



## Appendix D – Environmental and Recreational Assessment Methodology and Framework

South Platte Basin Implementation Plan

South Platte Basin Roundtable/Metro Basin  
Roundtable

April 17, 2015



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# 1 Environmental and Recreational Protections Assessment Methodology

In order to assess the protections existing in environmental and recreational focus areas as well as determine and assess goals and measurable outcomes, a complex methodology and framework were developed which can be used to assess the overlap of focus areas, attributes, protections or projects and potential habitat. The implementation of M&I projects and methods, whether represented in the analysis data as IPPs or other projects, increasingly must consider the impacts on other parts of the water system, including environment, recreation, and agriculture, in particular if multi-purpose projects are being evaluated. The methodology and framework developed to assess the protections and the impacts of projects on environmental and recreational attributes are described in detail in this Appendix.

# 2 Projects Assessment

While the Statewide Water Supply Initiative (SWSI) 2010 considered each demand component, including M&I, agriculture, environmental and recreational, the level of detail for M&I needs was much higher than other considerations. There are two fundamental approaches to answer the question “How will Project or Method X impact the environment, in particular environmental and recreational focus areas and attributes?” The first approach is to evaluate each M&I project and method for potential impacts (positive and negative), including some level of impact. For example, “Project X may decrease flows in Stream Y” or “Project X may decrease flows in Stream Y by 10 CFS during the period May-Sep”. If permitting is required, then such evaluations are already occurring as part of permitting processes.

### Reference Documents

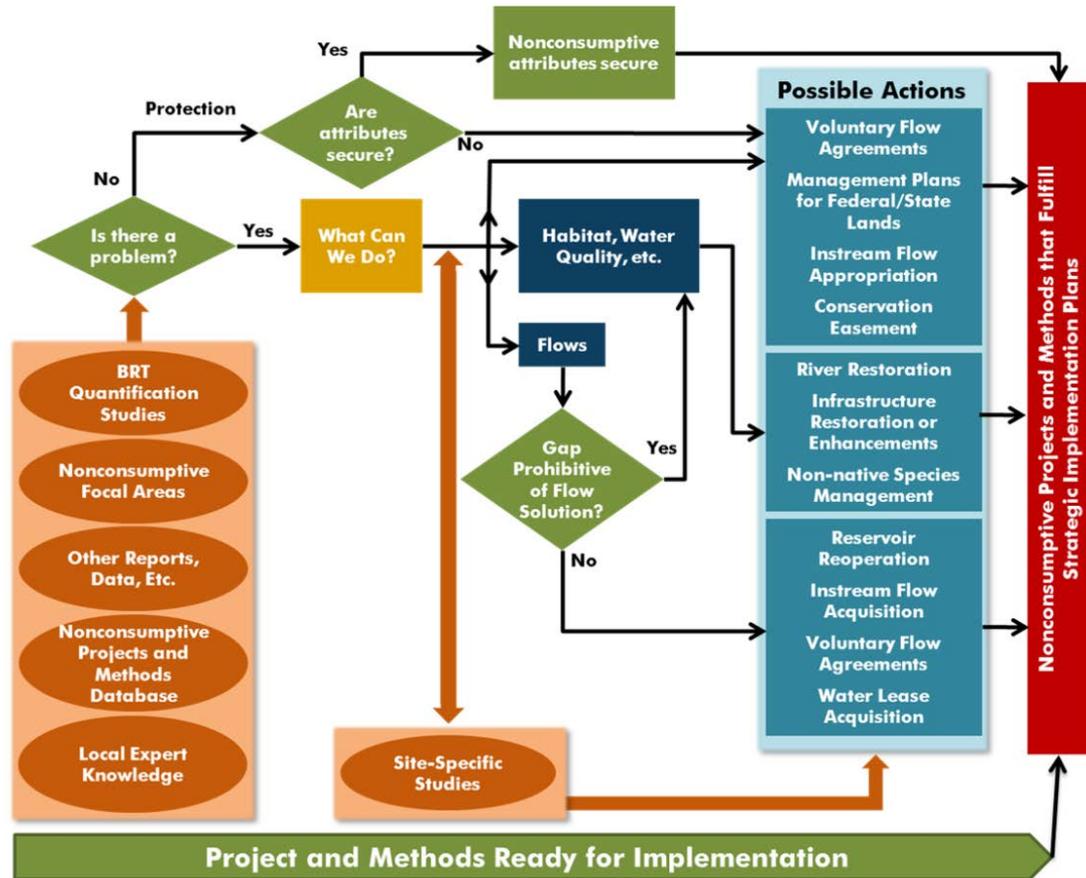
The following discussion is based upon:

[SWSI 2010 South Platte Basin Report Basinwide Consumptive, Nonconsumptive Water Supply Needs Assessments, and SWSI Nonconsumptive Toolbox](#)

For other projects, an evaluation of impacts could be included in project data, in particular if there is motivation for a multi-purpose project. Although project proponents may be aware of specific values that need protection, they may not be tracking such information consistent with the SWSI Non-Consumptive Needs Assessment (NCNA) attributes, and there may only be a data gap for NCNA attributes when an attribute is omitted from an area. The second option for analysis is to evaluate for each focus area or attribute what might be the impacts of each planned project. It is likely that advocates for focus areas (such as conservation organizations operating in the area) monitor potential impacts of NCNA attributes and take action accordingly. However, detailed analysis and monitoring may be difficult and more general goals of maintaining and improving water quality, streamflows, or habitat extent, may be easier metrics to evaluate. Advocacy may be absent if no organization exists in the area of concern, although State or Federal agencies may be present.

The SWSI Nonconsumptive Toolbox includes a decision tree for evaluating and planning “nonconsumptive” projects.<sup>1</sup> The decision tree is shown in Figure 2-1.

**Figure 2-1 Nonconsumptive (Environmental and Recreational) Projects and Methods Decision Tree**



The toolbox focuses on new projects to address an existing environmental and/or recreational need. However, a similar decision tree could be used to address the impacts of a planned M&I (or agricultural) project. In this case, the initial question of “Is there a problem?” is asked through the lens of “What impact will Project X have?” The toolbox could therefore be utilized to evaluate enhancing any project, perhaps converting the project into a multi-purpose project.

### 3 Discussion of Methodology and Framework

In order to assess whether or not a project is needed in a particular focus area, a methodology and framework based on data regarding attributes and projects were developed. A general basin-wide methodology was developed in Phase I of the South Platte BIP work and a stream mile representation framework was developed in Phase II. The evaluation of the existing data to determine environmental and recreational needs

<sup>1</sup> Nonconsumptive Toolbox, CWCB, 2011

and opportunities used the SWSI 2010 data as well as the new data sets supplied by CDM, the SWSI consultant for the CWCB. The evaluation and methodology described herein implements queries and analyses of two separate data sources, 1) GIS shapefiles, which contain spatial information regarding focus areas, attributes, and projects, and 2) the MS Access Nonconsumptive Needs Assessment (NCNA) database, which contains more detailed information on some attributes, projects, and protection categories for the projects. The GIS shapefiles were created for SWSI, however, the MS Access database was used for project and protection data analysis.

### 3.1 General Basin-Wide Methodology

A general basin-wide methodology was developed in Phase I of the South Platte BIP to generally assess the available data, resulting in broad determination such as “there are X miles of stream habitat suitable for species Y and Z miles are sufficiently protected with projects and methods”. However, BIP Phase I scope and data limitations did not allow for development of a robust method for the assessments of attributes or sufficiency of projects. Based on a review of both data sources during the BIP project, significant differences were found between the data contained in the GIS data and NCNA database that preclude a complete analysis of focus areas, attributes, projects and protections. The one common variable that could be used to crosslink both data bases is the COMID. This is a unique identifier for smaller stream segments taken from the National Hydrography Dataset (NHD). Some of the differences between the NCNA database and the GIS shapefiles have been rectified to be able to conduct some preliminary analyses, however, additional work is needed to fully incorporate new focus area and project data into the Access database to ensure consistency between the database and GIS. Steps were taken in Phase I of the South Platte BIP to develop the methodology as a method to incorporate some of this data in the future.

