alternatives are identified first, and a combination buyouts and easements alternative is also considered. Assumptions for each approach are described below, and cost estimates for alternatives are summarized below.

Buyouts assumptions:

- Cost estimates for property buyouts were assumed to be 120% of 2011 Lincoln County Assessor total property values (land, structures, and improvements).
- Structure demolition on buyout properties was assumed to be $7,500 per structure.
- The buyouts only alternative was considered for the primary impacts areas shown in Figure 1.
- The buyouts process would be:

- Negotiate option to purchase property and complete purchase when enough properties are secured to cover primary flood impacts area.
- Demolish or sell and move existing structures (note that the cost of selling and moving structures would likely be higher than the cost to demolish them, but the cost to demolish structures was included in this alternative).

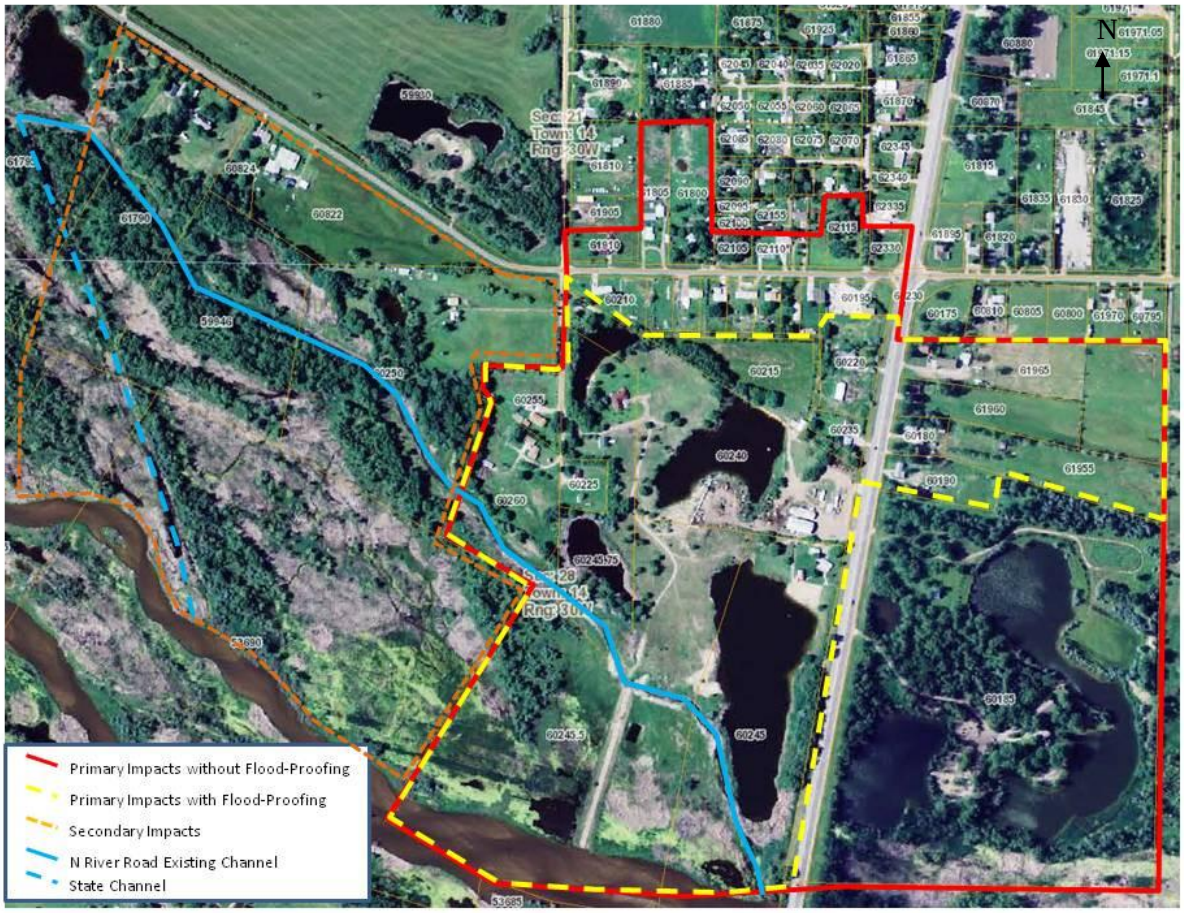

Figure 1. Extent of Flood Impacts with and without Flood-Proofing Projects

Easements assumptions:

