SOUTH PLATTE WATER CONSERVATION PROJECT
A MUNICIPAL-AGRICULTURAL PARTNERSHIP

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ABSTRACT

Municipal water demand for the Front Range of Colorado is expected to increase substantially over the coming years. As these demands continue to grow, the pressure to dry up agricultural water supplies in the South Platte River basin continues to be more acute. The Northern Colorado Water Conservancy District (Northern Water) along with fifteen municipal water providers is presently in the permitting process for the Northern Integrated Supply Project (NISP). This project will consist of two distinct but integrated pieces – the new 170,000 acre-ft Glade Reservoir located northwest of Fort Collins, Colorado, and the South Platte Water Conservation Project (SPWCP). The SPWCP involves a pump station on the South Platte River which pumps water during the non-irrigation season to the proposed 45,600 acre-ft Galeton Reservoir located northeast of Greeley Colorado. The SPWCP will then deliver water during the summer to two large irrigation companies – the Larimer and Weld Irrigation Company and the New Cache Ditch Company. A like quantity of water that those companies would have diverted under their senior water rights will be exchanged upstream to Glade Reservoir for municipal use. This paper will discuss the formulation of the SPWCP project as well as the partnership that has been formulated with the ditch companies. In addition to an overview of issues associated with NISP, specific issues associated with the exchange with the ditch companies will be presented. In particular, the benefits of the municipal-agricultural partnership will be explained.

BACKGROUND

In April, 1986 a suburban city north of Denver Colorado announced that they had acquired nearly half of the shares of the Water Supply and Storage Company in northern Colorado for their future water supply. While the Arkansas basin in southeastern Colorado has seen the devastation of large-scale irrigated agricultural dry-up, northern Colorado has largely been immune to this type of activity. However, pending the execution of the transfer of these water rights, this action will ultimately dry up 20,000 acres of productive irrigated farm ground, resulting in a direct loss to the northern Colorado economy, and will have a ripple effect throughout the supporting businesses and industries.

In December, 1992, Northern Water engineers posted new water right notice signs throughout the Cache la Poudre River basin announcing Northern Water's intent to file water rights for a new water project called the South Platte Water Conservation Project (SPWCP). This project, instead of relying on agricultural dry-up, would involve a partnership with agricultural water users to keep irrigated farms in production while

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enabling municipal water users to take advantage of the high quality water that the ditch companies have historically been utilizing.

The formulation of the SPWCP was based upon the unique river basin geography in northern Colorado. The Cache la Poudre River (Poudre) flows into the South Platte River near Greeley Colorado. A picture of the river near this location is shown in Figure 1. An overall map of the basin is shown in Figure 2. Specifically, a large portion of the Poudre River basin irrigation lies a short distance from the South Platte River where flows are generally more plentiful, particularly during the winter and spring months. These characteristics make this basin ideal for a water exchange with municipal water users. The challenges are in finding the right infrastructure to enable the South Platte flows to be utilized and developing ditch company partnerships to allow for an exchange to be made between the ditch companies and municipalities.

At the heart of the SPWCP lies a relatively simple concept – divert water from the South Platte River during the winter and spring months, store that water until the irrigation season, release that water to Poudre River irrigation ditches, and exchange the high quality water that those ditches would have diverted higher up in the Poudre system. The project would put water suitable for agricultural use onto irrigated farms, and by exchange, provide high quality mountain runoff water to municipalities. Compensation would be made to the ditch companies and irrigators for the privilege of utilizing their senior water rights and a partnership would be created between the agricultural community and the municipal water users to insure the continued use, and therefore, the continued exchange of this new water supply.

