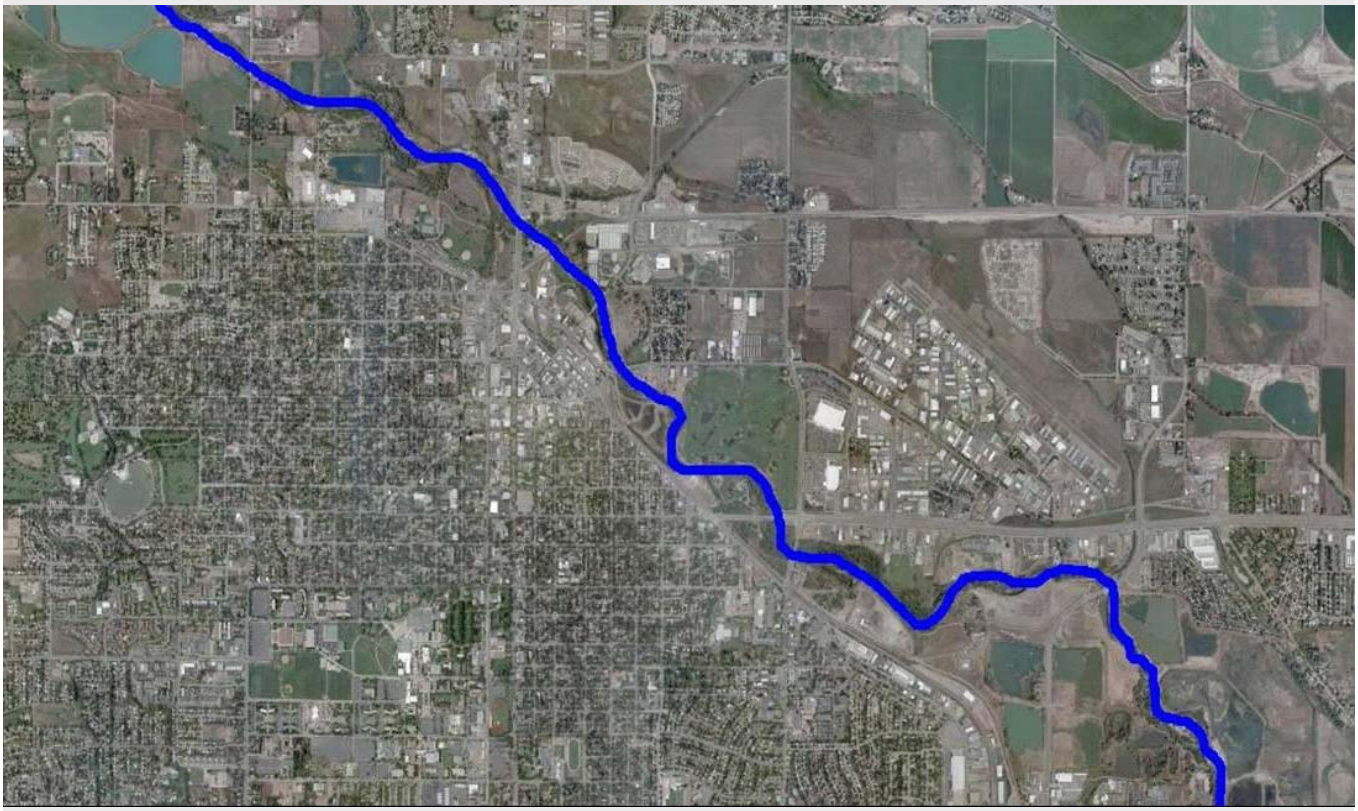
PRELIMINARY IDENTIFICATION OF POTENTIAL IMPACTS OF GLADE RESERVOIR ON THE CACHE LA POUDRE RIVER

(OVERLAND TRAIL to INTERSTATE 25)



Prepared for the City of Fort Collins

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Final Report
April 2008

PRELIMINARY IDENTIFICATION OF POTENTIAL IMPACTS OF GLADE RESERVOIR ON THE CACHE LA POUDRE RIVER FROM OVERLAND TRAIL TO INTERSTATE 25

Prepared for

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EXECUTIVE SUMMARY

The City of Fort Collins has expressed concerns about potential adverse impacts on the Poudre River through the city as a result of reduced flow (depletions) associated with the proposed Glade Reservoir, which is an off-channel reservoir that is part of the Northern Integrated Supply Project (NISP). NISP is being promoted as a regional project to meet the needs of 15 water providers who represent emerging communities experiencing rapid growth. NISP will provide 40,000 ac-ft of new water yield to these 15 project participants. The NISP project webpage indicates that Glade Reservoir will divert 10% of the Poudre River's 300,000 ac-ft average annual flow, as gaged at the mouth of the Poudre Canyon. About one half of this 30,000 ac-ft diversion represents new water diversions and the other half will come from the project's agricultural partners. Water would be diverted from the Poudre River at the existing Poudre Valley Canal Diversion (near the mouth of Poudre Canyon) and pumped into Glade.

This report represents the results of a preliminary identification of potential impacts of the NISP diversion on the Poudre River based on available literature, data, and a one day field reconnaissance. This study was intended to be high-level and preliminary in nature. This study did not examine the River as a recreational, economic or aesthetic resource, nor did it consider the River as a quality of life amenity for the community. Ayres did not have final data on NISP project depletions, impacts or mitigation, and therefore has not made any final conclusions on these matters. Further, Ayres did not evaluate whether NISP will comply with the 404(b)(1) guidelines or other applicable authority. Based on these issues, this study is subject to review, revision and supplementation.

The Cache la Poudre River from the canyon mouth to Interstate 25 has undergone significant morphological changes (e.g., channel straightening, incision, and narrowing) over the last century due to agricultural flow diversions, urbanization, channelization, aggregate mining, and changes in upper basin hydrology associated with storage projects. In light of these historical changes, there are potential impacts to river geomorphology that may be induced by additional changes in flow patterns created by the proposed Glade Reservoir. The primary concerns are associated with the potential for increased fine sediment buildup in the river channel and the potential for loss of channel capacity associated with vegetation encroachment. The potential accumulation of fine sediment in the channel as a result of reduced flows can have a direct impact on habitat for aquatic species and invertebrates and may also provide a substrate for the encroachment of unwanted species of vegetation. Reductions in peak and summer mean monthly flows could also impact the groundwater levels in the river's floodplains, which in turn could have a direct impact on the stability and heath of riparian vegetation along the river and an indirect impact on the health of river’s aquatic species and riparian vegetation communities subjacent to the river.

The areas of concern for aquatic habitat and aquatic species, as they relate to potential changes to the current flow regime from Glade Reservoir, are changes to the physical conditions upon which the aquatic species depend. Studies dating back to the mid to late 1980s suggest that the flow regime requires both peak flows for habitat creation and maintenance as well as maintaining a suitable low flow to provide habitat during the late summer months. These low flows were identified as one of the major limiting factors for the fishery through the City of Fort Collins and, therefore, reducing these low flows even further may not provide the habitat that is available through the City today. In addition, the ground water/surface water interaction in the river may change with change in peak flow. This could affect riparian conditions, which in the long term could produce changes in riparian cover, provide additional thermal input to the river, and ultimately result in higher water

temperatures. A rise in water temperatures in the long term may reduce the trout fishery that is present today and could result in a shift to a warm water aquatic community in the future.

Existing vegetation along the riparian corridor has mostly developed in the years after European settlement and under conditions influenced by upstream reservoirs, irrigation diversions, and stream channelization. In spite of the changes that have occurred in the riparian vegetation along the Cache la Poudre River, the existing plant communities provide important habitat for many resident and migrant wildlife species and also provide natural areas for human use. Under the existing stream flow regimes it is unlikely that natural recruitment of native species will occur frequently enough to maintain a native forest type. The potential exists for the reduced peak flows associated with the project to increase problems associated with low flow conditions. Therefore, one of the major concerns related to impacts on vegetation resources centers on whether the existing vegetation can be maintained under a regime of reduced peak flows that may occur from Glade Reservoir. The concern includes issues related to survival of the existing riparian species as well as for potential reproduction and establishment of native species. Other concerns include the direct impacts of reduced flows on groundwater and the indirect impact to vegetation communities on the surrounding floodplain that rely heavily on the groundwater interconnectivity between the river and its floodplain.

1. INTRODUCTION

The City of Fort Collins is concerned about potential adverse impacts on the Poudre River from the proposed Glade reservoir. Glade reservoir is part of the Northern Integrated Supply Project (NISP). NISP is being promoted as a regional project to meet the needs of 15 water providers who represent emerging communities experiencing rapid growth. These 15 water providers have partnered with the Northern Colorado Water Conservancy District (NCWCD) on NISP, which will provide 40,000 ac-ft of new water. The total cost of NISP, as proposed, is $400 million or about $10,000 per ac-ft of water. **Figure 1** shows the geographic locations of the NISP partners.

NISP includes two new off-channel reservoirs, Glade and Galeton. Galeton reservoir is located near the town of Galeton (north and east of Greeley) and will be 40,000 ac-ft. Glade reservoir is located north of Fort Collins, approximately one mile north of the junction of Highways 287 and 14 (Teds Place), and will be 170,000 ac-ft (slightly larger than Horsetooth). **Figure 2** shows the locations of these reservoirs and other facilities associated with NISP.

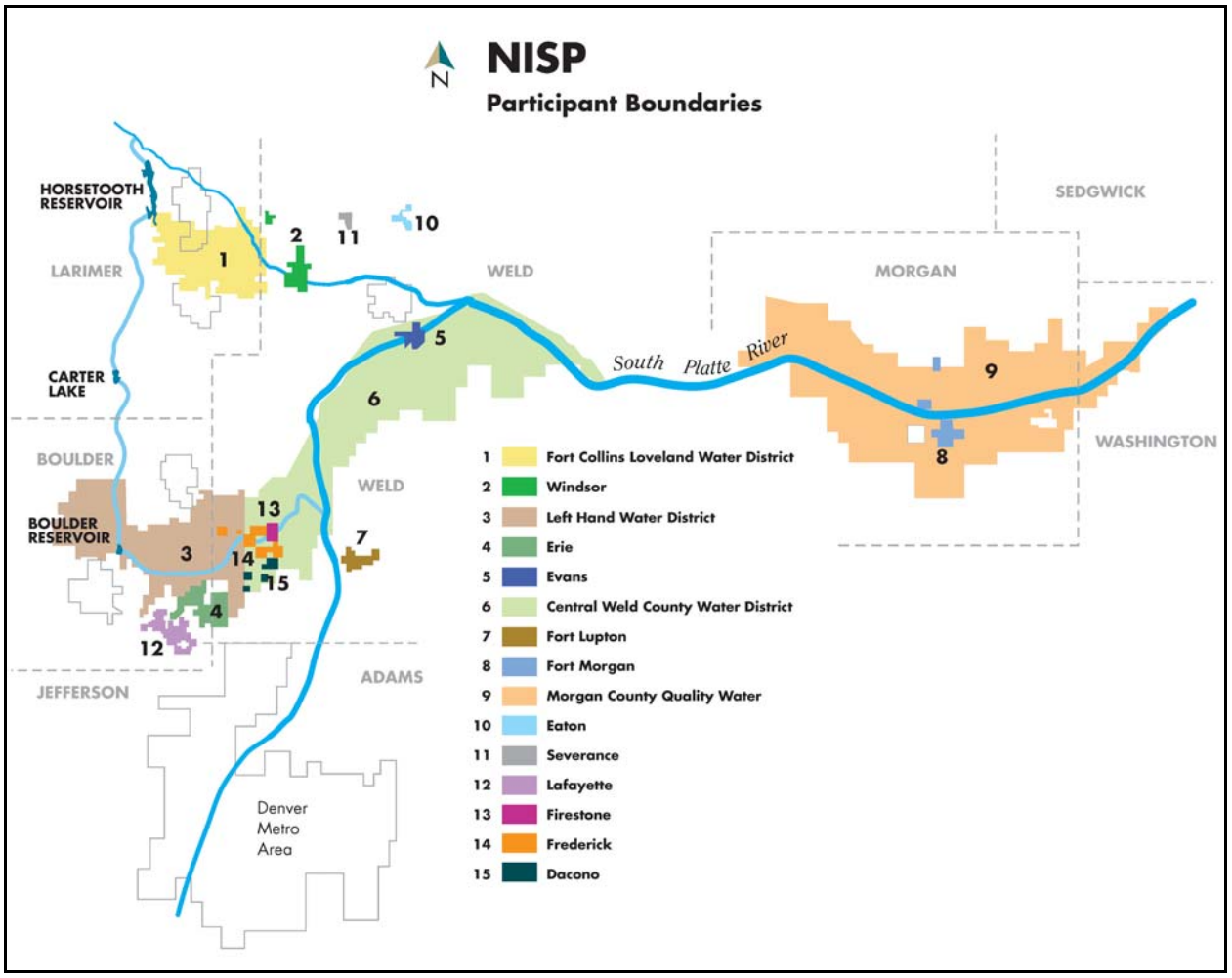

Figure 1. NISP project participants.
(from http://www.ncwcd.org/project_features/nisp_main.asp)

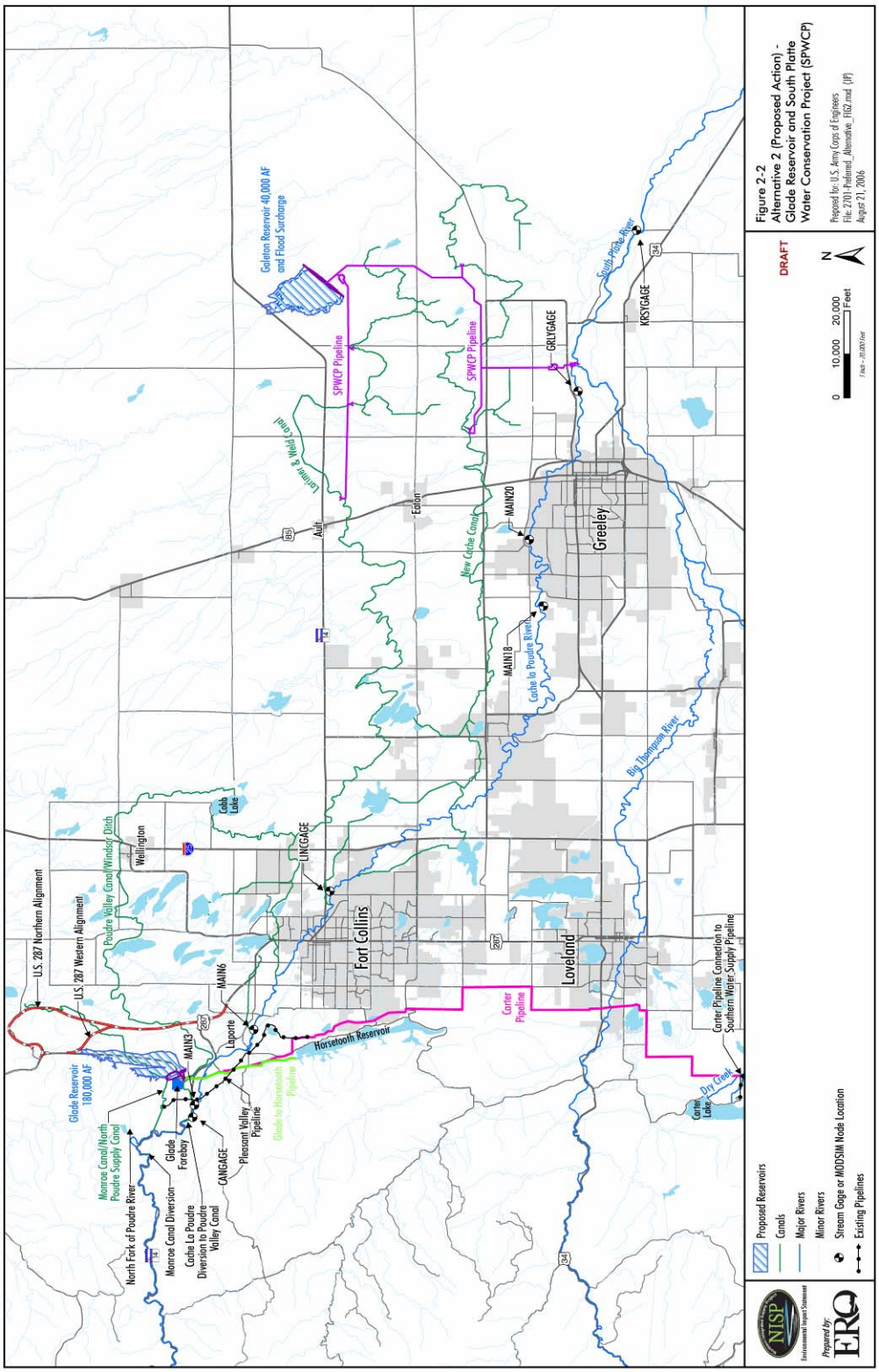

Figure 2. Location Glade and Galeton Reservoirs.
(from http://www.ncwcd.org/project_features/nisp_details.asp

Water would be diverted from the Poudre river at the existing Poudre Valley Canal Diversion (near the mouth of Poudre Canyon) and pumped into Glade. The maximum diversion rate based on the pump station capacity is 1,000 cfs. The potential impacts on the river corridor through town resulting from reduced flow (depletion) in Poudre River flow is a potential concern to the City of Fort Collins.