For the general basin-wide analysis, a method was devised to link the Focus Area identifier (a unique number) with the MS Access database. The GIS shapefiles contained the unique identifier included for all Focus Areas. The GIS data included a COMID for all stream segments in each Focus Area and the narrative description of the Focus Area. The Focus Area identifiers and names are being added to the MS Access database and additionally a table relating Focus Area to segment are also being added to relate the focus areas to existing data in the database. This data joining provides a means to link the common variable of COMID in the MS Access and GIS data. A number of queries could be executed if the MS Access database is fully updated to list focus area, attribute, segment, and project combinations details and summaries.

The attributes evaluated for each Focus Area in the South Platte Basin were approved by the South Platte and Metro Roundtables (BRTs) in 2010 (Table 1) as part of the SWSI process. The SWSI 2010 Focus Segments have numeric and descriptive labels. The GIS database contains both the numeric and descriptive label for each SWSI 2010 focus segment.

**Table 1 - South Platte Basin Attributes**

South Platte Attributes	Attribute Type		Data Availability		Attribute Inclusion Approved	
	Environmental	Recreational	SWSI 2010 shapfile	Quantitative data	Yes/No	Date
Boreal Toad	X		Y	Y	Y	SWSI 2010
Greenback Cutthroat Trout	X		Y	Y	Y	SWSI 2010
Brassy Minnow	X		Y	Y	Y	SWSI 2010
Common Shiner	X		Y	Y	Y	SWSI 2010
Lake Chub	X		Y	Y	Y	SWSI 2010
Northern Redbelly Dace	X		Y	Y	Y	SWSI 2010
Plains Minnow	X		Y	Y	Y	SWSI 2010
River Otter	X		Y	Y	Y	SWSI 2010
Stonecat	X		Y	Y	Y	SWSI 2010
Suckermouth Minnow	X		Y	Y	Y	SWSI 2010
Yellow Mud Turtle	X		Y	Y	Y	SWSI 2010
Iowa Darter	X		Y	Y	Y	SWSI 2010
Northern Leopard Frog	X		Y	Y	Y	SWSI 2010
Plains Orangethroat Darter	X		Y	Y	Y	SWSI 2010
Colorado Outstanding Waters		X	Y	Y	Y	SWSI 2010
CWCB Instream Flow Water Rights	X		Y	Y	Y	SWSI 2010
CWCB Natural Lake Level Water Rights	X		Y	Y	Y	SWSI 2010
Ducks unlimited projects		X	Y	Y	Y	SWSI 2010
Eligible Wild and Scenic	X		Y	Y	Y	SWSI 2010
Flatwater Boating		X	Y	Y	Y	SWSI 2010
Gold Medal Trout Lakes		X	Y	Y	Y	SWSI 2010
Gold Medal Trout Streams		X	Y	Y	Y	SWSI 2010
Northern Cricket Frog	X		Y	Y	Y	SWSI 2010
Plains Leopard Frog	X		Y	Y	Y	SWSI 2010
Rare Aquatic-dependent plants	X		Y	Y	Y	SWSI 2010
Recreational In-Channel Diversion Structures		X	Y	Y	Y	SWSI 2010
Reservoir and Lake Fishing		X	Y	Y	Y	SWSI 2010
River and stream fishing		X	Y	Y	Y	SWSI 2010
Waterfowl Hunting / Viewing		X	Y	Y	Y	SWSI 2010
Whitewater Boating		X	Y	Y	Y	SWSI 2010
Preble's Meadow Jumping Mouse	X		Y	Y	Y	SWSI 2010
Common Garter Snake	X		Y	Y	Y	SWSI 2010
Active Bald Eagle Nests	X		Y	Y	Y	SWSI 2010
Audubon important bird areas	X		Y	Y	Y	SWSI 2010
Significant Plant Communities	X		Y	Y	Y	SWSI 2010
Wilderness Waters	X		Y	Y	Y	SWSI 2010
Wood Frog	X		Y	Y	Y	SWSI 2010

The NCNA attributes also are listed in each Focus Area by the COMID label. The total reach length for each attribute within a Focus Area was used to determine the amount of each attribute (length and percent) by Focus Area in the South Platte Basin. These data can provide the existing amount of the attribute in the Focus Area. In addition, the data contains some information regarding the current protections in the Focus Areas, although significantly more information is needed. Analyses to determine where the focus areas, attributes and projects overlap can allow for the possible determination of the amount of potential increase for a given attribute and the potential for future projects and protections. Additional species specific analyses can determine the extent of potential habitat.