Figure 1. South Platte River Near Greeley, Colorado

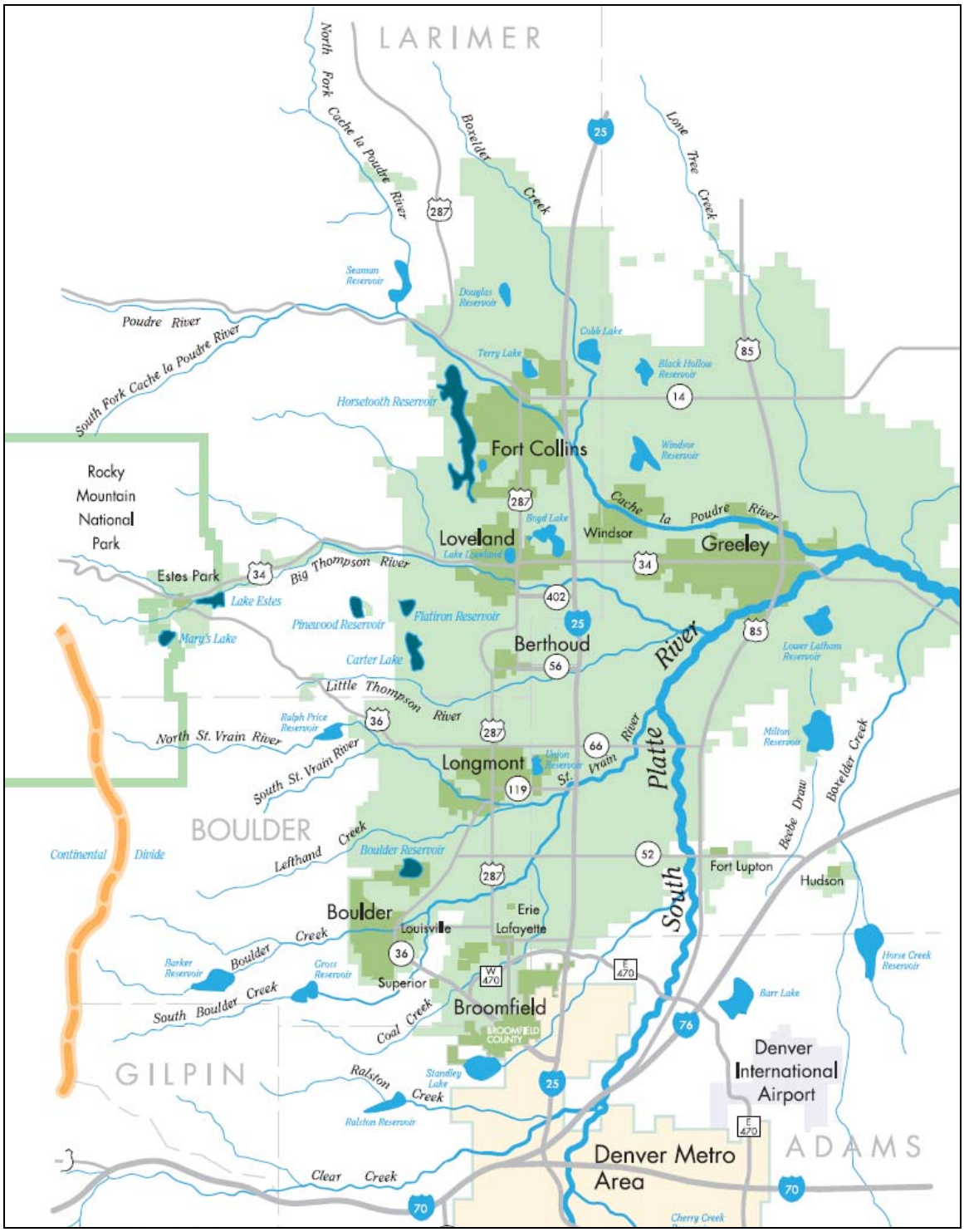

Figure 2. Northern Colorado Front Range River Basin Map

PROJECT FORMULATION

Water Availability

The South Platte River near Greeley, Colorado sits at the confluence with the Poudre River. The proposed SPWCP diversion location lies below the entire Colorado front-range population as well as below a substantial amount of irrigated agriculture. As such, the river flow is dominated by upstream treated municipal wastewater flows and agricultural groundwater return flows. Additionally, the river can receive high flows during the spring from both mountain snowmelt as well as rain runoff. The rain runoff in particular appears to be a growing component of the spring flows as development and corresponding urbanized impervious areas increase upstream.

Flows in excess of the existing ditch diversions are considered to be available for a new water rights appropriation. Most of the water rights on the South Platte River date back to the late 1800's and early 1900's. The SPWCP water rights by contrast have a conditional water right of 1992. Hence, for water to be available to the SPWCP, all other senior water rights which are in priority must be satisfied.

Figure 3 illustrates the monthly average available unappropriated water compared to the average flow in the river and the proposed pump station capacity for the SPWCP. From December through June, there is generally unappropriated water available to be diverted to storage. Note that these flows are based upon present operating conditions superimposed on historical hydrology for the years 1950-2005.