2. SCOPE OF WORK

Ayres Associates suggested a three phase study. The first phase was a qualitative assessment based primarily on available literature and a one day field reconnaissance. An important part of this initial work effort was coordinating with the City of Fort Collins Utilities staff (Dennis Bode and Donnie Dustin) on the flow analysis and hydrologic modeling underway for the Halligan-Seaman Water Management project. That modeling has been completed assuming that the Glade project is built, and therefore, provides an understanding of the potential impacts of Glade to the Cache la Poudre river.

The second phase, as required, will be a more quantitative investigation and could involve detailed geomorphic mapping and hydraulic modeling to better describe the impacts on channel morphology and inundation levels. If needed, the aquatic habitat quantification conducted during the late 1980s will be updated with new model analysis using the more recent cross section and hydraulic data developed for the hydraulic modeling. These same data sets could be used to describe impacts to riparian vegetation.

The third phase will be on-call work, as required, with the City in reviewing and commenting on the NISP Draft EIS when it is issued.

This report presents the results of the Phase I study. The following sections provide information in five discipline areas: hydrology, geomorphology, hydraulics, aquatic habitat and species, and vegetation. At the end of the report, recommendations for Phase II and III are provided.

The Phase I study was intended to be high-level and preliminary in nature. The Phase I study did not examine the River as a recreational, economic or aesthetic resource, nor did it consider the River as a quality of life amenity for the community. Ayres did not have final data on NISP project depletions, impacts or mitigation, and therefore has not made any final conclusions on these matters. Further, Ayres did not evaluate whether NISP will comply with the 404(b)(1) guidelines or other applicable authority. Rather, the Phase I study is subject to review, revision and supplementation.

3. HYDROLOGY

3.1 Historical Changes in Annual Peak and Mean May, June and July Discharges

The gage data for the flows at the canyon mouth were examined to identify general changes that have occurred since the 1880s. These changes in annual and monthly flow patterns can be directly attributed to agricultural demands and urbanization within the region. **Figures 3**, **4, 5, and 6** represent the peak and mean monthly discharges for May, June, and July, respectively, which show a general decrease of between 33 and 50% in flow (red linear best fit line) since the 1880s. The trend remained the same after 1957, when additional flow was added to the system as a result of the Colorado-Big Thompson Project.

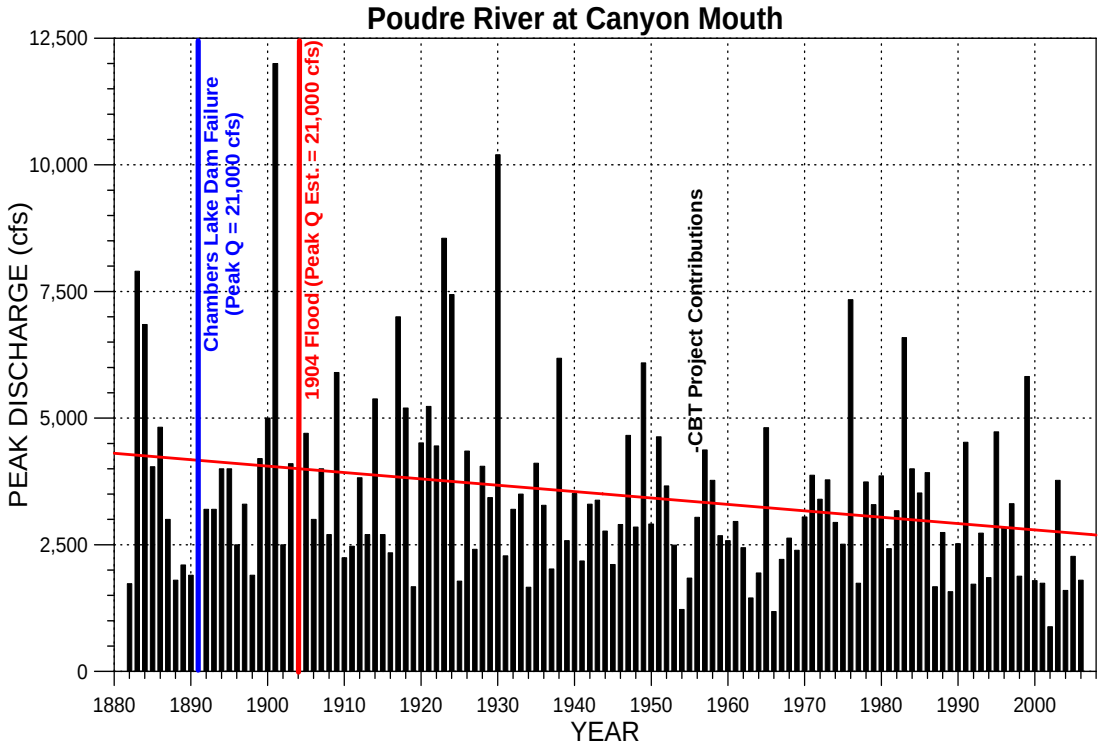

Figure 3. Peak discharge for the Cache la Poudre River at canyon mouth.

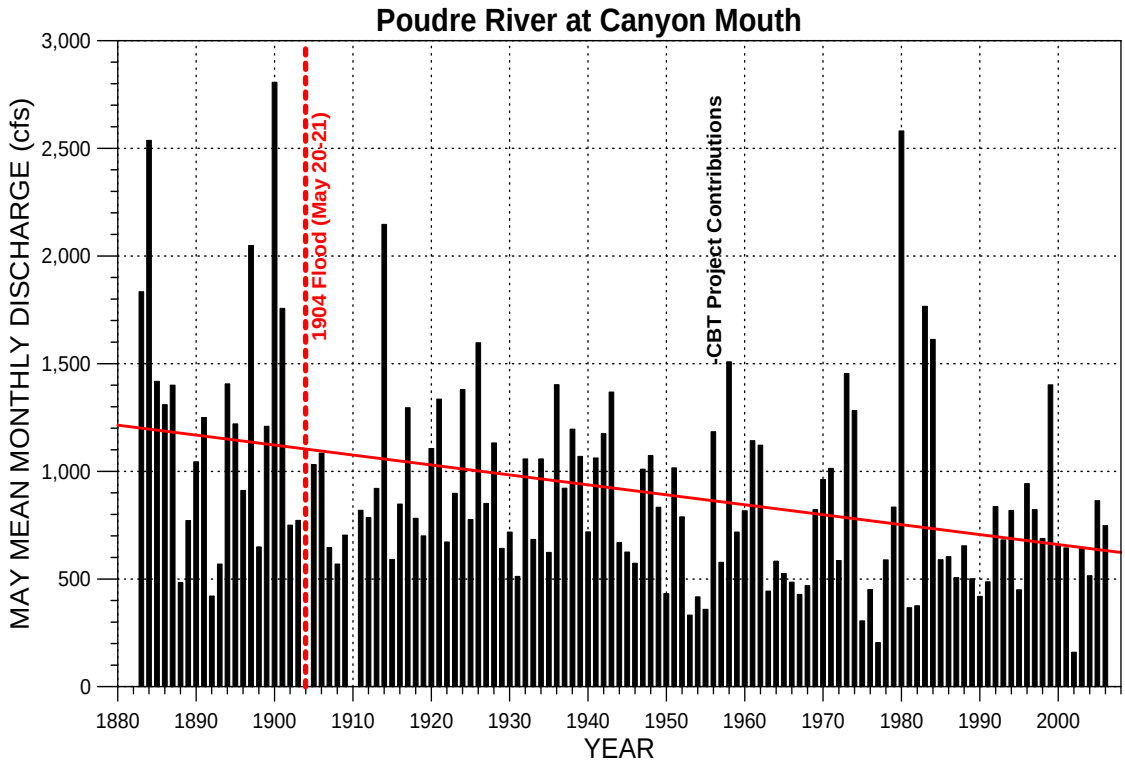

Figure 4. Mean monthly discharge for May for the Cache la Poudre River at canyon mouth.

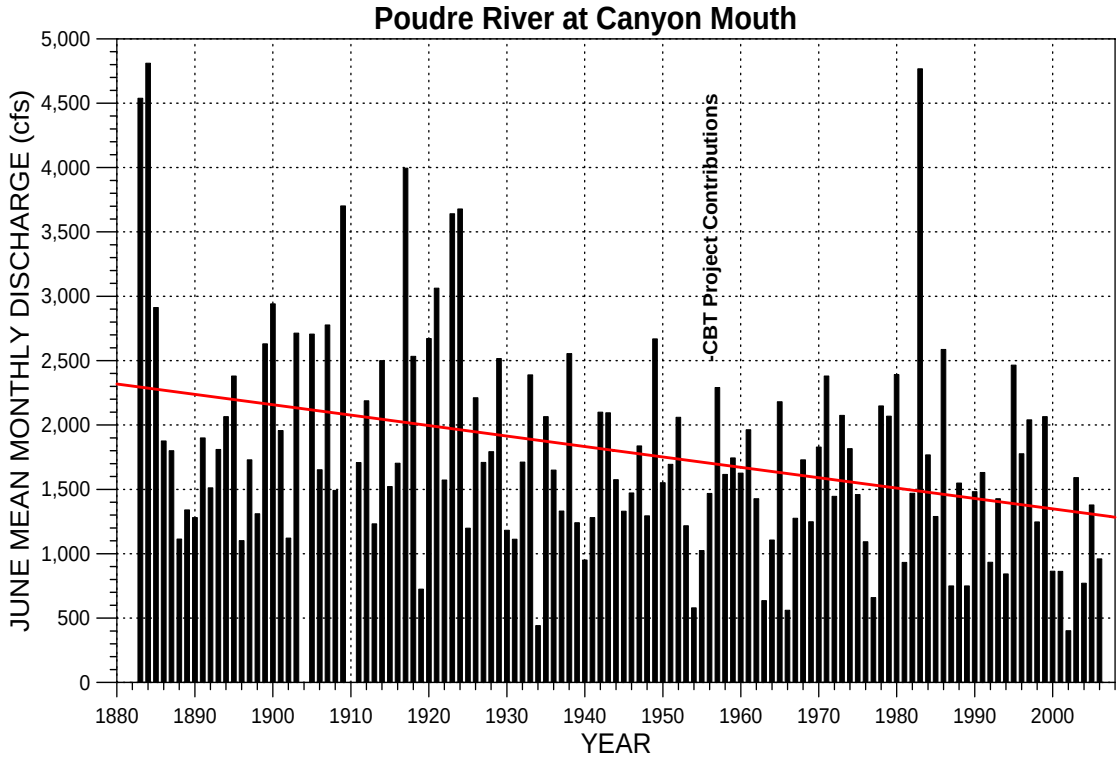

Figure 5. Mean monthly discharge for June for the Cache la Poudre River at canyon mouth.

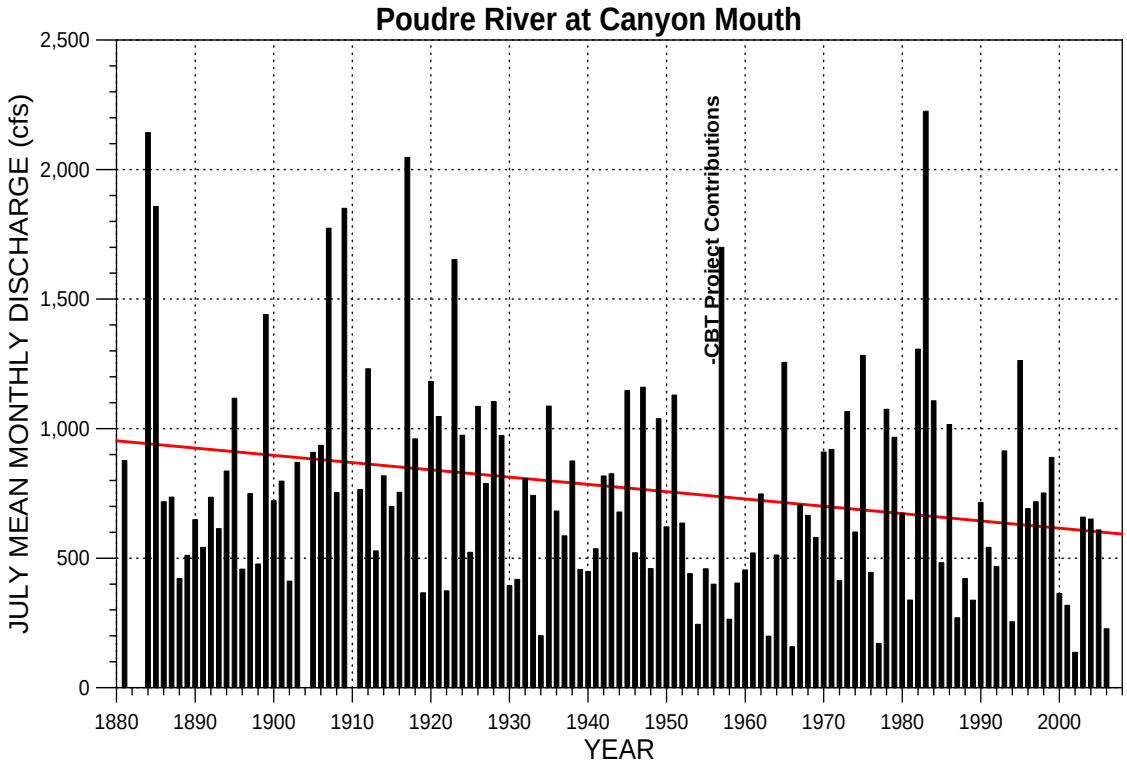

Figure 6. Mean monthly discharge for July for the Cache la Poudre River at canyon mouth.

The largest historical peak flows, estimated at approximately 24,000 cfs, occurred in 1891 and 1904. The 1891 flood occurred as a result of the failure of the Chambers Lake Dam on June 9, 1891. The 1904 flood occurred as a result of a major precipitation event near Livermore on May 20-21, 1904, and resulted in major flooding and damage in the City of Fort Collins. Between 1882 and 1930, peak flows in excess of 5,000 cfs occurred 13 times, but subsequent to 1930, the river has experienced peak flows in excess of 5,000 cfs only 5 times.

3.2 Average Annual Depletion from NISP

NISP will provide 40,000 ac-ft of new water yield to the 15 project participants. The NISP project webpage (accessible from the NCWCD website) indicates that Glade Reservoir will divert 10% of the Poudre River's 300,000 ac-ft average annual flow as gaged at the mouth of the Poudre Canyon. About one half of this 30,000 ac-ft diversion represents new water diversions and the other half will come from the project's agricultural partners. In other words, about 15,000 additional ac-ft of new depletions will occur on average from the Poudre River upstream of Fort Collins. This water will be diverted at the existing Poudre Valley Canal diversion dam during times of higher than average flow from snowmelt or larger rainfall events.

3.3 Computer Modeling Results

Several computer models of the Poudre Basin hydrology and water operations and management have been developed over the past 20 years. These models in general have been built using a program called MODSIM developed at Colorado State University. Both the City of Fort Collins and NCWCD have built MODSIM models to assist with water supply and demand management as well as proposed project scenario evaluation. NCWCD is using MODSIM to model the hydrology and operations of the Glade Reservoir project. Poudre River flows at various points are simulated by the model using a variety of diversion scenarios and hydrologic assumptions associated with Glade Reservoir and the South Platte Water Conservation Project.