For example, Focus Area 12 has the descriptive label “all mountain tributaries with greenback cutthroat trout”. These tributaries include 122 miles of streams. Greenback

cutthroat trout are present in 89 miles (69%) of the Focus Area. Protections in the Focus Area include CWCB instream flow (ISF) protections. There are 56 miles (45%) of the Focus Area protected by CWCB ISF.

If available, the data for each Focus Segment can be used in the future to set more specific measurable goals and outcomes for attributes in the South Platte Basin based on the priorities of the BRT. The data for the occurrence of each attribute by Focus Segment can be used to quantify each attribute. One goal in the South Platte is to maintain the attributes at their present levels and if possible increase the attributes. Additional specific analyses can determine the extent of potential habitat.

Table 2 shows the percent occurrence in the basin by attribute in all focus areas as described in Appendix B, based solely upon the data available in the GIS shapefiles regarding location of attributes. These percent occurrences do not necessarily demonstrate the vitality or lack of habitat of a species. Current habitat may be sufficient to maintain species if such habitat is not degraded, or additional habitat or connectivity may be needed. Some species are micro-habitat specific and may occur throughout the basin in appropriate areas, or may need additional habitat to thrive. Location specific studies and analyses are needed to fully determine the species habitat, potential habitat and sufficiency of protections for the species.

**Table 2 - South Platte Basin Percent Occurrence by Attribute in Focus Areas**

<b>State Endangered, Threatened, and Species of Concern</b>		
Greenback Cutthroat Trout		5%
Brassy Minnow		47%
Common Shiner		27%
Iowa Darter		47%
Lake Chub		3%
Northern Redbelly Dace		14%
Plains Orangethroat Darter		8%
Plains Minnow		7%
Suckermouth Minnow		8%
Stonecat		8%
Boreal Toad		4%
Bald Eagle Active Nest Sites		3%
River Otter Confirmed Sightings		2%
Yellow Mud Turtle		2%
Common Garter Snake		10%
Preble's Meadow Jumping Mouse		53%
Northern Leopard Frog		19%
Northern Cricket Frog		4%
Plains Leopard Frog		3%
Wood Frog		1%
<b>Rare Plants and Significant Plant Communities</b>		
Rare Plants		20%
Significant Plant Communities		49%
<b>Special Value Waters</b>		
Colorado Outstanding Waters		5%
Eligible/Suitable Wild and Scenic		12%
CWCB Instream Flow Water Rights		27%
CWCB Natural Lake Level Water Rights		4%
Wilderness Area Waters		6%
<b>Whitewater and Flatwater Boating</b>		
Whitewater Boating		20%
Flatwater Boating		1%
Recreational In-Channel Diversion Structures		0%
<b>Important Cold and Warm-Water Fishing</b>		
Gold Medal Streams and Lakes		4%
River and Stream Fishing		21%
Reservoir and Lake Fishing		2%
<b>Waterfowl Hunting/Viewing</b>		
Audubon Important Bird Areas		3%
Waterfowl Hunting/Viewing Parcels		14%
Ducks Unlimited Projects		20%
<b>High Recreation Areas</b>		
High Recreation Corridors		4%

The attributes were grouped into subcategories in SWSI 2010 Table 3. These subcategories can simplify the analysis. Figure 3-1 and Figure 3-2 illustrate the grouping for environmental and recreational attributes. These subsets were obtained from the CWCB database distributed in December 2013 and refined by the nonconsumptive subcommittee in 2014 to more clearly categorize the attributes. The categorization of the attributes is shown in Table 3.