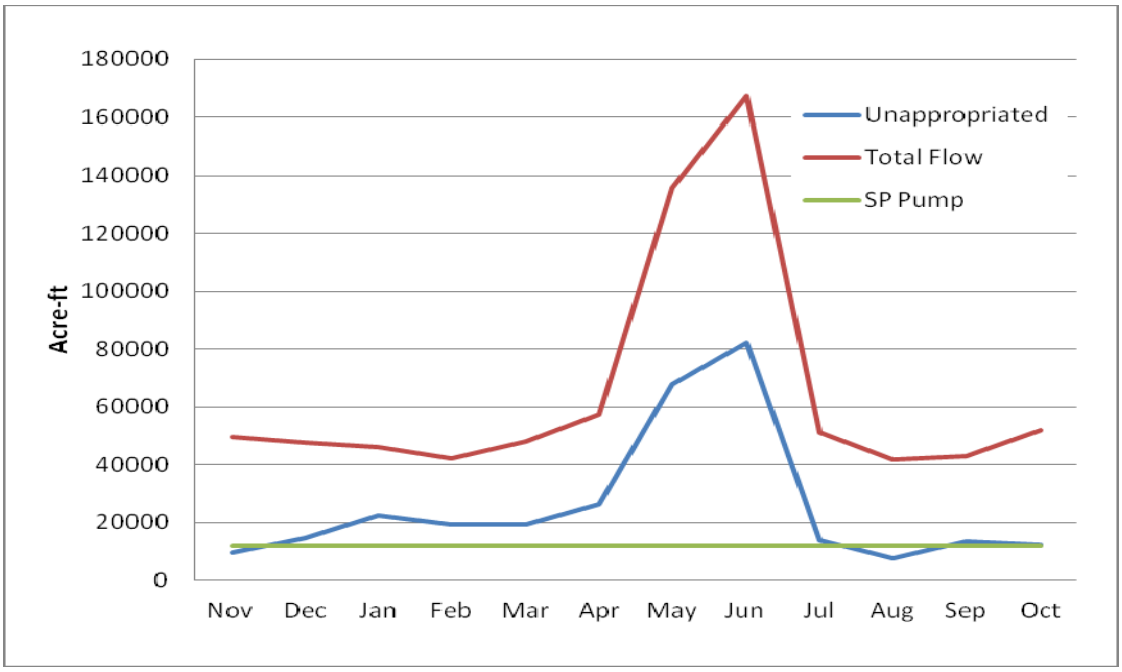

Figure 3. Average Monthly Water Availability

Presently, the South Platte River provides water directly to irrigators during the summer months. During these periods, very little if any flow is available under a junior water right. During the winter, there are numerous off-channel reservoirs and groundwater augmentation sites that fill if icing is not a factor. Once the reservoirs fill, or if ice begins to build in the fill-canals, the water rights "call" comes off, and flow becomes available for junior water rights. During the spring months when both mountain snow runoff is at its highest and when the front-range of Colorado receives the highest amount of precipitation, flows in the South Platte River can often exceed 5,000 to 10,000 cubic feet per second (cfs) and divertible flows are available during that period as well for a junior water right.

While demonstrating an approximation of average water availability, the above graph does not take into account the substantial differences which can exist from year to year on the South Platte River. Figure 4 shows the total water availability can range from zero in dry years to over a million acre-ft in wet years. Periods of drought such as 2000 through 2006 result in no available water for diversion by junior water rights, thus the need for longer term storage.

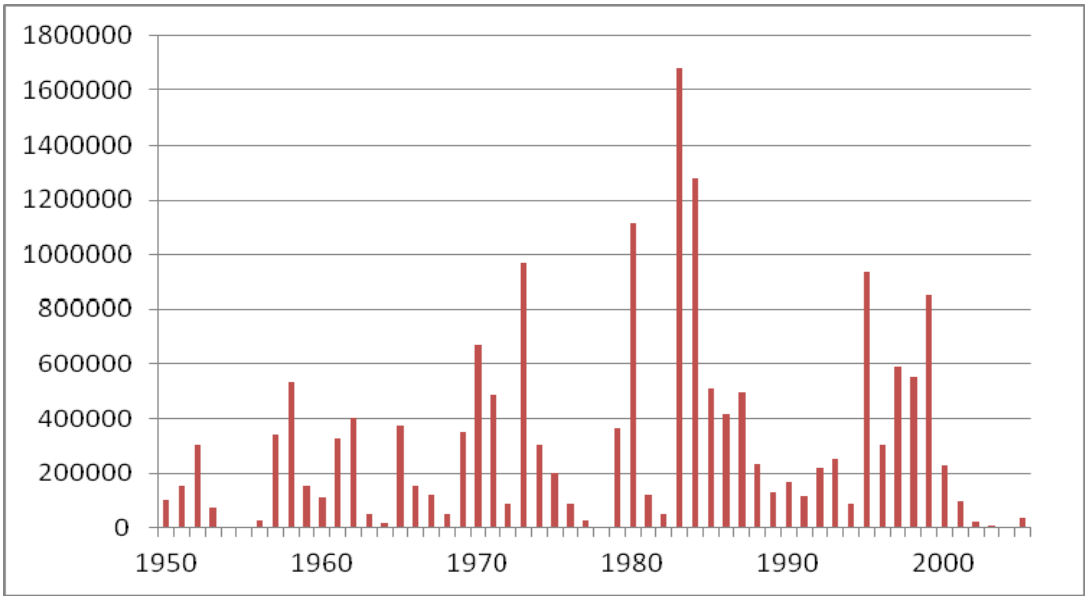

Figure 4. Annual Water Availability (acre-ft)

Project Configuration

The SPWCP involves pumping from the South Platte River to storage during times when water is available and releasing that water to two ditch companies – the Larimer and Weld and New Cache Ditch companies- during the irrigation season. The project would need to include a diversion off of the South Platte River, conveyance pipelines, and storage.