All of the MODSIM models developed for the Poudre River Basin use a monthly time step. Therefore, the most detail that such a model can produce will be monthly average diversions, exchanges, flows, etc for the period of a month. However daily fluctuations in both operations and the resulting flow values can vary significantly. Monthly averaging of the model input data tends to dampen the peaks and valleys of daily flows, diversions, and reservoir operations. Typically in modeling applications such as the Poudre River Basin a monthly time step is used because a daily time step model is very time consuming and complex to develop due in part to the enormous amount of daily input date that must be generated. However, it is important to understand that using monthly time steps coarsen the model resolution and fail to reflect the daily variations in the hydrologic system. Daily flow variation can be evaluated by disaggregating the monthly flow values using an average daily flow pattern developed from daily flow records. That approach will not provide the level of detail that a model with a daily time step would yield, however it will provide insight to the potential effects that daily fluctuation could have on the Poudre River hydrology through Fort Collins.

City staff included the NISP project as part of the MODSIM modeling and analysis being conducted for the City's Halligan Reservoir enlargement project. The City wanted to include the impacts of Glade in any modeling that was done for the Halligan project. Specific NCWCD NISP modeling information is unavailable at this time and so city staff reconstructed

the impacts of Glade and modified their Halligan MODSIM model accordingly. City staff has also completed a spreadsheet analysis of the impacts due to NISP at the Lincoln Street Gage using information obtained from the NCWCD website along with data generated by the city's MODSIM models.

The city's spreadsheet analysis used daily gage data collected at the Lincoln Street gage from April 1975 through October 2007. From this period of record, three years representing an average, wet, and dry year were selected to compare the effects of NISP on the flows at the Lincoln Street Gage during each of the three hydrologic scenarios (average, wet, dry). 1996 was selected as the representative average year; 1980 was chosen to represent a wet year; and 1989 serves as the representative dry year. A wet year is defined as a year during which the Poudre River flows at the Lincoln Street Gage were greater than average and similarly a dry year is defined as one during which flow is less than average. The average annual flow of the period of record (POR) used for this analysis is 112,500 acre-ft. Given that definition, over the POR there were 22 years classified as below average or dry and 9 years above average or wet. The representative average, wet, and dry years were selected arbitrarily from the 31 years of data.

The spreadsheet analysis results indicate that flows in the Poudre River as measured at the Lincoln Street Gage would decrease from April through September during the selected representative average, wet, and dry years. The monthly reduction in flow ranges from 2% to 68% when assumed NISP operations were applied to the representative average (1996), wet (1980), and dry year (1989). In general the largest flow reductions (greater than 27%) occur during the high runoff months of May, June, and July. In terms of average daily flow rate, the largest daily decreases from the three representative years are; 1140 to 140 cfs (88%) during June 22, 1996 , 1400 to 425 cfs (70%) during June 8, 1980, and 412 to 234 cfs (43%) during June 1, 1989. Overall the yearly annual decrease in flow for all scenarios is between 2% and 56% representing 2,000 to 106,000 ac-ft per year with assumed NISP operations applied from 1976 - 2001. Given that these numbers represent the range of potential depletions, and bracket the average annual number of 30,000 ac-ft identified on the NISP webpage, the calculations appear generally reasonable. Until the DEIS is released for public review it is difficult to draw any further conclusions. Furthermore, it is not known at this time what mitigation might be proposed for whatever depletions are occurring.

3.4 Water Rights

The two primary water rights of the NISP project preferred alternative are the Grey Mountain decree for approximately 16,000 ac-ft into Glade Reservoir and the South Platte Water Conservation Project water rights for approximately 24,000 ac-ft. These two rights in conjunction with a series of diversions and exchanges are projected to achieve the NISP annual yield goal of 40,000 ac-ft.

NCWCD plans to use a 1980 conditional water right on the Poudre River for NISP operations at Glade Reservoir. A conditional water right is a right that will be developed in the future. Conditional water rights maintain their priority until a project is complete as long as the owner periodically shows the water court reasonable diligence in pursuing the project. Originally the conditional water right was granted to NCWCD for Grey Mountain Reservoir located on the mainstem of the Poudre River. The Grey Mountain Reservoir water right would have allowed 220,000 ac-ft of in-channel reservoir storage on the Poudre River. In 2006 the NCWCD won a water court case allowing them to transfer the diversion and storage of their conditional Grey Mountain water right to other locations including Glade Reservoir. Glade Reservoir as currently planned will be able to store 170,000 ac-ft of water.

The water rights that NCWCD holds for diversion to Glade Reservoir will be exercised at the Poudre Valley Canal diversion location on the mainstem of the Poudre River. Water diverted into the Poudre Valley Canal will then be pumped into Glade Reservoir. NCWCD projects that under the Grey Mountain water right, water will be diverted for storage four out of every 10 years on average.

The South Platte Water Conservation Project (SPWCP) water right, with a decree date of 1992, allows NISP to divert South Platte River flows below the confluence with the Poudre River. This water right is projected to yield water on an annual basis except for very dry years. Water from the SPWCP diversion point on the South Platte River will be pumped to Galeton Reservoir, a new reservoir with approximately 40,000 ac-ft of storage. Galeton Reservoir releases will be pumped into the lower third of the Larimer & Weld and New Cache Canals. SPWCP water pumped to those canals will be exchanged upstream to Glade Reservoir when an exchange potential exists. The exchange allows water that would have been captured further upstream the Poudre River by the Larimer & Weld Canal and New Cache Canal to be diverted for storage in Glade Reservoir.

3.5 In-Stream Flow Considerations

The NCWCD website includes NISP information addressing "several" in-stream flow requirements on the Poudre River through Fort Collins. Specifically the NISP News dated June 2007 states**, "**NISP is committed to meeting three in-stream flow requirements through LaPorte and Fort Collins. The project will not take water from the river when those flows are not met." A NISP informational video on the Glade Reservoir project repeats the idea that NISP will not divert water from the Poudre River until the three minimum flows are met.

The three in-stream flow requirements are the Watson, Power Plant Dam and Nature Center Dam water rights. Those three rights, decreed to the City of Fort Collins, are junior to the NCWCD Poudre Project water rights and junior to numerous other water rights held within the Poudre River Basin. NCWCD has included the three in-stream flow rights in their DEIS MODSIM model. HDR in their technical review (HDR report, 2005) of the NISP MODSIM model make the following observation:

> "In general, if the flow in the river is high, the minimum flow demands are exceeded. If flow in the river is low, the minimum flow demand is not met. NCWCD said that NISP diversions are limited or shut off if a minimum flow target is not being met (meeting minutes 11/08/04). However, all senior water rights on the river are still satisfied to the extent possible before the minimum flow demands receive any water."

A comparative review of the spreadsheet analysis results at the Lincoln Street Gage with the in-stream flow requirements show a number of days over the period of record when simulated Poudre River average daily flow at the Lincoln gage is less than the in-stream flow requirements. NISP alternatives modeling conducted for the DEIS may satisfactorily address this issue. However, verification of the operations of NISP that would allow the in-stream flow rights to be achieved will be delayed until more information about the NISP DEIS modeling is released.

4. CACHE LA POUDRE RIVER GEOMORPHOLOGY

The Cache la Poudre River from the canyon mouth to Interstate 25 has undergone significant morphological changes over the last century due to agricultural flow diversions, urbanization,

channelization, sand and gravel mining, and changes in upper basin hydrology associated with storage projects. Over time, the channel in this reach has degraded and narrowed as annual peak and mean daily flows, especially during the late spring and summer months, have significantly decreased as agricultural and urban demands on river flows have increased. The river's bed has coarsened and become armored in places as a result of decreases in sediment supply, and bar forms have eroded away, shrunk in size, or no longer form except during major flow events. Many of the historical bars have become partially or completely disconnected from the low-flow channel because of channel degradation or colonized with vegetation because of significant reductions in annual peak flows, which historically rejuvenated bar materials and scoured the bars of much of the existing young vegetation.

4.1 Literature Review

Ayres Associates has conducted several previous studies on the Poudre River for the City and Larimer County (RCE 1994; Ayres Associates, 2001, 2002, 2005a, 2005b). All of the studies have included hydrologic, hydraulic, and geomorphic analyses of the river. The principal study conducted by Ayres Associates, the Cache la Poudre River Master Drainageway Plan (2001), is inclusive of the NISP impact reach identified by City staff. A detailed field reconnaissance, geomorphic mapping effort, and geomorphic, hydrologic, and hydraulic analyses were conducted by Ayres personnel in 1992 as part of the original Cache la Poudre River Master Drainageway Plan study (RCE 1994).

Other relevant studies include the river stability study of the Poudre River for the reach from the Fossil Creek Reservoir Inlet Ditch diversion to the Burlington Northern Railroad Bridge just upstream of Horsetooth Road conducted by Anderson Consulting Engineers (2001, 2002), and those conducted for Colorado State University's Colorado Water Resources Research Institute (CWRRI). Historical maps of the Old Fort Site and the river in downtown Fort Collins were prepared by Marmor (2002). These studies are documented in the reference list at the end of this report. In addition, the Colorado State University Library's Sage Online Catalog was searched for documents pertaining to the Cache la Poudre River that are available through the CSU Library. The document list from the Sage online catalogue is provided in **Appendix A**.

4.2 Historical Changes in Channel Morphology and Current Conditions

Major changes in channel morphology have occurred along the Poudre River, especially in the City from about Taft Hill Road to the interstate. An examination of aerial photos taken in 1937 reveals that the river at that time was a relatively wide, shallow, meandering channel that was braided in places. There were several flow splits, with flow occupying a primary channel and secondary channels. Sand and gravel bars including mid-channel and point bars were common along the reach. Numerous old oxbows and meander scrolls are evident along the bounding floodplain and overbank flow appears to have been common as evidenced by existing active overbank flow paths and channels seen in the photos. Subsequent changes over the last 70 years have significantly altered the character of the river and its floodplain.

South Taft Hill Road to College Avenue

Changes in river morphology that occurred between 1937 and 2005 for the reach between the South Taft Hill Road bridge crossing and the College Avenue bridge crossing are evident in **Figure 7**. The numbered sites in the figure represent locations of significant planform changes in the river between 1937 and 2005.

The arrow at Site 1 represents the downstream end of a major flow split that was present on the river in 1937. This flow split began a few hundred feet upstream of the South Taft Hill Road bridge crossing. There were 2 bridge crossings at that location, one for each channel of the river. The Arthur's Ditch Diversion structure was present on the south channel just downstream of the South Taft Hill Road bridge crossing in 1937, but was replaced with the current structure between 1956 and 1969. By 1969, there was only one bridge crossing, the bridge having been rebuilt after 1956, and much of the area was being mined for sand and gravel resulting in the complete obliteration of what was once the north channel of the river. The new Arthur's Ditch diversion structure across the river immediately downstream of the bridge crossing currently provides a significant amount of grade control. Immediately downstream of the arrow for Site 1 is the Larimer and Weld Canal diversion structure, which has been in place since prior to 1937. This structure also maintains a significant amount of grade control. The current combined drop across these two structures is probably on the order of 12 to 15 feet.

The box delineating Site 2, as seen in Figure 7, represents a reach of the river that was modified prior to the 1937 aerial photos. In the 1937 aerial photo, the reach within the box appears to have been straightened. A meander bend on the right (south) bank has been cutoff and abandoned, and it is evident in the photos that linear piles of sediment with evenly spaced scrape marks line both banks. The abandoned meander has been mostly obliterated by mining, but a portion is still present as a perched, vegetated bench along the right (south) bank.

Site 3 in Figure 7 shows two historic cutoffs of flow splits that have occurred since 1937. The first major flow split extended from the downstream end of the box identifying Site 2 and the downstream arrow for Site 3. The northern channel which was still active in 1937, is no longer viable, but is still visible as a meandering line of vegetation in the 2005 aerial photos. The southern channel is the current channel. By 1956, the area between the two channels upstream of Shields Avenue was being mined for sand and gravel. Sometime between 1956 and 1969, the north river channel upstream of Shields Avenue was completely obliterated by mining and a new channel had been constructed that connected the Josh Ames Diversion to what remained of the north river channel east of Shields Avenue. The Josh Ames Diversion structure, which was also constructed between 1956 and 1969, is identifiable at the downstream end of the Site 2 box in Figure 7.

The south river channel between the two Site 3 arrows seen in Figure 7 underwent a cutoff sometime between 1937 and 1950. An overbank channel was evident on the floodplain at this location in the 1937 aerial photo. From 1956 and 1969, this area was actively being mined and the abandoned cutoff had been completely obliterated. Vegetated islands that are currently evident in the channel at this location were established unvegetated braid bars in 1969.

The Lake Canal Diversion located just upstream of College Avenue was already established in the 1937 aerial photos and is still present today. Portions of the vegetated islands that were present downstream of the structure in 1937 are no longer present today.

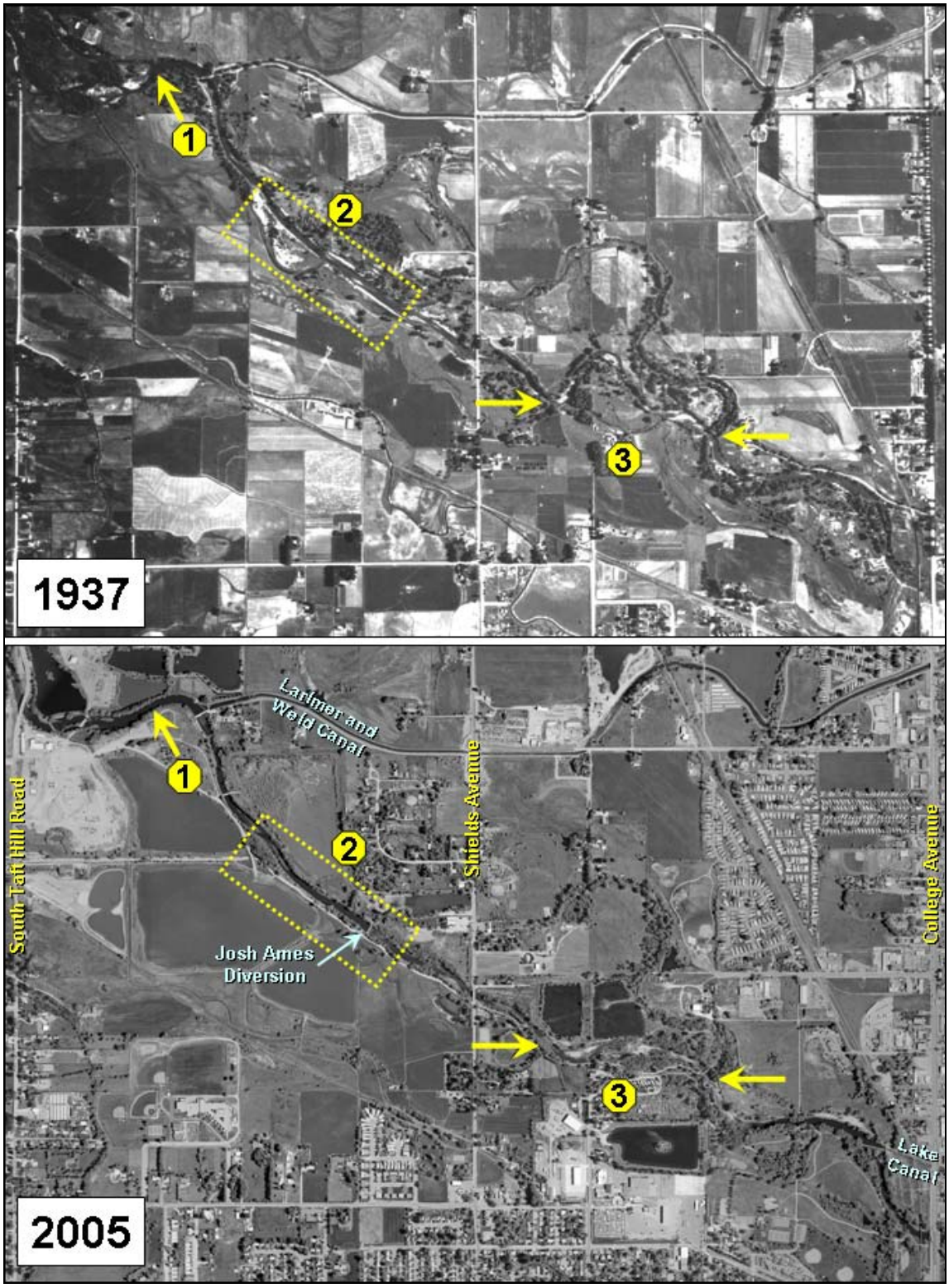

Figure 7. Comparison of Poudre River planform from 1937 and 2005 for reach between South Taft Hill Road and College Avenue.

