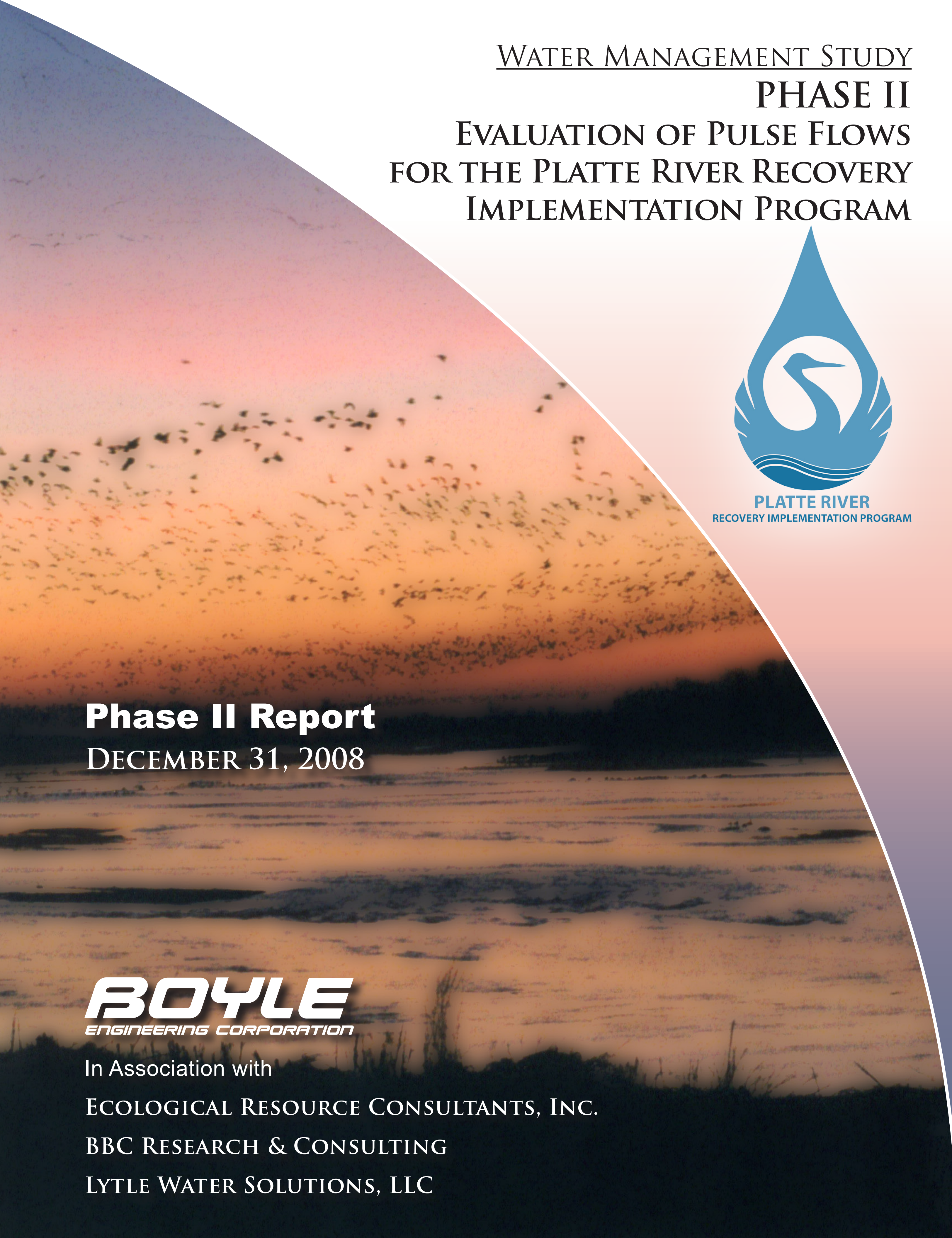
Water Management Study

PHASE II

Evaluation of Pulse Flows for the Platte River Recovery Implementation Program

PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM



Phase II Report

December 31, 2008

BOYLE
ENGINEERING CORPORATION

In Association with

Ecological Resource Consultants, Inc.

BBC Research & Consulting

Lytle Water Solutions, LLC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

EXECUTIVE SUMMARY

Introduction and Background

Among its many responsibilities, the Platte River Recovery Implementation Program (PRRIP or Program) develops and manages water supplies and acquires and improves associated habitat to help assure the survival of four threatened and endangered species along the Platte River corridor in central Nebraska. Supporting the Program is its on-going Water Management Study (WMS), for which Phase II results are presented in this report. The WMS complies with Program requirements and complements previous environmental studies that identify specific Platte River flow regimes needed for recovery of the four species.

The PRRIP is being conducted under an Adaptive Management process which incrementally tests hypotheses, measures habitat and species response and is periodically adapted by the PRRIP Governance Committee and Program participants (federal agencies, the States of Colorado, Nebraska, and Wyoming water users, environmental interests, and other stakeholders). The following flow objectives are set in the Program documents and through Governance Committee direction:

For purposes of the WMS and this report, three flow objectives are defined as follows:

- *WMS Pulse Flow Target*: Ability to deliver 5,000 cfs of Program water in addition to other non-Program flows for a duration of three days at the Overton gage during the period of lower demands, typically from September 1 through May 31.
- *WMS Irrigation Season Flow Target*: Up to 800 cfs of Program water to supplement other non-Program flows to achieve a total of 800 cfs at the Overton gage during the irrigation season, May 1 through September 15. (Note: This definition was revised for Phase II to include Program water as supplemental flow to existing flows at Overton per comments to the Phase I Report by Program participants.)
- *Average Annual Target Flows*: Reductions in shortages to Program target flows as summarized in Appendix E of Attachment 5, Section 11 of the Water Plan Reference Materials (page 34), totaling 130,000 to 150,000 ac-ft per year on average. These contributions are evaluated at Grand Island, NE.

Phase I of the WMS evaluated the ability of the existing river and irrigation/hydropower systems to be operated to achieve the WMS Pulse Flow Target (5,000 cfs) and WMS Irrigation Season Flow Target (800 cfs). These flow objectives have evolved from Phase I to refine the analysis and the focus of the Phase II evaluation. Phase II focused on the ability to provide 5,000 cfs of Program water for the Pulse Flow. It did not evaluate occurrences of combined flows greater than 6,000 cfs as was conducted in Phase I. This is to assure the ability to provide 5,000 cfs of Program water every year. The Irrigation Season Flow Target now includes only the amount of Program water necessary to supplement other flows to achieve a total flow of 800 cfs at Overton. This change in the target lessened the required total volume of Program water.

Phase I concluded that storage near the associated habitat is needed to help achieve the pulse flow objectives based on upstream capacity constraints in the Platte River and the availability of conveyance and storage capacity in the Nebraska Public Power District (NPPD) and Central Nebraska Public Power and Irrigation District (CNPPID) systems. Conclusions from the Phase I analysis are presented in the following text box for the convenience of the reader. This text is reproduced from the Phase I Report with minor editorial changes.

Conclusions from Phase I of the WMS

Phase I of the WMS evaluated the ability to provide pulse flows of 5,000 cfs of Program water (during low-use periods) and deliveries of 800 cfs of Program water (during the irrigation season) on the Platte River to the gage at Overton, NE. The occurrences of total flow greater than 6,000 cfs were also evaluated. Environmental Account (EA) releases from Lake McConaughy and managed return flows from the Tamarack I Project on the South Platte River in Colorado comprised the sources of Program water. Flow capacities of the Districts' systems and in the North Platte River constrain the delivery of Program water to achieve the target flows. The North Platte River capacity at the choke point was assumed to have been improved to 3,000 cfs for this evaluation. The 5,000 cfs target for Program water is met in some years for a single day, but not for the preferred three day duration. The 800 cfs target flow could be met on most days, but would require a significant volume of Program water (more than 200,000 to 240,000 ac-ft at Overton depending on the definition of the target period). *Subsequent to the completion of the Phase I analysis, the irrigation season target flow definition was refined with the input of Program participants. The 800 cfs target represents a total flow in the river at Overton from May 1 through September 15, and the required volume of Program water is the amount needed to supplement other flow in the river, up to 800 cfs. This revised definition was incorporated in the Phase II analysis. However, the Phase I analysis was not re-evaluated and the results therefore represent a flow of 800 cfs of Program water.*

The thirteen projects identified in the Water Action Plan and the potential of each to contribute to the flow targets were also characterized as part of Phase I. Results from the routing analyses demonstrate that to be effective in meeting the pulse flow targets, the water from these projects will need to be managed either in Lake McConaughy or with other existing or new storage facilities near the associated habitats.

The following details the specifics of these conclusions:

- 5,000 cfs Program water - Case I (Districts divert Program water):
  - Pulse flows of 5,000 cfs of Program water can be achieved about every 1 in 3 years, but only for one day of the three day target duration. The 5,000 cfs is not achieved in any of the Wet years of the study period.
  - The required volume of EA water necessary to be released from Lake McConaughy (from the current and potential projects) is significant for each water year classification in Case I. The average release of EA water is approximately 72,000 ac-ft in Wet years to nearly 100,000 ac-ft in Dry years to achieve average peak Program water flows ranging from 3,800 cfs to 5,200 cfs for one day.
  - Shortages to the 5,000 cfs target flow occur for various reasons for Case I, including:
    - North Platte River capacity at North Platte
    - Capacity and ramping rates of the Keystone Diversion, capacity in Sutherland Canal, and capacity and ramping rates at the North Platte Hydro Return
    - Regulating capacity in Johnson Lake, both volume and time of year per the "EA Bypass Agreement"
- 5,000 cfs Program water - Case II (Districts Bypass):
  - The average peak flow of Program water reaching Overton is 2,500 cfs for Average, Wet, and Dry years. The average volume for the 3 day pulse flow is approximately 14,500 ac-ft, approximately half of the target three-day volume.
  - The required volume of EA releases range from 41,000 ac-ft in average years to 46,300 ac-ft in wet years.
  - The constraint to target flows in Case II is the choke point capacity on the North Platte River at North Platte.

Conclusions from Phase I cont'd

- 6,000 cfs for 3 days at Overton:
    - Flows in excess of 6,000 cfs occur for durations of 3 days or more approximately 1 in 3 years, in contrast to the goal of 2 in 3 years.
    - On occasion, EA water contributes to the flow in excess of 6,000 cfs. However, the flow is never entirely EA water. Most occurrences of these target flows are a result of historical flows.
- 800 cfs Program Water - Cases I and II:
    - The 800 cfs of Program water for May-September is achievable on most days for each year type assuming there were to be adequate EA water in storage at the start of each year. The 800 cfs flow target equates to a volume of Program water of about 200,000 to 240,000 ac-ft per season, depending on the duration (given either a May 1 or May 11 start date through September 15 or September 30). Releases from Lake McConaughy, in an attempt to meet this target, range from about 280,000 ac-ft in Wet years (Case II), to about 580,000 ac-ft in Dry years (Case II), when losses are highest. Part of the flow target is met by yields of the Tamarack I project on the South Platte, but these are small compared to the required release from Lake McConaughy.
    - Shortages occur on individual days due to system capacity constraints. Shortages are typically a result of:
        - North Platte River capacity at North Platte
        - North Platte River below Keystone ramping limitation
        - Capacity and ramping rates of the Keystone Diversion, capacity in Sutherland Canal, and capacity and ramping rates at the North Platte Hydro Return
- Assessment of the 13 Water Action Plan Projects:
    - The maximum flow rate that could result if all thirteen of these Projects were on-line simultaneously and operating under perfect conditions is about 10,000 cfs or approximately double the target rate of 5,000 cfs.
    - If all thirteen Projects are used solely to meet the 800 cfs objective and there are no transit losses or flow constraints, the entire yield of the projects could contribute only about 210 cfs of the 800 cfs target (250 cfs if the effective period is May 11 to September 15).
    - Of the 13 Projects identified previously, up to 11 could provide flows manageable on a daily basis, if suitable arrangements can be made to deliver or exchange the project yield into either the EA or into new or existing storage along the CNPPID's system. Modeling results show that for these projects to be effective in meeting the timing of the pulse flow, the water will need to be managed either in Lake McConaughy or by other managed capacities to allow for a timed release.

Phase II of the WMS

The purpose of Phase II is to identify, screen, and evaluate the technical, cost, environmental, and institutional attributes of selected water storage projects that could contribute to the Program's flow objectives. Phase II aggressively moves the Program forward by characterizing the attractiveness of a relatively broad range in types of storage projects near the associated habitats. It was accomplished in a six month period from April to October 2008, in part by building on site-specific information for several of the alternatives previously developed by the Program participants, especially work performed by the U.S. Bureau of Reclamation and by the Central Nebraska Public Power and Irrigation District (CNPPID). Hydrologic analyses were efficiently developed using computer tools developed by Boyle in previous study phases. These include a flow Routing Tool and a conveyance loss model that were again expanded and used to assess abilities of the potential storage reservoirs to deliver the desired flows to locations of specific interest.

Phase II Projects

The three projects evaluated in Phase II were selected from a preliminary list of 47 individual projects. The preliminary list was developed by Boyle Engineering with input from the Executive Director's Office and the Water Advisory Committee. During an Alternatives Workshop with the Water Advisory Committee, 23 of these projects were identified to be carried forward in a numeric screening process. The screening process applied a scoring for each of the projects based on Cost, Technical Feasibility, Liability and Risks, and Environmental and Permitting Issues. The results of the screening process were presented to the Water Advisory Committee during a Screening Workshop. With the input of the Committee, three project concepts, totaling 9 individual projects and variations were selected for the next level of evaluation. These project concepts were:

- **Elwood Reservoir** – Re-operation of the existing Elwood Reservoir for Program needs by upsizing three siphons on the E-65 Canal upstream of Elwood Reservoir in order to make irrigation deliveries currently met by the reservoir. Releases to the Platte River would be met via a new channel to the Platte River and/or with improvements to Plum Creek.

- **Plum Creek Reservoir –** A range of reservoir capacities are to be considered for this site. It is anticipated that the variation of sizes will consist of the same, or very similar, dam location. Two sizes are anticipated for inclusion in this analysis.
  - Plum Creek – small, approximately 30,000 AF
  - Plum Creek – large, approximately 100,000 AF
- **"Re-regulation" reservoirs supplied by CNPPID Supply Canal –** This group of reservoirs include those sites that are supplied by the CNPPID Supply Canal and return to the Platte River by means other than the Supply Canal. The alternatives from the Preliminary List of Alternatives that meet this criteria include:
  - Jeffrey Canyon Reservoir
  - Gallagher Canyon Reservoir
  - North Plum Canyon Reservoir
  - J-2 Forebay Reservoir
  - J-2 Return Reservoir
  - Phelps 9.7 Reservoir

From these nine projects, Elwood Reservoir, a small Plum Creek Reservoir, and one of the re-regulation reservoirs (a 'featured' project) was carried forward for additional reconnaissance analysis. The selection of a featured re-regulation reservoir was based on observations during a field reconnaissance trip of the eight project sites selected in the screening process.

Based on site visits Boyle recommended using the J-2 Return Reservoir in further reconnaissance-level evaluations based on it's proximity to the J-2 Return for supply, the Platte River for delivery, storage capacity, lack of power interference costs, and anticipated construction costs. In addition, the intent to carry forward Elwood Reservoir and Plum Creek Reservoir to evaluate a range of reservoir project types was also confirmed.

These three projects provide a varied cross section of reservoir project concepts. The J-2 Return Pool Reservoir characterizes a small but well placed contribution to the pulse flow.

Because of its small size, the permitting, design, and construction activities are anticipated to be smaller than that of a larger reservoir such as Plum Creek Reservoir. Plum Creek Reservoir provides a contrast in size and ability to contribute to the entire pulse flow. Plum Creek also represents the permitting, design, and construction associated with a new large, on-stream reservoir. Elwood Reservoir represents the re-operation of an existing project for use by the Program. The permitting, design, and construction activities related to Elwood Reservoir are a mix of those related to the J-2 Return Reservoir and Plum Creek Reservoir, while providing contributing flows similar in size to those of Plum Creek Reservoir.

The projects set aside from the preliminary list of the 47 projects and not carried forward in Phase II have not been removed from consideration by the Program for future implementation. These projects may receive additional attention related to future analysis of the WMS Flow objectives, or other Program objectives.

Hydrologic Assessments

The Routing Tool was developed in Phase I of the WMS to evaluate the ability of Program water stored in Lake McConaughy to contribute to the WMS Pulse Flow Target and the WMS Irrigation Season Flow Target (flows from the Tamarack Project on the South Platte were also included). The Phase I Routing Tool extends from Lake McConaughy on the North Platte and Roscoe, NE on the South Platte downstream to Overton, NE, where contributions to the WMS Flow Targets are evaluated. Overton is near the upstream end of the associated habitats at Lexington and the location of a long term streamflow gage. At the suggestion of the Water Advisory Committee, the Routing Tool was extended downstream to Grand Island as part of this Phase II effort. The purpose for the extension is to allow for the estimation of the attenuation and resulting flows at the downstream end of the associated habitats, where the Annual Average Target flows are assessed. The Routing Tool is a daily spreadsheet tool that tracks flows through the Platte River system and the NPPD and CNPPID systems downstream applying capacity constraints, ramp rate limits, release capacities, and attenuation factors. The period of record for historical flows in the Routing Tool, and for which each analysis is run, is 1947 through 2006 (water year). The historical flow in the Phelps County Canal, on the downstream end of the J-2 Return was also incorporated as a part of this update to the Routing Tool. Included in the development of the Routing Tool were estimates of flood stage monitored by the National Weather Service (NWS) at Grand Island. Travel times and flow attenuation estimates were also extended to Grand Island.

The Phase II projects, J-2 Return Reservoir, Elwood Reservoir, and a small Plum Creek Reservoir, were evaluated for each project's ability to contribute to the WMS Pulse Flow Target over a 3 day period at Overton. Given the proximity of each reservoir at or near the downstream end of the CNPPID system and Overton, the primary constraint of each reservoir in providing a pulse flow is their storage capacity and the conveyance capacity of the river return. Based on the historical residual capacity in the CNPPID system (2,250 cfs diversion capacity) upstream of the projects during the winter months, it appears feasible to fill the reservoirs prior to releases for pulse flows. The time required to fill each reservoir is dependent on the reservoir's active capacity, inlet capacity, and hydrologic conditions. Return capacities were sized based on drawing down the active contents of each reservoir over three days. Therefore, in the current analysis, the ability to contribute to a Pulse Flow is solely related to the active capacity of each reservoir. The maximum three-day contributions to WMS Pulse Flow Target of 5,000 cfs are as follows: 1) J-2 Return Reservoir – 500 cfs; 2) Elwood Reservoir – 4,000 cfs; and 3) Plum Creek Reservoir - 5,000 cfs, without any constraints in reservoir inlet capacity, rate of reservoir drawdown, reservoir outlet capacity and river return capacity. This analysis assumes that water is available to the Program to route through the CNPPID system every year to fill the reservoirs. No evaluation of the location and timing of excess flows at the CNPPID diversion was made as a part of this analysis.

The reservoirs were also evaluated in their ability to contribute to the WMS Irrigation Season Flow Target at Overton from May 1 through September 15. Similar to the pulse flow evaluation, it was assumed that water was available to the Program to route through the CNPPID system every year to fill the reservoirs. For all of the evaluations, the reservoirs were filled during the days or months prior to May 1. Releases from the reservoir were made based on a need to supplement flows at Overton to meet the 800 cfs flow target. Therefore, Program water was used to contribute from 0 to 800 cfs of flow at

Overton. The contribution of projects ranged from supplemental supplies of two to three days to zero contributions in one particular wet year, when historic flows were consistently greater than 800 cfs. The contribution to this target ranged from 1,360 ac-ft in average Wet years for the J-2 Return Reservoir to more than 22,000 ac-ft for Plum Creek Reservoir in average Dry years. The volume of water required over the irrigation season to meet the 800 cfs target range, on average, from 27,000 ac-ft in Wet years to 127,000 ac-ft in Dry years.

The reservoir projects were not evaluated to meet both targets in a given year by refilling. Initial results indicate that in attempting to maximize contributions to the pulse flow, and the required time to fill, that this is not a likely possibility. However, if the pulse flow contribution from any given project were reduced, then this could provide the opportunity to refill or make contributions to the Irrigation Season Flow Target. Additional operational modeling of combined targets would provide insight into what level of contributions to both targets might be possible.

Program water released for the benefit of the Program will be credited as a contribution to the First Increment objective of 130,000 to 150,000 ac-ft to the extent that Program water is "controllable". For this reason, the water released to contribute to the 5,000 cfs Pulse flow and the 800 cfs irrigation season flow will be credited to the First Objective.

The resulting volume of these contributions at Grand Island was evaluated for the period 1975-2006 with the WMC Loss Model. The resulting contributions at Grand Island range from 87 percent to 97 percent of the flows released to Overton. The average losses of 3 percent to 13 percent reflect evaporation and other consumptive losses. For contributions to the pulse flow, these volumes range from 2,800 ac-ft for the J-2 Return Reservoir to over 28,000 ac-ft for the Plum Creek Reservoir. For contributions to the irrigation season flow, these volumes range from 1,200 ac-ft for the J-2 Return Reservoir to over 21,000 ac-ft for the Plum Creek Reservoir.

Project Evaluations

Preliminary estimates of opinions of probable cost were developed for the J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir. Costs were initially developed based on information available from previous studies and the reconnaissance field visit.

Project costs include construction costs, land acquisition, annual operating costs, and power interference costs where applicable. Estimates of construction costs represent the major cost items associated with each project, such as dam and appurtenances, inlet and outlet facilities and canals. Annual operating, maintenance, and power interference costs were also developed, and included in the total present worth capital cost. Based on this approach and level of analysis these estimates are conservative and represent upper bound costs. Further analysis of any of the projects will result in more refined and detailed estimates.

The project layouts developed for the purposes of developing cost estimates are conceptual in nature. Additional alignments of canals and siting of smaller re-regulation reservoirs would be explored and refined during feasibility and final design stages.

The estimated capital cost for the J-2 Return Reservoir ranges from approximately $21 million to $44 million depending on how the project is configured and whether material excavated in excess of volume needed for the dam can be cost effectively used on-site. The resultant unit costs range from about $6,500 to $14,640 per ac-ft of contribution to the pulse flow. The estimated capital cost for the Elwood Reservoir project is approximately $76 million, or $3,240 per ac-ft of contribution to the pulse flow. The estimated capital cost for the Plum Creek Reservoir (30,000 ac-ft active capacity) ranges from approximately $160 million to $198 million, or from about $5,000 to $6,750 per ac-ft of contribution to the pulse flow. Even at the lower end of the cost ranges listed above, these unit costs are significantly higher than the costs included in the September 2000 Water Action Plan due to cost escalations and the inclusion of facilities to make high peak pulse flow releases. The budget for implementing the water action plan as agreed to by the Program participants is approximately $95.6 million and includes several components, of which the projects evaluated in this Phase II are only a part. The disparity in these cost estimates and the budgeted resources will need to be addressed as a part of future feasibility studies including the evaluation of refined cost estimates, multiple uses of projects, combined operations, and potentially combined ownership and use to offset project costs.