- Flood easement cost assumed to be $2,000/acre (typical cost for accretion ground easements in Central Platte Valley)
- Structure demolition on easement properties was assumed to be $7,500 per structure.
- Easement only area was considered for both the primary and secondary flood impacts areas in Figure 1.
- Easements process would be:
  - Negotiate option for flood easement and complete easement when easements for enough properties are secured to cover primary and secondary flood impacts area (Figure 1).

- PRRIP purchase existing structures at assessed values for easement properties with structures.
- PRRIP demolish or sell and move existing structures (note that the cost of selling and moving structures would likely be higher than the cost to demolish them, but the cost to demolish structures was included in this alternative).
- Owners reserve the right to record title, control public access, control subsurface mineral rights (provided access is from outside of the easement area), and right to undeveloped recreational use.

Cost estimates are presented in Table 1 for buyouts only, easements only, and a combination of buyouts and easements. Figure 2 shows the most likely alternative, which would include a combination of buyouts for residential properties along North River Road and easements for the largely undeveloped areas between North River Road and the NPR. Easements were assumed to occur for the secondary impacts area shown in Figure 1, plus similar properties upstream approximately one-half mile as a conservative approach to preventing future flooding issues that could result in lowering of flood stage.

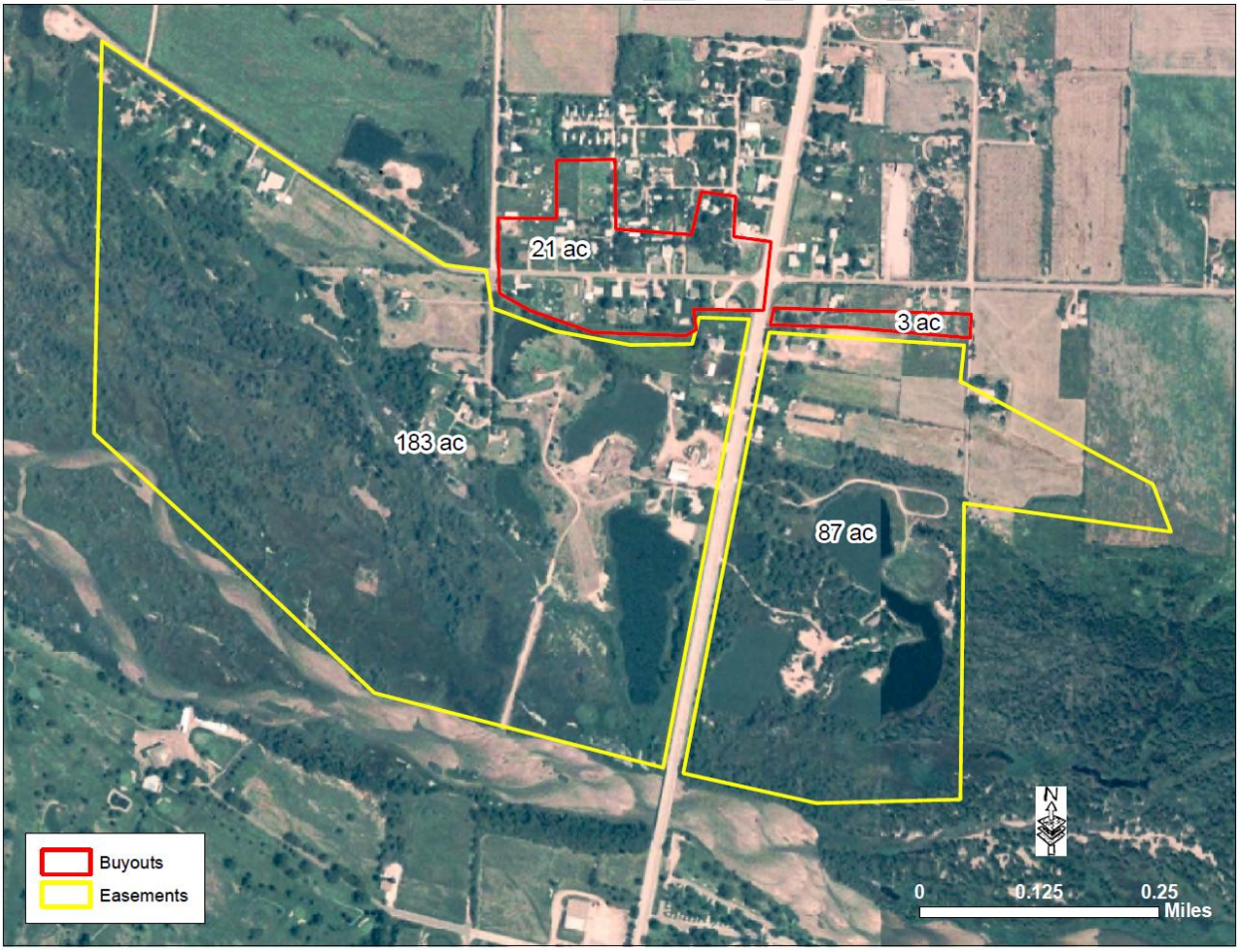

Figure 2. Buyouts and Easements Combination Alternative

Table 1. Preliminary Cost Estimates for Property Buyouts and Easements

Scenario	# Landowners	Buyout/Easement Cost	Demolition Cost	Total Cost
BUYOUTS FOR PRIMARY FLOOD IMPACTS AREA[1]				
Without Flood-Proofing	33	$4.1M	$200,000	$4.3M
With Flood-Proofing	13	$1.8M	$75,000	$1.9M
EASEMENTS FOR PRIMARY AND SECONDARY FLOOD IMPACTS AREA[1]				
Without Flood-Proofing	37	$3.5M	$200,000	$3.7M
With Flood-Proofing	19	$1.8M	$83,000	$1.9M
BUYOUTS AND EASEMENTS FOR PRIMARY AND SECONDARY FLOOD IMPACTS AREA[1]				
Without Flood-Proofing	37	$3.9M	$200,000	$4.1M
With Flood-Proofing	19	$1.8M	$83,000	$1.9M