Figure 3-1 - Relationship between Environmental Attributes

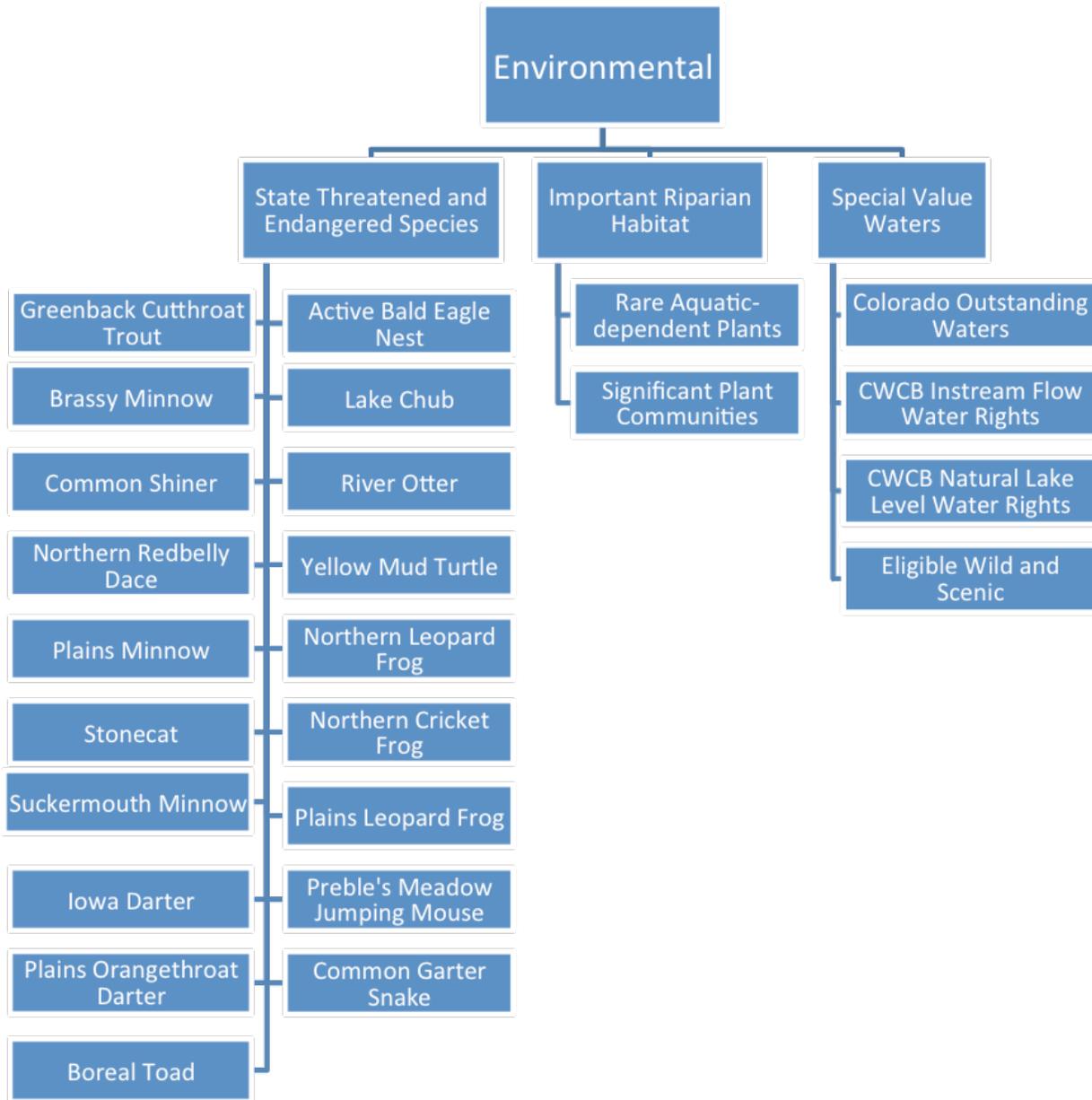
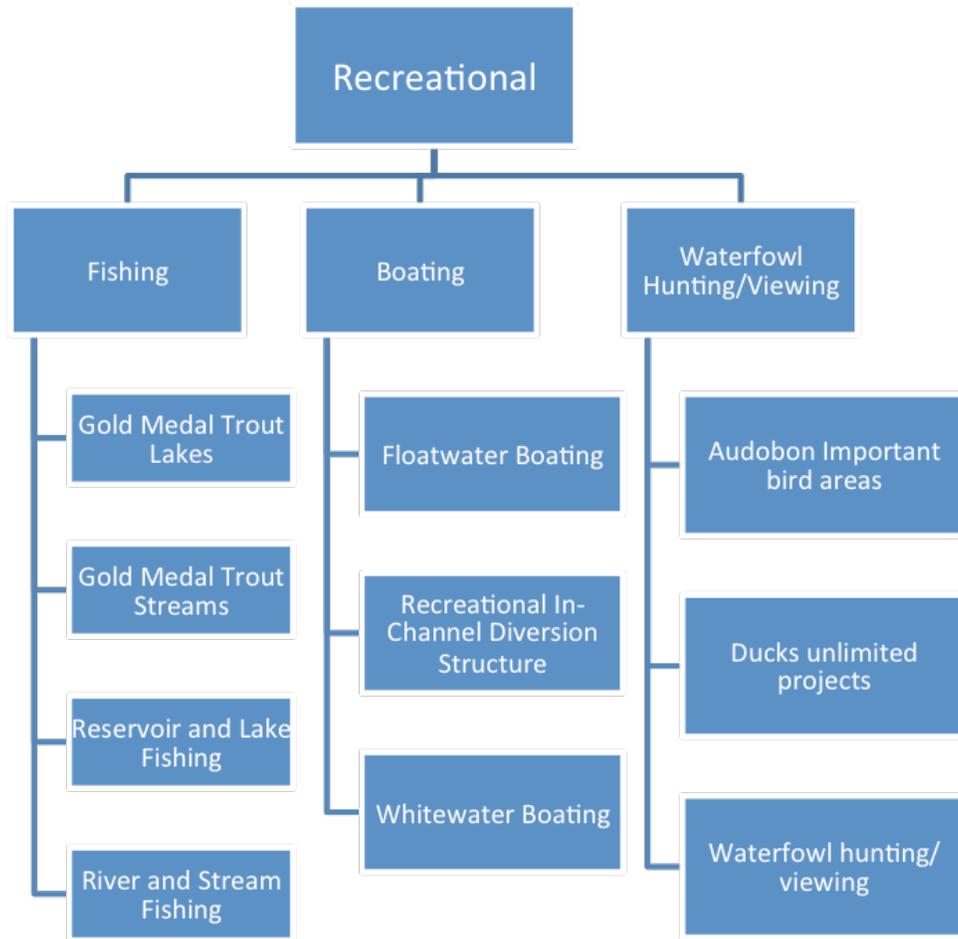