Table ES-1, “Project Evaluation Summary” below summarizes the contributions to targets, projects costs, and project attributes as related to the benefit or obstacles to implementation for the three projects evaluated in Phase II. In addition, the five re-regulation reservoirs not featured in the evaluation are compared qualitatively to the results of the J-2 Return Reservoir, the “featured” re-regulation reservoir.

Table ES-1 - Project Evaluation Summary

Project	Est. Active Capacity (ac-ft)	Potential Contribution to WMS Pulse Flow	Potential Contribution to WMS Irr Season Flow	Capital Cost	Unit Cost per ac-ft Pulse	Power Interference	Impact to Landowners (qualitative)	Location of Return to Platte River	Length of Supply Conveyance	Length of Return Conveyance
Plum Creek – small	30,000	100%	18-26%	$160 to 198MM	$5,000 to $6,750	Johnson 2	Several Owners	near Overton	3.4 mi	7 miles
Plum Creek – large	100,000	100%	50-100% (estimated)	$230MM	$7,730 (estimated)	Johnson 2	Several Owners	near Overton	3.4 mi	7 miles
Elwood Reservoir	24,000	80%	15-39%	$76MM	$3,240	Johnson 1, Johnson 2	Potential for Several	near Overton	Replace 1.4 mi of E-65 siphon	16 miles
J-2 Return Reservoir	3,300	10%	2-5%	$21 to 44MM	$6,500 to $14,640	None	Few	near Overton	None	None
Comparison of additional re-regulation reservoirs to J-2 Return Reservoir										
Jeffrey Canyon	10,400	35% (positive)	(positive)	(N/A)	(N/A)	Jeffrey, Johnson 1, Johnson 2 (negative)	(N/A)	d/s of Brady (negative)	Pumped pipeline 1-2 miles (negative)	3-7 miles (negative)
Gallagher Canyon	3,300	10% (neutral)	(neutral)	(N/A)	(N/A)	Johnson 1, Johnson 2 (negative)	(N/A)	Lexington (neutral)	None (neutral)	5-8 miles (negative)
North Plum Canyon	2,300	8% (negative)	(negative)	(N/A)	(N/A)	Johnson 1, Johnson 2 (negative)	(N/A)	Lexington (neutral)	2-3 miles (negative)	5-7 miles (negative)
J-2 Forebay	3,400	11% (positive)	(positive)	(N/A)	(N/A)	Johnson 2 (negative)	(N/A)	near Overton (neutral)	2-3 miles (negative)	6-7 miles (negative)
Phelps 9.7	1,300 – 2,200	7% (negative)	(negative)	(N/A)	(N/A)	None (neutral)	(N/A)	at Overton (neutral)	None (neutral)	2-3 miles (negative)

Conclusions and Recommendations for Project Implementation

All three water storage projects are technically feasible and will help accomplish the Program's flow objectives. Refined layouts and cost estimates are needed to support any conclusions on affordability, especially in light of the current estimates in relation to those presented in the September 2000 Water Action Plan. Because none of the reservoirs will individually meet the WMS Pulse Flow and Irrigation Season Flow targets, a combination of these reservoirs and other water management projects and strategies will be required.

The WMS focuses on the ability to use excess capacities in the Districts' systems and the Platte River to meet the WMS Pulse Flow and Irrigation Season Flow Targets. These analyses currently rely on the assumption of Program water availability in Lake McConaughy or other sources of water for the Program. Additional evaluation of the potential to divert and store water in times of excess at Grand Island should be conducted as the Program continues through full feasibility and implementation of projects.

Analyses of contributions to the WMS Flow Targets have been conducted on an individual project basis. Evaluation of combined operations from Lake McConaughy, re-regulation in Johnson Lake, and the reservoir projects identified in the WMS will provide additional insight into a more flexible and managed contribution to the WMS Flow Targets as Program implementation continues. Combined operations of multiple projects would also allow for scaling down some of the large cost items identified in this study, and therefore potentially reduce some of the unit costs of contributing flows.

Conflicts and benefits may be realized with implementation of multiple projects. Water supplies may be additive or competing and infrastructure may be complimentary or competing. For example, water supplies conveyed through the CNPPID system all rely on the remaining available capacity. If more than one project is implemented along the CNPPID system, then combined operations will compete for the available capacity, resulting in longer fill times. In addition, the physical location of multiple projects may conflict. For example, construction of a new Plum Creek Reservoir would inundate a portion of a new Elwood Reservoir Return, or improvements to the creek if the Elwood project is implemented before Plum Creek Reservoir. If this sequence is reversed the

Elwood releases would pass through Plum Creek reservoir eliminating the need for that portion of the canal construction or creek improvements.

Suggested next steps in the implementation process include:

- Review effects of recent high flows on channel morphology and maintenance and determine what conclusions can be extrapolated to the potential for managed pulse flows to accomplish the desired effects in the Platte River corridor. The results of these analyses should be considered in future refinements to the reservoir feasibility and implementation in relation to the timing and location of the reservoir pulse flow releases.
- Perform a pilot pulse flow in the spring of 2009. Results from this pilot study will provide additional insight into channel maintenance, capacities, and flow attenuation.
- Re-regulation of Johnson Lake will be a key component of a full pulse flow. CNPPID has currently agreed to test re-regulation of 6,000 ac-ft. If results of a test operation are positive, this volume of re-regulation might be increased. In addition to the physical results of a test, the process involved in positioning Program water and making releases timed to supplement natural events and will help define procedures for annual implementation.
- Further investigate: 1) next steps to achieve the 2011 pulse flow goals, 2) benefits of J-2 Return Reservoir on hydro-cycling and 3) procedures for implementing a test release from Johnson Lake.
- Define the 2009 Program activities related to the WMS Flow objectives:
    - Additional operations modeling of individual and combined projects.
    - Select preliminary design activities for specific storage sites, including:
        - Development of field exploration program(s) and data collection
        - Refinement of project facility types and capacities
        - Refinement and development of project cost ranges based on feasibility level design

- Review the need to update assessments of previously defined Water Action Plan alternatives and/or quantification of availability of flows in excess to targets.
- Review the need to enhance the existing Routing Tool and Loss Model to potentially include:
  - Multiple-year operations for the Routing Tool
  - Ability to evaluate multiple targets in combination
  - Multiple project operations
  - Link daily time step Routing Tool with monthly time step Loss Model
  - Enhanced user output

- Investigate the reaction of land owners in the project areas to participate in the development of a project.
- Continue work on expanding the safe-conveyance capacity of the North Platte River at North Platte (choke point) and other channel restrictions that may be identified in the future. Continued improvements to restore a capacity of 3,000 cfs or greater at North Platte are important in achieving flow targets, and to the extent possible minimizing the need and size of additional structural solutions.

1.0 INTRODUCTION

Per the direction of the Governance Committee of the Platte River Endangered Species Recovery Implementation Program, this multiphase Water Management Study (WMS) further investigates strategies to provide 5,000 cubic feet per second (cfs) of Program water to supplement flows that would otherwise occur for three days at the Overton gage during periods when other competing water demands are low (typically, September 1 through May 31). In addition, the WMS also evaluates the ability of Program water to supplement existing flows to provide a flow of 800 cfs at the Overton gage during typical irrigation seasons (May 1 through September 15). The WMS currently encompasses two phases. This report presents the findings of Phase II, a reconnaissance-level evaluation of representative water storage projects in central Nebraska located to potentially supply, or supplement, the desired peak flows on short-notice, contribute to the irrigation season flows, and also to contribute to reductions in shortages to average annual target flows as described in Attachment 5, Section 11 of the Program Document (130,000 to 150,000 ac-ft per year on average). For purposes of the Phase II of the WMS and this report, the three flow objectives described above are defined as follows:

- *WMS Pulse Flow Target*: Ability to deliver 5,000 cfs of Program water in addition to other non-Program flows for a duration of three days at the Overton gage during the period of lower demands, typically from September 1 through May 31.

- *WMS Irrigation Season Flow Target*: Up to 800 cfs of Program water to supplement other non-Program flows to achieve a total of 800 cfs at the Overton gage during the irrigation season, May 1 through September 15. (Note: This definition was revised for Phase II to include Program water as supplemental flow to existing flows at Overton per comments to the Phase I Report.)

- *Average Annual Target Flows*: Reductions in shortages to Program target flows as summarized in Appendix E of Attachment 5, Section 11 of the Water Plan Reference Materials (page 34), and totaling 130,000 to 150,000 ac-ft per year on average. These contributions are evaluated at Grand Island, NE.

These flow objectives have evolved from Phase I to refine the analysis and the focus of the Phase II evaluation. Phase II focused on the ability to provide 5,000 cfs of Program water for the Pulse

Flow. It did not evaluate occurrences of combined flows greater than 6,000 cfs as was conducted in Phase I. This is to assure the ability to provide 5,000 cfs of Program water every year. The Irrigation Season Flow Target now includes only the amount of Program water necessary to supplement other flows to achieve a total flow of 800 cfs at Overton. This change in the target lessened the required total volume of Program water.

Phase I of the WMS evaluated the ability of the Program to achieve the WMS Pulse Flow Target and the WMS Irrigation Season Flow Target under two Cases. Case I simulates diversion of Program water released from Lake McConaughy by the Nebraska Public Power District (NPPD) and Central Nebraska Public Power and Irrigation District (CNPPID) up to the remaining capacity in their systems. Case II simulates only the use of the Platte River to convey Program water to the Overton gage. Phase I also evaluated the potential of the 13 Water Action Plan components approved in the Program's Final Environmental Impact Statement (FEIS) (USDOI, 2006) to contribute to the WMS Pulse Flow and Irrigation Season Flow Targets (as opposed to the contribution to Average Annual Target Flows estimated in prior studies). A hydrologic flow Routing Tool (that represents the central Platte River basin and the Districts' systems) and an update to the hydrologic "Loss" model were developed during Phase I for use in evaluating these cases. Phase I concluded that Program water contributions to a pulse flow equal to 5,000 cfs for three days are not achievable given capacity constraints in the river and the Districts' systems. In addition, contributions to the 800 cfs are to a large extent possible but require a significant volume of water released from Lake McConaughy. Detailed results of the Phase I study are presented in the *Water Management Study, Evaluation of Pulse Flows for the Platte River Recovery Implementation Program, Phase I Report* (Boyle, 2008).

Based on the results of Phase I, the purpose of Phase II of the WMS is to identify and evaluate, at a reconnaissance-level, the ability of storage reservoirs located in the central Platte River basin to contribute to the three flow objectives described above. Each of the reservoir project concepts is evaluated for its potential contribution to the WMS Pulse Flow and WMS Irrigation Season Flow Targets and the resulting contributions to the Average Annual Targets independently. The projects are not operated in conjunction with each other or with other Program concepts, other than the supply from Lake McConaughy. The reservoirs are not operated to meet both WMS Flow Targets in the same season; rather these are evaluated for each Target and year separately. An additional underlying basis of the evaluation is the use of the projects solely for the benefit of contributing to Program objectives. Operations for recreation or other non-Program benefits are not evaluated explicitly.

Preliminary reconnaissance-level opinions of estimated cost and a review of potential environmental, permitting, and legal issues for further investigation are also presented as part of Phase II.

2.0 ASSESSMENT OF POTENTIAL PHASE II PROJECTS

2.1 Identification of Projects

A preliminary list of alternatives was prepared for evaluation in Phase II of the WMS. This preliminary list was developed based on findings of Phase I, a review of the *Water Conservation/Supply Study* (Boyle, 2000), and through additional discussions with the Executive Director's Office and members of the Water Advisory Committee (Committee). The preliminary list of alternatives developed in conjunction with the Committee during the May 16, 2008 Alternatives Workshop is presented in Table 2-1 entitled, "Preliminary List of Alternatives for WMS Phase II Evaluation". The preliminary list of 47 individual projects included changes in administration/operations, channel improvements, and structural projects.

Table 2-1 - Preliminary List of Alternatives for WMS Phase II Evaluation

Project Name	Project Description
Choke Point Improvements	Improve capacity at choke points and capacity limitations all along river the system
South Platte Re-Reg	Storage along the South Platte River in Nebraska
Elwood Reservoir - Central Platte Re-reg Reservoir	Improvements to Elwood Reservoir to facilitate larger releases
Phelps 9.8 Reservoir - Central Platte Re-reg Reservoir	Phelps 9.8 Reservoir off of CNPPID Phelps Canal, new reservoir, aka Kirkman or 9.8 Reservoir
J-2 Return Pool Reservoir - Central Platte Re-reg	J-2 Return Pool Reservoir off of CNPPID near J-2 Return, new reservoir
Robb Lake / Jeffrey Island	Robb Lake - new dam would be located on south channel of Platte River near Jeffrey Island
J-2 Forebay Reservoir - Central Platte Re-reg Reservoir	J-2 Forebay reservoir, new reservoir near J-2, fed by existing reservoir
Plum Creek	Dam on Plum Creek downstream of J-2 Return
Ovid Reservoir	New reservoir near South Platte River in Colorado
Inflatable Dam(s)	Inflatable dam on river near habitat or other strategic location
Elm Creek Reservoir	New dam and reservoir on Elm Creek to provide flood storage and other potential uses.
Dawson/ Gothenburg GW Recharge	Divert during non-irrigation season with return flows to the river via groundwater flow.
LaPrele Reservoir	Purchase storage space in reservoir
Tamarack – Phase III	Expansion of Tamarack I project- retiming of diversions from the South Platte River via recharge basins
Jeffrey Canyon	New dam and reservoir supplied by CNPPID Supply Canal
Smith Canyon	New dam and reservoir supplied by CNPPID Supply Canal
Midway Lakes	New dam and reservoir supplied by CNPPID Supply Canal
North Plum	New dam and reservoir supplied by gravity or pumping
Active Groundwater	Pump groundwater mound from Funk Lagoon to Platte River
Lost Creek / Dry Creek Cutoff Channel	Cut off ditch to run water to Platte River
Lost Creek / Ft. Kearney Cutoff Channel	Cut off ditch to run water to Platte River
Adams County Canal	Enlarging existing canal to create reservoir storage for returns to Platte River
Rehabilitate/improve conveyance canals	Is there potential to reduce seepage to produce additional water?
Repair/Improve Water control structures	Potential to increase capacities and/or ramping rates, Improvements to Sutherland system
Gallagher Canyon	New dam and reservoir supplied by CNPPID Supply Canal
Conjunctive Use on South Platte	Conjuctive use of groundwater near South Platte River, pumping deliveries directly to the river.
Perkins Canal Reservoir	Reservoir located on or near the Perkins Canal
Delivery from the Loup River	Delivery of water from the Loup River basin or other source in the Sandhills
Modified Bypass	Hybrid Case I and Case II of Phase I - EA water bypassed at CNPPID and stored EA water is released
Increase Capacity for EA via Interruptible Water Supplies	Interruptible water supplies or short-term leasing in April/May to free-up capacity for pulse flow
NPPD Bypass Exchange	Short-term exchange of EA water for bypass of South Platte flows at Korty
Increase Ramping Rates on North Platte River	Sensitivity analysis to ramping rate limitation on the North Platte River below Keystone
Summer Pulse via exchange of EA	Release irrigation water on top of wet event, and exchange for EA water held in McConaughy
Central Platte Power Interference	Payments to off set power revenue while holding water back in McConaughy to store in EA
Pathfinder Municipal Account	Contribution of water from Pathfinder Modification Municipal Account, delivered to McConaughy
Glendo Storage	Water in excess of Wyoming contract and depletions could be available to deliver to McConaughy
Net Controllable Conserved Water	Result of conservation and efficiency efforts by CNPPID
Phreatophyte Eradication	Removal and eradication of prhreatophytes along river reaches
Water Leasing – Nebraska	Lease water from irrigation districts with account in McConaughy and store consumptive portion in EA
Nebraska Water Management Incentives	Compensation for reduced diversions by irrigation districts with accounts in McConaughy
Water Leasing – Wyoming	Lease water rights from irrigators with storage water, deliver consumptive portion
Conversion to Groundwater	Replace surface water irrigation deliveries with groundwater pumping
Dry land Farming	Conversion of irrigated agriculture to dry land crops
Combination Irrigation	Combination of dry land farming and groundwater irrigation on a rotating basis.
Evaporation reduction	Activities to reduce the amount of water lost to evaporation and unnecessary evapotranspiration
Grand Island Dewatering	Install dewatering systems for residents in the city of Grand Island, NE

During the May 16, 2008 Alternatives Workshop, the Committee directed Boyle to focus the evaluation of alternatives primarily on the ability to contribute to the WMS Pulse Flow Target. The Committee also directed Boyle to evaluate each alternative in its ability to contribute to the WMS Irrigation Season Flow Targets and Average Annual Target Flows.

The workshop resulted in the identification of several projects to evaluate. Table 2-2 lists the resulting 23 alternatives carried forward for the next level of analysis. The fact that 24 of the 47 projects were not carried forward in Phase II does not indicate that they were removed from any future study of potential implementation by the Program.

Table 2-2 - Phase II Projects included in Screening

Number	Project
1	South Platte Re-Reg
2	Perkins County Canal Reservoir
3	Elm Creek Reservoir
4	Plum Creek
5	Elwood Reservoir - CNPPID Re-reg Reservoir
6	Jeffrey Canyon - CNPPID Re-reg Reservoir
7	Smith Canyon - CNPPID Re-reg Reservoir
8a	Midway Lakes #2 - CNPPID Re-reg Reservoir
8b	Midway Lakes #5 - CNPPID Re-reg Reservoir
9	North Plum - CNPPID Re-reg Reservoir
10	Gallagher Canyon -CNPPID Re-reg Reservoir
11	Phelps 9.7 Reservoir - CNPPID Re-reg Reservoir
12	J-2 Return Reservoir - CNPPID Re-reg Reservoir
13	Robb Lake / Jeffrey Island
14	J-2 Forebay Reservoir - CNPPID Re-reg Reservoir
15	Interruptible Water Supplies
16	Summer Pulse via exchange of EA
17	Conjunctive Use on South Platte
18	Choke Point Improvements
19	Rehabilitate/improve conveyance canals
20	Repair/Improve Water control structures
21	Inflatable Dam(s)
22	Grand Island Dewatering
23	Delivery from the Loup River

2.2 Selection Process

Readily available information for each of the 23 projects was collected or derived to evaluate the short list of alternatives. This screening was based on a process of scoring each alternative in several categories. These categories were Cost, Technical Feasibility, Liability and Risks, and Environmental and Permitting Issues.

Sub-categories were developed for each of the main categories. Each alternative was scored across the sub-categories on a basis of 0-5. Zero representing the lowest score, likely a fatal flaw, and five representing the best possible score.

The averages of the scores for each sub-category were summed to produce a total screening score for each alternative. The overall score, with a possible range of 0-20, was compared in a summary table and also presented graphically (See Appendix 1).

Alternatives were grouped based on performance in each of the categories as well as based on total score for comparison purposes. Results of the numeric screening used to guide the selection of projects is presented in Appendix 1.

The preliminary scoring for each of the alternatives was presented to the Water Advisory Committee during a July 16, 2008 workshop. The goal of the workshop was to evaluate and refine the scoring for each alternative and to select three alternatives to carry forward in the reconnaissance-level analysis.

2.3 Selection Results

The three project concepts selected with the input from the Committee are:

- **Elwood Reservoir** – Re-operation of the existing Elwood Reservoir for Program needs by upsizing three siphons on the E-65 Canal upstream of Elwood Reservoir in order to make irrigation deliveries currently met by the reservoir. Releases to the Platte River would be met via a new channel to the Platte River and/or with improvements to Plum Creek.

- **Plum Creek Reservoir –** A range of reservoir capacities are to be considered for this site. It is anticipated that the variation of sizes will consist of the same, or very similar, dam location. Two sizes are anticipated for inclusion in this analysis.

    - Plum Creek – small, approximately 30,000 AF
    - Plum Creek – large, approximately 100,000 AF

- **"Re-regulation" reservoirs supplied by CNPPID Supply Canal –** This group of reservoirs include those sites that are supplied by the CNPPID Supply Canal and return to the Platte River by means other than the Supply Canal. The alternatives from the Preliminary List of Alternatives that meet this criteria include:

    - Jeffrey Canyon Reservoir
    - Gallagher Canyon Reservoir
    - North Plum Canyon Reservoir
    - J-2 Forebay Reservoir

- J-2 Return Reservoir
- Phelps 9.7 Reservoir

Elwood Reservoir, a small Plum Creek Reservoir, and one of the re-reg reservoirs (a ‘featured’ project) was carried forward for additional reconnaissance analysis.

A brief description of the location and configuration of 9 individual projects is included in Table 2-3.

Table 2-3 - Resulting Projects from Screening

Project	Est. Capacity	Location	Supply	Return to River	Power Facilities Bypassed
Elwood Reservoir	24,000 (active)	South of Johnson Lake, tributary to Plum Creek	CNPPID E-65	Plum Creek	J-1, J-2
Plum Creek – small	30,000 (active)	On Plum Creek, southeast of J-2 Powerplant	J-2 Forebay (East Phillips Lake)	Plum Creek	J-2
Plum Creek – large	100,000 (active)	On Plum Creek, southeast of J-2 Powerplant	J-2 Forebay (East Phillips Lake)	Plum Creek	J-2
Jeffrey Canyon	10,400	Adjacent to Jeffrey Reservoir	Jeffrey Reservoir	New return	Jeffrey, J-1, J-2
Gallagher Canyon	3,300	North of Supply Canal and Gallagher Lake (u/s of Johnson Lake)	CNPPID Supply Canal	30-mile Canal or new return	J-1, J-2
North Plum Canyon	2,300	North of Supply Canal (u/s of Johnson Lake)	CNPPID Supply Canal	30-mile Canal or new return	J-1, J-2
J-2 Forebay	3,400	On Plum Creek, southeast of J-2 Powerplant	CNPPID J-2 Forebay (East Phillips Lake)	Plum Creek	J-2
J-2 Return	3,300	d/s of J-2 Powerplant adjacent to Phelps County Canal and J-2 Return Canal to the Platte River	CNPPID J-2 Return	J-2 Return Canal (d/s of Powerplant)	None
Phelps 9.7	1,300 – 2,200	9.7 miles d/s of J-2 on Phelps County Canal, south of Overton	Phelps County Canal (d/s of J-2)	Tributary to Platte River	None

3.0 FIELD RECONNAISSANCE

The project team conducted a field reconnaissance trip as part of the reconnaissance-level evaluation on September 2-3, 2008 to the eight potential project sites. The eight projects were selected during the Alternatives Screening Workshop with the Water Advisory Committee on July 16 2008, and include Elwood Reservoir, Plum Creek Reservoir, and six re-regulation reservoirs supplied by CNPPID Supply Canal, Jeffrey Canyon Reservoir, Gallagher Canyon Reservoir, North Plum Creek Reservoir, J-2 Forebay Reservoir, J-2 Return Reservoir, and Phelps 9.7 Reservoir (listed upstream to downstream). These sites are all located on the south side of the Platte River in central Nebraska, generally between Brady and just downstream of Overton. The location of each of the sites visited is shown on Figure 3-1, “Project Locations.”