[1] Primary flood impacts areas are the red and yellow areas in Figure 1. Secondary flood impacts area is the orange area in Figure 1.

INFRASTRUCTURE TO CONVEY WATER AROUND CHOKE POINT FROM NPR TO SPR

A portion of flow in excess of flood stage capacity could be conveyed around the choke point from the NPR to the SPR using a combination of existing/new regulating storage in NPPD's system, a new pipeline, and existing canals. The ED Office has completed an initial inventory of potential infrastructure options, and considerations for each of the options are described below.

Existing or New Regulating Storage in NPPD's System

The ED Office met with NPPD to discuss potential options to utilize existing and/or new storage on NPPD's system for Program regulating storage. Additional regulating storage could provide the following benefits:

- Program benefits – additional capacity to make up for lack of NPR capacity, and ability to store excess SPR flows for future releases for both SDHF and target flows.
- NPPD benefits – additional hydropower revenue, and system redundancy in case of emergency shutdown of the North Platte hydropower return.
- TPNRD benefits – water stored for subsequent release to offset post-1997 depletions.

Existing operating capacities in NPPD's system are primarily 1,800 cfs between Sutherland Reservoir and the North Platte hydropower return (Figure 3). Operating capacity is based on operation of two 900 cfs hydropower turbines, but the system was originally designed with the potential of installing a third turbine. Although design capacity is 2,700 cfs for some sections of NPPD's system, issues such as a seepage and stability prevent increasing NPPD's return capacity beyond current operating capacity of 1,800 cfs.

A new 1,400 cfs capacity return to the SPR and/or significant improvements to NPPD's system would be needed to increase return capacity to the SPR to the amount needed to make up the difference between the Program's 3,000 cfs objective for the NPR and the current 1,600 cfs flow at minor flood stage in North Platte. Due to system capacity constraints upstream of Sutherland reservoir, in addition to a new SPR return, approximately 9,000 AF of additional regulating storage would be needed to provide three days of Program flow at a rate of 1,400 cfs for SDHF releases.