By 2005, the floodplains on both sides of the river between South Taft Hill Road and College Avenue had been extensively mined for sand and gravel and the existing pits were abandoned and subsequently filled with water. Gravel and cobble bars that were present in 1937 and are still present today, appear as low, silted over, heavily vegetated islands or inset floodplains along the channel margins. It was noted during the field recon that at least one bank attached bar that was free of vegetation only a few years ago, is now covered with fine sediments and is densely colonized by young saplings, shrubs and grasses. These islands, vegetated bars, and inset floodplains represent the results of long-term channel degradation caused by flow pattern changes, channelization, and reductions in normal sediment supply (coarse sand to cobble size material) associated with agricultural diversions, channelization, bed and bank stabilization, and urbanization.

In addition, small pools and zones of slow or slack water along the reach are currently filled or partially filled with fine sediment (silt and sand) as a result of a lack of significant flushing flows or a large peak flow over the last couple of years. Channel bed armoring by large bed material is apparent in places. In some places, the coarse armor has fine sediment infilling the interstices between the coarser particles.

College Avenue to Timberline Road

There are several bridge crossings between College Avenue and the current Timberline Road bridge. These include Linden Street, Lincoln Avenue, Mulberry Street (SH 14), and Lemay Avenue. **Figure 8** shows aerial photos for the reach from 1937 and 2005. Extensive channelization and modifications to the river and urban encroachment in the segment between College Avenue and Lemay Avenue had significantly changed the character of the river resulting in a less sinuous, degraded channel. There is very little sediment storage in this segment as evidenced by the lack of established bars and the exposed bedrock in the channel bed and banks throughout the segment. The channel banks have been armored along much of the reach in an effort to halt bank erosion and channel migration.

Two major cutoffs (Sites 4 and 5 in Figure 8) and minor channel straightening associated with the installation of the Mulberry Street Bridge have had a significant impact on the river. The effect of these changes is to increase the slope of the river, which increases the erosion potential of existing flows in the reach. Thus, the river has reacted to these changes by degrading. However, degradation has been significantly slowed by bedrock exposed in the channel bed and banks in places and by channel bed armoring at bridge crossings and elsewhere. Much of the degradation has been captured by the diversion dam and grouted rock grade control structure just downstream of College Avenue near the site of the old power plant.

Although the river's planform has changed only slightly between the Lemay Avenue crossing and Timberline Road since 1937, the channel has become narrower and deeper with few remaining active bars. Again, small pools and zones of slow or slack water along this relatively unchanged segment are currently filled or partially filled with fine sediment (silt and sand) as a result of a lack of significant flushing flows or a large peak flow over the last couple of years. Channel bed armoring by large bed material is apparent in a few places. In some places, the coarse armor has fine sediment infilling the interstices between the coarser particles. The Timnath Reservoir Inlet Ditch diversion structure that was present in 1937 is still present and functional. Where the river is pinned against the high right (south) bank, small outcrops of bedrock are present in the channel bed as well as in the right bank. Most of the bars that remain in this reach are fairly well vegetated.

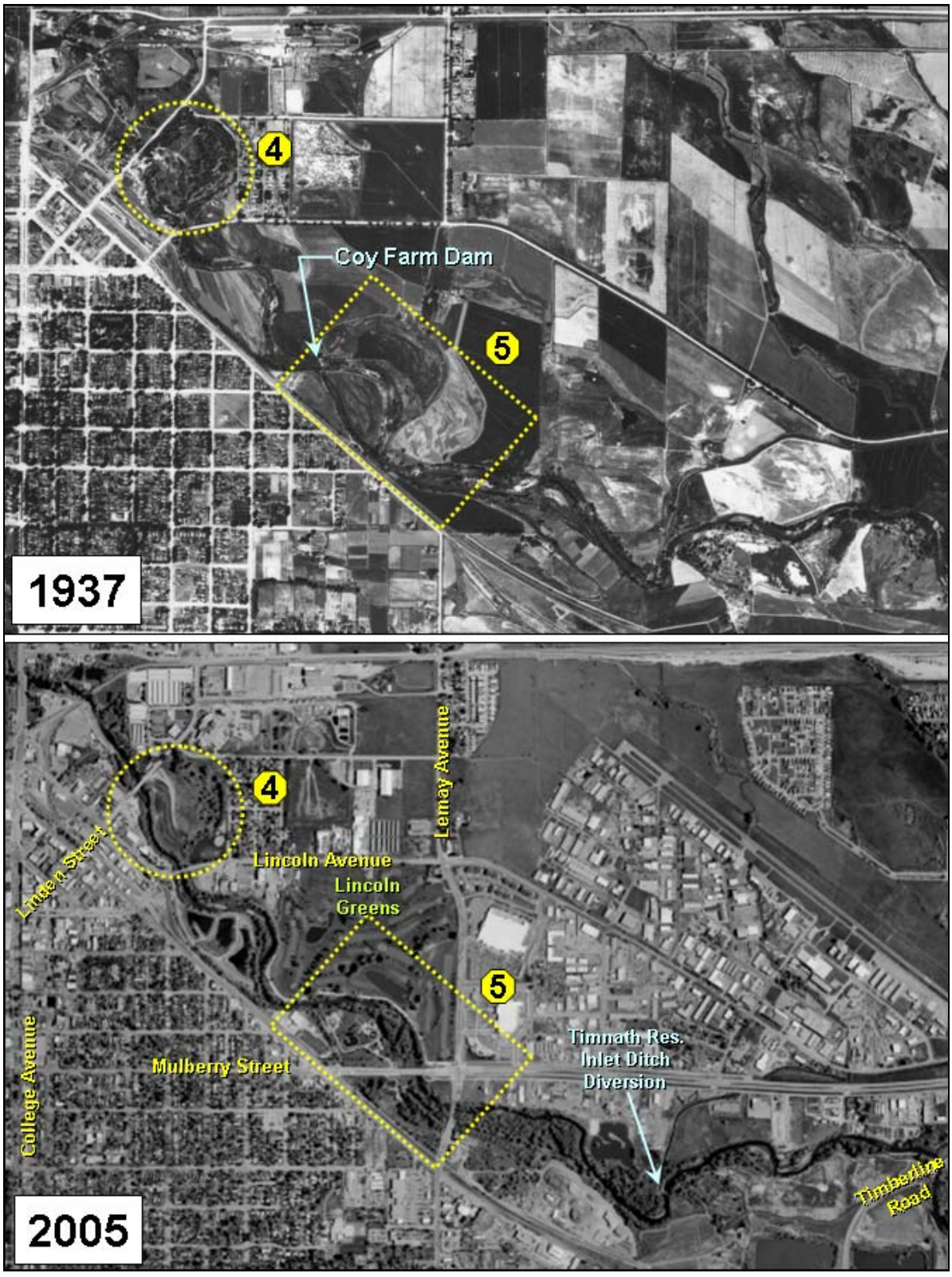

Figure 8. Comparison of Poudre River planform from 1937 and 2005 for reach between College Avenue and Timberline Road.

Timberline Road to Drake Road

The reach from Timberline Road to Drake Road has been extensively mined for sand and gravel since 1937 (**Figure 9**). In 1937, the reach was highly sinuous with multiple flow paths and well developed bars.

The floodplain on both sides of the river contained numerous old oxbows and meander scrolls which were evidence of a highly active meandering system prior to European settlement. However, with increasing growth of the City, the demand for sand and gravel increased and this area became the primary source for these building materials.

The river has been extensively modified by sand and gravel mining between Timberline Road and Prospect Road. Although sand and gravel pits line both banks in this reach, the banks along most of this segment are generally unrevetted and the remaining sand and gravel bars are still active.

The river between Prospect Road and the Fossil Creek Reservoir Inlet Ditch diversion structure has been completely modified and controlled by sand and gravel mining. The river is no longer freely meandering, but is instead heavily confined between sand and gravel pits that line both its banks throughout this reach. The Boxelder Ditch and Fossil Creek Reservoir Inlet Ditch diversion structures provide significant grade control. The Boxelder Ditch structure creates a significant flow split around one sand and gravel pit. Downstream of the Fossil Creek Reservoir Inlet Ditch diversion structure, the river is partially diverted into one of the sand and gravel pits via the failed Poudre River Diversion Dike creating a major flow split in the river which extends downstream to about the location of the Drake Road alignment. This segment of the river is part of the CSU Environmental Learning Center. Although this area is being allowed to return to a more naturalistic appearance, the river and the surround area are no longer in a "natural" state compared to their state prior to sand and gravel mining. Riverine and riparian functions and processes are currently being controlled by existing conditions related to sand and gravel extraction.

4.3 Preliminary Issues Regarding Potential Impacts from Glade Reservoir

The issues identified here are based on the limited available literature, the site visit, and the preliminary hydrology and geomorphology results provided above. The impacts associated with the identified issues could be changed when the NISP EIS is distributed for comments. As such, any conclusions listed below should be reviewed and revised accordingly. It is expected that the NISP EIS will extensive provide data and analysis related to channel geomorphology.

There are potential impacts to river geomorphology that may be induced by changes in flow patterns created by the proposed Glade Reservoir. The primary concerns are associated with the potential for increased fine sediment buildup in the river channel and the potential for loss of channel capacity associated with vegetation encroachment. During normal peak flows, fine sediments that have built up in the channel in the channel bed are generally flushed from the system. In addition, areas where temporary armoring may develop in low or normal peak flow years may be rejuvenated by less frequent, large peak flows that occur less frequently.

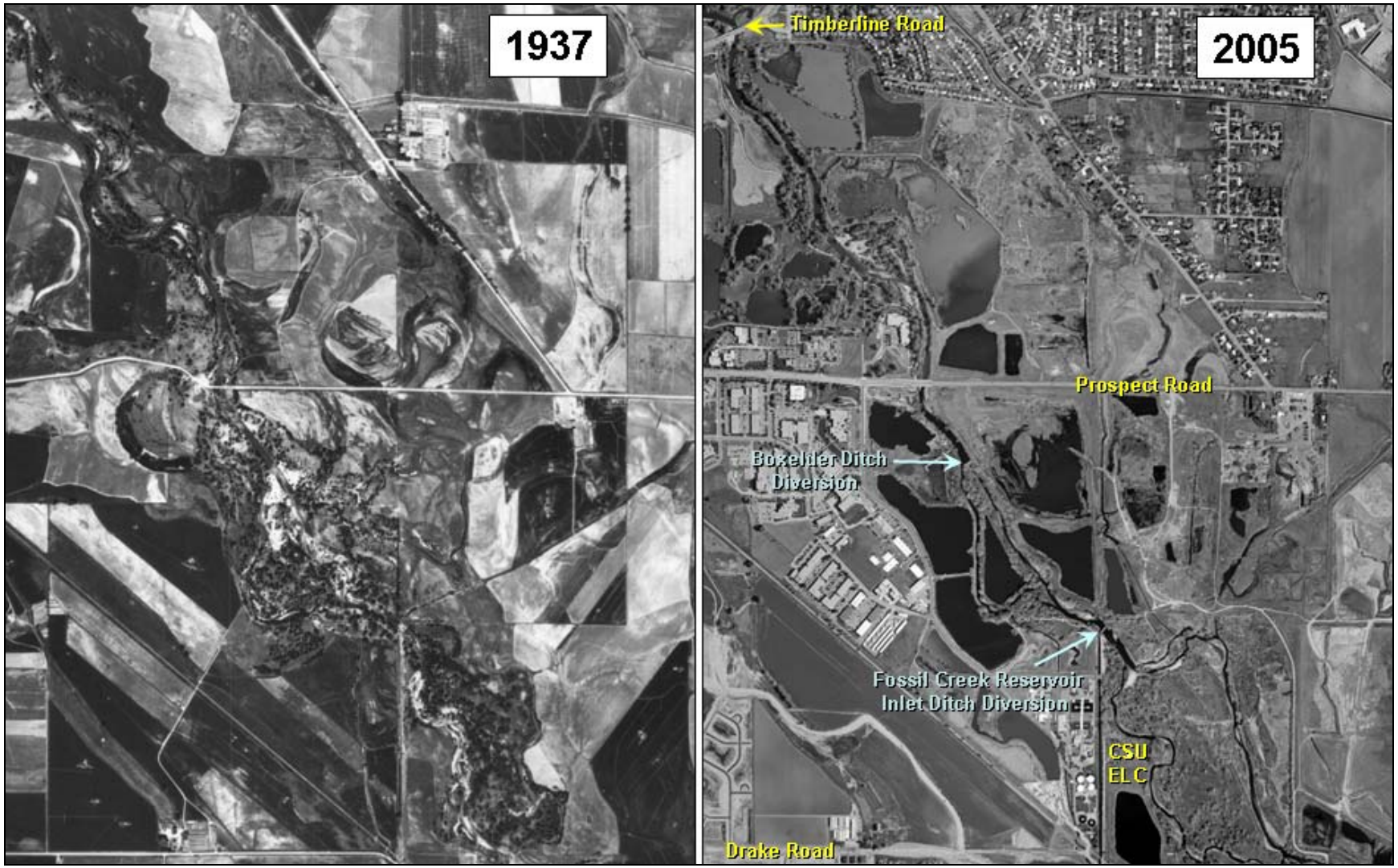

Figure 9. Comparison of Poudre River planform from 1937 and 2005 for reach between Timberline Road and Drake Road.

Fine sediments can have a significant impact on a river or stream if not flushed frequently. A buildup of fines on bars may allow vegetation to become established and flourish. Over time, bars that are normally dynamic during most flow events may be stablilized by the vegetation over time and become vegetated islands or low-lying riparian land along the channel margins. As vegetation encroaches on the channel the roughness increases, thus reducing channel velocities and increasing the potential for sediment deposition and buildup, as well as reducing the capacity of the channel to carry large flows. This, in turn, can increase the risk of overbank flooding in low-lying areas during major flow events. Vegetation encroachment, if significant, can also increase the potential for further channel degradation by concentrating flow in a narrower zone.

Where fine sediments accumulate in the channel, they may fill pools and bury or infill around coarser materials that compose riffles, runs or glides, which are habitat for aquatic species and invertebrates. The accumulation of fine sediment in the channel may also provide a substrate for the encroachment of phreatophytic species of vegetation that may also have an impact on aquatic habitat.

Peak flows and summer flows have an influence on groundwater levels along the floodplain. Thus, a reduction in peak flows and summer mean monthly flows may also reduce the hyporheic exchange between the river and the floodplain. The hyporheic zone is a region beneath and lateral to a stream bed, where there is mixing of shallow groundwater and surface water. The flow dynamics and behavior in this zone (termed hyporheic flow) is recognized to be important for surface water/groundwater interactions, as well as fish spawning, among other processes. Therefore, reductions in peak and summer mean monthly flows could impact the groundwater levels in the river's floodplains, which in turn could have an impact on the stability and heath of riparian vegetation along the river.

Given that there are numerous water-filled sand and gravel pits along the margins of the river throughout the city, there may be an interrelationship between the pits and the river. At this point it is unknown if there is a groundwater exchange between the pits and the river, but if an interrelationship exists, it should be investigated further in order to determine if there may be an advantage in using gravel pit water to supplement river flows during NISP withdrawals.

5. HYDRAULICS

Past hydraulic analyses were evaluated to determine their usefulness in evaluating the relative impacts of NISP on flow conditions in the Cache la Poudre River through the City of Fort Collins and are shown in **Table 1**. For this analysis, the hydraulic analysis and data from the 1994 Cache la Poudre Master Drainageway Planning Study was utilized.