The purpose of the field visit was to provide a general impression of the feasibility of each potential project to store and release Program water to the Platte River for purposes of a pulse flow and contribution to irrigations season flows. Representatives from the Executive Director’s Office, CNPPID, and Boyle Engineering participated in the field trip. The field visit was limited to visual assessment of the sites to characterize attributes of land use, ownership, development, vegetation, geology/geotechnical issues, and conveyance options. The field visit provided information for Boyle Engineering to make a selection of one re-regulation reservoir to carry forward in the evaluation as a featured site. Based on these site visits the J-2 Return Reservoir was selected. In addition, the intent to carry forward Elwood Reservoir and Plum Creek Reservoir to evaluate a range of reservoir project types was also confirmed.

Descriptions of the projects and observations from the field trip are included in Appendix 2.

3.1 Recommended Re-regulation Reservoir to Feature

As part of Phase II of the WMS, three sites will be evaluated in more detail related to hydrological effects and opinion of costs: Elwood Reservoir, Plum Creek Reservoir, and one off-channel reservoir supplied by CNPPID Supply Canal (re-regulation reservoirs). One of the purposes of the field trip was identify and feature one off-channel reservoir site supplied by CNPPID Supply Canal for the next level of evaluation.

The six off-channel reservoirs supplied by CNPPID Supply Canal have similar characteristics, such as construction of a new dam, geologic conditions, and operations.

However, they differ in other areas, such as proximity to the Platte River, dam volume to storage volume ratio, storage capacity, inlet and outlet structures, and potential for power interference.

The dam construction methods likely employed for the re-regulation projects are typical methods with little differentiation other than size. The one difference may be the use of a cut and fill operation for the J-2 Return Reservoir; however, similar dam design and construction techniques are likely to be used. Therefore, in order to separate one featured site from the six sites a comparison of proximity to the Platte River, dam volume to storage volume ratio, reservoir capacity, reconnaissance level estimate of cost, and power interference are assessed as follows.

The proximity of a project to the Platte River and the habitat has an effect both on the effectiveness of the pulse release and the cost associated with the return facilities. The farther the Program water travels in the Platte River upstream of Overton, the less impact it may have on the associated habitats as flows may attenuate or contribute to groundwater flows. In addition to longer travel times, higher costs for construction or improvements to return paths are associated with significant costs. Return distances, estimated from aerial mapping, range from feet (J-2 Return Reservoir) to approximately 7 miles (J-2 Forebay Reservoir). The most suitable site based on return proximity to the Platte River is the J-2 Return Reservoir.

Reservoir capacities are important for a site's ability to deliver an effective volume of Program pulse flows to the habitat. Capacities range from 2,200 acre-feet (Phelps 9.7 Reservoir) to 10,400 acre-feet (Jeffrey Canyon Reservoir). The median capacity is approximately 3,200 acre-feet. Based on potential re-regulation capacity, the Jeffrey Canyon Reservoir site is the most attractive. The J-2 Return Reservoir site has a potential storage capacity of 3,300 acre-feet, which is close to the median storage value of the re-regulation sites.

At this level of assessment, dam volume to storage volume ratios are based on an estimate of dam crest length and height from topographic mapping. The ratio of dam volume to storage volume range from good (Jeffrey Canyon and Gallagher Canyon Reservoirs) to less favorable (North Plum Creek and Phelps 9.7 Reservoirs). Based on the reservoir volume and cut and fill construction associated with the site, the J-2 Return Reservoir appears favorable in this regard.

Power interference costs resulting from bypassing any of the Jeffrey, J-1, or J-2 Power Plants will vary for each of the reservoir projects. Operation of Jeffrey Canyon Reservoir would result in cost associated with bypassing all three power plants. J-2 Return and Phelps 9.7 are both located downstream of all three power plants and therefore would not be assessed power interference costs.

Boyle has selected to feature the J-2 Return Reservoir in further reconnaissance-level evaluations based on it's proximity to the J-2 Return and Platte River, storage capacity, lack of power interference costs, and anticipated construction costs.

4.0 PROJECTS SELECTED FOR RECONNAISSANCE EVALUATION

Three projects were carried forward in the reconnaissance-level investigation, the J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir. These were identified during the screening process and field reconnaissance to represent a range of project types and sizes. The J-2 Return Reservoir and Plum Creek Reservoir projects are both new storage with contrasting active capacities and proximities to the Platte River. Elwood Reservoir and Plum Creek are similar in their size of active capacities and requirement of a long return to the channel, but allow for the comparison of modifying operations of existing storage and building new storage. These contrasting projects provide good base points of comparison of these projects and others for the Program to consider implementing.

The three projects are located to the south of the Platte River, situated near the Johnson Lake end of the CNPPID system. Supply to each reservoir is anticipated to be from the CNPPID Canal ranging from the E-65 Canal (upstream of Johnson Lake) for Elwood Reservoir, East Phillips Lake for Plum Creek Reservoir, to the J-2 Return for the J-2 Return Reservoir. The location of these projects at the lower portion of the system coincides with the upstream end of the associated habitats, near Overton. Figure 4-1, “J-2 Return Reservoir”, Figure 4-2, “Elwood Reservoir”, and Figure 4-3, “Plum Creek Reservoir” illustrate the approximate extents and location of the J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir, respectively. The approximate alignment of the supply and return canals are also illustrated. The alignments of the supply and return canals and the location of the J-2 Return Reservoir are conceptual in nature and are intended to provide approximate quantities for cost estimating and comparison. Additional alignments of the supply and return canals and locations of the J-2 Return Reservoir would be explored and refined during feasibility and final design stages.

A description of the layout and configuration of each project as considered in this reconnaissance-level evaluation is presented below. A general discussion of the geologic setting is presented for the three projects as a group with specific considerations detailed in each the following descriptions.

4.1 Geologic Setting of Projects

Available geologic/subsurface information varied from site-specific information to information for existing projects located several miles from the proposed projects. Site-specific information for the potential projects is limited to the Plum Creek project.

Project Setting

The three project areas are located on the upland surface in the Dissected Plain topographic region of Nebraska adjacent to and a short distance south of the Platte River valley. The Platte River valley is a relatively wide valley, generally on the order of several miles in width, trending generally east west through Nebraska. The topography in the region of the project areas consist of a relatively flat upland surface dissected by generally north trending drainages.

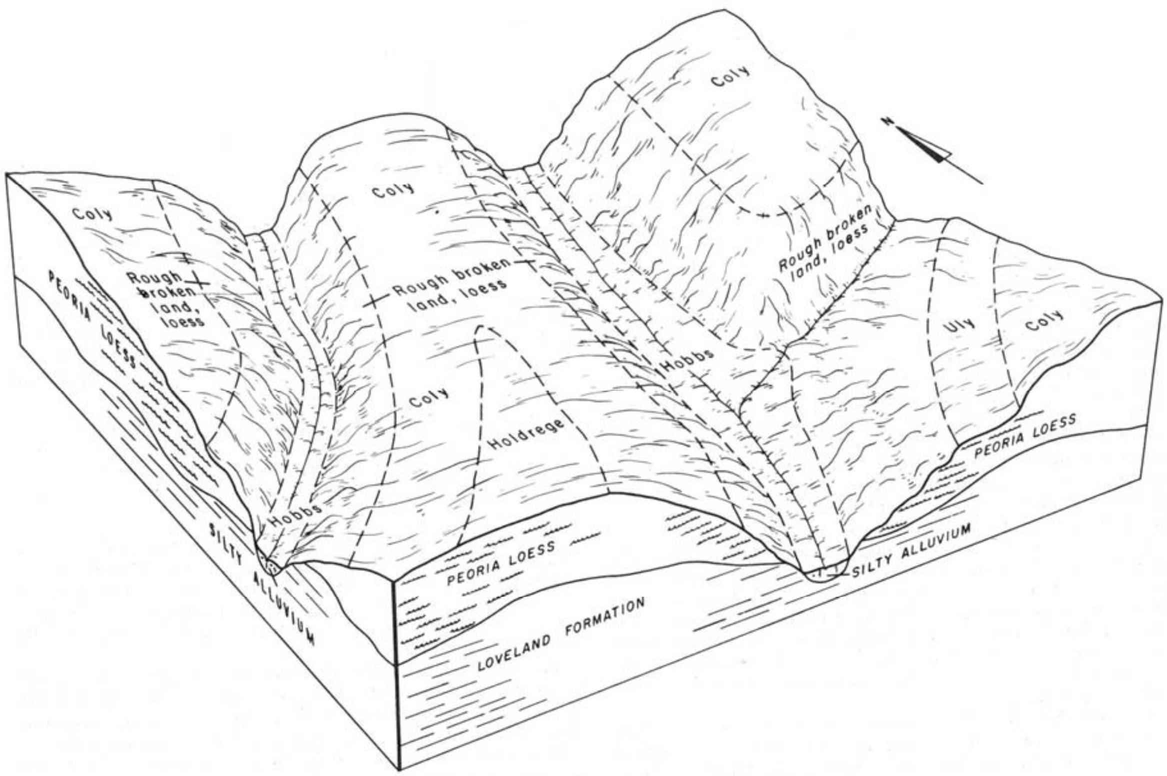
Available topographic quadrangle maps indicate the existence of numerous reservoirs on the upland surface along the south side of the Platte River valley in the region of the potential projects.

Regional Geology

The potential project areas are located in the Dissected Plain topographic region of Nebraska. The project region and the central portion of the state of Nebraska are underlain by the Tertiary age Ogallala Formation. This formation consists of clay, silt, sand, and gravel. The lithology varies laterally and vertically within short distances. Sandstone beds are common and calcium carbonate cement forms “mortar beds” and locally, secondary silica forms quartzite beds (Dreeszen, 1973).

The Ogallala Formation is overlain by a series of unconsolidated fluvial and wind blown deposits. Based primarily on well records, these sediments have been estimated to range upwards in thickness of 300 feet (Dreeszen, 1973). These unconsolidated deposits generally consist of the surface deposit of the Peoria Loess, the underlying Loveland Formation, and the Grand Island Formation. The Peoria Loess and the underlying Loveland Formation consist primarily of wind blown silt and clay with lesser amounts of fine sand. The Grand Island Formation consists primarily of fluvial deposits, sand and gravel, and overlie the Ogallala Formation. The general relationship of these units is shown in Figure 4-4, obtained from the Lincoln County soil survey publication (USDA, 1978). Originally the Loveland Formation consisted of lower alluvial deposits overlain by loess deposits. Subsequent to Figure 4-4, the fluvial portion of the deposit has been designated as the Grand Island Formation.

Figure 4-4 - Generalized Subsurface Profile (Source: USDA, 1978)



Some loess soils have a limey cementation and can stand in near vertical slopes in a dry condition. When wetted and/or saturated, this cementation can be dissolved resulting in loss of strength. In addition, these loess deposits have the characteristic of settlement when loaded and/or wetted.

The loess deposits can be somewhat permeable and the permeability may vary with direction, vertically and horizontally. Due to the permeability of the loess deposits, it is anticipated that there will be a rise in ground water in the project areas. In addition, some erosion and/or beaching could occur along the margins of the reservoirs. The permeability of the loess deposits has been illustrated by the changing of Plum Creek from an intermittent stream to a perennial stream after the construction of the nearby Elwood and Johnson reservoirs (Reclamation, 1989).

Project Geology

The review of available geologic and/or subsurface information suggest that the project areas are similar with the area underlain at depth by the Ogallala Formation while the near surface deposits are likely to consist of the Peoria Loess and/or the underlying Loveland Formation. The fluvial Grand Island Formation that generally overlies the Ogallala Formation may be absent in some areas.

It is assumed that similar subsurface conditions exist at all three project areas. As previously mentioned loess deposits underlie the potential dam and reservoir sites. The near surface soils of these deposits have been classified as clay (CL), clay and silt (CL-ML), and silt (ML).

Foundation preparations vary ranging from minimal stripping of surface materials and shallow cutoff trenches beneath embankments for existing dams to the recommendation for removal of the Peoria Loess deposit and pre-wetting the excavated surface to reduce settlement for the proposed Plum Creek project.

Subsurface investigations will be required at each of the proposed project sites to obtain site-specific information.

4.2 J-2 Return Reservoir Project Configuration

The J-2 Return Reservoir evaluated in this Phase is a 3,300 ac-ft (active) reservoir located adjacent to the J-2 Return wasteway to the Platte River. It is estimated that a maximum reservoir depth of approximately 10 feet is sufficient for the target storage volume. Construction of the dam is anticipated to be a ring dike surrounding excavated storage on the site. The reservoir depth of 10 feet was also chosen as a reasonable depth to facilitate gravity operations with the J-2 Return canal and wasteway to the river.

Supply to the reservoir would utilize remaining capacity in the J-2 Return canal (2,000 cfs) that runs adjacent to the site. For purposes of evaluating filling requirements, an upper limit of 2,000 cfs fill-rate was used. Gravity fill from the canal appears possible, though further investigation may suggest the need to check-up the existing supply canal in order to completely fill the reservoir. If upon further investigation this is deemed necessary, effects on the upstream portion of the canal, including the supply and return to the Canaday Power Plant will require investigation. If filling the entire reservoir by gravity is not possible, or additional storage capacity is warranted, the potential to pump from the canal should be considered in the feasibility investigation. It is anticipated that in order to fill via pumping, the fill rates will be significantly reduced.

Releases to the Platte River from the reservoir will be made at the existing J-2 Return wasteway location. A capacity of 500 cfs was evaluated for the contribution to the WMS Flow Targets and is based on a three day release of the entire reservoir volume. A higher release rate for a shorter duration is potentially possible and should be considered in future studies. Modification of the existing gate structure including the headgate on the Phelps County Canal will be necessary to allow releases from the J-2 Return Reservoir concurrent with pulse flow contributions from the J-2 Return Canal. This modification will need to consider the hydraulics of emptying the reservoir while running the J-2 Return to the wasteway without circumventing flow back into the reservoir. Improvements to the wasteway are anticipated to require some improvements to accommodate the higher combined flows. These improvements would be made along with the modifications to the gate structures. Options to fill the reservoir via pumping should be investigated in future studies along with the potential to expand the capacity of the reservoir and return to the river.

With the exception of the soil survey map no site-specific subsurface information is available. It is estimated that the thickness of unconsolidated deposits overlying the Ogallala Formation is on the order of 100 feet. The soil survey map indicates the near surface materials to be clay (CL) and silt (ML). The soil survey indicated the Lex Loam soil unit, which is described as being sandy and thus more permeable, underlies the northern portion of the site. A clay unit is shown parallel and adjacent to the existing canal section traversing through this soil unit and may represent a relative impermeable liner for the canal.

Ground water flow and dewatering during construction and operation of this reservoir could potentially be significant factors for design. It is anticipated that some ground water would be encountered, but to what extent and with what magnitude of flow are unknown. Potential solutions for isolating the reservoir from ground water influences could include a slurry wall surrounding the reservoir, lining the reservoir, or a lining and under drain combination. Another option may be to allow ground water intrusion into the reservoir, and acquire the appropriate permits and loss mitigation for use of the water for Program purposes. These concepts should be considered in future studies. A provision for construction of a slurry wall has been included in the development of the opinion of estimated cost.

No power interference costs are associated with the J-2 Return Reservoir because it is located downstream of all of the NPPD and CNPPID hydros. All Program water entering J-2 Return Reservoir will passed through the CNPPID supply canal and hydros.

4.3 Elwood Reservoir Project Configuration

Elwood Reservoir is an existing reservoir owned and operated by CNPPID. It is used to store irrigation water over the winter for releases during the irrigation season on the E-65 canal. The siphon sections on the E-65 canal upstream of Elwood Reservoir do not currently have enough capacity to allow full irrigation deliveries via the canal alone. The project concept for use by the Program is to upsize the three siphons on the E-65 canal upstream of Elwood Reservoir to allow for full irrigation deliveries to CNPPID customers during the irrigation season. The new capacity of the siphons would need to be approximately 650 cfs to match the current capacity of the canal sections. A total length of approximately 7,500 feet of siphons needs to be replaced.

Elwood Reservoir has an existing storage capacity of approximately 40,000 ac-ft; approximately 24,000 ac-ft of this is active capacity. The reservoir is supplied via the E-65 canal, which diverts from the Supply Canal just upstream of Johnson Lake. A pump station with three 300-Hp pumps is currently used to fill the reservoir in the winter. Current operations require the use of three of the pumps to fill the reservoir, and one pump to maintain the reservoir when full. It is anticipated that if the Program were to utilize Elwood Reservoir, similar filling operations would be implemented. The reservoir would fill in the winter to allow for full use of the E-65 canal for irrigation deliveries during the summer. If additional filling capacity were required for Program operations, then a retrofit of the pump station would be required. Investigation of additional pumping capacity should be done during future studies involving detailed operational studies and inspection of the pump station.

Releases from Elwood Reservoir would likely be made either via a new return canal to the Platte River or to Plum Creek. For purposes of contributing to the WMS Pulse Flow Target, and maximizing the use of the capacity of Elwood Reservoir, a new return canal has been included in this evaluation. A return canal capacity of 4,000 cfs would maximize Elwood Reservoir's active capacity and contribution to the pulse flow. It is acknowledged that a canal of this capacity is a significant undertaking with significant project costs. This canal capacity was evaluated in this study to maximize the potential contributions and to provide an upper bound to the potential conveyance costs. These flows associated with the pulse flow are believed to be too high for Plum Creek without significant channel improvements and protection. A high flow event occurred in May of 2008 which resulted in inundation of a road crossing, mass wasting of nearby crop land, and destruction of the stream gage, in addition to other property damages. At the time of this study, the magnitude of the event was not known. Based on inspection of the historical flow records, flows greater than 1,000 cfs have been recorded only a few times (based on an incomplete gage record). If upon further investigation, including operational modeling, it is found that a smaller release from Elwood Reservoir is appropriate, the possibility of returning via Plum Creek should be investigated. The current outlet works for Elwood Reservoir are sized at 350 cfs; therefore a release greater than 350 cfs would require the construction of a new outlet works for the dam.

With the exception of the soil survey map no site-specific subsurface information is available. It is estimated that the thickness of unconsolidated deposits overlying the Ogallala Formation is on the order of 300 feet. The soil survey map indicates the entire project area to be underlain by silt loams described predominately as silt (ML). It is anticipated that these near surface deposits belong to either the Peoria Loess and/or the underlying Loveland Formation. There may be a change in ground water levels in the general area as a result of any potential re-operations of the reservoir. The nearby Plum Creek has been changed from an intermittent stream to a perennial stream after the construction of the nearby Elwood and Johnson reservoirs (Reclamation, 1989).

Seepage estimates for Elwood Reservoir are on the order of 26,000 ac-ft per year on average, or up to 70 cfs when full (CNPPID, 2008). The potential effects of additional seepage on the surrounding area are discussed in Section 8.1. As described in Section 8.1, seepage from Elwood Reservoir contributes to the ground water mound in the vicinity. A portion of this mound contributes to ground water flow to the Republican River Basin. If the Program were to modify any portion of the existing reservoir, it would be warranted to investigate potential seepage mitigation efforts at the same time.

Power interference costs for Program water bypassing NPPD and CNPPID facilities would apply to Elwood Reservoir. Program water would bypass the J-1 and J-2 hydros. Costs associated with the bypass are assumed to require compensation as outlined in the EA Bypass Agreement between the Districts and the Program.

4.4 Plum Creek Reservoir Project Configuration

Plum Creek Reservoir would be a new reservoir on the drainage tributary to the Platte River. The reservoir site is located near the town of Smithfield, NE, southeast of Johnson Lake. Two reservoir sizes are being considered in this Phase of the WMS. A small Plum Creek Reservoir with an active capacity of 30,000 ac-ft and a larger reservoir of 100,000 ac-ft of active capacity are considered. Evaluation of the ability to contribute to the WMS Flow Targets will be evaluated for the small reservoir. Opinions of cost are presented for both reservoir sizes in Section 7. The proposed dam alignment for the two reservoirs is the same as that investigated by Reclamation in the Prairie Bend study in 1989. A normal water surface elevation of approximately 2,450 feet and 2,475 feet correspond to the active capacities of the two reservoirs, respectively. At this level of investigation, a dead pool requirement for sedimentation has not been evaluated.

Supply to Plum Creek would require a new canal from East Phillips Lake or other location on the CNPPID Supply Canal upstream of the J-2 forebay. The location considered in this evaluation is East Phillips Lake. For purposes of evaluating contributions to the WMS Flow Targets, a canal capacity of 1,000 cfs was used. A smaller capacity canal or pipeline could result in lower projects costs. More detailed operations studies would be needed to evaluate cost / benefit of a smaller, or larger, supply canal.

Releases from Plum Creek Reservoir would likely be made either via a new return canal to the Platte River or to Plum Creek. For purposes of contributing to the WMS Pulse Flow Target, and maximizing the use of the capacity of Plum Creek Reservoir, a new return canal has been included in this evaluation. A return canal capacity of 5,000 cfs would maximize Plum Creek Reservoir's active capacity and contribution to the pulse flow. It is acknowledged that a canal of this capacity is a significant undertaking with significant project costs. This canal capacity was evaluated in this study to maximize the potential contributions and to provide an upper bound to the potential conveyance costs. These flows associated with the pulse flow are believed to be too high for Plum Creek without significant channel improvements and protection. A high flow event occurred in May of 2008 which resulted in inundation of a road crossing, mass wasting of nearby crop land, and destruction of the stream gage, in addition to other property damages. At the time of this study, the magnitude of the event was not known. Based on inspection of the historical flow records, flows greater than 1,000 cfs have been recorded only a few times (based on an incomplete gage record). If upon further investigation, including operational modeling, it is found that a smaller release from Plum Creek Reservoir is appropriate, the possibility of returning via Plum Creek should be investigated.

The soil survey map for the Plum Creek project indicates a complex series of soil units. This could reflect complex subsurface conditions. However the majority of the soil units are designated as clay (CL), clay and silt (CL-ML), and silt (ML). The Plum Creek project has had site-specific subsurface exploration associated with the previous investigations. Geologic exploration was performed at the Plum Creek site by the Bureau of Reclamation as part of the 1989 Prairie Bend report (Reclamation, 1989). It is estimated that the thickness of unconsolidated deposits overlying the Ogallala Formation is on the order of 100 to 200 feet. Recommendations for the Plum Creek dam and reservoir included excavation and removal of the Peoria Loess and the Loveland Formation to a depth at which the loess has an in-place density of 104 pounds per square foot. The depth of excavation is estimated at about 60 feet thus indicating the Peoria Loess deposit to be less than 60 feet in thickness (Reclamation, 1989). Based on available information, no riprap material is available in the project region and would need to be imported. Alternatively soil cement could also be used to provide erosion protection (Reclamation, 1989).