The current SPWCP project configuration utilizes surface storage at the proposed Galeton Reservoir. The project will include the following:

- South Platte River diversion
- South Platte River pumping station and forebay
- 29 miles of pipeline conveyance
- Galeton Reservoir

A map of the SPWCP facilities is shown on Figure 5.

Integration into NISP

Northern Water is moving the Northern Integrated Supply Project (NISP) forward on behalf of fifteen municipal water supply entities. NISP would develop 40,000 acre-ft of new yield utilizing both the Glade Reservoir Project and the SPWCP. A map of NISP is shown in Figure 6. The Glade Reservoir would be a new 170,000 acre-ft impoundment. It will receive supplies both from "flood flow" water rights off of the Poudre River as well as the exchanges from the SPWCP. Approximately half of the supply is from the flood rights and half from the SPWCP. The two components of NISP – Glade and the SPWCP – will work well together. Glade Reservoir will act as the primary storage vessel and allows the project to provide yield through extended drought periods. The SPWCP provides a relatively consistent year-to-year yield except for extreme droughts. The Glade Reservoir flood rights on-the-other-hand provides yield in approximately forty percent of years. Glade on its own has a storage-to-yield ratio of approximately ten. However, when combining with the SPWCP the overall storage-to-yield ratio of NISP drops by half to five, thereby making more efficient use of the Glade Reservoir.