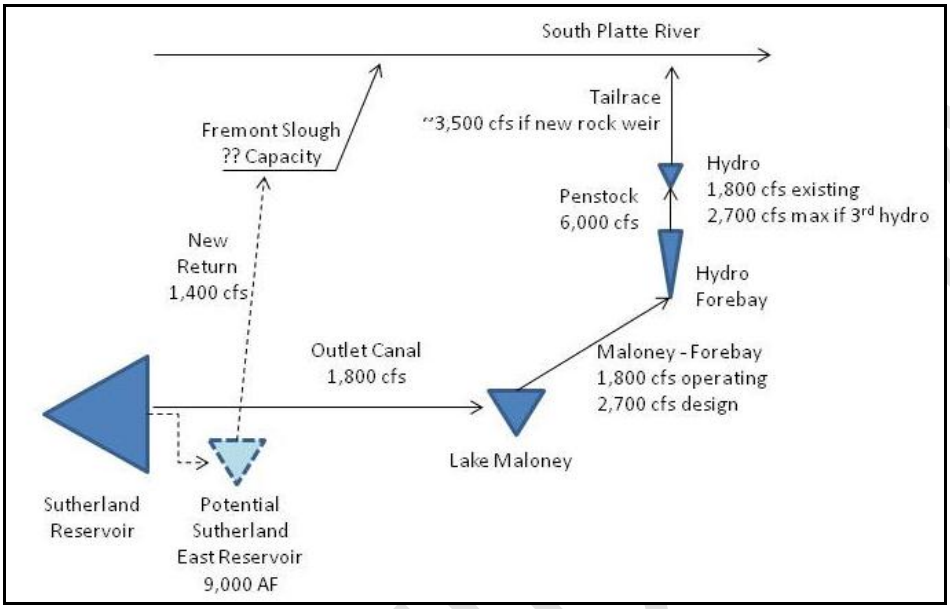

Figure 3. NPPD System Capacities

The ED Office and NPPD discussed several options for additional regulating storage on their system, and the pros/cons of each option are summarized in Table 2. Based on an initial discussion of options, a combination of East Sutherland Reservoir and a new SPR return may be the most feasible option. However, the time needed to complete such a reservoir will likely be at least 5 years and may be more of a long-term solution to the choke point issue. Preliminary cost estimates for Sutherland East Reservoir and a new SPR return to the Fremont Slough would be about $40 to $50M (Table 3). If this alternative moves forward, an initial step would be hiring a contractor to update the feasibility study of the Sutherland East Reservoir and a new SPR return.

Table 2. Options for NPPD System Expansion

Option	Pros/Cons
East Sutherland Reservoir regulating storage	Pro: benefits to PRRIP, NPPD, and TPNRD Con: time-consuming to construct
New SPR return from near Sutherland Reservoir	Pro: benefits to PRRIP, NPPD, and TPNRD Con: need additional study
Sutherland Reservoir regulating storage	Con: require costly lining to address seepage (~$200M-$400M)[1]
Expand outlet canal between Sutherland Reservoir and Lake Maloney	Con: seepage and core bank issues with any increased capacity
New hydro bypass for total SPR return of 3,500 cfs	Con: need additional study to determine feasibility

Notes:
[1] Based on NPPD 1993 Water Resource Utilization Study, and indexed to 2012 cost based on Bureau of Reclamation construction cost indices.

Table 3. Cost Estimate for NPPD Storage and New SPR Return

Item	Cost[1]
Sutherland East Reservoir (7,500 AF)	$45.0M
Sutherland East Reservoir (12,500 AF)	$54.3M
New SPR Return via Fremont Slough	$10M

Notes:
[1] Sutherland East Reservoir cost estimates based on NPPD 1993 Water Resource Utilization Study, and indexed to 2012 cost based on Bureau of Reclamation construction cost indices. Cost estimate for new SPR return based on ballpark estimate discussed on June 20, 2012 choke point workgroup call.