Power interference costs for Program water bypassing NPPD and CNPPID facilities would apply to Plum Creek Reservoir. Program water would bypass the J-2 hydro power plant. Costs associated with the bypass are assumed to require compensation as outlined in the EA Bypass Agreement between the Districts and the Program.

5.0 ROUTING TOOL EXTENSION

5.1 Routing Tool Development and Extension

The Routing Tool was developed in Phase I of the WMS to evaluate the ability of Program water originating in Lake McConaughy to contribute to the WMS Pulse Flow Target and the WMS Irrigation Season Flow Target (flows from the Tamarack Project on the South Platte were also included in the routing analysis at a steady, lower flow rate relative to the Lake McConaughy releases). The extents of the Phase I Routing Tool were from Lake McConaughy on the North Platte and Roscoe, NE on the South Platte downstream to Overton, NE. The downstream terminus of Overton, NE is the location where contributions to the WMS Flow Targets are evaluated. Overton, NE is near the upstream end of the associated habitats at Lexington, NE and the location of a long term streamflow gage.

The Routing Tool is a daily spreadsheet tool that tracks estimated required releases through the Platte River system and the NPPD and CNPPID systems downstream to Overton, applying capacity constraints, ramp rate limits, release capacities, and attenuation factors. Releases of Program water to meet the WMS Flow Targets are routed 'on-top' of historical flows in the system. The period record of historical flows in the Routing Tool and over which each analysis is run is 1947 through 2006 (water year). A detailed description of the Routing Tool is presented in the Phase I Report.

At the suggestion of the Water Advisory Committee, the Routing Tool was extended downstream to Grand Island as part of this Phase II effort. The purpose for the extension is to estimate the attenuation and resulting flows at the downstream end of the associated habitats, where the Annual Average Target flows are assessed. These resulting flows were evaluated for the WMS Flow Targets evaluated in this Phase. Phase I results were not re-evaluated at this time; however the influence of the lag time and attenuation factors to the Phase I results could be evaluated as part of further studies.

The historical flows in the Phelps County Canal, on the downstream end of the J-2 Return, were also incorporated as a part of this update to the Routing Tool. The historical records of the Phelps County Canal were included for two reasons. The first is that these flows are not reflected in the gaged flows of the J-2 Return to the river. Therefore, during the irrigation season, the actual remaining capacity in the J-2 Return should reflect these flows. The influence of these flows on the Phase I results are likely small due to the timing of the flows in the summer months when available capacity in the CNPPID system is limited. The second reason to include the Phelps County Canal flows is to facilitate the analysis of potential Phase II projects that may rely on available capacity in the J-2 Return of Phelps County Canal.

5.2 Estimated Flood Stage at Grand Island, NE

Included in the development of the Routing Tool were estimates of flood stage and monitored by the National Weather Service (NWS). The flood stage for Grand Island was estimated to be 10,000 cfs based on the published NWS flood stage chart (http://www.weather.gov/ahps/). The value of 10,000 cfs was interpolated from the data on the chart. No rating curve was available for this site to develop a more accurate estimate of the flood flow level. Included in Table 5-1 "*Estimated Flow at NWS Flood Stage for Platte River Reaches*" are the estimated flows associated with the NWS flood stage for the gage locations included in the Routing Tool. The estimated flood stage values presented in Table 5-1 represent interpretation of the flood stage charts obtained from the NWS and best available rating curve. The date of development of each chart is not presented with the information obtained from NWS.

Table 5-1 - Estimated Flow at NWS Flood Stage for Platte River Reaches

Location	Unit	Flow
North Platte River at North Platte, NE**	CFS	3,000
South Platte River at Roscoe, NE	CFS	9,970
South Platte River at North Platte, NE	CFS	18,700
Platte River at Brady, NE*	CFS	15,846
Platte River at Cozad, NE*	CFS	5,845
Platte River at Overton, NE	CFS	7,430
Platte River at Grand Island, NE***	CFS	10,000

* Flood flow calculated based on NWS Flood Stage and best available rating curve data.
** Capacity estimated based on anticipated channel improvements to North Platte "choke point"
*** Flood flow at Grand Island estimated from NWS Flood Stage Chart

5.3 Historical Flow Records

Available historical flow data for the Platte River at Grand Island and for Phelps County Canal were obtained for the period 1947 through 2006. Flows at Grand Island were obtained from the USGS for the site "*06770500, Platte River near Grand Island, NE*". Flows for the Phelps County Canal were provided by Nebraska Department of Natural Resources for site *"122000 Phelps County Canal from Platte River via Tri-County Canal"*. Missing data for the Phelps County Canal was filled with representative average values based on Average, Wet, and Dry hydrologic classifications. These classifications are discussed in Section 6.

5.4 Travel Times and Flow Attenuation

The estimated travel time from the Overton to Grand Island is two days. The river distance between the two gages is approximately 50 miles. The two day estimate was derived by analysis of historical peak flow hydrographs at the two gage locations. Table 5-2 "*Travel Times on the Platte River – Keystone to Grand Island*" presents travel time estimates on the Platte River developed for use in the Routing Tool.

Table 5-2 - Travel Times on the Platte River – Keystone to Grand Island

Reach	Upstream Location	Downstream Location	Approx. River Miles	Travel Time
South Platte River – Roscoe to North Platte	Roscoe, Nebraska	North Platte, North Platte Hydro, and CNPPID Diversion	50	2 Days
North Platte River – Keystone to North Platte	Lake McConaughy	North Platte, North Platte Hydro, and CNPPID Diversion	60	2 Days
Platte River – Confluence to Brady	North Platte, North Platte Hydro, and CNPPID Diversion	Brady, Nebraska and Jeffrey Return	20	1 Day
Platte River – Brady to Overton	Brady, Nebraska and Jeffrey Return	J-2 Return and Overton, Nebraska	50	1 Day
Platte River – Overton to Grand Island	Overton, Nebraska	Grand Island, Nebraska	70	2 Days

Attenuation and loss factors for the daily routing for Overton to Grand Island were derived by constructing a naturalized flow of the river. A detailed discussion of the approach used to develop the attenuation factors is presented in Section 3.5 of the Phase I Report. The general concept is repeated here in a shorter form.

Daily river losses or attenuation factors were developed on a seasonal basis for the river reach from Overton to Grand Island. The seasonal variation was limited to winter (October - April) and summer (May - September) periods. Loss factors were evaluated for both winter and summer values for each of the water year classifications. The analysis resulted in a single loss factor for winter months for each classification and three loss factors for the summer months corresponding to the year classification.

The term "loss" in the daily analysis is used as a general term to represent a combination of effects on river flows as they move downstream including attenuation, in-channel storage, bank storage, evaporation, or other losses (phreatophytes, irrigation diversions, pumping for irrigation and municipal uses, and unrecorded diversions).

Loss factors were developed based on an empirical analysis of historic daily flows at the upstream gage and naturalized flows at the downstream gage of each reach. The naturalized flows were estimated for the 60 year period utilizing the available daily data for the river gage, measured diversions, and measured returns to the river. Major diversions occurring in the reach were added back to the downstream gage and major returns were subtracted from the downstream gage to remove these influences from the gage. For reaches and periods that appeared to be gaining at the downstream gage, the baseflow portion of flow was subtracted from the gage. The baseflow was estimated for individual events using a straight line method. Baseflow estimates varied for each location, event, or season evaluated. The naturalization calculation is represented by the following equation:

Naturalized Flow = Downstream Gage + Diversions – Returns – Baseflow

Table 5-3 entitled, "Diversions and Returns Included in Daily Loss Estimates" lists the diversions, and returns (inflows) included in the naturalized flow calculation for each river reach evaluated in the Routing Tool. To determine the attenuation factor for a given event, a trial factor is applied to the upstream gage to calculate an estimated downstream flow. This estimated flow is compared to the naturalized downstream gage flow for fit in peaks and shape of the hydrograph. If the fit is not suitable, then a new factor is applied and the fit checked again. This continues in an iterative fashion until a suitable factor is estimated.

Table 5-3 - Diversions and Returns Included in Daily Loss Estimates

Reach	Diversions	Returns
South Platte River – Roscoe to North Platte	Korty Diversion	N/A
North Platte River – Keystone to North Platte	Keith-Lincoln North Platte Paxton-Hershey Suburban Cody-Dillon	Birdwood Creek (est.)
Platte River – Confluence to Brady	CNPPID	(North Hydro Return included in estimate of flow at confluence)
Platte River – Brady to Overton	Thirty Mile Gothenburg Six Mile Cozad Orchard-Alfalfa Dawson County	Jeffrey Return J-2 Return
Platte River – Overton to Grand Island	Kearney Canal	Buffalo Creek Elm Creek Kearney Power Return

The estimated loss factors for the summer months vary based on year classification. In the case of winter months, little variability was seen across year classification, and therefore a single winter loss factor is used. Table 5-4 entitled, "Attenuation Factor Estimates" summarizes the loss terms by season and water year classification.

Table 5-4 - Attenuation Factor Estimates

Reach	Winter	Summer		
	All years	Avg. years	Wet years	Dry years
South Platte River – Roscoe to North Platte	5%	20%	10%	35%
North Platte River – Keystone to North Platte	5%	15%	15%	15%
Platte River – Confluence to Brady	5%	5%	5%	5%
Platte River – Brady to Overton	5%	13%	13%	50%
Platte River – Overton to Grand Island	5%	15%	5%	45%

6.0 CONTRIBUTION TO TARGET FLOWS

The WMS evaluates the ability of three reservoir project concepts to contribute to the WMS Pulse Flow, WMS Irrigation Season Flow, and Annual Average Flow Targets. The Program Document defines these flows and the intent of each. To place these targets and the evaluation of projects into context a discussion of the Program goals is included here.

Section 11 of The Water Plan (Attachment 5) of the Program Document describes the USFWS Instream Flow Recommendations. The instream flow recommendations are comprised of target flows, peak flows, and other flows deemed important by the USFWS. "Target flows" include "species flow" plus "annual pulse flow" recommendations, as summarized in Appendix E of the Water Plan Reference Materials. The target flows are the flow levels that the Program actively seeks to achieve through provision of Program water, re-timing of river flows, and prevention of new depletions. Target flows are used as the basis for "scoring" the water-related benefits of Program activities relative to the 130,000 - 150,000 acre-foot/year First-Increment objective for reductions in shortages to targets.

The Program Document (Attachment 5, Section 11, page 6) defines "short-duration high flows" as flows approximately three to five days in duration with magnitudes approaching but not exceeding bankfull channel capacity in the habitat reach. These flows are desired on an annual or near-annual basis to help scour vegetation encroaching on channel habitat areas and to mobilize sand and build ephemeral sandbars to benefit the target species. Short-duration high flows may be achieved naturally or by means of supplementing other flows with Program water. In the interest of ensuring that the Program has the ability to generate short-duration high flows of sufficient magnitude, duration, and frequency, the Water Management Study (WMS) investigates strategies for providing 5,000 cfs of Program water for three days at the Overton gage when other competing demands are low (September 1 through May 31), referred to in Phase II as the WMS Pulse Flow Target. Phase II of the WMS focused on providing this 5,000 cfs of Program water in every year of the simulation period during the low demand period of September through May. The evaluation did not include timing of the release with existing peak flows or considering other peak flow targets.

Attachment 5, Section 11 of the Program Document specifies that to the extent Program water is used to create or augment short-duration high flows, it will be counted toward the Program score and that short-duration high flows will not be used as a basis for calculating shortages relative to the 130,000 to 150,000 acre-foot/year First Increment of the Program. Phase II of the WMS estimates the potential for three types of reservoirs to contribute to the WMS Pulse Flow Target, as well as the potential to reduce or eliminate shortages to the Average Annual Target Flows. To the extent that Program water is used to contribute to short-duration high flows, they will be considered contributions to the First Increment objective (even if they occur at times when there are no shortages to target flows, that is, during periods of flow excesses). The full 5,000 cfs will be included as a contribution to the First Increment objective of 130,000 to 150,000 acre-feet, to the extent that water is controllable by the Program and is intentionally delivered for purposes of contributing to a short-duration high flow.

Phase II of the WMS also evaluates the ability of these reservoir projects to contribute to the WMS Irrigation Season Flow Targets. Based on WMS Phase I comments provided by USFWS, Phase II evaluates the ability to release Program water from the three types of reservoir projects to supplement river flows and achieve a total flow of 800 cfs at Overton. The volume of water required over the irrigation season to meet the 800 cfs target range, on average, from 27,000 ac-ft in Wet years to 127,000 ac-ft in Dry years.

The contribution of Program water to the 800 cfs will be included as a contribution to the First Increment objective of 130,000 to 150,000 acre-feet, to the extent that water is controllable by the Program and is intentionally delivered for purposes of contributing to the irrigation season flows.

6.1 Approach

Project evaluations in Phase II utilize the Routing Tool and the WMC Loss Model extension developed in Phase I. Each of the three reservoir concepts, J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir, is evaluated for its ability to contribute up to 5,000 cfs of Program water at Overton during the winter and spring months, up to the 800 cfs target flow at Overton during the irrigation season, and the resulting contribution of these flows downstream at Grand Island in reducing average annual shortages to target flows.

The physical supply to each reservoir is assumed for the purposes of the Phase II analyses to be releases of Program water (from Lake McConaughy or another source) or water developed or re-timed by the Program capable of being delivered to the Districts' diversion points. This approach focuses the Phase II analyses on the ability of each reservoir concept to fill and release based on existing system capacities.

Additional analysis of the excess flows, the physical location, and daily operations of the concept reservoirs in conjunction with other Program projects for re-timing is required in additional phases to refine the required operational capacities.

The evaluation of the contribution to the WMS Pulse Flow and Irrigation Season Flow Targets are performed using the Routing Tool developed as part of Phase I and updated in Phase II.

Subsequent to the evaluation of the project contributions to the WMS Pulse Flow and Irrigation Season Flow Targets, the releases from the storage reservoirs are tracked in the Platte River from Overton to Grand Island on a monthly basis utilizing the WMC Loss Model. The timestep and period implemented in the WMC Loss Model differ from that of the Routing Tool. The Loss Model calculates gains and losses on a monthly time step from 1975 to 2006. These tools overlap for the years 1975-2006. The input to the Loss Model is the resulting flows (summed to monthly values) at Overton as estimated with the Routing Tool.

Based on the results of and comments to the Phase I report, in addition to the nature of the Phase II projects, there are differences in how these projects were evaluated in contrast to Phase I. The differences should be recognized, but they do not preclude comparison of the results from Phase I and Phase II. These differences include:

- The use of Average, Wet, and Dry year classifications as developed by USFWS based on flows at Grand Island. The use of flows at Grand Island is different than the classifications developed for Phase I, which were based on annual flows at Overton. This change was made to facilitate the coupling of the Routing Tool with the WMC

Loss Model, and future evaluation in the context of periods of excess and shortage at Grand Island. The USFWS classifications were provided for the period of 1947-2006, and are intended to mimic the classifications used in the OPSTUDY model (Anderson, 2007). The method for classifying these years, as provided by FWS are:

(1) The annual river discharge as reported by the USGS for the gage near Grand Island (#06770500)

(2) Data by calendar year

(3) Years 1947 through 1994 are the basis for establishing Wet, Average, Dry classifications. Flow thresholds are applied to all other years.

(4) The Program's definition of Wet/Average/Dry as that the 1/3 wettest years are Wet, the 1/4 driest years are Dry, and all others are Average.

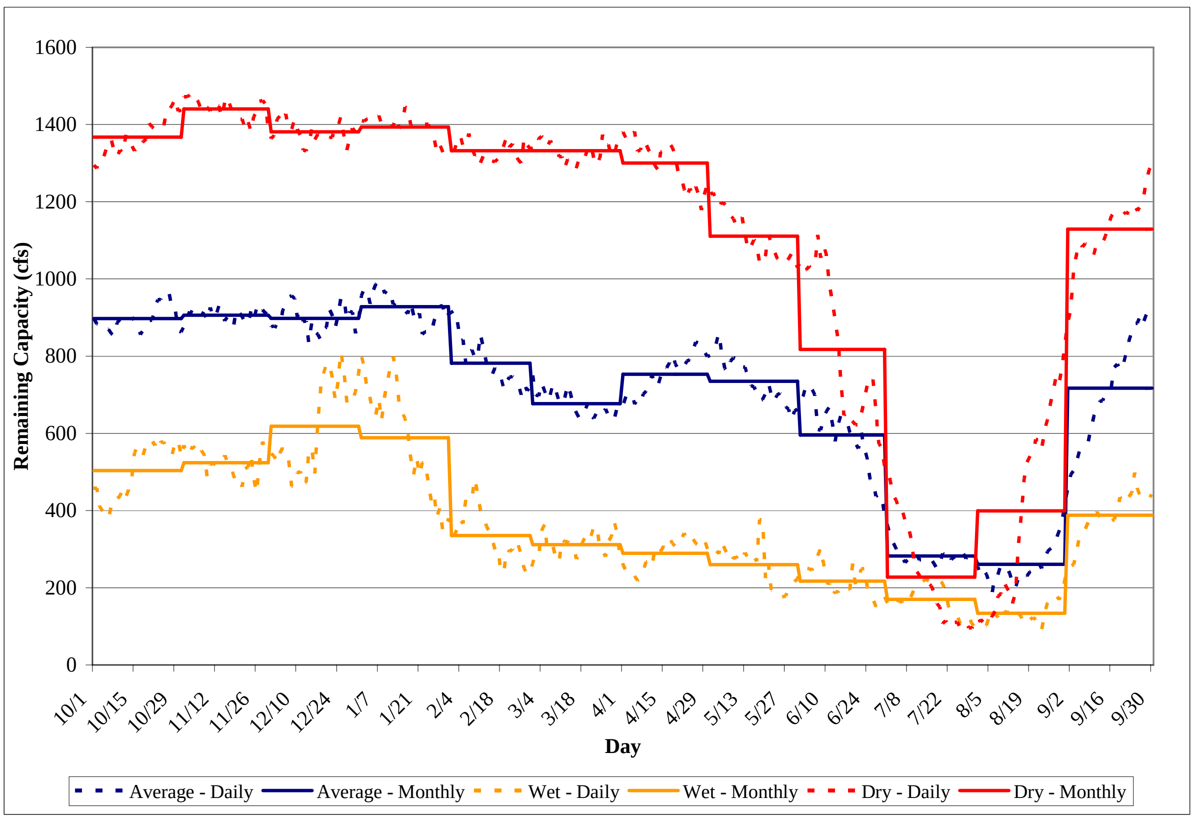
For this 60 year period, differences in classification exist for a total of 13 years, 9 of which are reclassified as wetter than in Phase I. (The effect of the 13 years of differing classification is small because the routing of water in Phase II is less dependent on hydrologic year types and associated losses than in Phase I. Also the contribution to Average Annual Targets was not performed in Phase I, and therefore was not influenced by the USFWS classifications.) Table 6-1, "USFWS Classification of Water Years Based on Average Annual Flow at Grand Island (1947-2006)" lists each year and its associated classification.

Table 6-1 - USFWS Classification of Water Years Based on Average Annual Flow at Grand Island (1947-2006)

Water Year	Classification		Water Year	Classification
1947	Average		1977	Average
1948	Average		1978	Average
1949	Wet		1979	Average
1950	Average		1980	Wet
1951	Wet		1981	Dry
1952	Wet		1982	Average
1953	Dry		1983	Wet
1954	Dry		1984	Wet
1955	Dry		1985	Wet
1956	Dry		1986	Wet
1957	Dry		1987	Wet
1958	Average		1988	Average
1959	Dry		1989	Average
1960	Average		1990	Average
1961	Dry		1991	Dry
1962	Average		1992	Average
1963	Dry		1993	Wet
1964	Dry		1994	Average
1965	Wet		1995	Wet
1966	Average		1996	Wet
1967	Average		1997	Wet
1968	Average		1998	Wet
1969	Average		1999	Wet
1970	Wet		2000	Wet
1971	Wet		2001	Average
1972	Wet		2002	Dry
1973	Wet		2003	Dry
1974	Wet		2004	Dry
1975	Average		2005	Dry
1976	Dry		2006	Dry

- Program water is routed through the CNPPID system upstream of the project being evaluated. This is in contrast to Phase I where Program water was routed from Lake McConaughy downstream. Due to the nature of the three projects being reservoirs fed lower in the CNPPID, and that a smaller amount of remaining capacity is required to fill during the winter (as opposed to the capacity needed to attempt a full 5,000 cfs pulse from Lake McConaughy) the filling of the reservoirs is estimated utilizing the minimum of the available capacity at the CNPPID Diversion and the portion of the system immediately upstream of the project. Figure 6-1 “Remaining Capacity at CNPPID Diversion at North Platte” shows the average monthly and average daily remaining capacity at the CNPPID diversion based on the years 1947-2006. These values are from the Phase I capacity analysis. These results indicate that on average, sufficient capacity for Program water is available at the CNPPID diversion. Because these are average values, there may be some years where the remaining capacity will limit diversions. This is particularly true in Wet years, when remaining capacity is generally lower. This constraint is reflected in the routing analysis for each reservoir concept as this comparison is made on a daily basis in the Routing Tool. However, this impact is limited to only a few instances of Wet years in the evaluation of Plum Creek (30,000 ac-ft). It would also impact a large Plum Creek to a greater extent, however this reservoir concept was not evaluated explicitly with the routing tool.

Figure 6-1 - Remaining Capacity at CNPPID Diversion at North Platte (Diversion capacity = 2,250 cfs)



- Each of the project concepts is evaluated as a stand-alone project that is supplied using excess capacity in the CNPPID system; therefore there is not a case of using only the Platte River for delivery. The Phase II results compare with the Case I results of Phase I where Program water is routed in the Districts' system up to the remaining capacity. (CNPPID Diversion capacity = 2,250 cfs)
- The WMS Irrigation Season Target Flow is evaluated based on Program water contributing to, or supplementing, other flows in the river to achieve a total flow of 800 cfs. This flow target is in contrast to Phase I where 800 cfs of *Program water* was targeted in *addition* to other flows at the Overton gage. The irrigation season target is evaluated from May 1 to September 15 in Phase II, as opposed to the end date of September 30 used in Phase I. These differences are a result of discussions and comments related to the Phase I Report, and a refined interpretation of the Program goals.

The three storage sites are located near the bottom of the CNPPID system and therefore, the approach to evaluating contributions to targets flows is similar. The primary differences are in how each is supplied by the CNPPID canal, storage capacity, and appropriate filling and release capacities. The underlying approach and basis for evaluation for each of the projects include the following:

- The evaluation in Phase II is focused on the potential contribution of individual projects to target flows. Each project is evaluated independent of the others as well as independent of other potential contributions of Program water (e.g. releases from Lake McConaughy to the Platte River).
- The potential contribution of each project to the WMS Pulse Flow and WMS Irrigation Season Flow is evaluated independently. The operations of the reservoirs are not simulated to provide combined or integrated contributions to both targets in the same year.
- The estimated active capacity of each reservoir is modeled as a complete fill and release in one season. No reserve pool for recreation or other uses is considered at

this level of analysis. In addition, with the target of a three day pulse flow, this would require a rapid drawdown of each reservoir.