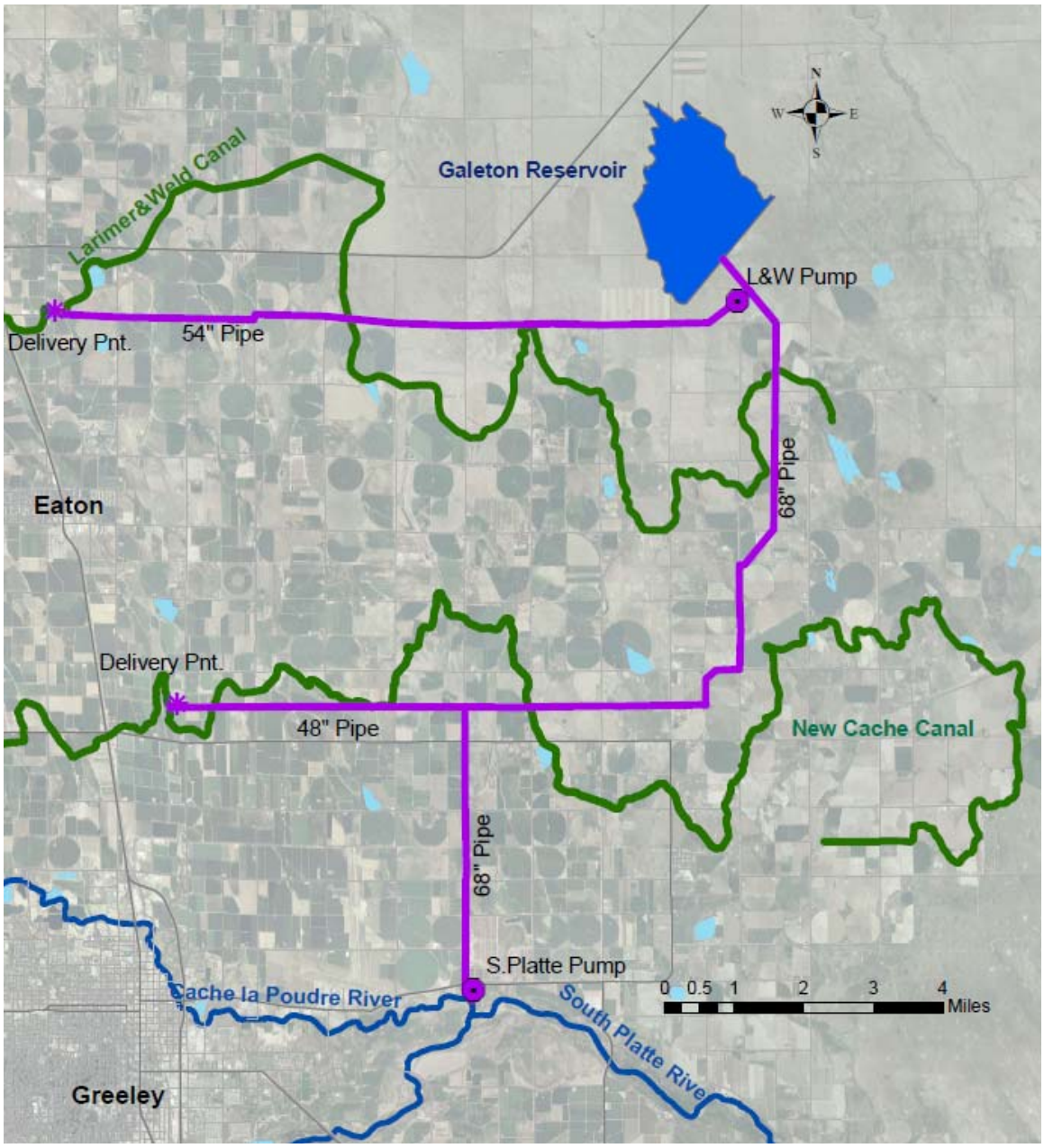

Figure 5. SPWCP Proposed Facilities

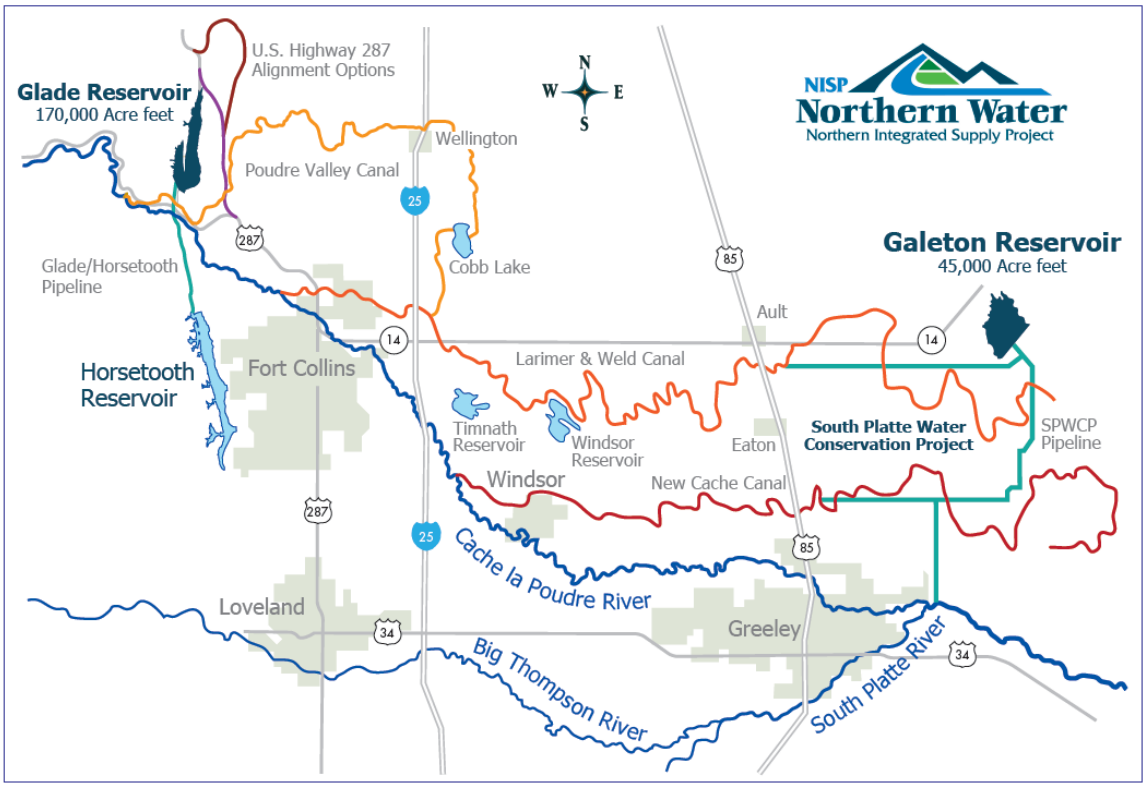

Figure 6. Map of NISP

NISP was formulated around the participant requested yield of 40,000 acre-ft. The Poudre and South Platte basins were modeled using MODSIM with a 50-year time period for both existing river conditions and potential future river conditions. The project facilities were sized to provide a firm yield through this period and achieve an average annual yield of roughly fifty percent from each of the project components. Table 1 provides the final SPWCP facility sizes which will be used for NISP.