Existing Canals from NPR to SPR

NPR flows could be diverted to the SPR outside of the May to August irrigation season using existing canals that divert from the NPR and return or waste to the SPR. Ditch riders for each of the three canals in Table 4 were contacted by the ED Office to determine ditch capacities and to identify improvements that would be needed to run Program water. Ditch riders were receptive to the idea of running Program water before irrigation season, and thought wetting the canals earlier in the season may even be beneficial for flushing debris and sediment from canals before irrigation deliveries begin. The ED Office also discussed the need to meet with each of the canal board of directors for further consideration and eventual approval for running Program water through the canals. Locations of each of the canals are identified in Figure 4.

Under existing conditions, approximately 190 cfs could be returned to the SPR using the three canals that waste/return to the SPR. This total could potentially be increased to about 350 cfs if approximately $50k of canal improvements were made as described in Table 4. Note that the $50k cost estimate for canal improvements is a placeholder that is in the process of being refined by the geomorphic advisor to the ED Office. Seepage losses between the NPR headgates and the SPR return would be approximately 30 to 40

percent of the amount diverted (Table 5). Diversions from the NPR to SPR through existing irrigation canals would provide a small chunk of water towards the Program objective, but would not be a complete choke point solution without additional means of increasing capacity through the NPR.

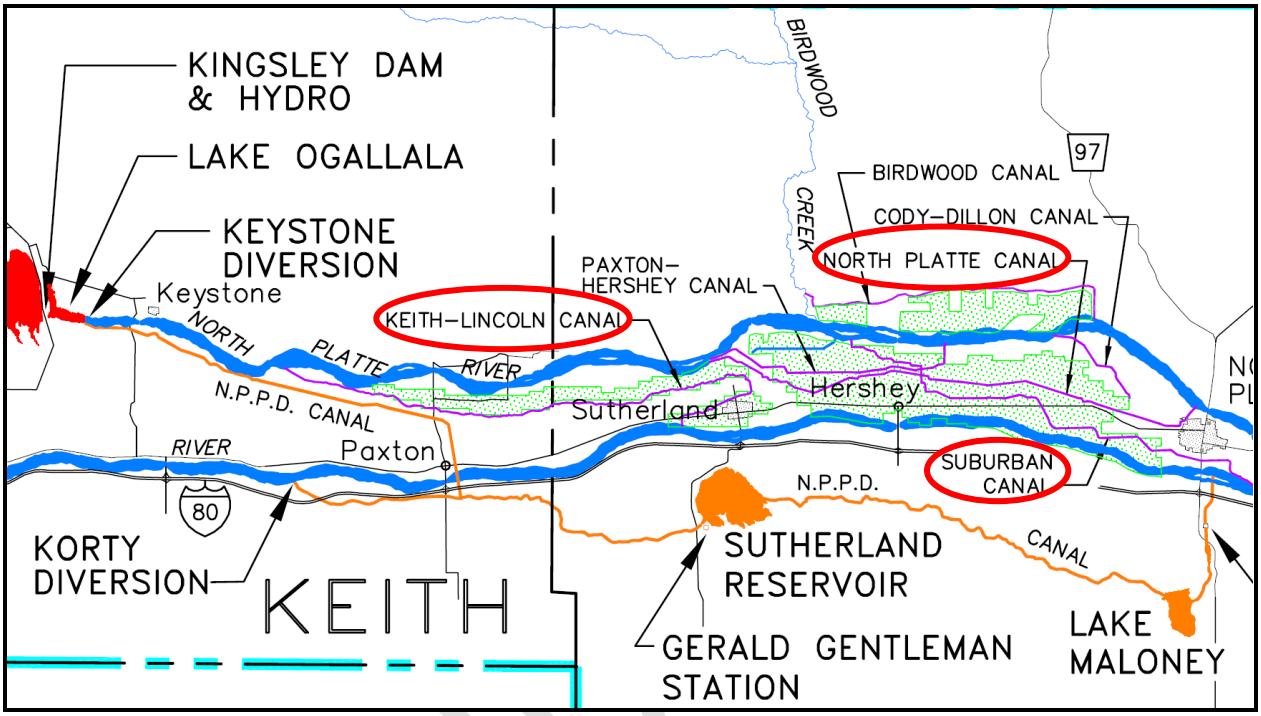

Figure 4. North Platte River Canals (from CNPPID Map) (Red Circles Indicate Canals with SPR Returns)