  - J-2 Return Reservoir active capacity = 3,300 ac-ft
  - Elwood Reservoir active capacity = 24,000 ac-ft
  - Plum Creek Reservoir active capacity = 30,000 ac-ft

- Outlet capacities and channels are sized to allow a full reservoir release in three days. Appropriate ramping rates, if necessary, should be evaluated as part of the feasibility design.
  - J-2 Return Reservoir return capacity = 500 cfs
  - Elwood Reservoir return capacity = 4,000 cfs
  - Plum Creek Reservoir return capacity = 5,000 cfs
- Inlet capacities are sized based on an estimate of reasonable available capacity upstream in the system and fill time, or as limited by facility layout.
  - J-2 Return Reservoir inlet capacity = 2,000 cfs
  - Elwood Reservoir inlet capacity = 190 cfs (estimated pumping capacity at near-full elevation)
  - Plum Creek Reservoir inlet capacity = 1,000 cfs
- Each reservoir is filled utilizing estimated available capacity at the CNPPID diversion and just upstream of the projects over the preceding winter months. The reservoir is filled in a given year to a full active capacity.
- Reservoir losses associated with evaporation and seepage are based on average historical losses at Elwood Reservoir for the period of 1978-2004. Historical values were provided by CNPPID. The historical average monthly losses are used to approximate daily seepage and evaporation values for each reservoir. Seepage and evaporation losses for the J-2 Return Reservoir and the Plum Creek Reservoir are derived from the estimated values at Elwood pro-rated based on the maximum surface areas of each reservoir.

- Reservoir releases for pulse flows were made at approximately the same time of year as modeled in Phase I when possible to facilitate comparison with the Phase I results. This comparison will reflect similar constraints in the system. This was not possible for every routing scenario due to the required fill times and losses associated with the reservoirs sitting full. The reservoirs were not operated specifically to time with existing higher flow events. However, an attempt was made to operate releases during the relatively higher flows of the similar period, over a range of the adjacent days.
- Releases for the pulse flow are made at full capacity for 3 days. A small volume of water typically less than 100 ac-ft remains in the reservoir and is therefore released on the 4th day. This 4th day contribution is not counted towards the pulse flow, but is included in the total contribution measured downstream at Grand Island.
- Releases for the irrigation season flow targets begin on May 1 and continue through September 15 subject to the storage in the reservoir. Releases to this target are the minimum of the volume in storage, the release capacity, and the balance of flow at Overton less than 800 cfs.
- Routing from the reservoir to Overton is approximated at less than one day for each project. Return distances range from less than one mile for the J-2 Return Reservoir to about 15 miles for Elwood Reservoir.
- Loss or attenuation in the return to the river is neglected based on the return distances.
- For each project and target flow scenario, resultant Program flows at Overton are summed on a monthly basis and input to the WMC Loss Model. These flows are evaluated downstream at Grand Island to estimate monthly losses associated with the volume of contribution.

6.2 Contribution to Pulse Flows

The Phase II projects, J-2 Return Reservoir, Elwood Reservoir, and a small Plum Creek Reservoir, were evaluated for each project's ability to contribute a pulse flow over a 3 day period at Overton. Given the proximity of each reservoir at or near the downstream end of the CNPPID and Overton, the primary constraint of each in providing a pulse flow is the storage capacity of each and the capacity of the river return.

Based on the historical remaining capacity in the CNPPID system at the diversion and just upstream of the projects during the winter months, the reservoirs fill over the days and months prior to the timing of a pulse flow. Filling in the winter is the current operation of Elwood Reservoir as necessary to meet summer irrigation demands served by the E-65 Canal. The required time to fill each reservoir is dependent on the active capacity, inlet capacity, and historic remaining capacity in the system. In dry years the reservoirs fill quicker due to the higher remaining capacity in the CNPPID system. Conversely, in wet years when the system is fuller, the reservoirs require longer fill times. Given the small size of the J-2 Return Reservoir and its location adjacent to the J-2 Return to the Platte River, this reservoir fills in as little as 1 or 2 days during Dry years, and up to a month in Wet years. Filling of Elwood Reservoir as modeled in the Routing Tool typically takes longer than two and half months in Dry years, and up to six months in Wet years. Filling of Elwood Reservoir is primarily limited by the modeled fill rate of 190 cfs. This fill rate is based on the estimated pump station capacity when the reservoir is near full. During actual operations, a higher fill rate is possible (as high as 270 cfs with all three pumps operating). The lower estimate was used in this analysis to provide a conservative estimate of required time to fill. The time required to fill in Wet years is a function of capacity at the CNPPID diversion. The fill time for Elwood could be reduced by increasing the size and/or number pumps and the inlet. These fill times could also be reduced if the capacity at the diversion historically used for filling Elwood Reservoir for CNPPID uses is made available for Program water. Typical filling times for the 30,000 ac-ft Plum Creek Reservoir with a maximum fill rate of 1,000 cfs ranges from 16 days in Dry years , typically up to 40 days in some Wet and Average periods, and greater than six months in a few Wet years when capacity is very limited.

The ability to fill a larger Plum Creek Reservoir was not evaluated explicitly in Phase II. However, based on the results of the small Plum Creek Reservoir routing analysis, it would be difficult to fill the reservoir in one season during some Wet years. Filling of Plum Creek Reservoir with native flows is subject to excesses to shortages, new storage rights, and the physical flow in the creek. An evaluation of the 22 years of available data for the USGS gage on Plum Creek near Smithfield (#06767500) indicates the average annual physical flow in the creek is approximately 7,300 ac-ft. This value is a gross volume and does not consider periods of excesses or downstream diverters that would be reliant on these flows. This analysis does lead to the conclusion that a large Plum Creek Reservoir could not rely on native flows to fill. In addition, the inability to fill in one season from CNPPID indicates that the large Plum Creek Reservoir would be suited only for year to year operations for filling and releasing.

Return capacities were sized based on drawing down the active contents of each reservoir over three days. Therefore, in the current analysis, the ability to contribute to a Pulse Flow is solely related to the active capacity of each reservoir. The peak day contribution in cubic feet per second and three-day total volume, in acre-feet, of each reservoir is presented in Table 6-2 below. The peak contribution for the J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir are 500 cfs, 4,000 cfs, and 5,000 cfs, respectively. Because of the close proximity to Overton, the complete fill of the reservoir in the winter season, and the use of dedicated return canal, there is no variation in the contribution from a project when considering an Average, Wet, or Dry year. The variation as a result of the hydrologic conditions influences the time required to fill, and therefore the volume of reservoir losses. This is also presented in Table 6-2 as the total diversion to the project.

Also presented in the table is the resulting peak flow of Program water routed downstream to Grand Island in the Routing Tool. The estimated attenuation to a peak flow during the winter months from Overton to Grand Island is 5 percent as discussed in Section 5.

Table 6-2 - Contributions to a Pulse Flow

Year Class	J-2 Return Reservoir				
	Diversion to Project (ac-ft)	Peak 3-Day Total to Overton (ac-ft)	Total Project release to Overton (ac-ft)	Peak Program water Overton (cfs)	Peak Program water Grand Island (cfs)
Average	3,340	2,980	3,210	500	480
Wet	3,410	2,980	3,230	500	480
Dry	3,320	2,980	3,220	500	480

Year Class	Elwood Reservoir				
	Diversion to Project (ac-ft)	Peak 3-Day Total to Overton (ac-ft)	Total Project release to Overton (ac-ft)	Peak Program water Overton (cfs)	Peak Program water Grand Island (cfs)
Average	27,500	23,800	23,810	4,000	3,800
Wet	27,530	22,900	22,910	4,000	3,800
Dry	27,510	23,800	23,800	4,000	3,800

Year Class	Plum Creek Reservoir				
	Diversion to Project (ac-ft)	Peak 3-Day Total to Overton (ac-ft)	Peak Program water Grand Island (cfs)	Peak Program water Overton (cfs)	Peak Program water Grand Island (cfs)
Average	31,870	29,750	29,750	5,000	4,750
Wet	32,580	28,440	28,440	4,960	4,710
Dry	31,260	29,750	29,750	5,000	4,750

Results for the Pulse Flow contribution of the J-2 Return Reservoir, Elwood Reservoir, and a small Plum Creek Reservoir are compared to the Phase I results in Table 6-3. These Phase I results reflect the Average, Wet, and Dry year average contributions to a pulse flow for Case I. Case I in the Phase I study allowed for the Districts to divert Program water up to the remaining capacity and the balance of the release from McConaughy traveled downstream in the Platte River channel. The contributions of the Phase II projects are consistent among each of the hydrologic scenarios in contrast to the flows in Phase I.

Delivering water on the order of magnitude of the Pulse Flow from Lake McConaughy is influenced more by capacity limitations and variability in addition to ramping rates associated with the river and District systems. The volumes of total water required for each of the scenarios in Table 6-3 also indicates that a greater amount of water is required for release from Lake McConaughy to create the Pulse Flow as compared to positioning the water lower in the system over time. The volumes of water diverted to the reservoirs in Table 6-3 may be lower than what would actually be released from McConaughy and diverted into CNPPID's system. This is a result the attenuation/ loss factors applied higher up in the system in Phase I. These losses could amount approximately to an additional 15 percent requirement to fill the reservoirs. These losses were not modeled explicitly in Phase II because the season-long fill is less constrained by remaining capacity and attenuation of flows. Because only the active capacity of each reservoir was modeled, seepage incurred in the off-season is not accounted for in the routing analysis. An estimated 3,500 to 7,500 ac-ft per year may seep and evaporate during the off-season. These values are derived from the historic seepage data for Elwood Reservoir. The dead pool requirement for J-2 and Plum Creek Reservoir is not evaluated in this Phase, therefore additional seepage and evaporation loss estimates were not developed. The potential for these additional losses will be dependent on the design of each reservoir and would be considered during preliminary design.

Table 6-3 - Comparison of Phase I and Phase II Pulse Flow Contribution at Overton

Year Class	Phase I (No Project)			
	5,000 cfs Target (ac-ft)	Release from McConaughy (ac-ft)	Peak Program water Overton (cfs)	Peak 3-Day Total to Overton (ac-ft)
Average	29,750	81,300	4,700	22,200
Wet	29,750	71,600	3,800	19,100
Dry	29,750	99,900	5,200	24,300

Year Class	J-2 Return Reservoir			
	5,000 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Peak Program water Overton (cfs)	Peak 3-Day Total to Overton (ac-ft)
Average	29,750	3,340	500	2,980
Wet	29,750	3,410	500	2,980
Dry	29,750	3,320	500	2,980

Year Class	Elwood Reservoir			
	5,000 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Peak Program water Overton (cfs)	Peak 3-Day Total to Overton (ac-ft)
Average	29,750	27,500	4,000	23,800
Wet	29,750	27,530	4,000	22,900
Dry	29,750	27,510	4,000	23,800

Year Class	Plum Creek Reservoir			
	5,000 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Peak Program water Overton (cfs)	Peak 3-Day Total to Overton (ac-ft)
Average	29,750	31,870	5,000	29,750
Wet	29,750	32,580	4,960	28,440
Dry	29,750	31,260	5,000	29,750

6.3 Contribution to Irrigation Season Flows

The J-2 Return Reservoir, Elwood Reservoir, and a small Plum Creek Reservoir were evaluated in their ability to contribute to the 800 cfs irrigation season flow target at Overton from May 1 through September 15. For all of the evaluations, the reservoirs were filled during the days or months prior to May 1. Releases from the reservoir were made based on the goal to supplement flows at Overton to meet the 800 cfs flow target. Therefore Program water is used to contribute from 0 to 800 cfs of flow at Overton. The contribution of projects ranges from supplemental supplies of a few days for operations of the J-2 Return Reservoir to some instances of near season long contributions from Plum Creek Reservoir. The minimum volume of contribution is zero, when in 1983, a wet year, no releases are necessary for the 800 cfs flow at Overton. This zero release is the same for all reservoirs evaluated. Table 6-4 presents the total volume of water diverted to each of the reservoirs and the total contribution in ac-ft to the 800 cfs target for Average, Wet, and Dry year classifications.

Contributions in Dry years are the greatest for all three reservoirs evaluated. This is a result of a greater need for supplemental flows in these years. Average years result in the second highest contribution for each project. The season total contribution for Average years is lower than in Dry years as a result of greater seepage and evaporation losses as the reservoirs stay fuller longer. The lowest supplemental contributions result in Wet years as a result of both smaller needs, and the longer residence time resulting in greater seepage losses, similar to the Average year results.

Average monthly contributions for each year class are presented in Appendix 3.

Table 6-4 - Contributions to 800 cfs Irrigation Season Flows at Overton

Year Class	J-2 Return		
	Required Supplemental Flow for 800 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Contribution to 800 cfs at Overton (ac-ft)
Average	74,180	3,380	2,500
Wet	27,390	3,630	1,360
Dry	126,980	3,330	2,870

Year Class	Elwood Reservoir		
	Required Supplemental Flow for 800 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Contribution to 800 cfs at Overton (ac-ft)
Average	74,180	29,920	17,110
Wet	27,390	30,570	10,500
Dry	126,980	29,680	19,270

Year Class	Plum Creek Reservoir (30 KAF)		
	Required Supplemental Flow for 800 cfs Target (ac-ft)	Diversion to Project (ac-ft)	Contribution to 800 cfs at Overton (ac-ft)
Average	74,180	33,940	19,730
Wet	27,390	36,450	11,490
Dry	126,980	32,710	22,710

6.4 Credits of Resultant Flows at Grand Island

Program water that is released for the benefit of the Program, to the extent that water is otherwise controllable, will be credited as a contribution to the First Increment objective 130,000 to 150,000 ac-ft. For this reason, the water released to contribute to the 5,000 cfs Pulse flow and the 800 cfs irrigation season flow will be credited to the First Objective. The resulting volume of these contributions at Grand Island were evaluated with the WMC Loss Model for the period 1975-2006. The WMC Loss Model is a monthly spreadsheet that applies historic gains and losses to Program water introduced to the Platte River. For this application, contributions made at Overton were tracked downstream to Grand Island. It is understood that all of the flow resulting at Grand Island will be credited to the Program regardless of whether it occurs in a time of shortage or excess. The contributions to flows at Grand Island are presented on a monthly basis for the Average, Wet, and Dry year classifications for both flow targets and all three projects. The results are presented in Table 6-5 below. The monthly summaries of all flows for 1975-2006 are presented in the tables in Appendix 3.

The pulse flow releases from the J-2 Return Reservoir contribute to flows at Grand Island from about 2,800 ac-ft to 3,120 ac-ft. The low value is the average of Dry years, when transit losses are higher. Conversely, the higher value is associated with Wet years with lower transit losses from Overton to Grand Island.

Contributions at Grand Island from the J-2 Return Reservoir resulting from the irrigation season flow range 1,200 ac-ft to 2,800 ac-ft. The lower value represents Wet year contributions when the need to the supplement the 800 cfs target flow is smaller. Dry year contributions to Grand Island are higher during the irrigation season because the demand for supplemental flow is higher and the contributions are made sooner, thus minimizing the residence time in the reservoir and seepage and evaporation losses.

The pulse flow releases from Elwood Reservoir contribute to flows at Grand Island from about 21,600 ac-ft to 22,800 ac-ft. The low value corresponds with Wet years, and is influenced by years when, due to filling constraints, a full 3-day contribution of 4,000 cfs was not achieved (water years 1998 and 2000). Average year and Dry year resulting flows are similar, with Dry years lower due to transit losses.

Contributions at Grand Island from Elwood Reservoir resulting from the irrigation season flow range 8,000 ac-ft to 18,300 ac-ft. The lower value represents Wet year contributions when the need to the supplement the 800 cfs target flow is smaller. Dry year contributions to Grand Island are higher during the irrigation season because the demand for supplemental flow is higher and the contributions are made sooner, thus minimizing the residence time in the reservoir and seepage and evaporation losses.

The pulse flow releases from Plum Creek Reservoir contribute to flows at Grand Island from about 26,000 ac-ft to 28,500 ac-ft. The low value is the average of Dry years, when transit losses are higher. The high value is the average of the Average years. The average contributions in Wet years were influenced by one year when due to filling constraints, a full 3-day contribution of 5,000 cfs was not achieved (water year 2000).

Contributions at Grand Island from Plum Creek Reservoir resulting from the irrigation season flow range 8,600 ac-ft to 21,400 ac-ft. The lower value represents Wet year contributions when the need to the supplement the 800 cfs target flow is smaller. Dry year contributions to Grand Island are higher during the irrigation season because the demand for supplemental flow is higher and the contributions are made sooner, thus minimizing the residence time in the reservoir and seepage and evaporation losses.

Table 6-5 - Resulting Flows at Grand Island (WMC Loss Model Results)

Resultant Flow at Grand Island - J-2 Return Reservoir - 5,000 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	250	290	1240	1310	0	0	0	0	0	3090
Wet	0	240	0	220	970	960	730	0	0	0	0	0	3120
Dry	0	150	0	0	380	600	1670	0	0	0	0	0	2800

Resultant Flow at Grand Island - J-2 Return Reservoir - 800 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	0	0	0	0	2000	410	0	0	0	2410
Wet	0	0	0	0	0	0	0	300	390	460	50	0	1200
Dry	0	0	0	0	0	0	0	2790	0	0	0	0	2790

Resultant Flow at Grand Island - Elwood Reservoir - 5,000 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	1810	2110	18900	0	0	0	0	0	0	22820
Wet	0	0	1810	1580	7210	10620	400	0	0	0	0	0	21620
Dry	0	0	2690	0	2780	16890	0	0	0	0	0	0	22360

Resultant Flow at Grand Island - Elwood Reservoir - 800 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	0	0	0	0	8080	7980	470	0	0	16530
Wet	0	0	0	0	0	0	0	970	1360	5060	510	110	8010
Dry	0	0	0	0	0	0	0	15710	2600	0	0	0	18310

Resultant Flow at Grand Island - Plum Creek Reservoir - 5,000 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	2259	2632	23619	0	0	0	0	0	0	28510
Wet	0	0	0	4253	8824	12855	628	0	0	0	0	0	26560
Dry	0	1397	0	0	3475	19960	1202	0	0	0	0	0	26034

Resultant Flow at Grand Island - Plum Creek Reservoir - 800 cfs Target (ac-ft)

Year Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average	0	0	0	0	0	0	0	8352	10006	927	0	0	19284
Wet	0	0	0	0	0	0	0	969	1490	5294	699	112	8565
Dry	0	0	0	0	0	0	0	17570	3719	81	0	0	21370

7.0 OPINIONS OF PROBABLE COST

Preliminary estimates of opinions of probable cost were developed for the J-2 Return Reservoir, Elwood Reservoir, and Plum Creek Reservoir. Costs were initially developed based on information available from previous studies and the reconnaissance field visit. Project costs include construction costs, land acquisition, annual operating costs, and power interference costs where applicable. Estimates of construction costs represent the major cost items associated with each project, such as dam and appurtenances, inlet and outlet facilities and canals. Unlisted items and a contingency factor were also added. Annual operating and maintenance costs were estimated based on the construction cost subtotal and computed as a capital costs for a 25-year project life with an interest rate of 6%. Power interference costs were derived for Elwood Reservoir and Plum Creek based on the average annual diversion to storage lost revenue estimate provided in the EA Bypass Agreement. Additional cost items used in these initial estimates for all three projects are as follows:

- Contractor mobilization and demobilization equal to 5% of the construction subtotal.
- Unlisted construction items equal to 10% of the construction subtotal.
- A construction cost contingency of 30% is applied to the construction subtotal.
- Permitting and Design costs are approximated as 8% of the construction subtotal.
- Annual operation and maintenance are estimated to be 2% of the total estimated construction cost. This estimate includes routine maintenance and replacement costs over the life of the project. Annul operations and maintenance costs are calculated as a present worth for 25 years at a 6% discount rate.
- Estimates of power interference costs are included for Elwood Reservoir and Plum Creek Reservoir. The actual cost for power interference is dependent on the duration, timing, and amount of generation shortage due to the bypassed flows. The actual cost of lost power generation is determined on the NPPD delivered market price of at the time of loss and the actual generation lost. For purposes of comparison of these reservoir project concepts, power interference costs associated only with CNPPID's contract cost is included. The estimated contract rate for 2008 is $32.45 / NMwh

(CNPPID, 2008b). The annual costs calculated for Elwood Reservoir and Plum Creek Reservoir operations utilize the 2008 contract rate. Annual interference costs are based on the total volume of water bypassing the respective powerplant(s) and the contract rate, based on the example calculation included in Exhibit A of the EA Bypass Agreement.

These initial cost estimates were developed to be consistent with the scope of work for this Phase II study, were based on previously performed work on the Plum Creek project, and did not include optimization of the layout for the J-2 Return Project. The result of this approach, as shown below, yields conservative cost estimates that raise the question of affordability under the Program's funding. These initial estimates when compared with cost information provided by the Executive Director's office for a recently construction Nebraska dam project and from other similar projects designed by Boyle (including the recently constructed Dry Creek Dam Project in the South Platte River Basin in Colorado) demonstrate the need to refine the project layouts and perform more detailed evaluations of costs. Presented below are the initial estimates, which should be considered upper bounds to the planning-level opinions of probable construction costs, and suggestions for updating these costs as the Program moves forward.

J-2 Return Reservoir

Embankment Dam. Construction of storage at this site involves excavation and placement of material in a ring dike around all sides of the reservoir. The initial or "upper bound" costs were based on the following procedures, assumptions, and data. The embankment costs for the sides adjacent to the canal are included in the cost estimate because it is envisioned that some level of improvement or tie-in to the existing canal will be required. The dam configuration utilizes 3:1 side slopes, a 20 foot wide crest, and a dam height of 20 feet. The approximated depth of the reservoir is 10 feet. The 20 foot dam height is utilized to account for sufficient freeboard and also to maximize on-site placement of the excavated material. The unit cost for placement of the dam material includes ancillary items such as drains and foundation preparation.

Excavation and Disposal of Spoil. In order to maximize the storage potential and to allow a gravity fill and release operation, a significant amount of material will require excavation and off-site disposal. Modifications to this estimated volume will be evaluated during preliminary and final design, where a more balanced cut and fill operation may be possible. The unit cost estimate for this line item accounts for hauling the material to an off-site location. Distance to the disposal site and fuel costs could impact this cost significantly. A local disposal site will need to be investigated at the feasibility level. If the material that is excavated in excess of the volume needed in the embankment can be utilized or disposed of on-site, approximately $16 million of the initial "upper bound" estimate could be eliminated.

Groundwater Cut-off Measures. Excavation of the reservoir will likely intersect groundwater. Project drawings of the Supply Canal and J-2 Return in the vicinity of the J-2 Return Reservoir indicate that during exploration drilling, water was encountered at approximately 7 feet below the ground surface. It is unknown at this level of investigation how groundwater levels in this area will affect excavated storage. The potential exists that water will flow into the excavated portion of the reservoir. Mitigation methods for groundwater interactions range from a low cost solutions to potentially significant project costs. Typical methods include a bentonite slurry wall around the reservoir or lining the reservoir bottom in conjunction with an under drain system to alleviate the upward flow of the groundwater and resulting pressures. A place holder cost for a bentonite slurry wall is included in the opinion of cost in this study.