Table 1. List of SPWCP Facilities, Capacities and Sizes

Facility	**Capacity**	**Description**
South Platte Diversion	200 cfs	Gated concrete diversion
South Platte Forebay	200 acre-ft	Lined gravel pit
South Platte Pump Station	200 cfs	13,500 hp - Vertical Turbine Pumps
South Platte to Galeton Pipeline	200 cfs	68-inch steel pipeline, 15 miles
Delivery Pipes	100 cfs	48-inch steel pipeline, 4 miles 51-inch steel pipeline, 10 miles
Larimer&Weld Pump Station	100 cfs	2,500 hp
Galeton Reservoir	45,600 acre-ft	Earth fill dam, 2 mile crest, 70 foot max height

NISP is presently nearing the end of the NEPA permitting stage. It is anticipated that the project design will start in 2014 with construction starting in 2016. The project will

likely be built in phases with the final phase coming on line in the early 2020's. NISP will meet the majority of the participant future needs well into the 2040's to 2050's.

Project Operations

The SPWCP yield relies on the pumping of water from the South Platte River to Galeton Reservoir and the subsequent release of that water to the ditch companies. A conceptual diagram of the project operations are shown in Figure 7. The SPWCP will replace approximately 25,000 acre-ft of deliveries to the exchange area which represents approximately one-third of their irrigation supply.

Exchanges on the Poudre River will ultimately be administered by the Colorado State Engineer's office through the local river commissioner. The exchanges will be made to the Glade Reservoir headgate, or will be exchanged for Colorado-Big Thompson (C-BT) releases from Horsetooth Reservoir into the Poudre River for NISP participant use from other C-BT facilities.

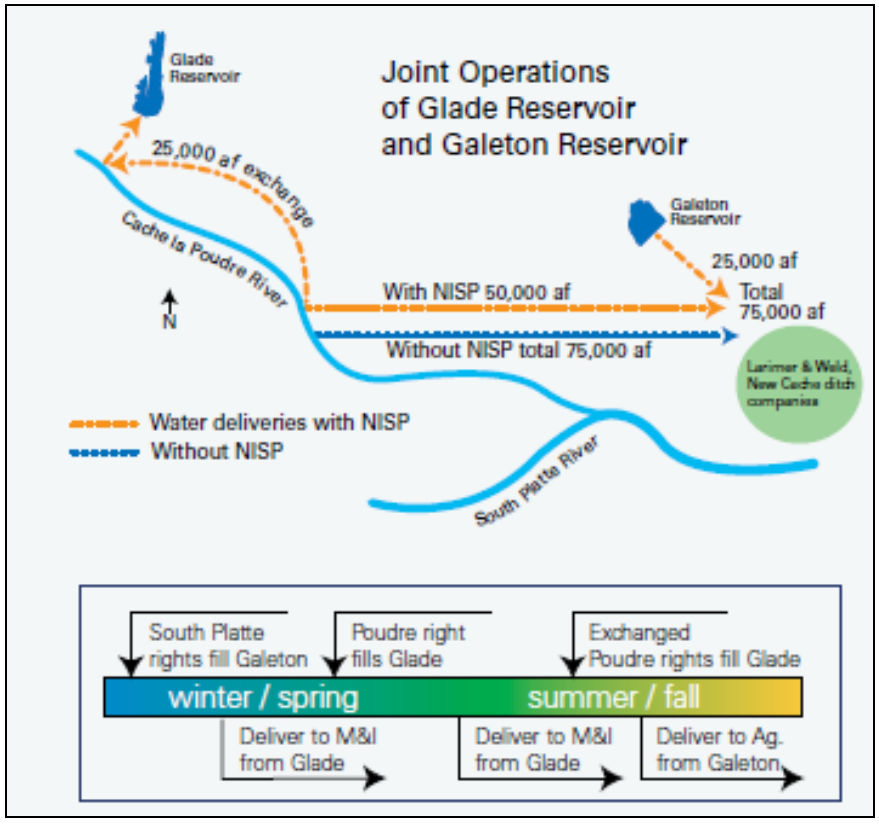

Figure 7. SPWCP Operation's Schematic

Project Costs

The SPWCP costs will include capital and operations and maintenance costs. Northern Water retained a team of Integra Engineering (now Dewberry) and GEI Consultants to prepare a feasibility design of the project facilities and in turn estimate the cost. The total

capital cost for the SPWCP is estimated to be $171,000,000 and is summarized in Table 2 (2010 dollars). The total cost of NISP with Glade Reservoir is $490,000,000. The total cost per acre-ft of NISP yield is $12,300 for the capital costs.

Table 2. SPWCP Costs

Item	Cost
Diversion and Forebay	$5,200,000
South Platte Pump Station	$22,100,000
South Platte-Galeton Pipeline	$45,200,000
Delivery Pipelines	$19,300,000
Larimer and Weld Pump Station	$4,800,000
Galeton Reservoir	$46,100,000
Engineering/Administration $16,300,000	
Other Costs (ROW, Land, Other Facilities)	$12,000,000
Total	**$171,000,000**

Pumping will also be required for the SPWCP. The approximate lift from the South Platte River to Galeton Reservoir including headloss is 400 feet. Each acre-ft will require 500 kilowatt-hours of energy. Assuming an approximate cost of $0.06 per kilowatt-hour, the energy cost will be approximately $30 per acre-ft. With other maintenance costs, the total operations and maintenance cost is estimated to be $60 per acre-ft.