Table 4. Information for Canals that Divert from NPR and Return or Waste to SPR

Canal	Length to SPR	Diversion Capacity	Approx. Return Capacity at SPR	Improvements
Keith-Lincoln Co Canal	29 mi	85 cfs	35-45 cfs	Minor vegetation clearing
North Platte Canal	• 4.6 mi main • 1.2 mi new turnout • 3.2 mi existing wasteway	300 cfs	• 80-100 cfs using existing SPR wasteway • 250 cfs with improved SPR wasteway	Enlarge 2.3-mi of existing SPR wasteway ($50,000[1])
Suburban Canal	22 mi	120 cfs	60 cfs	None

Notes:
[1] $50k for SPR wasteway enlargement is a placeholder, and is in the process of being refined by the geomorphic advisor to the ED Office.

Table 5. NPR Canal Diversions and Returns

Scenario	Approximate Rate (cfs)		
	Diversion	Loss	SPR Return
Existing with no Improvements	335	145	190
Potential with Improvements	505	155	350

New Pipeline from NPR to SPR

Water could be conveyed in a pipeline from the NPR to the SPR near Sutherland or Hershey. Headgate wells would be needed to pump water from the alluvium and over the elevation divide between the NPR and SPR.

Several alternative pipeline routes between Sutherland and North Platte were considered that would a) minimize pipe length, b) minimize elevation gain along the route, and c) utilize an existing right-of-way. The optimal pipe route based on the above criteria was determined to be east of Sutherland along North Game Trail Road, and would include a 3.5-mile pipe with a total elevation gain of 14 feet (Figure 5). The pipe would need to be tunneled under Highway 30 approximately three miles east of Hershey.

Assuming installation of 10 headgate wells with a pumping capacity of 1,000 gpm per well, total flow rate would be limited to 10,000 gpm (22 cfs). An 18-inch diameter pipe would accommodate a flow rate of 22 cfs, assuming a maximum velocity of 15 fps. Total cost of wells and pipe would be about $1.5M ($750k for well installation, plus $750k for pipe cost). This cost does not include cost of tunneling under Highway 30 or pipe installation labor. Given the low potential flow rate and high cost, a pipeline from the NPR to SPR is likely not an alternative to pursue further.