The original HEC-2 computer model data files were imported into HEC-RAS v3.1.3 (newest version of the computer model) and the geometry was slightly modified to remover critical errors within the data. For purposes of the Phase I study, the Cache la Poudre River through the City of Fort Collins was divided into two sub-reaches. The upper reach begins upstream of Taft Hill Road and continues downstream to the Timnath Reservoir diversion structure. The lower reach begins at the Timnath Reservoir diversion structure and continues downstream to the I-25 Bridge.

Table 1. Relevant Hydraulic Analyses.		
Title	Date	Performed By
Larimer County Flood Insurance Study (FIS) Restudy	1993	Resource Consultants and Engineers, Inc.
Cache la Poudre Master Drainageway Planning Study	1994	Resource Consultants and Engineers, Inc.
Cache la Poudre River, Larimer County, FIS / Map Revision	2005	Ayres Associates
Prospect Road Conditional Letter of Map Revision (CLOMR)	2004	Anderson Consulting Engineers, Inc.
Oxbow Letter of Map Revision (LOMR)	2006	Anderson Consulting Engineers, Inc.

For lack of any better hydrology information at this time the pre- and post-project flow rates from the hydrology investigation (Section 3, above) were used to evaluate the relative impacts of Glade Reservoir on the in-channel hydraulics of the Cache la Poudre River. Monthly average flows within the main channel were used for the hydraulic analysis. As noted above, these flow results are preliminary and may change when the Draft EIS is issued. Results from this analysis are shown in **Tables 2 and 3**. Note that results in and around diversion structures were excluded from reported reach averaged properties.

Table 2. Wet Year Hydraulic Analysis Results.*				
	June 1980			
	Discharge (cfs)	Velocity (ft/s)	Wetted Perimeter (ft)	Hydraulic Radius (ft)
Existing Conditions				
Upper Reach	1132	4.4	112	2.7
Lower Reach	1132	3.6	109	2.7
Alternative 2 and 4				
Upper Reach	568	3.6	95	2.0
Lower Reach	568	2.8	85	1.9
Percent Change				
Upper Reach	50	18	15	26
Lower Reach	50	21	22	31
**Hydraulic parameters represents reach averaged main channel properties*				

Table 3. Dry Year Hydraulic Analysis Results.*				
	June 1989			
	Discharge (cfs)	Velocity (ft/s)	Wetted Perimeter (ft)	Hydraulic Radius (ft)
Existing Conditions				
Upper Reach	158	2.5	78	1.1
Lower Reach	158	2.2	71	1.3
Alternative 2 and 4				
Upper Reach	98	2.2	70	0.9
Lower Reach	98	1.9	64	1.1
Percent Change				
Upper Reach	38	13	10	16
Lower Reach	38	13	10	17
**Hydraulic parameters represents reach averaged main channel properties*				

The changes in velocity for the wet year results are of most interest given the impact on flushing flows for sediment and scouring of emergent vegetation from bars. Changes in hydraulic radius, effectively flow depth, are most relevant for dry year results given the impact on minimum flow conditions.

6. AQUATIC HABITAT AND AQUATIC SPECIES

The objective of this initial phase of the project is to identify areas of potential impacts associated with the proposed NISP project. For aquatic habitat and aquatic species, the issues to review include any change to the current flow regime from Glade Reservoir and associated changes to the physical conditions upon which the aquatic species depend. This initial phase relied on existing data, published and unpublished literature and first hand information about the river corridor. This data may include some of the same information used to produce the NISP EIS but there will likely be new information that was collected by the NISP team that may supersede the information presented here.

6.1 Background

Studies dating back to the mid to late 1980s were initiated to develop a sport fishery plan for the Cache la Poudre River through Fort Collins. The planning for these activities began in 1986 and was a combination of efforts by the local Trout Unlimited chapter, the City of Fort Collins, Colorado State University, and others. The main focus of these activities was for habitat evaluation, water quality, in particular water temperature evaluation, and evaluation of flow regimes.

The studies conducted out of these planning efforts were an instream flow study at two sites on the Cache la Poudre River (Nelson 1987). This study used the physical habitat simulation methodology and established a site near Martinez Park on the Poudre River and also the Riverbend Ponds area. The evaluation of physical habitat focused on rainbow trout and brown trout as well as warm water species, in particular common carp and smallmouth bass. The findings for this study showed that trout habitat was present in the river and was at its lowest at both the very low flows and the higher flows. Flows in the range of 20 to 200 cfs provided the highest habitat for rainbow and brown trout.

In addition to the physical habitat studies, a water temperature modeling effort was conducted through the City to assess the thermal regime for the urban sport fishery. These studies (Bartholow 1988 and 1991) were focused on ways to maintain water temperature in the river below a 23.3^{o}C temperature for trout. This study concluded that one of the main ways to lower stream temperatures was not by increasing riparian shade but by narrowing river channel. The wider exposed channel was more susceptible to solar heating than a narrower channel configuration. An alternative also suggested was that the fishery might be converted to a warm water fishery or a cool water fishery using smallmouth bass.

The physical habitat study, the plan for the urban fishery and other documents suggest that the flow regime requires both peak flows for habitat creation and maintenance as well as maintaining a suitable low flow to provide habitat during the late summer months. These low flows were identified as one of the major limiting factors for the fishery through the City of Fort Collins.

The have been additional fish collections in the Cache La Poudre River within the Fort Collins city limits since the 1980s. These collections show that the sport fish listed above still exist in the river and also native non-game species. The native non-game species, which include native minnows, have become more important to overall river management than when the studies for the sport fishery were conducted.

6.2 Current Conditions Site Visit September 19, 2007

A site visit was conducted along the Cache la Poudre River in Fort Collins starting at Taft Hill Avenue and progressing downstream to the Environmental Learning Center. The purpose of the site visit was to familiarize all the participants with the Poudre River through Fort Collins in preparation for a response to the draft EIS for Glade Reservoir. In particular, W.J. Miller is responsible for the aquatic resource review and the fish and aquatic sections for the City of Fort Collins.

The site visit started at the parking lot of the bike trail at Taft Hill with participants reviewing maps and aerial photographs for the site visit. The photos are detailed and show various features throughout the river and stops were made at several locations to get a closer look at diversion structures and off-channel wetland areas, riparian areas, and other associated features.

The first stop was at a secondary channel, approximately 1/2 mile downstream from the Taft Hill starting point. Review of the feature shows a side channel with water but several feet higher than the main river channel. It appears to be a remnant of either a field drain or possibly be capturing water from upstream at an old diversion point.

The second stop occurred at the diversion that provides water to the City Pond off Shields Avenue. That structure is a perpendicular structure in the stream with a sharp crest and appears to be a fish passage block at all but probably the highest flows (**Figure 10**). The next stop was made just upstream from the Shields Street bridge. There is a bar in the river channel that is partially vegetated. Vegetation observations were made at that location and it appears that there is an encroachment of some new vegetation onto these in-channel bars.

Another stop was made at the power line area downstream of Shields Avenue to look at the inflow channel at that location. At various locations along the Poudre through Fort Collins, there are numerous off-channel ponds, old gravel pits, and other irrigation features that return water to the channel. It is difficult to determine whether the groundwater flow moves toward or away from the river. It appears in many locations that the channel receives water from off-channel.

Approximately 1/4 mile downstream from Shields Avenue there is a large cottonwood riparian area, one of the few that still remains in the river corridor. It also shows some evidence of multiple channels from high flows that occasionally overflow into this area. This area had an in-channel floodplain, unlike some of the other areas that have a very incised channel and steep banks that don't allow flows to go out into the riparian zone. The riparian vegetation in many locations is limited to a narrow strip along the channel margins.

Figure 10. Diversion structure to McMurray ponds.

There were fish observed throughout this reach from Taft Hill through Shields and downstream to College Avenue with large brown trout observed and some small rainbow trout that appeared to be the size stocked by Division of Wildlife. Other fish observed included suckers and possibly some dace although no fish were captured. There is another diversion structure upstream of the College Avenue Bridge (**Figure 11**).

Stream characteristics begin to change at College Avenue. Downstream from College Avenue is the reconstructed dam at the old power plant and the boat chute that was constructed at that location (**Figures 12 and 13**). This is also the location for the new water park that has been proposed by the City. The river in this location has a lower gradient than upstream of College Avenue and most of the pool features are associated with large trees or fixed structures on the riverbank. Also downstream of Lincoln Avenue there was a considerable amount of bedrock at those locations. The bedrock features in that area control the depth of the channel and also channel migration. There were numerous areas with concrete placed along the banks to stop erosion.

Downstream of Lincoln Avenue there was more in-channel bar development with the channel meandering within the channelized area. Substrate in this reach has more gravel and less cobble rather than dominated by cobble as it was upstream.

Figure 11. Diversion structure upstream of College Avenue.

Figure 12. Reconstructed boat chute and fish passage downstream of College Avenue.

Figure 13. New boat chute downstream of College Avenue.

The river downstream of Mulberry Avenue is much lower gradient. There are wide areas of riparian vegetation although much of the vegetation seems to be nonnative. A diversion structure is approximately 1/2 mile downstream of Lemay Avenue that diverts water to the north (**Figure 14**). The channel throughout this reach is more meandering and not as straight as the upstream reaches but it still has fairly steep banks and little connection to the overall floodplain itself. There are occasional deep pool habitats where large trees are on the river bank.

Figure 14. Diversion downstream of Lemay Avenue.

Downstream of Timberline Avenue, the channel retains the flat characteristic. There are several areas of secondary channels that have formed but overall this reach is a fairly low gradient stream.

Downstream of Prospect Avenue, the channel splits into multiple channels and there are two to three diversions in this reach that divide the flow. Most of the flow is again in a single thread channel by the time it reached the Environmental Learning Center. There are areas in this reach of the river that are fairly low banks and high flows could go out of bank and change the channel configuration. This has occurred in the past.

The field visit concluded at the Environmental Learning Center with the final observations near the diversions just upstream of the Environmental Learning Center.

6.3 Preliminary Issues Regarding Potential Impacts from Glade Reservoir

The issues identified here are based on the limited available literature, the site visit, and the preliminary hydrology and geomorphology results provided in Section 4. The impacts associated with the identified issues could be changed when the NISP EIS is distributed for comments. As such, any conclusions listed below should be reviewed and revised accordingly. It is expected that the NISP EIS will provide data for and technical analysis of the following aquatic resources:

- Quantification of change in aquatic habitat associated with the change in flow regime
- Quantification of fish species currently present in the Cache la Poudre River within the project area.
- Quantification of macroinvertebrate species currently present in the Cache la Poudre River within the project area.
- Evaluation of the change in aquatic habitat and aquatic community due to changes to water quality.
- Proposed mitigation to offset impacts to the aquatic resources associated with the NISP project.

Current conditions in the Poudre River for flow regimes show that the average June peak is approximately 900 cfs. This peak is projected to be reduced by almost 50% with the operation of Glade Reservoir. Lower flows through the descending limb of the runoff in summer and into fall would have less effect on flow regimes. The flows in July and August are potentially changed by as much as 80% in average years in July and by approximately 30% in August. There is very little change in September and October. Changes in July are predicted to go from 174 cfs for the average flow to 83 cfs and projected to change from 16 to 11 cfs in August. An area of concern expressed in the results for the physical habitat modeling is that reducing these low flows even further may not provide the habitat that is available through the City today.

The preliminary geomorphic report shows that there has been a considerable amount of change in plan form in the river from 1937 through 2005. Loss of complexity is one of the main features that appears to be missing from the river today that was there in the past. These changes have likely resulted in changes to physical habitat as it exists and potentially to changes in the aquatic biota that inhabit the river today.

One of the main issues identified associated with NISP and Glade Reservoir impacts would be change in peak flows and accumulation of fine sediments within the river. The river today is confined in many areas by armored banks and channelization and the force of the river is concentrated within the channel. However, a reduction of 50% or greater in peak discharges could change that dynamic. In addition, the ground water/surface water interaction in the river may change with change in peak flow. This could affect riparian conditions which in the long term change in riparian cover, additional thermal input to the river and result in higher water temperatures. A rise in water temperatures in the long term may reduce the trout fishery that is present today. The result would be a shift to a warm water aquatic community in the future.

7. VEGETATION

For vegetation studies, the initial phase of the project included a preliminary assessment of potential impacts related to the proposed NISP project. One of the major concerns related to impacts on vegetation resources centers on whether the existing vegetation can be maintained under a regime of reduced flows that may occur from Glade Reservoir. The concern includes issues related to survival of the existing riparian species as well as for potential reproduction and establishment of native species.

7.1 Background Information

Prior to settlement, the vegetation along the Cache la Poudre River most likely consisted of forested areas, riparian shrublands and wetland areas. The meandering stream channel provided suitable environments for establishment of native cottonwood and willow tree species. Annual flooding from snow melt as well as periodic flooding served as important factors in maintaining the riparian system. High flows from flood events scoured the stream channel and also deposited sediments along the channel and on nearby flood plain sites. As flood waters receded, the exposed bare sediments provided ideal sites for establishment of seedlings of the native tree species. These annual flood events were important for the maintenance of forested areas, since the light, wind blown seeds of cottonwoods and willows will not germinate in the litter on the forest floor, but rather require moist, exposed bare sediments. In addition the forested areas, other vegetation types were present on the river floodplain. Riparian shrublands dominated by species of willow occurred on saturated streamside sites and on wet depressions on the flood plain. Once established, these communities tend to persist by vegetative expansion and are not solely dependent on established from seed. Herbaceous communities dominated by various species of sedges and grasses occurred on moist floodplain sites. Marshes were also likely present on the flood plain and would have occurred on sites where stream meander loops were cut off and isolated as the river meandered across the flood plain. While the vegetation patterns on the flood plain would have been continually changing in response to changes in the stream dynamics, these basic vegetation types would have been consistently present in the riparian system.

Since the time of settlement by Europeans, the riparian system has been greatly altered by several factors, including (1) construction of upstream dams, (2) creation of irrigation diversion systems, (3) alluvial aggregate mining, (4) stream channelization and (5) introduction of non-native species.

The creation of dams and reservoirs has served to control run-off from snow melt in the spring and captures flows from summer precipitation events. The change in flow volumes and flow patterns has altered the potential for on-going natural recruitment of the native tree species. Occasional events may occur which could create suitable seedling establishment sites, but the annual events that occurred prior to settlement have mostly been eliminated.

Development of irrigation systems has reduced the total amount of water that flows through the system by diverting water into delivery ditches and off channel storage areas. While there is still adequate water in the system to support the vegetation along the river, the original patterns of high flows in the spring and lower late summer flows have been altered by irrigation practices.

Extensive aggregate mining has altered the floodplain structure and has created numerous ponds and small lakes. In order to maintain the ponds, it is necessary to control the river so that the channel does not meander into the ponds.

Channelization has reduced the sinuosity of the river and has altered the bank cutting and depositional patterns that were characteristic of the original floodplain environment. This reduces the overall extent of potential native tree seedling establishment sites.

Many species of non-native trees have been introduced into the Fort Collins area as a result of residential landscaping. Over the years, some of these species have escaped cultivation and have become established in the riparian habitats along the river. In some cases, these introduced species are better adapted to establishment than are the native species because of their ability to germinate and grow in riparian communities that already have established forest canopies. The native cottonwood and willow trees produce small, wind blown seeds that readily germinate on open wet soils, but do not germinate in the plant litter in forest understories. Introduced tree species observed in the riparian areas along the Cache la Poudre River include crack willow *(Salix fragilis)*, Siberian elm *(Ulmus pumila)*, silver maple *(Acer saccharinum)*, green ash *(Fraxinus pensylvanica)*, American elm *(Ulmus americana)* and honeylocust *(Gleditsia triacanthos)*.

The changes in the hydrologic regime of the river have greatly reduced the dynamic character of the pre-settlement vegetation. By controlling the flows in the river, the vegetation patterns have become more static and are less likely to change. Since the stream no longer meanders on its flood plain, the existing land surfaces tend to persist for time periods that exceed the life expectancy of the native tree species. Under these more static conditions once the existing trees die, the potential for natural recruitment is greatly reduced.

In spite of the changes that have occurred in the riparian vegetation along the Cache la Poudre River, the existing plant communities provide important habitat for many resident and migrant wildlife species and also provide natural areas for human use.