Modification to Gate Structures. The J-2 Return Reservoir is located at the bifurcation of the CNPPID Supply Canal to the J-2 wasteway to the Platte River and the head of the Phelps County Canal. The current bifurcation structure consists of two 12 foot gates. Modification to this structure or the addition of a third gate upstream on the canal to fill the reservoir is envisioned. Modification of the current structure at some level is likely necessary to tie-in to the reservoir and also allow for a combined outflow from the canal and reservoir concurrently.

River Return Modifications and Protection. The area just downstream of the gate structures is expected to require earthwork and some level of armoring to accommodate the higher flows resulting from a pulse release. A linear foot unit cost is included for this work.

Land Acquisition. The current land use at the site is irrigated agriculture. Estimates of required acquisition account primarily for the dam and reservoir. Additional land acquisition may be required to facilitate improvements to the wasteway channel to accommodate higher flows.

Table 7-1, "Initial "Upper Bound" Opinion of Probable Cost for J-2 Return Reservoir" presents the estimated project costs for the reservoir concept.

Table 7-1 – Initial "Upper Bound" Opinion of Probable Cost for J-2 Return Reservoir

J-2 Return Reservoir	Quantity	Unit	Unit Cost	Total Cost
Construction Costs				
Earth Embankment Dam	820,000	CY	$ 6	$ 5,000,000
Excavation and Disposal	6,780,000	CY	$ 2	$ 13,600,000
Dewatering Measures	184,000	SF	$ 6	$ 1,200,000
12' Gate	3	EA	$ 100,000	$ 300,000
Existing Gate Structure Upgrades	1	LS	$ 1,000,000	$ 1,000,000
River Return Modifications and Protection	2,000	LF	$ 200	$ 400,000
			Construction Subtotal	**$ 21,500,000**
			Mobilization (5%)	$ 1,100,000
			Unlisted Items (10%)	$ 2,200,000
			Contingency (30%)	$ 6,500,000
			Permitting and Design (8%)	$ 2,240,000
			TOTAL ESTIMATED CONSTRUCTION COSTS	**$ 33,540,000**
Land Acquisition Costs				
Irrigated Agriculture	350	AC	$ 3,400	$ 1,190,000
			Land Acquisition Subtotal	**$ 1,190,000**
			Contingency (20%)	$ 238,000
			TOTAL ESTIMATED LAND ACQUISITION COSTS	**$ 1,428,000**
Annual O&M (Present worth cost at 6% discount rate)				
Operations and Maintenance (2%)	25	YRS	$ 670,800	$ 8,580,000
Power Interference	25	YRS	$ -	$ -
			TOTAL ESTIMATED COST OF PROJECT	**$ 43,548,000**

Through optimization of the project layout, including material disposal cost and reservoir filling facilities, the Total Estimated Cost could be reduced from the $43.5 million shown above to approximately $21 million.

Elwood Reservoir

Siphon Enlargements and Repair. Probable costs for the repair and replacement of the E-65 canals were developed based on discussions with CNPPID and review of previous estimates developed by the District. Costs for replacing the three siphons include new steel pipe (from 96" to 120" diameter), excavation and backfill, removal of existing siphons and anchors, installation of reinforced concrete thrust blocks, anchors, retaining walls, connections, and site restoration.

Unlined Return Canal. A return canal sized to accommodate 4,000 cfs of flow to the Platte River is estimated to be approximately 15.7 miles. Preliminary estimates were derived by modifying and updating canal costs developed by Reclamation for Plum Creek Reservoir in the Prairie Bend project. These estimates of unit costs include excavation, compaction, baffled apron drops, and waterway protection.

Dam Outlet. The existing outlet from the reservoir has a capacity of 350 cfs. To facilitate release flows of 4,000 cfs a new outlet will be required. Placement of a new outlet will require modifications to the dam, potentially including a bore through the abutment.

Miscellaneous Dam Improvements. Improvements to the existing dam and appurtenances may be necessary to mitigate against the effects of a rapid drawdown. Also included in this line item are potential seepage mitigation measures.

Land Acquisition. Land will need to be purchased for the return canal easement. The easement is expected to be approximately 200 feet wide. Consulting aerial photography, approximately 20 percent of the land may be irrigated agriculture and 80 percent is pasture land. A weighted average value for this mix of land is included in the acquisition costs.

Power Requirements. There are currently three-300 horsepower vertical turbine pumps at Elwood Reservoir. In the operations modeling, an inflow rate of 190 cfs was used to approximate the capacity of two of the existing pumps. An annual power cost was developed based on the average fill rate from the routing analysis of 26,000 ac-ft per year. An annual cost of $45,000 is estimated for this reservoir fill volume based on a rate of $.05 per KWH.

Power Interference. Power Interference costs for Program water diverted to Elwood Reservoir are calculated on a per ac-ft basis of water bypassing both the J-1 and J-2 hydropower plants. Based on example calculations included in the EA Bypass Agreement, this is estimated to be $7.78 per ac-ft. On average, approximately 26,000 ac-ft would bypass the plants to Elwood Reservoir.

Table 7-2, "Estimated Opinion of Probable Cost for Elwood Reservoir" presents the estimated project costs for the reservoir concept.

Table 7-2 – Estimated Opinion of Probable Cost for Elwood Reservoir

Elwood Reservoir	Quantity	Unit	Unit Cost	Total Cost
Construction Costs				
Siphon Enlargements and Repair	1	LS	$ 18,200,000	$ 18,200,000
Unlined Return Canal (4000 cfs)	83,000	LF	$ 160	$ 13,300,000
New Dam Outlet	1	LS	$ 4,600,000	$ 4,600,000
Miscellaneous Dam Improvements	1	LS	$ 1,000,000	$ 1,000,000
Construction Subtotal				**$ 37,100,000**
Mobilization (5%)				$ 1,900,000
Unlisted Items (10%)				$ 3,800,000
Contingency (30%)				$ 11,200,000
Permitting and Design (8%)				$ 3,864,000
TOTAL ESTIMATED CONSTRUCTION COSTS				**$ 57,864,000**
Land Acquisition Costs				
Mixed Land Use (irrigated and grazing)	85	AC	$ 1,320	$ 113,000
Land Acquisition Subtotal				**$ 113,000**
Contingency (20%)				$ 23,000
TOTAL ESTIMATED LAND ACQUISITION COSTS				**$ 136,000**
Annual O&M (Present worth cost at 6% discount rate)				
Operations and Maintenance (2%)	25	YRS	$ 1,157,280	$ 14,800,000
Pumping Requirements	25	YRS	$ 45,000	$ 580,000
Power Interference (@ J-1 and J-2)	25	YRS	$ 214,000	$ 2,740,000
TOTAL ESTIMATED COST OF PROJECT				**$ 76,120,000**

Plum Creek Reservoir

Dam. Dam and appurtenance cost estimates were developed based on the USBR Prairie Bend report prepared in 1989. An initial, “upper bound” opinion of probable construction cost was developed for 2008 construction price levels using the ENR CCI and adjusted for the estimated earth embankment volume. The lumped unit cost per embankment volume includes the zoned earth fill dam and drains, slope protection, instrumentation and access road. The dam and reservoir configuration in the Prairie Bend project provided significant flood storage, approximately 162,000 ac-ft. This flood capacity was configured in conjunction with a 2,600 cfs morning glory spillway, in addition to an outlet works capacity of 2,660 cfs. The outlet capacity considered in the WMS configuration is 5,000 cfs. This would potentially offset a portion of the required flood storage or spillway capacity. However, to reflect the significant cost associated with any type of flood storage or conveyance for a Plum Creek Reservoir ranging in size from 30,000 to 100,000 ac-ft active capacity, the original size spillway (2,600 cfs) and additional flood storage are both included in the cost estimate. The estimated flood storage for both reservoir sizes is 162,000 ac-ft.

Although roller compacted concrete (RCC) dams are now being constructed in more diverse geologic settings than they were when the 1989 Prairie Bend report was prepared, the site's foundation conditions and lack of readily available construction materials make selection of a RCC dam an unlikely choice. If future investigations address these issues in more detail, a RCC dam, with its ability to withstand overtopping flood flows could significantly reduce project costs.

Spillway. The spillway configuration included in the Prairie Bend project was a 2,600 cfs morning glory spillway. This was intended to be used in conjunction with a 2,660 cfs outlet works and significant flood storage in the reservoir. For purposes of the WMS and an initial "upper bound" cost estimate, the same size spillway in conjunction with flood storage is considered. Costs for the spillway have been updated to 2008 estimates using the ENR CCI.

Outlet Works. The outlet works are sized to accommodate a 5,000 cfs release. The cost for the outlet was based on the Prairie Bend costs, adjusted to 2008, and increased in capacity.

Unlined Supply Canal. Supply canal cost estimates were developed based on the Prairie Bend project and to 2008 costs using ENR CCI ratios. Cost includes excavation, compaction, structures, and waterway protection works. The cost was adjusted for a capacity of 1,000 cfs from East Phillips Lake.

Unlined Return Canal. Return canal cost estimates were developed based on the Prairie Bend project and to 2008 costs using ENR CCI ratios. Cost includes excavation, compaction, structures, and waterway protection works. The cost was adjusted for a capacity of 5,000 cfs to the Platte River.

Land Acquisition. Land acquisition for a Plum Creek Reservoir includes the dam and reservoir area, the supply canal, and the return canal and associated easements. The reservoir land area includes the flood storage capacity for the PMF. The supply canal easement is estimated to be 150 feet wide and the return canal easement is estimated to be 200 feet wide. Consulting aerial photography, approximately 20 percent of the land may be irrigated agriculture and 80 percent is pasture land. A weighted average value for this mix of land is included in the acquisition costs.

Power Interference. Power Interference costs for Program water diverted to Plum Creek Reservoir are calculated on a per ac-ft basis of water bypassing both the J-2 hydropower plant.

Based on example calculations included in the EA Bypass Agreement, this is estimated to be $4.35 per ac-ft. On average, approximately 31,000 ac-ft would bypass the plant for a Plum Creek of 30,000 ac-ft active capacity. The estimated volume bypassing the J-2 to fill a 100,000 ac-ft reservoir is 103,000 ac-ft.

Table 7-3, "Estimated Opinion of Probable Cost for Plum Creek Reservoir" presents the estimated project costs for the reservoir concept.

Table 7-3 – Initial "Upper Bound" Opinion of Probable Cost for Plum Creek Reservoir

Plum Creek Res - 30,000 ac-ft (active)	Quantity	Unit	Unit Cost	Total Cost
Construction Costs				
Dam	8,400,000	CY	$ 8	$ 67,200,000
Spillway (morning glory)	2,600	CFS	$ 1,440	$ 3,800,000
Outlet Works	5,000	CFS	$ 2,580	$ 12,900,000
Unlined Supply Canal (1,000 cfs)	18,000	LF	$ 400	$ 7,200,000
Unlined Return Canal (5,000 cfs)	36,500	LF	$ 200	$ 7,300,000
Construction Subtotal				**$ 98,400,000**
Mobilization (5%)				$ 5,000,000
Unlisted (10%)				$ 9,900,000
Contingency (30%)				$ 29,600,000
Permitting and Design (8%)				$ 10,240,000
TOTAL ESTIMATED CONSTRUCTION COSTS				**$ 153,140,000**
Land Acquisition Costs				
Mixed Land Use (irrigated and grazing)	2120	AC	$ 1,320	$ 2,799,000
Land Acquisition Subtotal				**$ 2,799,000**
Contingency (20%)				$ 560,000
TOTAL ESTIMATED LAND ACQUISITION COSTS				**$ 3,359,000**
Annual O&M (Present worth cost at 6% discount rate)				
Operations and Maintenance (2%)	25	YRS	$ 3,062,800	$ 39,160,000
Power Interference (@ J-2)	25	YRS	$ 140,000	$ 1,790,000
TOTAL ESTIMATED COST OF PROJECT				**$ 197,449,000**

Plum Creek Res - 100,000 ac-ft (active)	Quantity	Unit	Unit Cost	Total Cost
Construction Costs				
Dam	10,000,000	CY	$ 8	$ 80,000,000
Spillway (morning glory)	2,600	CFS	$ 1,440	$ 3,800,000
Outlet Works	5,000	CFS	$ 2,580	$ 12,900,000
Unlined Supply Canal (1,000 cfs)	18,000	LF	$ 400	$ 7,200,000
Unlined Return Canal (5,000 cfs)	36,500	LF	$ 200	$ 7,300,000
Construction Subtotal				**$ 111,200,000**
Mobilization (5%)				$ 5,600,000
Unlisted Items (10%)				$ 11,200,000
Contingency (30%)				$ 33,400,000
Permitting and Design (8%)				$ 11,568,000
TOTAL ESTIMATED CONSTRUCTION COSTS				**$ 172,968,000**
Land Acquisition Costs				
Mixed Land Use (irrigated and grazing)	4000	AC	$ 1,320	$ 5,280,000
Land Acquisition Subtotal				**$ 5,280,000**
Contingency (20%)				$ 1,056,000
TOTAL ESTIMATED LAND ACQUISITION COSTS				**$ 6,336,000**
Annual O&M (Present worth cost at 6% discount rate)				
Operations and Maintenance (2%)	25	YRS	$ 3,459,360	$ 44,230,000
Power Interference (@ J-2)	25	YRS	$ 464,000	$ 5,940,000
TOTAL ESTIMATED COST OF PROJECT				**$ 229,474,000**

Using the ENR CCI to update previously developed construction cost estimates can result in overly conservative estimates of construction costs because the inflation indices do not take into account the greater efficiencies of current large-scale earthmoving operations. Although construction consumables such as diesel fuel, cement, and steel have escalated considerably and are relatively volatile, these costs are generally offset by the larger and more productive equipment now being used. An opinion of probable cost developed with the unit cost data developed from recent bid tabulations would yield a Total Estimated Cost of about $160 million versus the "upper bound" cost of $197 million shown in the table above.

The "upper bound" project costs are compared on a cost per yield to a pulse flow basis in Table 7-4 below. Costs on a per ac-ft basis range from $3,200 for Elwood Reservoir to $15,000 for the J-2 Return Reservoir. However, optimizing the layouts of the projects and using actual bid tabulations instead of adjusting previous estimates would result in unit yield costs of about $6,500 per ac-ft of yield to pulse flows for the J-2 Return Reservoir and about $5,000 per ac-ft for Plum Creek Reservoir.

Table 7-4 - "Upper Bound" Project Costs per ac-ft of Yield of Pulse Flow Contribution

Project	Potential Pulse Flow Volume (ac-ft)	Estimated Construction Cost	Estimated Annual O&M and Power Cost	Est Annual Power Interference Cost	Estimated Total Capital Cost	Capital Cost per ac-ft of Yield to Pulse Flow
J-2 Return Reservoir	2,975	$ 33,540,000	$ 670,800	$ -	$ 43,548,000	$ 14,640
Elwood Reservoir	23,470	$ 57,864,000	$ 1,202,280	$ 214,000	$ 76,120,000	$ 3,240
Plum Creek Reservoir (30k)	29,270	$153,140,000	$ 3,062,800	$ 140,000	$197,449,000	$ 6,750

8.0 ENVIRONMENTAL, LEGAL, AND ECONOMIC CONSIDERATIONS

The potential benefits and impacts associated with the Phase II projects are similar in nature as they are primarily related to reservoir and canal construction and operations. Because Elwood Reservoir is an existing structure, it will minimize some impacts relative to new reservoir construction; however the impacts associated with construction of a new return canal and reservoir operations are similar for Elwood Reservoir and Plum Creek Reservoir. Differences among potential impacts are discussed where identifiable.

8.1 Environmental Considerations of Projects

Surface Water

Changes in streamflows in the Platte River basin will occur as a result of implementation of any of these projects. These changes are the intended consequence of the projects by nature, for purposes of meeting Program objectives. Depending on the source of water to be identified, diversions to storage may reduce available flows for new water users in the future or potentially existing users if they are not protected through the water rights administration process. However, it is anticipated that operations of the projects will be subject to water rights administration by the State of Nebraska. Diversions, releases, and return flows from reservoir seepage will also alter the timing of water available to downstream users. There are potential negative economic and hydrologic third party impacts due to changes in the quantity and timing of water. There may be surface water irrigators that use runoff or return flows that are reused several times by other surface diverters. Changing the operations of the CNPPID canal and reservoirs may impact the amount and timing of these flows.

Ground Water

This reconnaissance-level review identifies potential ground water issues related to the location, construction, and operation of these reservoir projects.

The area is underlain by Quaternary-aged sediments, including alluvium, terrace deposits, dune sands, and loess, and Tertiary-aged sediments, including the Ogallala Group. The Ogallala is the principal aquifer in the area, yielding moderate to large quantities of water to wells (Goeke, et. al. 1992). Where exposed at the surface, these sediments can be highly permeable, and losses from canals and reservoirs, and deep percolation of applied water, can be significant.

The principal ground water feature in this area is an elongated ground water mound, centered on the area of Elwood Reservoir, with its long axis aligned parallel with the CNPPID Supply Canal. The mound extends from the area of North Platte to an area south of Kearney. This prominent feature has formed as a result of leakage from conveyance, irrigation, and storage facilities operated by CNPPID and NPPD. There are broad areas where the water table has risen by more than 60 feet (UNL, 2008). The mound's formation began with the start of water diversions by CNPPID and NPPD. The mound does not appear to have changed significantly in size in recent years (UNL, 2008). Prior investigations concluded that the mound contained an estimated 14 million acre-feet (ac-ft) of water in storage (Bredehoeft and Hinckley, 1998). CNPPID presently holds storage rights awarded in two separate applications (Application No. U-2 and Application No. U-12) totaling 9.5 million ac-ft for water placed into underground storage.

The mound forms a ground water divide between the Platte and Republican River Basins. As a result, a portion of the water being added to the mound is lost to the Republican Basin. This is significant, in that seepage losses associated with the operation of new or existing reservoirs in this area may cause additional losses of water from the Platte Basin to the Republican Basin. Water leaves the mound principally through wells and discharges to the Platte and Republican River Basins. Prior modeling of the ground water system associated with the mound suggested that about 8 percent of the water leaving the mound was discharging to the Republican River Basin (Bredehoeft and Hinckley, 1998).

Continued growth of the mound to a point where the water table approaches or impinges on ground surface could render an area unusable because of wet soils, infiltration into basements, emergence of springs, etc. Prior study of this mound concluded that over most areas affected by the mound, depth to water exceeded 100 feet (Bredehoeft and Hinckley, 1998). Accordingly, it is unlikely that broad areas will be affected by groundwater encroaching the surface.

The issue of continued growth of the mound was investigated with a ground water model (Bredehoeft and Hinckley, 1998). In the absence of other changes in stresses (for example, the addition of pumping in the area of the mound), the model showed that the mound would not reach equilibrium but would continue to grow, although at a much slower rate than it has historically grown. This was found to be the case even when simulated for a 500-year period.

Elwood Reservoir overlies the ground water mound and has contributed significantly to its development. Seepage losses evaluated in connection with a study of changes to reservoir operations were estimated to have averaged about 26,000 ac-ft/yr for the period 1987-1992. (Central Nebraska Regional Water Conservation Task Force, 1998). Additional historic data provided by CNPPID confirms these estimates of annual average seepage and evaporation losses of approximately 26,000 ac-ft/yr from 1977-2004. Operations after 2004 have maintained the reservoir elevation lower and therefore have resulted in smaller losses (CNPPID, 2008a).

Relation to Reservoir Sites

While more detailed investigation might reveal significant differences in the soils and underlying sediments, the reservoir sites are likely to experience losses similar to those observed in Elwood Reservoir and those associated with the major delivery canals in this area. Further, the fact that a ground water mound has developed throughout the area indicates that seepage losses are relatively high.

A major consequence of operating one or more of these reservoir sites (assuming seepage rates are similar to those observed at Elwood and in the major delivery canals) will be a further buildup of the ground water mound. In such a case, losses to the Republican Basin may be expected to increase. Physical modifications of the reservoir sites, such as the use of liners, cutoff walls, etc. could reduce losses. Similarly, a well recovery system could potentially intercept some, or all, of these losses. The economics of these alternatives were not evaluated as a part of this reconnaissance-level study.

The State of Nebraska recognizes “incidental underground water storage.” Accordingly, it may be possible to apply for water that accrues to storage in connection with a potential reservoir. The rules and limitations on the absolute right to recover all such water placed into storage are not clear. For example, there may be limits on the timing and amount of recovery where the recovery of the stored water interferes with rights of a senior appropriator.

Additional Investigations Recommended

The following additional investigations are recommended to advance the analysis of ground water conditions associated with the re-regulation reservoir alternatives:

- Detailed geologic and soils investigations, including site-specific sampling and testing, to identify surface and subsurface hydrogeologic conditions and the potential losses that could be experienced.
- Analysis of current ground water level information to allow more precise definition of the configuration of the ground water mound.
- Review recent ground water level information to ascertain the rate of growth/decay of the mound in response to reservoir and canal modifications that have occurred.
- Analytical modeling of reservoir losses.
- Numerical modeling of the ground water system's response to reservoir operations. There are several ground water models available or under development that, with appropriate changes and updates, may be suited for this application. These include the model referred to herein (Bredehoeft and Hinckley, 1998), two ground water models under development by the COHYST program (Eastern Model Unit and Western Model Unit), and the "Conjunctive Management Model" being developed through the Department of Natural Resources.
- Further investigation of the legal framework governing recovery of stored water, and pumping for purposes of controlling losses from the mound.

Wetlands

Potential wetlands impacts associated with these reservoirs can be both positive and negative. There could be negative impacts to wetlands from the reservoir impoundment or canal construction and positive impacts resulting from the creation of additional wildlife habitat near the reservoir. These impacts have the potential to be significant depending on the size of the project. The potential for these projects to impact existing wetlands varies based on the size of reservoir inundation and length of supply and return canals. By virtue of its smaller footprint, location off-channel, and current land use, the J-2 Return Reservoir appears the least likely to impact wetlands. The return canal associated with Elwood Reservoir has the potential of impacting wetlands due to the length of the return and nature of crossing several drainages. The Plum Creek Reservoir is the most likely to impact wetlands due to its larger surface area and significant length of supply and return canals. National Wetlands Inventory mapping data for the three project sites indicates isolated areas classified as "Freshwater Emergent Wetlands" associated with each. The majority of areas are located within the Plum Creek Reservoir inundation areas. The nature of these reservoir projects offers the opportunity to create wetland areas adjacent to, or below the inundated area. Whether these areas would be sustainable or credited as benefits should be investigated further with USFWS.

Threatened and Endangered Species Habitat

Habitat for the American burying beetle (nicrophorus americanus) and the black-footed ferret (mustela nigripes) potentially exists in Gosper County as identified by USFWS (USFWS, 2008). These species are listed as endangered on the USFWES website. These listed species are in addition to those that are the focus of the Program. Site-specific surveys will be required as part of future feasibility studies.