AGRICULTURAL WATER USER COORDINATION AND ISSUES

Ditch Company Background

The SPWCP relies on exchange of water supplies with the Larimer and Weld and the New Cache ditch companies. These companies date back to the late 1800's and together irrigate approximately 200 square miles utilizing approximately 120,000 acre-ft of water from the Poudre River. Primary crops include corn, alfalfa, sugar beets, brewing barley, pinto beans, and a small amount of vegetable crops such as onions and carrots. The local agricultural economy also includes large dairies and cattle feedlots which rely upon the forage crops for their operations.

Both companies utilize a combination of direct flow water rights, storage rights, and exchange rights for their supply. The typical exchange involves releasing water from storage to a senior water right, and then diverting all or a portion of the senior water right for their use. In the case of the Larimer and Weld system, their supply is diverted upstream of the City of Fort Collins and would be considered a high quality water. In the case of the New Cache system, their diversion takes place downstream of the discharge of treated wastewater from the Fort Collins area and has a quality that is therefore diminished.

Both companies use a similar structure for their governance and operations. Shares of the companies are held by irrigators which entitles them to a certain number of acre-ft each year, depending on projected water availability. Each company has a board of directors

who oversee the management and decision making of the company. The staffing of the companies includes a manager, secretary, and ditch riders. There are also "sister" companies who own reservoirs as well as lateral companies who receive water from the main company.

Water Quality

The primary concern of both the individual irrigators and the ditch companies is that the South Platte River water might be of a lower quality compared to the high quality Poudre River water they are accustomed to using. In particular, this concern relates to salinity. The Poudre River is a mountain snow melt dominated river with a very high quality. The South Platte River on-the-other-hand has a greater percentage of waste water and ground water return flows and is lower in quality.

Salinity is the total concentration of dissolved ions in a system. Typically, ions contributing to salinity include the cations Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), and the anions SO4 (sulfate) and Cl (chlorine), HCO3 (carbonate). While different ions can cause different effects on plant growth, plants respond mainly to the sum total of ion concentration. If there is an excess of sodium, however, or high pH, water quality can degrade to the point of being unusable. In soils with high clay contents, high sodium in applied water can cause soil surface dispersion and sealing, effectively destroying any soil structure. This can lead to drainage problems, infiltration problems, and reduced porosity of soils.

The primary measurement of these ions is determined by electrical conductivity (EC) as measured in deciSiemens per meter (dS/m). Typical EC measurements in the Larimer and Weld Canal are approximately 0.5 dS/m. New Cache Ditch company measurements are higher at approximately 0.8 dS/m on average. The South Platte on the other hand is dominated by ground water return flows and can range from as little as 0.3 dS/m when spring snowmelt and rainfall dilution flows are high to 1.5 dS/m when flows are low. There is, therefore, the potential that salinity could increase in the canal systems as a result of the introduction of SPWCP water.

To address the salinity concern, Northern Water retained Dr. Glenn Hoffman to study the particular area that is being considered and make recommendations relating to the operation of the SPWCP. In addition to the potential salinity of the applied water, Dr. Hoffman considered the soils types, irrigation methods, and rainfall contribution. The conclusion was that there would be virtually no reduction in crop yields with the introduction of South Platte water. Only dry-beans have the potential of any decrease in yield and this would be on the order of approximately five to ten percent. Dr. Hoffman recommended a blending operations plan which would alleviate potential issues. The blending could be adjusted to meet the specific water quality of stored Galeton Reservoir water. The likely blending is approximately one third SPWCP water to two thirds native ditch water.

Northern Water continues to obtain salinity data via its remote sensing network. This program will continue through the actual implementation of the project to insure that there is no yield reduction impact to the irrigators. Additionally, specific water quality samples are taken to measure the specific ion constituents in the water. These analyses have shown the South Platte ion content to be dominated by calcium and sulfates and less so by sodium and chlorides.

Specifically, under certain conditions, sodium can cause soil problems and corresponding plant growth issues. Calcium can help alleviate this issue. The measurement of the problem is the Sodium Adsorption Ratio (SAR). It is the ratio of sodium ions to calcium and magnesium ions. A ratio greater than 10 is considered potentially harmful to irrigated crops. Measurements taken of South Platte water during a range of flows show the SAR to be between 1 and 2. Therefore, the SAR is not considered to be problematic for this project.