7.2 Existing Vegetation Resources

The evaluation of the current condition of the vegetation resources along the Cache la Poudre River was developed based on a site visit conducted on September 19, 2007. The field trip consisted of walking the length of the riparian corridor from Taft Avenue on the west to the Environmental Learning Center on the downstream end of the area.

The existing vegetation along the river consists of riparian woodlands that occur in narrow bands along the stream margin and in more well developed stands in broader portions of the floodplain. In the upstream part of the area, narrowleaf cottonwood *(Populus angustifolia)* occurs as a major species. In the central and downstream portion of the area, plains cottonwood *(Populus sargentii)* and crack willow *(Salix fragilis)* are more common (**Figure 15**). The wooded areas occur mostly as narrow, gallery forests along the edge of the stream, especially along channelized sections. In places where the flood plain is broader and old, low stream terraces occur, the forested areas may be more extensive. Mixed with the forests are streamside wetland areas dominated by coyote willow, reed canary grass and various other herbaceous wetland species (**Figure 16**). All of these communities are more or less dependent on the water resource provided by the river channel. The wetlands occur on sites with higher levels of saturation and forests occur on sites where the water table is somewhat deeper.

Figure 15. Gallery forest along the Cache la Poudre River, September 19, 2007.

Figure 16. Herbaceous wetland areas, coyote willow shrublands, forested areas and armored banks along the Cache la Poudre River, September 19, 2007.

7.3 Preliminary Issues for Potential Impacts From Glade Reservoir

Based on the available information, the following initial conclusions can be reached:

- Existing vegetation along the riparian corridor has mostly developed in the years after European settlement. There is probably very little native, undisturbed riparian vegetation. Some of the largest cottonwood trees may be more than 100 years old, but any of the original forests are gone. Vegetation that is present has developed under conditions influenced by upstream reservoirs, irrigation diversions and stream channelization. The potential exists for the project to increase problems associated with low flow conditions.
- Reductions in peak flows could influence the establishment of native cottonwood and willow species by further reducing the number of suitable seed germination and seedling establishment sites. Over time, this could result in a change in the forest canopy structure with introduced tree species rather than native cottonwoods and willows occurring as forest dominants. It is likely that specific management plans will need to be developed in order to maintain populations of native willow and cottonwood trees. This is especially true for plains cottonwood and peach-leaved willow. The management plans may include removal of non-native trees and planting designs to create stands of native trees.
- Spring flow reductions could have a greater potential impact on native cottonwood trees that are growing on higher banks or terraces outside of the lower flood plain of the Cache la Poudre River. These adjacent areas could potentially show reduced water content at depth as a result of less water in the system.

It is likely that the NISP EIS will include site specific vegetation data for sections of the Cache la Poudre River and will base the impact analyses on those data. Specifically, the following types of information should be expected to be included in the EIS:

- EIS should have a description of the existing vegetation resources in all parts of the project area. For the City of Fort Collins, the section that deals with the Cache la Poudre River as it passes through the city will be of the most interest. This section should have descriptions about existing plant communities and should include information about species composition, vegetation structure and observations about any rare plant species. There should also be a vegetation map showing the location and extent of the various vegetation types. The vegetation descriptions may also include an assessment of the relationship between vegetation development and the proximity of the ground water table to the land surface. For example, which of the plant communities are dependent on sub-irrigation or the degree to which the plant communities are dependent on sub-irrigation and which of the communities exist with precipitation as their only source of water.
- The impact assessment portion of the EIS should present a description of how the existing vegetation may be adversely affected if the proposed project is implemented. For vegetation resources, the major impacts that could occur will be in communities that depend on sub-irrigation from groundwater in the riparian areas. There may be "lateral" impacts related to a reduction in the amount of water that saturates the flood plain substrates at any given point along the river as it passes through Fort Collins or there may be "longitudinal" impacts that relate to an overall depletion of groundwater at the eastern end of the river's reach in Fort Collins because of insufficient inflow at the upper end of the reach.

(If impacts do occur, the expected result would be the death of native cottonwood trees in areas where the water supplies become reduced to levels below the tolerance range of the trees. Riparian communities immediately adjacent to the stream channel will not likely be affected by reduced flows, because as long as any flow occurs, these areas will likely remain saturated.) The impact assessment may be based on an assessment of past flow rates.

8. POTENTIAL FUTURE WORK

8.1 Phase II

The type of work that might be considered during a potential Phase II investigation includes:

Geomorphic Field Reconnaissance

Hydrology Modeling Review.

Hydraulic Studies

Aquatic/Riparian Studies.

8.2 Phase III

The Corps of Engineers (USACE) is the lead agency for the Draft Environmental Impact Statement (DEIS) being prepared for the NISP project. The DEIS is expected to be available for public comment sometime in April 2008.

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Poudre Corridor Fishery Plan. February 1987. Prepared by Poudre River Trust, Rocky Mountain Flycasters, Colorado Division of Wildlife, and U.S. Fish and Wildlife Service.

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APPENDIX A

SAGE ONLINE CATALOG FOR CACHE LA POUDRE DOCUMENTS

Record 1 of 161
CALL # SD397.C8 G555 2006.
AUTHOR Gilliam, Christopher Steven.
TITLE Channel planform alteration and cottonwood stem growth along the Cache la Poudre River, southeast of Fort Collins, Colorado (1941-1999) / submitted by Christopher Steven Gilliam.
PUBLISHER 2006.

Record 2 of 161
CALL # QL536 .M235 2005.
AUTHOR Maki, Anna.
TITLE A spatial analysis of mosquito density and habitat near the Cache la Poudre River, Colorado / submitted by Anna Maki.
PUBLISHER 2005.

Record 3 of 161
CALL # I 19.127:2005-3037.
AUTHOR Collins, Jim A.
TITLE The Cache la Poudre River, Colorado, as a drinking-water source / by Jim A. Collins and Lori A. Sprague.
PUBLISHER [Reston, Va.] : U.S. Geological Survey, [2005]

Record 4 of 161
CALL # GB653 .S63 no.15.
AUTHOR Laflin, Rose.
TITLE Irrigation, settlement, and change on the Cache la Poudre River / by Rose Laflin.
PUBLISHER Fort Collins, CO : Colorado Water Resources Research Institute, Colorado State University, [2005]

Record 5 of 161
CALL # GB653 .S63 no.15eb.
AUTHOR Laflin, Rose.
TITLE Irrigation, settlement, and change on the Cache la Poudre River [electronic resource] / by Rose Laflin.
PUBLISHER Fort Collins, CO : Colorado Water Resources Research Institute, Colorado State University, [2005]

Record 6 of 161
CALL # SH175 .A55 1999.
AUTHOR Allen, M. Brady.
TITLE Factors influencing the distribution of Myxobolus cerebralis, the causative agent of whirling disease, in the Cache la Poudre River, Colorado / submitted by M. Brady Allen.
PUBLISHER 1999.

Record 7 of 161
CALL # I 19.76:99-587.
AUTHOR Langer, William H.
TITLE Preliminary report on deposit models for sand and gravel in the Cache la Poudre River valley [microform] / by William H. Langer and David A. Lindsey.
PUBLISHER Denver, Colo. : U.S. Dept. of the Interior, U.S. Geological Survey, [1999]

Record 8 of 161
CALL # SH157.85.S75 H43 1998.
AUTHOR Hickey, John Terance.
TITLE Conceptual integration of economic, salmonid population, habitat, and water allocation models exploring instream flows for the Cache la Poudre River / submitted by John Terance Hickey.
PUBLISHER 1998.

Record 9 of 161
CALL # GB1227.C25 S48 1998.
AUTHOR Sexton, Julie M.
TITLE Historical changes in the Cache la Poudre River, Fort Collins, Colorado / submitted by Julie M. Sexton.
PUBLISHER 1998.

Record 10 of 161
CALL # GV776.C62 C33 1997.
AUTHOR Maddox, Bryan Greene.
TITLE A users guide to the wild & scenic Cache la Poudre River : a comprehensive guide for canoeing, rafting and kayaking Colorado's only designated "Wild & Scenic" river / by Bryan Greene Maddox.
PUBLISHER LaPorte, Colo. : Poudre Canyon Press, c1997.

Record 11 of 161
CALL # Y 1.1/5:104-188.
CORPORATE&NBSUnited States. Congress. Senate. Committee on Energy and Natural Resources.
TITLE Cache la Poudre River National Water Heritage Area Act : report (to accompany S. 342).
PUBLISHER [Washington, D.C.? : U.S. G.P.O., 1995]

Record 12 of 161
CALL # QK150 .K387 1994.
AUTHOR Kittel, Gwen M.
TITLE Montane riparian vegetation in relation to elevation and geomorphology along the Cache la Poudre River, Colorado / by Gwen M. Kittel.
PUBLISHER 1994.

Record 13 of 161
CALL # QL628.C6 P53 1990.
AUTHOR Platania, S. P.
TITLE Ichthyofauna of four irrigation canals in the Fort Collins region of the Cache la Poudre River valley / submitted by Steven P. Platania.
PUBLISHER 1990.

Record 14 of 161
CALL # A 13.2/2:C 11/3 DRAFT.
CORPORATE&NBSShalkey Walker Associates.
TITLE National recreation area study, Cache la Poudre River : draft report / prepared for City of Fort Collins, Colorado [and] Larimer County, Colorado ; prepared by Shalkey Walker Associates, Inc. in association with Hammer, Siler, George Associates ; ERO Resources Corporation [and] Dr. Charles F. Leaf.
PUBLISHER [Denver, Colo. : Shalkey Walker Associates] 1989.

Record 15 of 161
CALL # A 13.2/2:C 11/3.
CORPORATE&NBSShalkey Walker Associates.
TITLE National recreation area study. Cache la Poudre River : final report / prepared for City of Fort Collins, Colorado [and] Larimer County, Colorado ; prepared by Shalkey Walker Associates, Inc. in association with Hammer, Siler, George Associates ; ERO Resources Corporation [and] Dr. Charles F. Leaf.
PUBLISHER [Denver, Colo. : Shalkey Walker Associates] 1989.

Record 16 of 161
CALL # D 103.2/2:C 11.
TITLE Hydrologic analysis of the Cache la Poudre River basin : 1988 update, final report / U.S. Army Engineer District, Corps of Engineers.
PUBLISHER [Omaha, Neb. : The District, 1988]

Record 17 of 161
CALL # Y 1.1/5:99-354.
CORPORATE&NBSUnited States. Congress. Senate. Committee on Energy and Natural Resources.
TITLE Designating segments of the Cache la Poudre River in the state of Colorado as a component of the national wild and scenic river system : report (to accompany S. 1819).
PUBLISHER [Washington, D.C.? : U.S. G.P.O., 1986]

Record 18 of 161
CALL # Y 1.1/8:98-924.
CORPORATE&NBSUnited States. Congress. House. Committee on Interior and Insular Affairs.
TITLE Amending the Wild and Scenic Rivers Act to designate a segment of the Cache la Poudre River in Colorado for potential addition to the national wild and scenic river system : report (to accompany H.R. 5851) (including the cost estimate of the Congressional Budget Office).
PUBLISHER [Washington, D.C.? : U.S. G.P.O., 1984]

Record 19 of 161
CALL # HD1695.C3 F73 1983.
AUTHOR Freeman, David M.
TITLE Water and public policy conflict in the Cache la Poudre River Basin / David M. Freeman, David Hittle, and Edwin Shinn.
PUBLISHER Fort Collins : Colorado State University, [1983?]

Record 20 of 161
CALL # D 103.47:C119/2.
CORPORATE&NBSUnited States. Army. Corps of Engineers. Omaha District.
TITLE Cache la Poudre River basin, Larimer-Weld Counties Colorado / US Army Corps of Engineers, Omaha District.
PUBLISHER Omaha, NB : The District, 1981.

Record 21 of 161
CALL # I 19.16:1115.
CORPORATE&NBSGeological Survey (U.S.).
TITLE Storm and flood of July 31-August 1, 1976, in the Big Thompson River and Cache la Poudre River Basins, Larimer and Weld Counties, Colorado / report prepared jointly by the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, cooperating organization, Colorado Geological Survey.
PUBLISHER [Reston, Va.] : Dept. of the Interior, Geological Survey ; Washington : for sale by the Supt. of Docs., U.S. Govt. Print. Off., 1979.

Record 22 of 161
CALL # TD224.C6 M27 1978.
AUTHOR Mars, J. Peter.
TITLE Water quality investigations of the Cache la Poudre River, May through July, 1977 / report by J. Peter Mars.
PUBLISHER [Denver, Colo.?] : Colorado Dept. of Health, Water Quality Control Division, [1978].

Record 23 of 161
CALL # SH167.T86 C7.
AUTHOR Cressey, Scott Edward.
TITLE Supplemental feeding of trout in the Cache la Poudre River / submitted by Scott Cressey.
PUBLISHER 1975.

Record 24 of 161
CALL # QE92.C34 S83 1975a.
AUTHOR Swan, F. H.
TITLE Pleistocene and holocene deposits of the lower Cache la Poudre River Basin, Colorado / by Frank Herbert Swan, III.
PUBLISHER 1975.

Record 25 of 161
CALL # QH541 .C7 no.17A.
TITLE Cache la Poudre River near Fort Collins, Colorado, flood management alternatives : relocations and levees / by Robert E. Koirtyohann ... [et al.].
PUBLISHER Fort Collins, Colo. : Environmental Resources Center, Colorado State University, 1975.

Record 26 of 161
CALL # QH541 .C7 no.17Aeb.
TITLE Cache la Poudre River near Fort Collins, Colorado, flood management alternatives [electronic resource] : relocations and levees / by Robert E. Koirtyohann ... [et al.].
PUBLISHER Fort Collins, Colo. : Environmental Resources Center, Colorado State University, [1975]

Record 27 of 161
CALL # GB1227.C25 W4.
AUTHOR Wentz, Dennis A.
TITLE Environment of the middle segment, Cache la Poudre River, Colorado: Geology, streamflow, water chemistry, aquatic biology, access, channel and banks, by Dennis A. Wentz.
PUBLISHER Denver, Colorado Division of Wildlife, 1974.

Record 28 of 161
CALL # QH541 .C7 no.13.
TITLE Flood plain management of the Cache la Poudre River near Fort Collins, Colorado / by Glendol M. Combs, Robert A. McDonald, Marvin R. Martens, Gary M. Rowe.
PUBLISHER Fort Collins : Environmental Resources Center, Colorado State University, 1974.

Record 29 of 161
CALL # QH541 .C7 no.13eb.
TITLE Flood plain management of the Cache la Poudre River near Fort Collins, Colorado [electronic resource] / by Glendol M. Combs ... [et al.].
PUBLISHER Fort Collins : Environmental Resources Center, Colorado State University, 1974.

Record 30 of 161
CALL # SH687 .M37.
AUTHOR Marshall, Thomas Lawrence.
TITLE Trout populations, angler harvest and value of stocked and unstocked fisheries of the Cache la Poudre River, Colorado / submitted by Thomas L. Marshall.
PUBLISHER 1973.

Record 31 of 161
CALL # D 103.2/2:C 11/2.
TITLE Hydrology, Cache la Poudre River, Weld and Larimer counties, Colorado.
PUBLISHER [S.l.] : U.S. Army Corps of Engineers, [1973]

Record 32 of 161
CALL # QE92.C34 C48.
AUTHOR Ching, Paul Winford.
TITLE Economic gravel deposits of the lower Cache la Poudre River.
PUBLISHER 1972.

Record 33 of 161
CALL # I 19.91:I-687.
AUTHOR Hershey, Lloyd A., 1927-
TITLE Geologic map of the lower Cache la Poudre River Basin, north-central Colorado / by Lloyd A. Hershey and Paul A. Schneider, Jr.
PUBLISHER Washington, D.C. : U.S. Geological Survey, 1972.

Record 34 of 161
CALL # QH97 .S83.
AUTHOR Stanford, Jack Arthur, 1947-
TITLE Quantitative sampling of macroinvertebrates in the Cache la Poudre River, Colorado / submitted by Jack A. Stanford.
PUBLISHER 1971.

Record 35 of 161
CALL # HD1695.C3 H5.
AUTHOR Hill, Duane W.
TITLE Project completion report on organizational adaptation to changes in public objectives for management of Cache la Poudre River system. Principal investigator[s] Duane Hill, Phillip O. Foss [and] Roy L. Meek.
PUBLISHER [Fort Collins, Colorado State University] 1969.