Water Quality

Impacts to water quality could be both positive and negative associated with the operations of the reservoirs. The additional flow that is released during the irrigation season could benefit the water temperatures downstream of the project reservoirs. The additional diversions at the source of supply could impact the remaining streamflow. Use of the reservoirs to supplement a pulse flow and the associated rapid drawdown will need to be investigated in relation to temperature and sedimentation.

8.2 Legal Considerations of Projects

Potential permitting requirements identified in the Water Action Plan and HDR's Depletion Mitigation Study include:

- A new or modified storage permit to divert additional water through CNPPID's system may be required.
- U.S. Army Corps of Engineers 404 permit would be required in addition to a 401 Water Quality Certification.
- Potential need for FERC License amendment to construct a new reservoir.
- Coordination with the Nebraska State Historic Preservation Officer would be required before construction.
- NPDES Permit to Discharge Storm Water Associated with Construction Activity and associated Storm Water Pollution Prevention Plan for construction activity would be required.
- Construction activity would require review from the State of Nebraska DEQ-Air Quality Division.
- Local county construction permits could be required.

8.3 Economic and Social Considerations of Projects

The employment generated during the construction of these projects would benefit the local economies. The larger projects would offer higher economic stimulus to the area. In addition, if Plum Creek Reservoir were able to be operated in a manner compatible with recreation, this could also benefit the local economy. Elwood Reservoir is currently used for recreation; therefore the additional benefit will be limited. However, the operation of the reservoirs for purposes of a pulse flow could also have a negative impact on the recreation benefit. The rapid drawdowns that would be required could disrupt the use of the reservoir as a recreation amenity.

The Plum Creek Reservoir project could modify the flood risk for downstream properties, potentially reducing the frequency and magnitude of flood flows.

There are potential benefits to CNPPID facilities and operations. The siphon replacement for Elwood Reservoir would replace aging infrastructure while increasing capacity in the E-65 canal. One potential additional use associated with the J-2 Return Reservoir is for the dampening of hydrocycling flows from the J-2 power plant.

Lost hydropower generation, though compensated through the Power Interference costs, could result in the need to offset production with other supplies.

The potential for economical hydropower generation at the three is limited due to the short duration of high flows associated with the WMS Pulse Flow Target. In addition, the potential contribution to the WMS Irrigation Season Flows at this level of evaluation is also short in duration and variable.

9.0 CONCLUSIONS AND RECOMMENDATIONS FOR PROJECT IMPLEMENTATION

9.1 Conclusions

All three water storage projects are technically feasible and will help accomplish the Program's flow objectives. However, none of the reservoirs will individually meet the WMS Pulse Flow and Irrigation Season Flow targets so a combination of these reservoirs and other water management projects and strategies will be required.

The WMS focuses on the ability to use excess capacities in the Districts' systems and the Platte River to meet the WMS Pulse Flow and Irrigation Season Flow Targets. These analyses rely on the assumption of Program water availability in Lake McConaughy or other sources of water for the Program. Additional evaluation of the potential to divert and store water in times of excess at Grand Island should be conducted as the Program continues the implementation of projects. Evaluations should include the timing and location of available excess for diversion.

Analyses of contributions to the WMS Flow Targets have been conducted on an individual project basis. Evaluation of combined operations from Lake McConaughy, re-regulation in Johnson Lake, and the reservoir projects identified in the WMS will provide additional insight into a more flexible and managed contribution to the WMS Flow Targets as Program implementation continues.

Other general conclusions are listed below followed by conclusions specific to each project and by recommendations on project implementation strategies.

General

- The benefit of storage lower in the system, near the associated habitats is the ability to position Program water and time releases to increase natural peak flows in the river.
- With the exception of Plum Creek Reservoir, the reservoir projects currently evaluated, will meet only a portion of the WMS Pulse Flow Target.

- None of the reservoirs are able to meet the full WMS Irrigation Season Flow Target completely given their available storage. With the exception of one year, Elwood and Plum Creek Reservoirs are emptied in mid to late August in wet years. Incorporating a second fill may alleviate part of these shortages, however the water used to refill could also be released from Lake McConaughy directly downstream to Overton, or routed through the Districts' systems. A larger Plum Creek Reservoir would meet significantly more of the Irrigation Season Flow Target.
- Some combination of new storage projects, releases directly from Lake McConaughy, and re-regulation in Johnson Lake is necessary to meet the WMS Pulse Flow Target.
- Elwood Reservoir and Plum Creek Reservoir both require large return canals to accommodate the flows simulated in this analysis. Additional review of the feasibility of these canals is required prior to these projects moving forward to implementation.
- Additional monitoring and evaluation of ground water flow is necessary to answer concerns of groundwater impacts to the Platte and Republican River basins.
- Geotechnical investigations are needed for all sites to be designed and constructed.
- Wetlands and habitat surveys are also needed for all sites to be designed and constructed.
- Conflicts and benefits may be realized with implementation of multiple projects. Water supplies may be additive or competing and infrastructure may be complimentary or competing. For example, water supplies conveyed through the CNPPID system all rely on the remaining available capacity. If more than one project is implemented along the CNPPID system, then combined operations will compete for the available capacity, resulting in longer fill times. In addition, the physical location of multiple projects may conflict. For example, construction of a new Plum Creek Reservoir would inundate a portion of a new Elwood Reservoir Return, or improvements to the creek if the Elwood project is implemented before Plum Creek Reservoir. If this sequence is reversed the Elwood releases would pass

through Plum Creek reservoir eliminating the need for that portion of the canal construction or creek improvements.

J-2 Return Reservoir

- Contributions of the J-2 Return Reservoir to the Pulse Flow Targets were simulated to provide 500 cfs for three days. This represents only ten percent of the target, but provides the flows nearest the associated habitats of the three reservoirs evaluated. Contributions to the WMS Irrigation Season Flow Targets range from 2 to 5 percent depending on year class.
- The location of the J-2 Return Reservoir downstream of the J-2 powerplant results in no power interference costs to the Program.
- J-2 Return Reservoir impacts the fewest number of land owners as a result of its smaller footprint and lack of supply or return canals.
- The potential groundwater interactions of the J-2 Return Reservoir during construction and operation need to be evaluated as part of preliminary design. The potential exists that if ground water were to be used as a partial source of stored water, this may be of a neutral or beneficial impact for the Program. If it is necessary to isolate the reservoir from the ground water table, the details of the design warrant careful attention. This should include installation of observation wells and evaluation of similar projects and construction methods.
- The potential for optimizing a cut and fill operation to minimize off-site disposal of excavated material should be investigated. Potential disposal sites and/or uses of the excavated material should be investigated during the preliminary design.

Elwood Reservoir

- A significant portion (80%) of the WMS Pulse Flow Target can be met through the operation of Elwood Reservoir. Contributions to the WMS Irrigation Season Flow Targets range from 15 to 39 percent depending on year class.
- The location of the diversion to Elwood Reservoir upstream of both the J-1 and J-2 powerplants results in power interference costs for both plants to the Program.

- Contributions to the WMS Pulse Flow Target in the amount simulated would require drawing down the reservoir over a three day period. This is a significant change in reservoir elevations and the potential impacts to the reservoir and dam need to be evaluated.
- A return canal for Elwood Reservoir will affect multiple land owners.
- Cost estimates for the return canal are based on the assumption that it is an unlined canal. Rapid filling and dewatering may increase the potential for bank sloughing. Rapidly changing flows required for pulse deliveries will require costly bank protection measures including rip rap (limited availability) or concrete sections. However, if the canal is utilized for more consistent, steady operations, investigation into seepage and impacts to the water table will need to be evaluated in more detail.
- Utilization of an existing dam and reservoir rather than construction of a new dam is generally more attractive to the public, environmental interests, and regulatory agencies.
- The feasibility of constructing a 4,000 cfs canal from Elwood Reservoir to the Platte River should be investigated as part of the preliminary design. This investigation would include identifying potential alignments, hydraulics, and land ownership impacts.
- Increasing the size of the existing outlet in Elwood Reservoir will require construction of a new outlet works. This requires construction in the existing dam, or boring through one of the abutments. A geotechnical investigation is necessary to determine the feasibility and cost of this work.
- If operated in combination with other projects, smaller releases to the Platte River would be possible. In this event, additional investigation of a smaller return canal, or improvements to Plum Creek would be beneficial. The Plum Creek investigation should include a hydraulic evaluation of the existing capacity and the requisite level of improvements needed.

Plum Creek Reservoir

- Due to the larger capacity of the 30,000 ac-ft Plum Creek Reservoir, the contributions to the WMS Flow Targets are the largest of the reservoirs currently studied and could satisfy all of the 5,000 cfs for a three-day WMS Pulse Flow Target. Contributions to the WMS Irrigation Season Targets range from 18 to 42 percent depending on year class.
- A larger Plum Creek Reservoir (100,000 ac-ft) could contribute to both the WMS Pulse Flow Target and the Irrigation Season Target in the same year. Further investigation of the potential to fill a larger Plum Creek Reservoir is necessary.
- The location of the diversion to Plum Creek Reservoir upstream of the J-2 powerplant results in power interference costs to the Program.
- Satisfying the current WMS Pulse Flow Target would empty a 30,000 ac-ft reservoir over a three-day period. This is a significant change in reservoir elevations and the potential impacts to the reservoir rim and dam need to be evaluated.
- The reservoir footprint, supply canal, and return canal required for the construction of Plum Creek Reservoir will affect multiple land owners.
- Cost estimates for the supply and return canals are based on the assumption that they are unlined canals. Rapid filling and dewatering may increase the potential for bank sloughing. Rapidly changing flows required for pulse deliveries will require costly bank protection measures including rip rap (limited availability) or concrete sections. However, if the canal is utilized for more consistent, steady operations, investigation into seepage and impacts to the water table will need to be evaluated in more detail.
- The feasibility of the Plum Creek Dam and spillway to accommodate the PMF need further investigation in preliminary design. The configuration of the dam and spillway and their required capacities to meet flood flow requirements are a significant portion of the design and construction costs.

- The feasibility of constructing a 5,000 cfs canal from Plum Creek Reservoir to the Platte River needs further investigation. This investigation should include identifying potential alignments, hydraulic evaluation, and land ownership impacts.
- The feasibility of constructing a gravity canal from East Phillips Lake to the Plum Creek Reservoir should be investigated. This investigation would include identifying potential alignments, hydraulic evaluation, and land ownership impacts.
- If operated in combination with other projects, smaller releases to the Platte River may be possible. In this event, additional investigation of a smaller return canal, or improvements to Plum Creek would be beneficial. The Plum Creek investigation should include a hydraulic evaluation of the existing capacity in addition to the requisite level of improvements for a range in flows.

Comparison of Re-Regulation Reservoirs to the Featured J-2 Return Reservoir

Presented below are comparisons of several potential re-regulation reservoirs to the featured J-2 Return Reservoir. See Section 2 for additional information on the screening process for the re-regulation reservoirs and the selection of the J-2 Return Reservoir to feature in Phase II of the WMS. A matrix comparison of these projects and the three evaluated in more detail is presented in Table 9-1, "Project Evaluation Summary."

<u>Jeffrey Canyon Reservoir</u>

- Could yield up to 1,750 cfs contribution to the pulse flow, or 35 percent
- Requires a new return to the Platte River, or combined operations with existing Jeffrey Return (with shorter new return required)
- Power Interference costs for all three CNPPID facilities- Jeffrey, Johnson 1, and Johnson 2.
- Located on intermittent stream

<u>Gallagher Canyon Reservoir</u>

- Could yield up to 500 cfs contribution to the pulse flow, or 10 percent
- Requires a new return to the Platte River, or modification of Thirtymile Canal

- Power Interference costs for CNPPID facilities- Johnson 1, and Johnson 2
- Located on intermittent stream

North Plum Creek Reservoir

- Could yield up to 385 cfs contribution to the pulse flow, or 8 percent
- Requires a new return to the Platte River, or modification of Thirtymile Canal
- Power Interference costs for CNPPID facilities- Johnson 1, and Johnson 2
- Located on intermittent stream

J-2 Forebay Reservoir

- Could yield up to 570 cfs contribution to the pulse flow, or 11 percent
- Requires a new supply canal or pipeline from East Phillips Lake
- Requires a new return to the Platte River, or improvements to Plum Creek
- Power Interference costs for CNPPID facilities- Johnson 2
- Located on intermittent stream

Phelps 9.7 Reservoir

- Could yield up to 370 cfs contribution to the pulse flow, or 7 percent
- Requires improvements or modification to tributary to Platte River
- Requires modification to Phelps County Canal to accommodate inundated siphon
- No Power Interference costs
- Located on intermittent stream

Table 9-1 - Project Evaluation Summary

Project	Est. Active Capacity (ac-ft)	Potential Contribution to WMS Pulse Flow	Potential Contribution to WMS Irr Season Flow	Capital Cost	Unit Cost per ac-ft Pulse	Power Interference	Impact to Landowners (qualitative)	Location of Return to Platte River	Length of Supply Conveyance	Length of Return Conveyance
Plum Creek – small	30,000	100%	18-26%	$160 to 198MM	$5,000 to $6,750	Johnson 2	Several Owners	near Overton	3.4 mi	7 miles
Plum Creek – large	100,000	100%	50-100% (estimated)	$230MM	$7,730 (estimated)	Johnson 2	Several Owners	near Overton	3.4 mi	7 miles
Elwood Reservoir	24,000	80%	15-39%	$76MM	$3,240	Johnson 1, Johnson 2	Potential for Several	near Overton	Replace 1.4 mi of E-65 siphon	16 miles
J-2 Return Reservoir	3,300	10%	2-5%	$21 to 44MM	$6,500 to $14,640	None	Few	near Overton	None	None
Comparison of additional re-regulation reservoirs to J-2 Return Reservoir										
Jeffrey Canyon	10,400	35% (positive)	(positive)	(N/A)	(N/A)	Jeffrey, Johnson 1, Johnson 2 (negative)	(N/A)	d/s of Brady (negative)	Pumped pipeline 1-2 miles (negative)	3-7 miles (negative)
Gallagher Canyon	3,300	10% (neutral)	(neutral)	(N/A)	(N/A)	Johnson 1, Johnson 2 (negative)	(N/A)	Lexington (neutral)	None (neutral)	5-8 miles (negative)
North Plum Canyon	2,300	8% (negative)	(negative)	(N/A)	(N/A)	Johnson 1, Johnson 2 (negative)	(N/A)	Lexington (neutral)	2-3 miles (negative)	5-7 miles (negative)
J-2 Forebay	3,400	11% (positive)	(positive)	(N/A)	(N/A)	Johnson 2 (negative)	(N/A)	near Overton (neutral)	2-3 miles (negative)	6-7 miles (negative)
Phelps 9.7	1,300 – 2,200	7% (negative)	(negative)	(N/A)	(N/A)	None (neutral)	(N/A)	at Overton (neutral)	None (neutral)	2-3 miles (negative)

9.2 Recommendations on Project Implementation

Meeting key Program flow management objectives by 2011 through the construction of new dams and reservoirs is an ambitious goal. Typical dam development programs take much longer than the three year period remaining from the end of 2008 to the end of 2011. Some water storage projects, in the general size anticipated here, have been designed, and constructed in three years, but this is not typically the case. Exceptions to the rule, projects which take less than about eight years to proceed through preliminary design, final design, and construction generally are off-stream reservoirs, sited to avoid impacts that trigger federal environmental permitting processes or only require Environmental Assessments versus full Environmental Impact Statements. Two reservoirs considered herein (the J-2 Return Reservoir and the existing Elwood Reservoir) have the greatest potential of avoiding a time consuming full EIS, while the third, a new reservoir on Plum Creek, would have significant on-stream impacts that would require National Environmental Policy Act (NEPA) compliance and a U.S. Corps of Engineers (USACE) Section 404 permit for dredge and fill activities on "waters of the United States."

Accomplishing the 2011 flow objectives will require a combination of strategies including use of the Environmental Account in Lake McConaughy for all three flow objectives supplemented by pulse flow releases from existing and new water storage facilities. The reservoirs should be operated primarily for pulse flows, but will also contribute to the other flow objectives. If the Program water managers choose to release water during a period of excess to targets, the Program would be credited for this controlled release of Program water in the computation of reductions to average annual reductions in shortages to target flows.

As stated above, construction of the new J-2 Return Reservoir and the use of the existing Elwood Reservoir offer the best chances to have water in storage to contribute to 2011 pulse flow objectives. The J-2 Return reservoir would require very limited modifications to existing infrastructure to deliver water to and from the reservoir. Reservoir construction would occupy currently irrigated land and a suitable arrangement with the land owners would need to be quickly developed to keep the project moving forward efficiently. No site-specific environmental issues that would require time consuming environmental permits have yet been identified. The project also offers the possibility of offsetting some of the impacts of CNPPID's "hydro-cycling" operations (large and rapid changes in flow to increase on-peak, higher value energy production) on the Platte River.

Utilizing the existing Elwood Reservoir for Program use will require construction of new siphons to deliver irrigation water downstream of the reservoir. This project would also require construction of an enlarged reservoir outlet and enlarged channel capacity to deliver the storage water back to the Platte River. Although these construction activities are significant, they are not generally subject to the same types of environmental permitting challenges presented by new on-stream dams.

Plum Creek and several other storage sites on smaller Platte River tributaries will be faced with potentially significant environmental and land use challenges that would make it difficult for them to contribute to the 2011 flow objectives.

Design and permitting phases of water storage projects can be minimized by performing certain activities simultaneously and/or performing them prior to receipt of formal regulatory approvals. For example, final design can be initiated prior to receipt of USACE Clean Water Act Section 404 permit to place or dredge within "waters of the U.S.", however, the design costs may be wasted if USACE does not determine the selected project is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) consistent with its statutory approval authority. Most opportunities to minimize implementation schedules increase risks of stranded investments or wasted efforts for the Program and its participants. Therefore, it is important to consider the benefits, costs, and risks associated with each strategy to expedite the implementation process to achieve the 2011 flow objectives.

The implementation schedules presented below are based on seven major phases of the project implementation:

1) Project Agreements – The three water storage options considered in Phase II all involve existing CNPPID infrastructure. In addition, there are possibilities for shared use of the reservoirs for Program purposes and also to help offset future depletions to the Platte

River by other water users in the State of Nebraska. Therefore, the Program should initiate discussions with CNPPID, the State, and possibly others to establish the framework for moving forward quickly.

2) Land and Easement Acquisition - This phase could begin soon to determine whether there are major obstacles, especially in light of the Program's lack of eminent domain authority. Of the three projects, the Plum Creek project will affect the greatest number of existing land owners for the reservoir and for downstream channel improvements to deliver stored water to the Platte River. The J-2 Return reservoir would affect the fewest owners and the Elwood Reservoir project, although it currently exists, would affect land owners for the river return channel and potentially for new siphon construction. Based on communication with the ED Office, the Program's constraints regarding land acquisition are characterized as follows.

   The Program does not have the power of eminent domain, which means that all lands acquired by the Program must be purchased from willing sellers. This will alter the reservoir planning, design and construction sequence and will likely lengthen the project timeline. Reservoir projects undertaken by entities with the power of eminent domain often follow this sequence:

   - Pre-Feasibility or Reconnaissance Level Feasibility Study
   - Full Feasibility Study and Preliminary Design
   - Final Design and Permitting
   - Land Acquisition
   - Construction

   In this sequence, land acquisition is typically the final step before construction and can be accomplished in less than a year due to the well defined condemnation process. In cases, like the Program's, where condemnation is not an option, a different task sequence is typically followed:

- Pre-Feasibility or Reconnaissance Level Feasibility Study
- Full Feasibility Study and Preliminary Design
- Land Acquisition
- Final Design and Permitting
- Construction

In this sequence, land is acquired before the final design and permitting because all landowners impacted by the project must be willing to participate by voluntarily selling an interest in their properties. If the project sponsor decides to complete the final design before land acquisition is completed, they are taking a risk that the project will not be constructed despite the substantial design and permitting expenditures. The land acquisition timeline is also typically lengthy and hard to define because it often involves landowner education and negotiating with all impacted landowners. The more landowners that are impacted, the longer the negotiation process will take, resulting in less likelihood that all parties will be willing to participate.

This project sequence also introduces other challenges. For example, land rights should be acquired before completing the final design but permits for construction are not generally issued without a final design. As such, the project sponsor has to understand that there is a risk that the project will not receive environmental and/or construction permit approval even though they have already completed land acquisition.

3) Pre-Design Report(s) –This phase further investigates the engineering, environmental, regulatory, and economic aspects of the projects. The goal is to adequately address the most important questions for the Program before making the commitment to spend millions of dollars for design and construction. An additional goal of this phase is to determine, through specific environmental characterizations, whether a federal nexus may exist triggering an Environmental Assessment or an Environmental Impact Statement.

4) Environmental Compliance – This phase includes preparation of any required documentation and permits to satisfy the National Environmental Policy Act (NEPA) and other federal, state, and local environmental laws. This phase involves a significant potential for schedule delays as demonstrated by many other dam design and permitting projects around the country.

5) Final Design – This phase is self-explanatory and relatively straight-forward if traditional approaches are used. In most cases, final design does not start until receipt of a federal Record of Decision for environmental permits.

6) Construction Bidding and Award – This phase can overlap with the preceding final design phase for prequalification activities without incurring too much risk of stranded investments.

7) Construction - For the range of the three project types and sizes presented herein, construction would require between one and three years.

The "Base Case" Schedule represents the time expected to complete the seven major phases listed above assuming each phase proceeds efficiently and without major efforts by the Program to expedite development of the projects in ways that would expose the Program to significant risk of "stranded" investments. Examples of strategies to expedite the project in ways that could potentially result in stranded investments include, but are not limited to: 1) implementation of final design prior to completing the environmental compliance requirements; 2) completing final design but then encountering prolonged legal challenges that delay the project for an extended period and; 3) up-front expenditures on mitigation that do not result in project approval.

Many factors can affect the implementation schedule that is beyond the control of the Program. Therefore, the concept of exposure to stranded cost is important in assessing potential implementation schedules because most of the opportunities to expedite the schedule that are controllable by the Program involve the risk that the expenditures do not actually expedite implementation, risk the potential that work must be redone, and/or involve work that is subsequently determined not to have been needed.

Following are some of the key assumptions utilized in developing this base schedule:

- A full Environmental Impact Statement (EIS) is not required.
- Traditional design, bid, and construction with no incentives for early completion or overlapping phases.
- Each phase is generally completed before beginning the next phase.
- No litigation delays are encountered.

Several major issues not addressed in the "Base Case" schedule above (e.g. litigation delays, construction incentives, etc.) that could affect the schedule, either positively or negatively, are addressed in the table below. Five alternative schedule scenarios are shown including an "EIS" schedule, beginning the final design before completing the EIS, delays caused by litigation, and a fast track design and construction. Litigation delays represent the worst case or greatest schedule extension. Other scenarios will also develop but will likely fall within the schedule range presented in the table.