Ditch Company Compensation

Northern Water will need to receive the permission of the ditch companies to tie into their systems and exchange their water. Northern Water and the companies are working cooperatively on formulating contracts which describe how the project will integrate with their operations, and what compensation they will receive. Discussions with the companies have thus far indicated an interest in additional water as opposed to monetary compensation. Specifically, the following measures are being discussed:

- Provide an additional ten percent of water for each acre-ft exchanged
- Pump additional water when the South Platte Pump Station has flow available and Galeton Reservoir is full
- Give a preferred right to Colorado Big-Thompson unit rental from NISP participants in years that they have excess available
- Provide delivery infrastructure to allow for better utilization of their existing reservoirs

Operational Coordination with the Ditch Companies

Northern Water will coordinate the operations directly with the ditch companies. The goals are two-fold: 1) achieve the desired blending level between Galeton water and ditch water and ensure that the water levels in the ditch upstream of the SPWCP delivery point are high enough to make deliveries to those share holders. As previously discussed, water from Galeton Reservoir will be delivered at a rate up to 100 cfs to each ditch. The company's diversion from the river will then be curtailed a like amount. Northern Water is presently preparing a ditch company inventory of head gates, check structures, and other ditch features. This information will be integrated into a HEC-RAS hydraulic model to verify water levels in the canal are sufficient to make deliveries to upstream head gates. If the model finds that there are times when levels are insufficient to make deliveries, either the exchange will be curtailed, or additional check structures will be installed.

Northern Water will also work with the ditch companies to coordinate their SCADA systems with Galeton releases. The companies presently have some check structure automation. It is anticipated that with the ability to make instantaneous deliveries from Galeton to locations much further down the ditch, check structure and diversion structure operations will be automated via SCADA allowing less wait time on river diversion changes to the system.

Potential Risk

The primary risk to the SPWCP arises from the potential sale of the company shares to outside municipal water providers through the practice of buy-and-dry. The project exchange is formulated upon the assumption that the farmers will continue to irrigate in the area. In the event that the water is removed out of the system, there becomes a risk that project operations could be impacted. The following are methods that can be employed in the long term to address these risks:

- Monitor the amount and location of agricultural to municipal conversion. The amount of water which NISP will exchange through the SPWCP represents approximately a third of the water applied in the particular exchange area. Some amount could be sold out of the area and the project would remain operational.
- Extend the pipelines to the west. The project presently assumes an exchange area in the eastern portions of the ditch companies. The delivery pipelines could be extended to the west at a minor cost relative to the entire project and thus lessen the chance that the exchange would be impacted by transfers.
- Enter into "water easement" arrangements with irrigators. In this case, irrigators would be compensated for their right to sell their water to outside users. The value of the "easement" would presumably be the difference between the municipal value and the irrigation value of the water. The water with this easement could be sold to other irrigators as long as the water was used within the exchange area.
- Purchase the company shares and lease back. Under this arrangement, if shares become available for sale, NISP would buy shares and then lease them back to irrigators within the area.
- Work with dairy and cattle feedlot operators to incentivize keeping water in the exchange area. There are a number of very large dairy and cattle feedlot operators in or near the exchange area. These operations typically do not own a large portion of the land which is used to grow the forage and feed crops, typically corn and alfalfa. Instead, they contract with local growers for their crops. These operations have a mutual interest with NISP in maintaining the continuation of irrigation for raising forage crops. There may be ways of cooperatively working with cattle operations and growers to achieve the goal of continued irrigated agriculture in the exchange area.

It is likely that a combination of the above approaches will be used to insure that the SPWCP exchange continues. The approach can be implemented over time so that financially it becomes part of the operations and maintenance budget and not the capital

construction budget. Long term it will insure that at least a portion of the exchange area remains agriculturally productive.

CONCLUSIONS

The SPWCP will provide a new water supply to municipal suppliers through a cooperative program with the Larimer and Weld and New Cache ditch companies within the Poudre River basin. Through NISP, municipalities will be able to take advantage of the high quality water that the companies presently divert while providing a water supply suitable for irrigation to the ditch companies for agricultural use. Northern Water on behalf of the fifteen NISP participants has been working with the ditch companies to address their concerns and to find an equitable approach to provide net benefits to the company shareholders.

Ultimately, the SPWCP will rely on a partnership with the ditch companies. It will help insure the long term viability of agricultural production in the region while assisting in satisfying some of the anticipated additional regional municipal water supply needs.

REFERENCES

Hoffman, Dr. Glenn, "Impact of Utilizing Water Supplies from the South Platte Water Conservation Project on Crop Production," May, 2004.

Northern Colorado Water Conservancy District Salinity Program Website : http://www.ncwcd.org/ims/ims_agri_salinity.asp.

Swift, Curtis E., Ph.D, Colorado State University, "Sodium Adsorption Ratio", http://www.coopext.colostate.edu/TRA/PLANTS/sar.html.