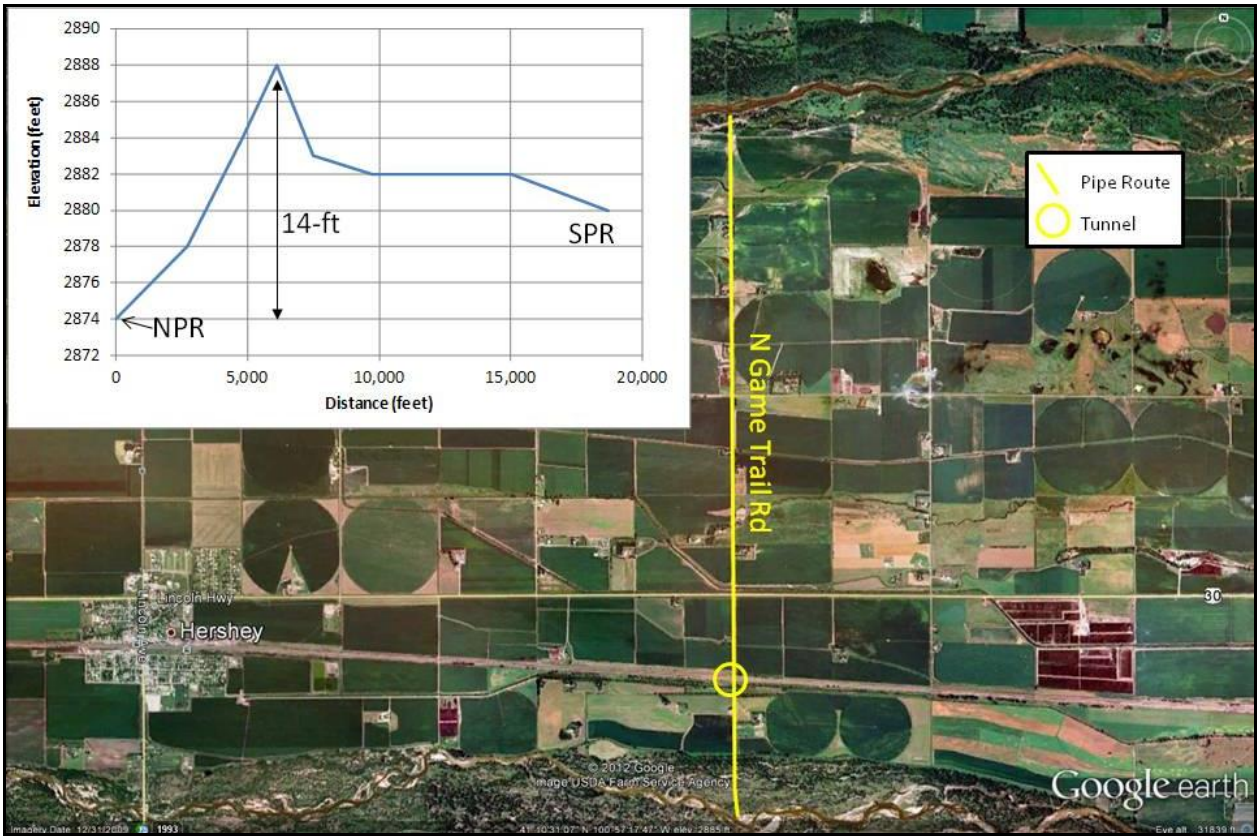

Figure 5. Hershey Pipeline Route Alternatives with Tunneling Locations Identified

REDUCED DREDGING WITH HYDRAULIC CONTROL STRUCTURES

Information on dredging amount, longevity, and cost were presented in the previous choke point workgroup memorandum dated June 10, 2012. Previous information indicated that dredging would lower the 3,000 cfs water surface elevation sufficiently to meet the objective of not exceeding the current 6-foot flood stage in North Platte. However, subsequent deposition would continue to occur after completion of dredging, making it necessary to periodically repeat dredging to maintain hydraulic capacity. Several dredging options were considered, and the option with the greatest longevity included dredging approximately 230,000 cubic yards of material between Highway 83 and the UPRR Bridge at an approximate cost of $1.6M. The workgroup asked the ED Office to consider reduced dredging alternatives with the addition of hydraulic structures such as bendway weirs (BWs) to potentially induce natural scour and increase longevity of a reduced dredging option.

Several approaches for jetties and/or BWs were modeled to determine the effectiveness at achieving and maintaining hydraulic capacity. The basic objective was to design structures to maximize flow velocity and sediment transport at low flows, but also minimize increases in water surface elevations (WSEL) at higher flows associated with the increased roughness of the structures. Anderson Consulting Engineers (ACE) and Chester Watson, Program advisors on geomorphology, completed an analysis of a range of jetty/BW designs for the ED Office (see attached ACE summary memorandum). The ED Office also discussed the potential application of BWs on the North Platte River with the consultant that is designing the BWs for the NE-WY Stateline flow measurement site. Highlights of the analysis are summarized below:

- Jetties/BWs increase velocity and sediment transport at low flows, but benefits at low flows are outweighed by the increased WSEL at high flows.
- Jetties/BWs without dredging would not achieve the Program goal of 3,000 cfs WSEL less than the current 6.0-foot flood stage. The result would be in an initial 0.6-foot increase in the 3,000 cfs WSEL, with subsequent scour that would reduce the 3,000 cfs WSEL to an apparent equilibrium value of about 6.8 feet. Note that this equilibrium value is equal to the current 3,000 cfs WSEL of 6.8 feet, and the end result of jetties/BWs would be equivalent to current conditions.
- Jetties/BWs combined with previously considered optimal dredging options do not increase the longevity of 3,000 cfs WSEL below 6.0 feet. In fact, the rate of increase in flood stage following dredging is approximately equal with or without jetties/BWs.
- Jetties/BWs are appropriate for reducing bank erosion on the outside bend of a stream (e.g., the application at the NE-WY Stateline flow measurement site). But model results and input from the NE-WY Stateline BWs consultant indicate that jetties/BWs are not appropriate for our objective of increasing NPR sediment transport capacity and inducing scour.