Table 9-2 - Project Implementation Scenarios

Scenario	Program Agreement(s)	Land & Easement Acquisition	Pre-Design	Environ. Compliance	Final Design	Bidding and Award	Construction Completed
1. Base Case[1]	May '09	July '09	Oct '09	Dec '09	June '10	Aug '10	Aug '11
2. "With EIS"[2]	May '09	July '09	Oct '09	Dec '11	June '13	Oct '13	Oct '15
3. Early start of final design[3]	May '09	July '09	Oct '09	Dec '11	Jan '13	Mar '13	Mar '15
4. Litigation delays[4]	May '09	July '09	Oct '09	Dec '13	Jan '15	Oct '15	Oct '17
5. Fast track design and construction[5]	May '09	July '09	Aug '09	Dec '10	Feb '11	Mar '11	Oct '12

[1] Based on the J-2 Return Project and assuming no delays between implementation phases and final design duration (including approvals) is only nine months. This Base Case also assumes that a full EIS will not be required and that a traditional design, bid, build process for project delivery is used.

[2] Extends schedule by at least two years if an EIS is required and there are no legal challenges that further delay the project. The larger Plum Creek reservoir was used as the basis for this implementation schedule. It assumes an aggressive 18 month design period and two years for construction.

[3] Uses the larger Plum Creek reservoir and assumes final design will be initiated 6 months prior to completing the Environmental Compliance phase.

[4] Assumes up to two years of litigation delays for the large Plum Creek reservoir.

[5] Based on large Plum Creek and assumes overlapping implementation phases, no EIS (just an EA with a FONSI), expedited design and peer reviews, and incentives for early construction completion. Essentially everything takes place without any delays. The Program would assume significant financial risk with expediting activities.

Table 9-2 shows project completion dates ranging from late 2011 for just the J-2 Return Project to late 2017 for the large Plum Creek reservoir with an EIS and protracted legal issues. The August 2011 date is a best case estimate for the J-2 Return reservoir which, by itself, will not meet the full 2011 flow objectives. To maximize the possibility of meeting the 2011 flow objectives, the Program should consider methods to expedite the preliminary design work, environmental assessments, and determination of required federal permitting, and final design and construction approaches that are appropriate considering the Program's willingness to accept risk of stranded investments.

Suggested next steps in the implementation process include:

- Review effects of recent high flows on channel morphology and maintenance and determine what conclusions can be extrapolated to the potential for managed pulse flows to accomplish the desired effects in the Platte River corridor.

- Perform a pilot pulse flow in the spring of 2009. Results from this pilot study will provide additional insight into channel maintenance, capacities, and flow attenuation.
- Further investigate: 1) next steps to achieve the 2011 pulse flow goals, 2) benefits of J-2 Return Reservoir on hydro-cycling and 3) procedures for implementing a test release from Johnson Lake.
- Re-regulation of Johnson Lake will be a key component of a full pulse flow. CNPPID has currently agreed to test re-regulation of 6,000 ac-ft. If results of a test operation are positive, this volume of re-regulation might be increased. In addition to the physical results of a test, the process involved in positioning Program water and making releases timed to supplement natural events and will help define procedures for annual implementation.
- Define the 2009 Program activities related to the WMS Flow objectives:
    - Additional operations modeling of individual and combined projects.
    - Select preliminary design activities for specific storage sites, including:
        - Development of field exploration program(s) and data collection
        - Refinement of project facility types and capacities
        - Refinement and development of project cost ranges based on feasibility level design
    - Review the need to update assessments of previously defined Water Action Plan alternatives and/or quantification of availability of flows in excess to targets.
    - Review the need to enhance the existing Routing Tool and Loss Model to potentially include:
        - Multiple-year operations for the Routing Tool
        - Ability to evaluate multiple targets in combination
        - Multiple project operations
        - Link daily time step Routing Tool with monthly time step Loss Model

    - Enhanced user output

- Investigate the reaction of land owners in the project areas to participate in the development of a project.
- Continue work on expanding the safe-conveyance capacity of the North Platte River at North Platte (choke point) and other channel restrictions that may be identified in the future. Continued improvements to restore a capacity of 3,000 cfs or greater are important in achieving flow targets, and to the extent possible minimizing the need and size of additional structural solutions.

10.0 REFERENCES

Anderson, Don, *E-mail communication regarding FWS year classification*, September, 2007.

Boyle Engineering Corporation, *Water Conservation/Supply Reconnaissance Study*, Governance Committee of the Cooperative Agreement for Platte River Research, December 1999

Boyle Engineering Corporation, *Reconnaissance-Level Water Action Plan*, Governance Committee of the Cooperative Agreement for Platte River Research, 2000

Boyle Engineering Corporation, *Water Management Study Phase I Evaluation of Pulse Flows for the Platte River Recovery Implementation Program*, Platte River Recovery Implementation Program, 2008

Bredehoeft, John, and Bern Hinckley, 1998. *The Impact of NPPD and CNPPID on the Platte River: Nebraska's Ground-Water Mound*.

CNPPID, *Project Information,* Provided September 2008a.

CNPPID, E-mail correspondence to Executive Director's Office, October 17, 2008b.

Central Nebraska Regional Water Conservation Task Force, 1998. Supplement II to the Comprehensive Water Conservation Plan.

Dreeszen, V. H., E. C. Reed, and R. R. Burchett, Nebraska Geological Survey, and G. E. Prichard, U. S. Geological Survey, Bedrock Geologic Map Showing Thickness of Overlying Quaternary Deposits, Grand Island Quadrangle, Nebraska and Kansas, Miscellaneous Geologic Investigations, Map I-819, 1973

Goeke, J.W., J.M. Peckenpaugh, R.E. Cady, and J.T. Dugan, 1992. *Hydrogeology of Parts of the Twin Platte and Middle Republican Natural Resources Districts, Southwestern Nebraska*.

Hamilton, Glenn, 1993. Elwood Reservoir Seepage Control Program. Technical Memorandum prepared for Central Nebraska Public Power and Irrigation District.

Johnson, Blomendahl, and Lukassen, Nebraska Farm Real Estate Market Developments 2007-2008, University of Nebraska-Lincoln Department of Agricultural Economics, 2008.

Nebraska Water Survey Paper No. 70.

HDR Engineering, Inc., Depletion Mitigation Study Phase I, March 20, 2000

Platte River Recovery Implementation Program (PRRIP) Program Document, October 24, 2006

Sanders, Glen, 2001. Ground Water and River Flow Analyses. Technical Report of the Platte River EIS Team, U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service.

University of Nebraska-Lincoln (UNL), 2008. Nebraska Water. Map produced by the University of Nebraska-Lincoln.

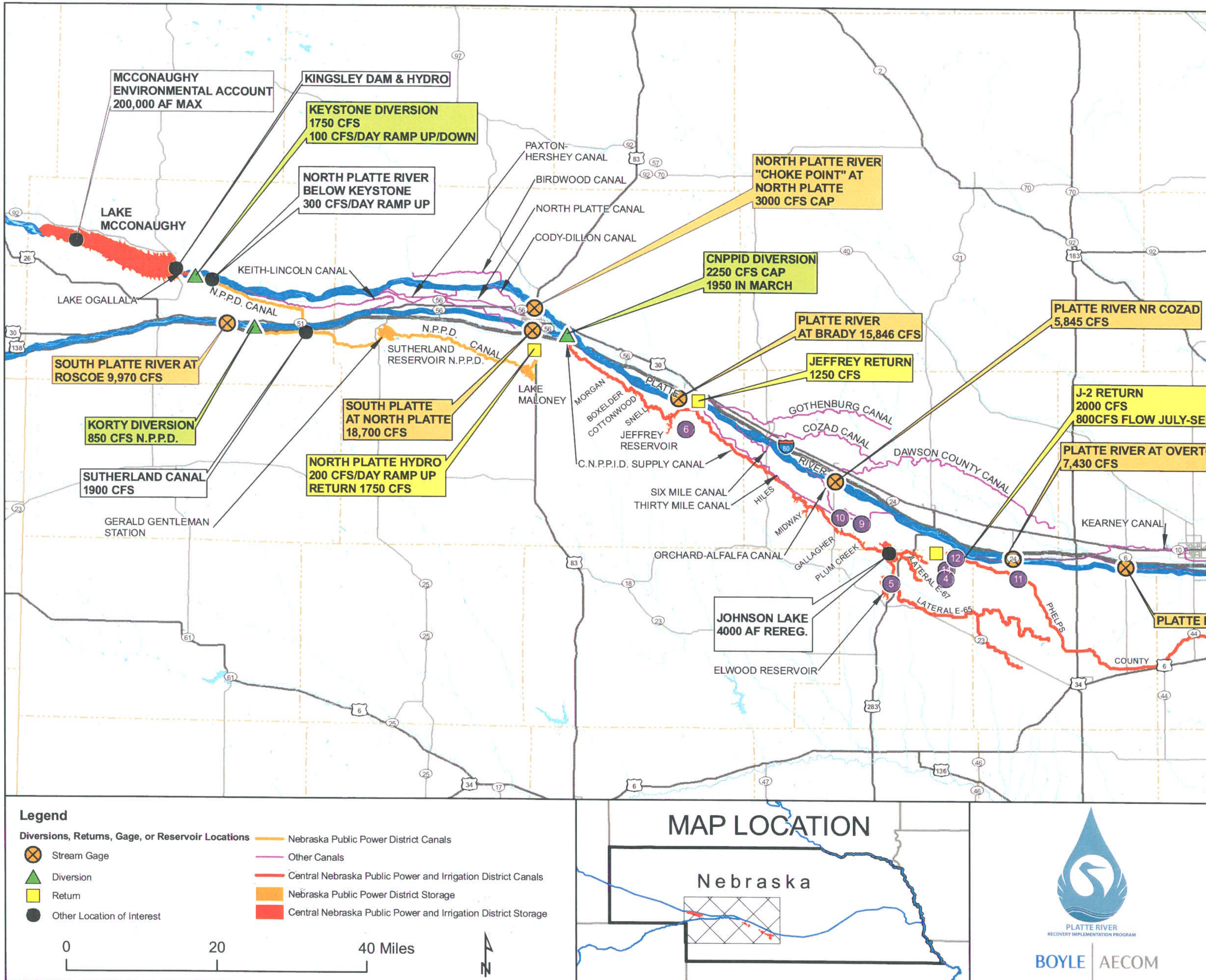
U. S. Department of Agriculture (USDA), Soil Survey of Lincoln County, Nebraska, U. S. Department of Agriculture, Soil Conservation Service in cooperation with University of Nebraska Conservation and Survey Division., 1978

U.S. Department of Interior (USDOI), Platte River Recovery Implementation Program Final Environmental Impact Statement, April 2006

U. S. Department of Interior, Regional Director's Planning Report/Draft Environmental Statement Engineering Appendix, Prairie Bend Unit P-SMBP, Nebraska, U. S. Department of Interior, Bureau of Reclamation, Great Plains Region, Nebraska Kansas Project Office, dated May 1989.

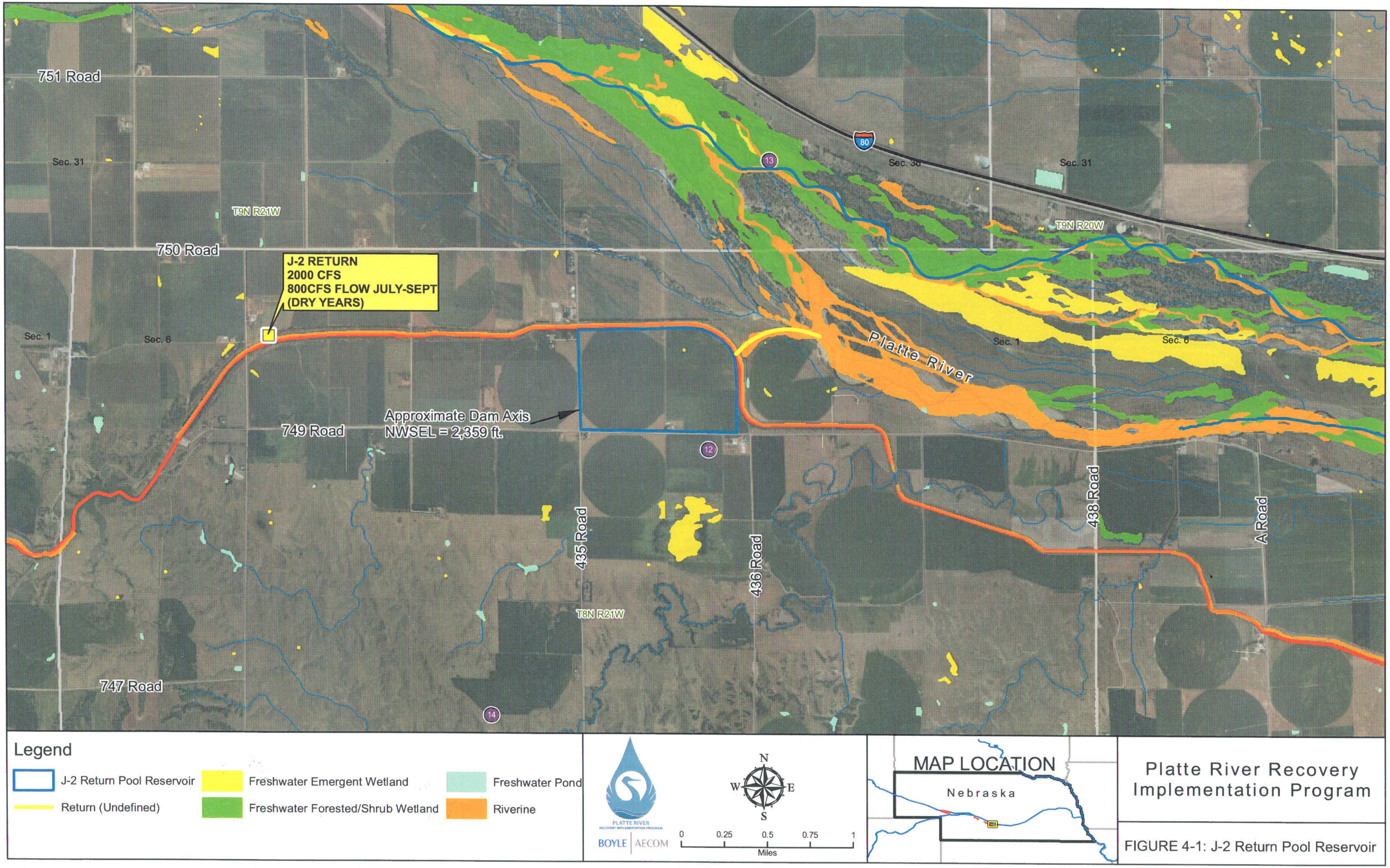
USWFS, http://www.fws.gov/endangered/, accessed October 2008

Nebraska Natural Resources Commission. Report on the South-Central Area Ground Water Planning Study. Nebraska Natural Resources Commission, 1999.



Platte River Recovery Implementation Program Water Management Study Study Area

FIGURE 3-1: PROJECT LOCATIONS



Platte River Recovery Implementation Program

FIGURE 4-1: J-2 Return Pool Reservoir

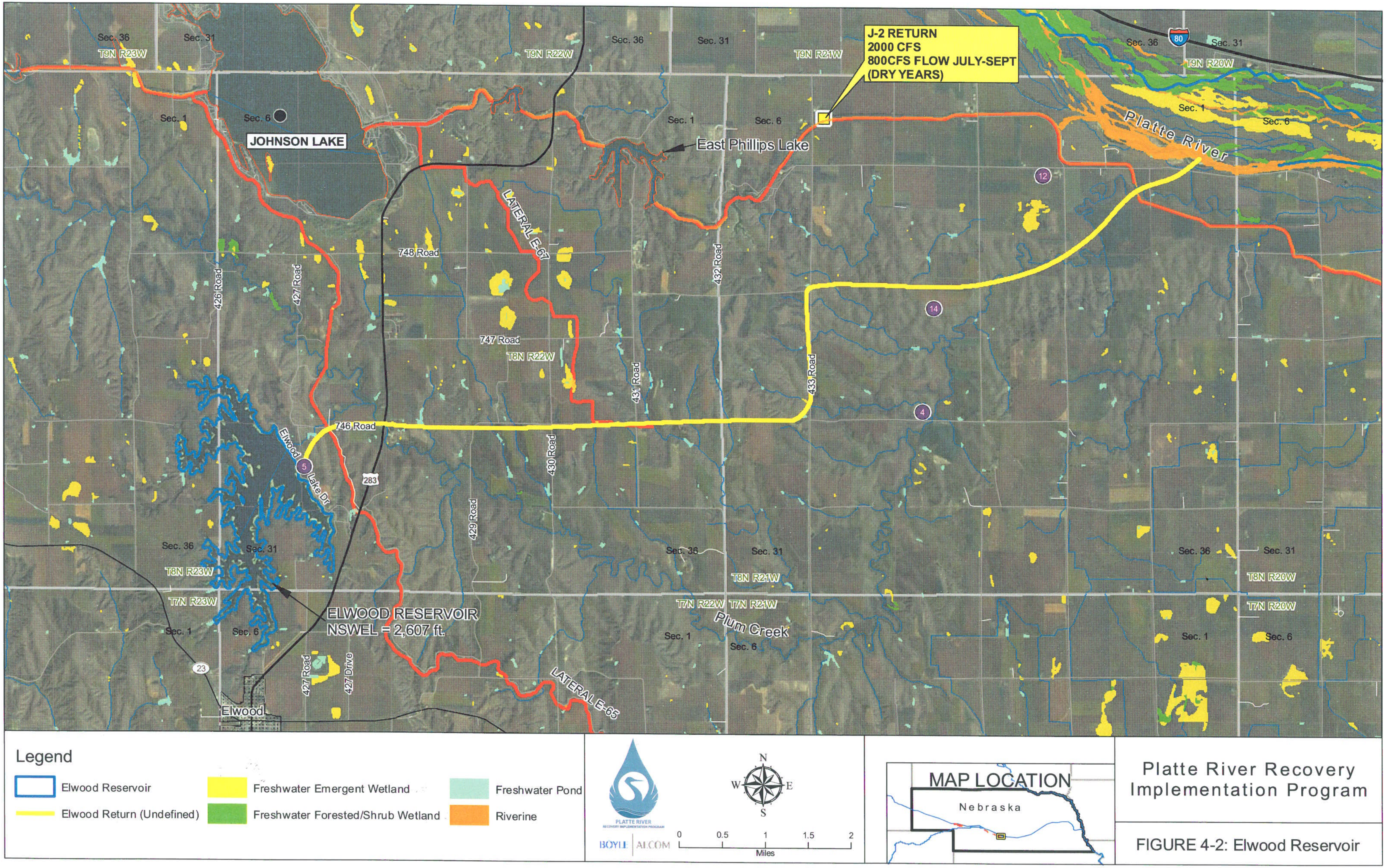
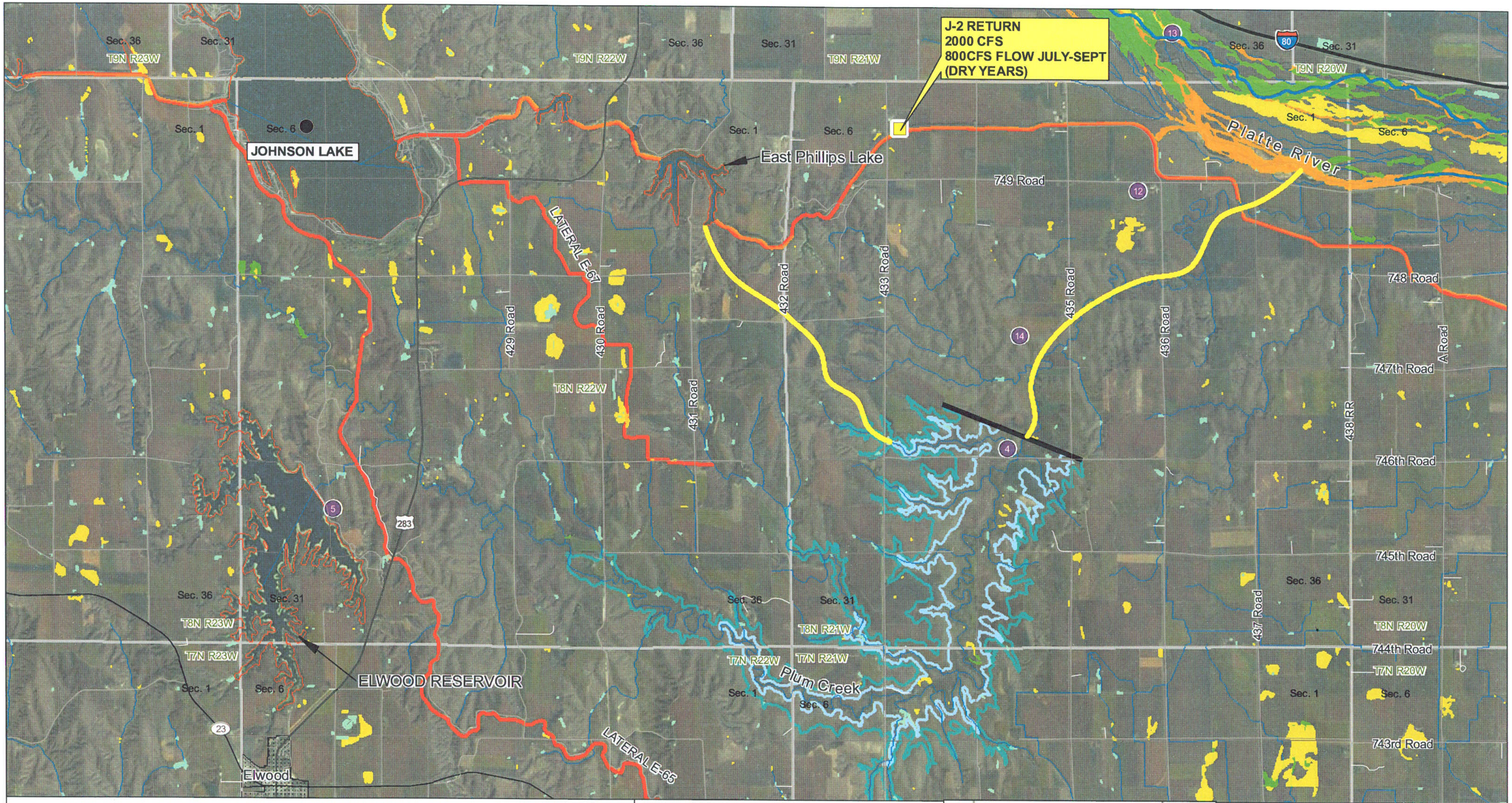


FIGURE 4-2: Elwood Reservoir



Legend

- Supply / Return (Conceptual)
- Approximate Dam Axis
- NWSEL For Approximately 30,000 AF Storage (Elev. 2,450 Ft.)
- NWSEL For Approximately 100,000 AF Storage (Elev. 2,475 Ft.)
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Riverine

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

BOYLE | AECOM

N W E S

0 0.5 1 1.5 2

Miles

Platte River Recovery Implementation Program

FIGURE 4-3: Plum Creek Reservoir