Record 36 of 161
CALL # UCSU6/14.10/11.
AUTHOR Hill, Duane W.
TITLE Organizational adaption to changes in public objectives for management of Cache la Poudre River system / principal investigators : Duane Hill, Phillip O. Foss, Roy L. Meek.
PUBLISHER Fort Collins : Natural Resources Center, Colorado State University, 1969.

Record 37 of 161
CALL # GB653 .C6 no.11eb.
AUTHOR Hill, Duane.
TITLE Organizational adaption to changes in public objectives for management of Cache la Poudre River system [electronic resource] / principal investigators : Duane Hill, Phillip O. Foss, Roy L. Meek.
PUBLISHER Fort Collins : Environmental Resources Center, Colorado State University, 1969.

Record 38 of 161
CALL # I 19.13:1669-X.
AUTHOR Hershey, Lloyd A., 1927-
TITLE Ground-water investigations in the lower Cache la Poudre River basin, Colorado / by Lloyd A. Hershey and Paul A. Schnieder.
PUBLISHER Washington, D.C. : U.S. G.P.O., 1964.

Record 39 of 161
CALL # GB705.C6 C68.
CORPORATE&NBSColorado State University. Cooperative Watershed Management Unit.
TITLE Watershed analysis of the Little South Fork of the Cache la Poudre River, Larimer County, Colorado, by Kendall L. Johnson [and others].
PUBLISHER Fort Collins [1962]

Record 40 of 161
CALL # GB705.C6 C67.
CORPORATE&NBSColorado State University. Cooperative Watershed Management Unit.
TITLE Watershed analysis of the North Fork of the Cache la Poudre River: Larimer County, Colorado, and Albany County, Wyoming, by Peter E. Black [and others].
PUBLISHER Fort Collins, 1959.

Record 41 of 161
CALL # 378.78 AO 1951 16.
AUTHOR Gruchy, David Francis.
TITLE A limnological study of a transect of the Cache la Poudre River.
PUBLISHER 1951.

Record 42 of 161
CALL # FCA 1.2/2:C 11.
AUTHOR Griffin, John H.
TITLE Engineering report on water district no. 3 embracing the Cache La Poudre River drainage basin : parts of Larimer and Weld counties, Colorado / by John H. Griffin.
PUBLISHER [Wichita : Federal Land Bank of Wichita, 1944]

Record 43 of 161
CALL # UB394.C6 O7.
TITLE Order setting aside land for the military reservation on the Cache la Poudre River in Colorado Territory.
PUBLISHER [S.l. : s.n., 1864]

Record 44 of 161
CALL # A 13.2/2:EF 3.
TITLE Effect of wild and scenic river designation on the Cache la Poudre River : point paper.
PUBLISHER [S.l. : s.n., 19--].

Record 45 of 161
CALL # F782.C34 B877 2006.
AUTHOR Burris, Lucy.
TITLE People of the Poudre : an ethnohistory of the Cache la Poudre River National Heritage Area, AD 1500-1880 / by Lucy Burris.
PUBLISHER Colo. : Xplore Interpretive Design, Inc., 2006.

Record 46 of 161
CALL # TP428.A37 P45 2006.
AUTHOR Pei, Ruoting.
TITLE Antibiotic resistance genes (ARG) as environmental contaminants : occurrence in Cache La-Poudre River watershed and response to biological treatment / submitted by Ruoting Pei.
PUBLISHER 2006.

Record 47 of 161
CALL # F782.L2 W95 2000.
AUTHOR Wylie, William, 1957-
TITLE Riverwalk : explorations along the Cache la Poudre River / photographs by William Wylie ; with a foreword by Merrill Gilfillan.
PUBLISHER Boulder : University Press of Colorado, 2000.

Record 48 of 161
CALL # I 29.2:C 11.
TITLE Resource assessment : proposed Cache la Poudre River national heritage corridor.
PUBLISHER [Denver, Colo.?] : National Park Service, Rocky Mountain Regional Office, [1990]

Record 49 of 161
CALL # QH541 .C7 no.25.
AUTHOR Morrison, Sumner M.
TITLE Surveillance data : plains segment of the Cache la Poudre River, Colorado, 1970-1977 / S. M. Morrison.
PUBLISHER Fort Collins, Colo. : Colorado Water Resources Research Institute, Environmental Resources Center, Colorado State University, 1978.

Record 50 of 161
CALL # QH541 .C7 no.25eb.
AUTHOR Morrison, Sumner M. (Sumner Martin), 1919-
TITLE Surveillance data [electronic resource] : plains segment of the Cache la Poudre River, Colorado, 1970-1977 / S.M. Morrison.
PUBLISHER Fort Collins : Colorado Water Resources Research Institute, Environmental Resources Center, Colorado State University, 1978.

Record 51 of 161
CALL # D 103.47:C 119.
CORPORATE&NBSUnited States. Army. Corps of Engineers.
TITLE Flood plain information : Cache la Poudre River, Colorado : Fort Collins - Greeley, Larimer - Weld County.
PUBLISHER Omaha, Neb. : Dept. of Defense, Army, Corps of Engineers, Omaha District, 1975.

Record 52 of 161
CALL # SK375 .C67 NO.30.
AUTHOR Klein, W. D. (William Dick)
TITLE Special regulations and elimination of stocking : influence on fishermen and the trout population at the Cache la Poudre River, Colorado / by W. D. Klein.
PUBLISHER [Denver] : Colorado Division of Wildlife, 1974.

Record 53 of 161
CALL # GV191.42.C6 B43 1968.
AUTHOR Beardsley, Wendell.
TITLE Evaluation of recreation benefits : the Cache la Poudre River, Colorado / by Wendell Beardsley.
PUBLISHER 1968.

Record 54 of 161
CALL # QH105.C6 P85 2007.
TITLE Pulse of the river : Colorado writers speak for the endangered Cache la Poudre / edited by Gary Wockner and Laura Pritchett ; foreword by Rick Bass.
PUBLISHER Boulder, Colo. : Johnson Books, c2007.

Record 55 of 161
CALL # TD428.A37 K55 2006.
AUTHOR Kim, Sung Chul.
TITLE Occurrence, fate, and transport of human and veterinary antibiotics in the watershed / submitted by Sung-Chul Kim.
PUBLISHER 2006.

Record 56 of 161
CALL # NR3.2/EN8/2005.
TITLE Citizen's guide to Colorado's environmental era / prepared by Colorado Foundation for Water Education.
PUBLISHER Denver, Colo. : Colorado Foundation for Water Education, c2005.

Record 57 of 161
CALL # TD224.C6 F67er.
CORPORATE&NBSFort Collins (Colo.)
TITLE Halligan-Seaman water management project [electronic resource].
PUBLISHER Fort Collins, Colo : Halligan-Seaman Project, c2004-

Record 58 of 161
CALL # GB1225.C6 P55 2003.
AUTHOR Phelps, Tracy Leigh.
TITLE Investigation of the hydraulic patterns in a riffle using three-dimensional velocity characteristics / submitted by Tracy Leigh Phelps.
PUBLISHER 2003.

Record 59 of 161
CALL # TC175.2 .R375 2001.
AUTHOR Rathburn, Sara L.
TITLE Modeling pool sediment dynamics in a mountain river / submitted by Sara L. Rathburn.
PUBLISHER 2001.

Record 60 of 161
CALL # HD1694.C6 H68 2000.
AUTHOR Howe, Susan.
TITLE Energy and market values of water in the Cache LaPoudre River Basin, CO / submitted by Susan Howe.
PUBLISHER 2000.

Record 61 of 161
CALL # F782.C34 W353 2000.
AUTHOR Walker, Phil.
TITLE Modern visions along the Poudre Valley / by Phil Walker.
PUBLISHER Fort Collins, CO : Walker Communications, [2000]

Record 62 of 161
CALL # TC175 .J33 1999.
AUTHOR Jack, Alison Fiona.
TITLE Implications of the wild & scenic act on bank stabilisation techniques / by Alison Fiona Jack.
PUBLISHER Glasgow : Dept. of Geography & Topographic Science, University of Glasgow, [1999]

Record 63 of 161
CALL # QH541.S7 S54 1998.
AUTHOR Shieh, Sen-Her.
TITLE Macroinvertebrate community structure, functional organization, production, and energy flow in a Colorado plains stream / submitted by Sen-Her Shieh.
PUBLISHER 1998.

Record 64 of 161
CALL # QH541.5.S7 C53 1998.
AUTHOR Chanat, Jeffrey George.
TITLE Abiotic factors affecting benthic macroinvertebrate biomass and community structure in a fourth-order Rocky Mountain Watershed / submitted by Jeffrey George Chanat.
PUBLISHER 1998.

Record 65 of 161
CALL # G4312.R66E63 1997 .T65.
CORPORATE&NBSTrails Illustrated (Firm)
TITLE Cache la Poudre, Big Thompson, Colorado.
PUBLISHER Evergreen, Colo. : Trails Illustrated, 1997, c1993.

Record 66 of 161
CALL # F782.C34 C33.
TITLE Cache la Poudre currents / Poudre River Trust.
PUBLISHER Fort Collins, Colo. : The Trust, 1996-

Record 67 of 161
CALL # TRA1/30.2/C11/1996.
TITLE Colorado Cache la Poudre, North Park scenic & historic byway.
PUBLISHER [Denver, Colo.? : Colorado Scenic and Historic Byways Commission?, 1996?]

Record 68 of 161
CALL # F782.C34 C37 1995.
AUTHOR Case, Stanley R., 1918-1995.
TITLE The Poudre : a photo history / by Stanley R. Case.
PUBLISHER Bellvue, Colo. : Stanley R. Case, c1995.

Record 69 of 161
CALL # SD387.R4 M34 1995.
AUTHOR McCool, Mary Jane.
TITLE Classification of the Cache la Poudre watershed using Landsat thematic mapper data and ancillary spatial data / submitted by Mary Jane McCool.
PUBLISHER 1995.

Record 70 of 161
CALL # HT168.F67 P68 1995.
TITLE Poudre River land use framework / City of Fort Collins Cultural, Library and Recreational Services, Henderson Associates, Colorado State University.
PUBLISHER Fort Collins, Colo. : The City, [1995?].

Record 71 of 161
CALL # F782.C34 W35 1995.
AUTHOR Walker, Phil.
TITLE Visions along the Poudre Valley / by Phil Walker.
PUBLISHER Fort Collins, CO : Philip Walker Communications, c1995.

Record 72 of 161
CALL # Y 4.EN 2:S.HRG.103-610.
CORPORATE&NBSUnited States. Congress. Senate. Committee on Energy and Natural Resources. Subcommittee on Public Lands, National Parks, and Forests.
TITLE Miscellaneous National Park, Bureau of Reclamation and other public lands measures : hearing before the Subcommittee on Public Lands, National Parks, and Forests of the Committee on Energy and Natural Resources, United States Senate, One Hundred Third Congress, second session, on S. 1270, S. 1324, S. 1402, S. 1703, H.R. 194, March 23, 1994.
PUBLISHER Washington : U.S. G.P.O. : For sale by the U.S. G.P.O., Supt. of Docs., Congressional Sales Office, 1994.

Record 73 of 161
CALL # GB653 .C6 no.187eb.
TITLE Developing a biotic index for Colorado stream quality [electronic resource] / by Scott A. Grotheer ... [et al.].
PUBLISHER Fort Collins, Colo. : Colorado Water Resources Research Institute, Colorado State University, [1994]

Record 74 of 161
CALL # S605.2.U6 F74 1993.
AUTHOR Friedenberg, Joyce.
TITLE Irrigation and water conservation in the Poudre Basin / submitted by Joyce Friedenberg.
PUBLISHER 1993.

Record 75 of 161
CALL # A 13.2:AR 1/2.
TITLE Arapaho & Roosevelt National forests : Cache la poudre : a wild & scenic river / produced in cooperation with the Rocky Mountain Nature Association and the USDA Forest Service.
PUBLISHER [Washington, D.C.?] : The Service, [1993?]

Record 76 of 161
CALL # Y 4.EN 2:S.HRG.102-705.
CORPORATE&NBSUnited States. Congress. Senate. Committee on Energy and Natural Resources. Subcommittee on Public Lands, National Parks, and Forests.
TITLE Cache la Poudre National Water Heritage Area; American Discovery Trail; and employee housing : hearing before the Subcommittee on Public Lands, National Parks, and Forests of the Committee on Energy and Natural Resources, United States Senate, One Hundred Second Congress, second session, on S. 1174 ... S. 1537 ... S. 1704 ... April 1, 1992.
PUBLISHER Washington : U.S. G.P.O. : For sale by the U.S. G.P.O., Supt. of Docs., Congressional Sales Office, 1992.

Record 77 of 161
CALL # F782.C34 P693 1992.
TITLE Poudre River Landscape Opportunities Study. Phase one, Identification of issues, opportunities and constraints : summary report : a cooperative study / by the City of Fort Collins and Colorado State University.
PUBLISHER [S.l. : s.n., 1992]

Record 78 of 161
CALL # GB653 .C6 no.166eb.
AUTHOR Wilkins-Wells, John.
TITLE Mutual irrigation company monitoring of main canal nitrogen levels [electronic resource] : a case study on the role of mutual irrigation companies in water quality management / John Wilkins-Wells, David Freeman ; with assistance from the New Cache la Poudre Irrigating Company and the Northern Colorado Water Conservancy District.
PUBLISHER Fort Collins, Colo. : Colorado Water Resources Research Institute, Colorado State University, 1992.

Record 79 of 161
CALL # QH105.C6 E94 1991.
AUTHOR Evans, Howard Ensign.
TITLE Cache la Poudre : the natural history of a Rocky Mountain river / Howard Ensign Evans and Mary Alice Evans.
PUBLISHER Niwot, Colo. : University Press of Colorado, c1991.

Record 80 of 161
CALL # QH105.C6 E94 1991eb.
AUTHOR Evans, Howard Ensign.
TITLE Cache la Poudre [electronic resource] : the natural history of a Rocky Mountain river / Howard Ensign Evans and Mary Alice Evans.
PUBLISHER Niwot, Colo. : University Press of Colorado, c1991.

Record 81 of 161
CALL # CWR1.2/C11/1990.
TITLE Cache la Poudre basin study extension / prepared for Colorado Water Resources & Power Development ; project sponsor, Northern Colorado Water Conservancy District ; study participants, EBASCO Environmental ... [et al.].
PUBLISHER [Denver, Colo.] : Colorado Water Resources & Power Development, 1990.

Record 82 of 161
CALL # A 13.2/2:AR 1/3.
TITLE Land and resource management plan : Arapaho and Roosevelt national forest : amendment no. 12a / U.S. Dept. of Agriculture, Forest Service.
PUBLISHER Fort Collins, Colo. : U.S. Dept. of Agriculture, Forest Service, [1990]

Record 83 of 161
CALL # A 13.2/2:C 11/5/DRAFT.
TITLE Cache la Poudre wild and scenic river draft management plan / U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Region, Arapaho and Roosevelt National Forests, Estes-Poudre Ranger District, Larimer County, Colorado.
PUBLISHER Fort Collins, CO : USDA Forest Service, [1989]

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CALL # QE601 .K36 1988.
AUTHOR Kaplin, John L.
TITLE An engineering geology site investigation of the proposed Poudre Dam site, Larimer County, Colorado / submitted by John L. Kaplin.
PUBLISHER 1988.

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CORPORATE&NBSNorthern Colorado Water Conservancy District (Colo.)
TITLE Cache la Poudre water & power project : FERC project no. 9290 : progress report / Northern Colorado Water Conservancy District.
PUBLISHER [Fort Collins, Colo.?] : The District, 1986-1988.

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CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre Basin water and hydropower resources management study : summary report / prepared by Harza Engineering Company and consultants Leonard Rice Consulting Water Engineers ... [et al.].
PUBLISHER Denver, Colo. : The Company, 1987.

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CALL # TC425.C23 H38 1987a.
TITLE Cache la Poudre basin water and hydropower resources management study : final report / Colorado Water Resources & Power Development Authority ; prepared by Harza Engineering Company and consultants Leonard Rice Consulting Water Engineers ... [et al.].
PUBLISHER Denver, Colo. : Colorado Water Resources & Power Development Authority, 1987.