CONCLUSIONS AND REQUESTED WORKGROUP INPUT

Several institutional and engineering options were considered that could increase the Program's ability to utilize its water supply in the EA. Additional capacity provided by each alternative, and a summary cost estimates are provided in Table 6.

Table 6. Cost Estimate Summary for Institutional and Engineering Alternatives

Alternative	Additional Capacity	Cost Estimate
BUYOUTS/EASEMENTS COMBINATION (most likely of buyout/easement options)		
Without Flood-Proofing	1,400 cfs	$4.1M
With Flood-Proofing	600 cfs	$1.9M
ENGINEERING ALTERNATIVES		
Sutherland East Reservoir and New SPR Return	1,400 cfs	$40M-50M
Existing Canals from NPR to SPR	190-350 cfs	$0-$50,000[1]
New Pipeline from NPR to SPR	22 cfs	$1.5M
Dredging	1,400+ cfs for 3-5 yrs	$0.8M-$1.5M

Notes:

[1] $50k for SPR wasteway enlargement is a placeholder, and is in the process of being refined by the geomorphic advisor to the ED Office.

The following summarizes the pros and cons of the alternatives under current consideration for increasing choke point capacity:

- Use of existing canals from NPR to SPR should be explored further and implemented where possible, since this appears to be a low cost option. However, use of existing canals will only get us a small step closer to the Program's goal of 3,000 cfs capacity.
- A short-term solution involving channel modification (e.g., dredging or potentially installation of flood levees in key areas) may be the only way to achieve the full Program goal of 3,000 cfs capacity within the First Increment. HDR (Evaluation of Alternatives for Improvements in Carrying Capacity of the North Platte River at North Platte, 2011) determined that flood levees near Cody Park would be ineffective at reducing flood impacts up to 3,000 cfs. However, the ED Office and Anderson Consulting are currently considering other locations for levees that may be more effective at reducing flood impacts that drive NWS flood stage. The ED Office will provide an initial report on effectiveness of levees during the next workgroup call.
- Sutherland East Reservoir and a new SPR return would provide benefits to the Program, NPPD, and TPNRD. However, the high cost and long timeline for this alternative make this a long-term solution at best (e.g., towards the end of the First Increment).
- Property buyouts and/or easements would reduce flood impacts to structures, but the success of buyouts/easements is dependent on willingness of property owners to participate. Flood stage could only be increased if all potentially affected property owners sold or granted an easement. There is a low likelihood of all owners willing to sell or enter into easements, and as a result this alternative should not be considered further.

- A new pipeline from the NPR to SPR would provide minimal additional capacity at a high cost, and as a result should not be considered further.

The ED Office recommends the following approach for proceeding with choke point capacity issues, and requests workgroup input on the approach.

1. Move forward with exploring the use of existing canals from NPR to SPR. This will include meeting with the boards for each of the canals to determine whether they would be interested in cooperating and what Program efforts/funds would be needed (if any).
2. Some form of channel modification (e.g., dredging or flood levees) may be the only short-term solution. The ED Office and Anderson Consulting will provide an initial summary of thoughts on flood levees during the next workgroup call. Once levee results are discussed with the workgroup, the workgroup will need to decide whether dredging or levees are technically feasible enough to request input from the WAC and Governance Committee (GC) to gauge the level of support for such a major undertaking. Further details needed for this workgroup decision are: a) how effective would channel modification be on flood stage and flood prevention, b) what methods would be practicable for implementing the modification on the North Platte River, and c) based on practicable methods, what would approximate costs be?
3. Further explore the concept of using Sutherland East Reservoir and a new SPR return to route water around the choke point. NPPD may include Sutherland East in their upcoming internal statewide hydropower study, but the timing of this study is unknown. Additionally, the Program, NPPD, and TPNRD should start to consider timing and specifics for a future feasibility study of this option. This would provide the Program with a long-term choke point solution.