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CALL # CWR1.2/C11/1990/v.3eb.
TITLE Cache la Poudre Basin Study Extension. Executive summary [electronic resource] / prepared for Colorado Water Resources & Power Development ; project sponsor, Northern Colorado Water Conservancy District ; study participants, EBASCO Environmental ... [et al.].
PUBLISHER Denver, Colo. : Colorado Water Resources & Power Development, 1987.

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TITLE Cache la Poudre Basin Water and Hydropower Resources Management Study [electronic resource] : final report / Colorado Water Resources & Power Development Authority ; prepared by Harza Engineering Company and consultants Leonard Rice Consulting Water Engineers ... [et al.].
PUBLISHER Denver, Colo. : Harza Engineering Company, 1987.

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TITLE Task 3 summary report on water supply and regional hydrologic assessment : executive summary.
PUBLISHER [Colorado : s.n., 1986?]

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CALL # TC425.C23 H38 1986C.
CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre Basin water and hydropower resources management study : executive summary, phase I : draft / prepared for Colorado Water Resources & Power Development Authority by Harza Engineering Company.
PUBLISHER Denver, Colo. : [The Company?] 1986.

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CALL # TC425.C23 H38 1986B.
TITLE Executive summary : task 5 summary report on analysis of regional and basinwide supply and demand.
PUBLISHER [Denver, Colo.? : Colorado Water Resources Power Development Authority? 1986?]

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CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre Basin water and hydropower resources management study : task 5 summary report / prepared for Colorado Water Resources & Power Development Authority by Harza Engineering Company and consultants, Leonard Rice Consulting Water Engineers [and] Browne, Brotz & Coddington.
PUBLISHER [Denver, Colo.? : [The Company?] 1986.

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CALL # TC425.C23 H38 1986E.
TITLE Cache la Poudre Basin study : public meeting no. 2 held in Greeley on May 29, 1986.
PUBLISHER [Denver, Colo.? : Harza Engineering Company? 1986]

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CALL # TC425.C23 H38 1986F.
TITLE Task 7 summary report on identification of plan elements : executive summary.
PUBLISHER [Denver, Colo.? : Harza Engineering Company? 1986?]

Record 96 of 161
CALL # TC425.C23 C34 1986.
TITLE Cache la Poudre basin study : summary report : draft.
PUBLISHER [Denver, Colo.? : Colorado Water Resources and Power Development Authority, 1986]

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CALL # TC425.C23 H38 1986G.
CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre Basin water and hydropower resources management study : task 7 summary report / prepared for Colorado Water Resources and Power Development Authority by Harza Engineering Company ... [et al.].
PUBLISHER Denver, Colo. : The Company, 1986.

Record 98 of 161
CALL # TC425.C23 H38 1986J.
CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre Basin water and hydropower resources management study : task 9 summary report / prepared by Colorado Water Resources and Power Development Authority by Harza Engineering Company and consultants Browne, Bortz & Coddington [and] Tom Pitts & Associates.
PUBLISHER Denver, Colo. : The Company, 1986.

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CALL # TC425.C23 H38 1986H.
TITLE Executive summary : task 8 summary report on formulation of alternative plans.
PUBLISHER [Denver, Colo. : Harza Engineering Company, 1986?]

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CALL # QR105 .W37 1985.
AUTHOR Warbington, Roy Carl.
TITLE Mutagenic activity of river water and river water mixed with sediments / submitted by Roy Carl Warbington.
PUBLISHER 1985.

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CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre basin water and hydropower resources management study : task 2 summary report / prepared for Colorado Water Resources and Power Development Authority ; prepared by Harza Engineering Company and consultants, Leonard Rice Consulting Water Engineers (Denver) ... [et al.].
PUBLISHER Denver, Colo. : [The Company], 1985.

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CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre basin water and hydropower resources management study : task 1 summary report / prepared for Colorado Water Resources and Power Development Authority ; prepared by Harza Engineering Company and consultants, Leonard Rice Consulting Water Engineers (Denver) ... [et al.].
PUBLISHER Denver, Colo. : [The Company], 1985.

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CALL # TC425.C23 H38 1985B.
CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre basin water and hydropower resources management study : task 2 summary report : executive summary.
PUBLISHER [Denver, Colo. : The Company? 1985]

Record 104 of 161
CALL # TC425.C23 H38 1985D.
CORPORATE&NBSHarza Engineering Company.
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PUBLISHER [Denver, Colo. : The Company? 1985]

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CALL # TC425.C23 H38 1985E.
CORPORATE&NBSHarza Engineering Company.
TITLE Cache la Poudre basin water and hydropower resources management study : task 4 summary report.
PUBLISHER Denver, Colo. : Browne, Bortz & Coddington, 1985.

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TITLE Executive summary : task 4 summary report on water demand.
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Record 107 of 161
CALL # F 782 C34P57.
TITLE Poudre profile.
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CORPORATE&NBSTudor Engineering Company.
TITLE Cache la Poudre project study / prepared for the Colorado Water Conservation Board by Tudor Engineering Company.
PUBLISHER [Denver, Colo.? : The Company?] 1983.

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CALL # TD225.C23 C33.
TITLE Cache la Poudre.
PUBLISHER Denver, Colo. : Colorado Water Conservation Board, Dept. of Natural Resources, [1982-1983]

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TITLE Cache la Poudre project study : draft summary report.
PUBLISHER [Denver, Colo. : Colorado Water Conservation Board], 1983.
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CORPORATE&NBSTudor Engineering Company.
TITLE Interim report on the Cache la Poudre project study : evaluation of six alternative projects / prepared for the Colorado Water Conservation Board, Colorado Department of Natural Resources by Tudor Engineering Company.
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CORPORATE&NBSTudor Engineering Company.
TITLE Special report, addendum to the Interim report on the Cache la Poudre project study : evaluation of two additional preliminary alternative projects / prepared for Colorado Water Conservation Board, Colorado Department of Natural Resources by Tudor Engineering Company.
PUBLISHER Denver, Colo. : The Company, 1982.

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CORPORATE&NBSFort Collins (Colo.). Planning Division.
TITLE Poudre area river concept / prepared by staff of the City of Fort Collins Planning Division.
PUBLISHER [Fort Collins, Colo.? : The Division?], 1981-1982 [v. 1, 1982]

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CALL # QL537.C456 S5.
AUTHOR Shoutis, Arthur H.
TITLE Distribution of the Chironomidae in the upper Poudre River / submitted by Arthur H. Shoutis.
PUBLISHER 1981.

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CALL # GB1227.C25 L3.
AUTHOR Lazaro, Rogelio Cruz.
TITLE Adaptive real-time streamflow forecasting model for hydrosystem operational planning / submitted by Rogelio Cruz Lazaro.
PUBLISHER 1981.

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CALL # TC175 .B67.
AUTHOR Bosley, Charles M.
TITLE Computer-assisted water administration for the Poudre River system / submitted by Charles M. Bosley.
PUBLISHER 1980.

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CALL # GB653 .C6 NO.114.
AUTHOR Turner, Charles D.
TITLE Planning water reuse, development of reuse theory and the input-output model. Volume I, Fundamentals / by Charles D. Turner and David W. Hendricks.
PUBLISHER Fort Collins, CO : Colorado Water Resources Research Institute, Colorado State University, 1980.

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AUTHOR Klooz, Darrel.
TITLE Planning water reuse : development of reuse theory and the input-output model. Volume II, Application of the input-output water balance model / by Darrel Klooz, David W. Hendricks.
PUBLISHER Fort Collins, CO : Colorado Water Resources Research Institute, Colorado State University, 1980.

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CALL # QH541 .C7 no.43.
AUTHOR Eubanks, Michael J.
TITLE An evaluation of the Cache la Poudre Wild and Scenic River draft environmental impact statement and study report / by Michael J. Eubanks.
PUBLISHER Fort Collins, Colo. : Colorado Water Resources Research Institute, Colorado State University, 1980.

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CALL # GB653 .C6 no.115eb.
AUTHOR Klooz, Darrel.
TITLE Planning water reuse, development of reuse theory and the input-output model [electronic resource]. Volume II, Application of the input-output water balance model / by Darrel Klooz and David W. Hendricks (Department of Civil Engineering, Colorado State University).
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CALL # GB653 .C6 no.114eb.
AUTHOR Turner, Charles D.
TITLE Planning water reuse, development of reuse theory and the input-output model [electronic resource]. Volume I, Fundamentals / by Charles D. Turner and David W. Hendricks (Department of Civil Engineering, Colorado State University).
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AUTHOR Eubanks, Michael J.
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AUTHOR Daubert, John Thomas.
TITLE Economic benefits from low-flow regulations on Colorado mountain streams / submitted by John Daubert.
PUBLISHER 1979.

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CORPORATE&NBSUnited States. Forest Service.
TITLE Cache la Poudre wild & scenic River : draft environmental impact statement and study report.
PUBLISHER [Fort Collins, Colo.] : Dept. of Agriculture, Forest Service, [1979]

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CALL # HC55 .C6 no.18eb.
AUTHOR Shafer, John M.
TITLE An interactive river basin water management model [electronic resource] : synthesis and application / by John M. Shafer.
PUBLISHER Fort Collins : Colorado Water Resources Research Institute, 1979.

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AUTHOR Reitano, Bartolomeo M.
TITLE An input-output model of the Cache la Poudre water system / submitted by Bartolomeo M. Reitano.
PUBLISHER Fort Collins, Colo. : [s.n.], 1978.

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AUTHOR Jønch-Clausen, Torkil.
TITLE Optimal allocation of water resources in an input-output framework / submitted by Torkil Jønch-Clausen.
PUBLISHER Fort Collins, Colo. : [s.n.], 1978.

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AUTHOR Shafer, John M.
TITLE Synthesis and calibration of a river basin water management model / by John M. Shafer, and John W. Labadie ; submitted to Office of Water Research and Technology, U.S. Department of Interior.
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AUTHOR Shafer, John M.
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TITLE The Poudre River.
PUBLISHER Denver : Gro-Pub Group, c1976.

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CALL # TD225.C15 A9.
AUTHOR Aukerman, Robert.
TITLE Effects of recreation on water quality in wildlands / Robert Aukerman, William T. Springer.
PUBLISHER [Fort Collins, Colo.] : Eisenhower Consortium for Western Environmental Forestry Research, 1976.

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AUTHOR Zuck, Ronald H.
TITLE An ecological versus managerial classification of forest communities / submitted by Ronald H. Zuck.
PUBLISHER 1974.

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CALL # QH91.8.B4 G3.
AUTHOR Galat, David L.
TITLE A comparative assessment of several biological indices of water quality applied to aquatic macroinvertebrate collections / submitted by David L. Galat.
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AUTHOR Evans, Robert G. (Robert George)
TITLE Agricultural land use in the Poudre Valley / Robert G. Evans, Wynn R. Walker, Gaylord V. Skogerboe.
PUBLISHER Fort Collins, Colo. : Colorado State University, 1973.

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CALL # EP 1.2:W 323/15.
CORPORATE&NBSUnited States. Environmental Protection Agency. National Field Investigations Center.
TITLE Effects of waste discharges on water quality of the Cache la Poudre and South Platte Rivers, Greeley, Colorado / [by] National Field Investigations Center and Region VIII.
PUBLISHER Denver : EPA Region VIII and NFIC, 1972.

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AUTHOR Waltz, James P.
TITLE Hydrogeology and water quality studies in the Cache la Poudre Basin, Colorado / by James P. Waltz ; submitted to Office of Water Resources Research, Department of Interior, Washington, D.C.
PUBLISHER Fort Collins, Colo. : Colorado State University, Natural Resources Center, 1969.

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CALL # GB653 .C6 no.14eb.
AUTHOR Waltz, James P.
TITLE Hydrogeology and water quality studies in the Cache la Poudre Basin, Colorado [electronic resource] / by James P. Waltz ; submitted to Office of Water Resources Research, Department of Interior, Washington, D.C.
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CALL # F 782 C34K4 1980.
AUTHOR Kennedy, John A.
TITLE Cache la Poudre, Colorado's natural scenic river / submitted by John A. Kennedy.
PUBLISHER 1967.

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CALL # TC 824 C6K37.
AUTHOR Kelly, William R. (William Robert), 1883-
TITLE A compilation and comment on fifty years, 1870-1920: I. Engineers and ditch men developed on the Cache la Poudre, 1870-1920. II. "Ditch men", water hunters of that fifty years, not engineers, by William R. Kelly.
PUBLISHER [n.p.] 1967.

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AUTHOR Ritchey, Norman C.
TITLE Multiple-use planning in the Little South Fork of the Cache la Poudre watershed / submitted by Norman C. Ritchey.
PUBLISHER 1964.

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CORPORATE&NBSUnited States. Bureau of Reclamation. Denver Development Office.
TITLE Reconnaissance report, February 1963.
PUBLISHER Denver : Bureau of Reclamation, Region 7, Denver Development Office, 1963.

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CALL # SK305.M6 S5 1961.
AUTHOR Simmons, Norman M.
TITLE Daily and seasonal movements of Poudre River bighorn sheep / submitted by Norman M. Simmons.
PUBLISHER 1961.

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CALL # F 782 C34F78 1955.
AUTHOR Fry, Norman Walter.
TITLE Cache la Poudre : the river : as seen from 1889 / by Norman Walter Fry ; photographs courtesy of Norman W. Fry ... [et al.]
PUBLISHER [Colorado : s. n., 1955?]

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AUTHOR Gross, Jack E.
TITLE A vegetation survey of the Poudre bighorn sheep range / by Jack E. Gross.
PUBLISHER 1955.

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CALL # KF5582.L37 W963 1917.
CORPORATE&NBSWyoming.
TITLE The state of Wyoming, complainant, vs. the state of Colorado, The Greeley-Poudre Irrigation District, and The Laramie-Poudre Reservoirs and Irrigation Company, defendants : [briefs on behalf of defendants]
PUBLISHER Denver : Clark Quick Printing Co., [1917-

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PUBLISHER Denver : Smith-Brooks Press, [1916]

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AUTHOR Tait, C. E.
TITLE Storage of water on Cache la Poudre and Big Thompson Rivers / By C. E. Tait.
PUBLISHER Washington : Govt. Print. Off., 1903.
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AUTHOR Nettleton, E. S.
TITLE The reservoir system of the Cache la Poudre Valley / by E. S. Nettleton.
PUBLISHER Washington : Govt. Print. Off., 1901.

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CORPORATE&NBSLarimer County District Court.
TITLE Larimer County District Court Map Collection, 1884-1953.

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AUTHOR Goslin, Ival V.
TITLE Ival V. Goslin Water Resources Collection, 1907-1991.

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AUTHOR Gardner, Susan.
TITLE Wastewater treatment system design in the Cache la Poudre Canyon / design team: Susan Gardner, Rosalyn Leautaud, Thomas J. Scholand.
PUBLISHER [Colo.? : s.n., 1995?]

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PUBLISHER [Fort Collins, Colo.?] : U.S. Dept. of Agriculture, USDA Forest Service, Arapaho and Roosevelt National Forests, State of Colorado, Dept. of Natural Resources, 1984.

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CORPORATE&NBSUnited States. Bureau of Reclamation. Region 7.
TITLE Cache la Poudre Unit, Longs Peak Division, Missouri River Basin Project : concluding report.
PUBLISHER Denver : Bureau of Reclamation, Region 7, 1966.

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TITLE Cache la poudre wild and scenic river final management plan.

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CALL # A 13.92:FES R 2-80/03.
TITLE Cache la poudre wild and scenic river.
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CALL # A 13.92:R 2-80-03.
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CALL # TRA1/30.2/G94/1999.
TITLE Discover Colorado : Colorado Scenic and Historic Byways.
PUBLISHER [Denver, Colo. : Colorado Scenic and Historic Byways Commission, 1999?]

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CALL # F774.3 .H83 1997.
AUTHOR Huber, Thomas Patrick.
TITLE Colorado byways : a guide through scenic and historic landscapes / Thomas P. Huber.
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AUTHOR Huber, Thomas Patrick.
TITLE Colorado byways [electronic resource] : a guide through scenic and historic landscapes / Thomas P. Huber.
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AUTHOR Koirtyohann, Jacquelyn C.
TITLE Cache la Poudre Trail interpretive plan / submitted by Jacquelyn C. Koirtyohann.
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