Figure 3-2 - Relationship between Recreational Attributes



**Table 3 - Attributes by Category**

<b>Attributes</b>	<b>Category</b>
Gold Medal Trout Lakes	Fishing
Gold Medal Trout Streams	Fishing
Reservoir and Lake Fishing	Fishing
River and stream fishing	Fishing
Greenback Cutthroat Trout	Greenback Cutthroat Trout
Rare Aquatic-dependent plants	Important Riparian Habitat
Significant Plant Communities	Important Riparian Habitat
Brassy Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Common Shiner	Plains Fish State Endangered, Threatened, Species of Special Concern
Northern Redbelly Dace	Plains Fish State Endangered, Threatened, Species of Special Concern
Plains Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Stonecat	Plains Fish State Endangered, Threatened, Species of Special Concern
Suckermouth Minnow	Plains Fish State Endangered, Threatened, Species of Special Concern
Iowa Darter	Plains Fish State Endangered, Threatened, Species of Special Concern
Plains Orangethroat Darter	Plains Fish State Endangered, Threatened, Species of Special Concern
Flatwater Boating	Recreation
Recreational In-Channel Diversion Structures	Recreation
Whitewater Boating	Recreation
Boreal Toad	State Endangered, Threatened, Species of Special Concern
Lake Chub	State Endangered, Threatened, Species of Special Concern
River Otter	State Endangered, Threatened, Species of Special Concern
Yellow Mud Turtle	State Endangered, Threatened, Species of Special Concern
Northern Leopard Frog	State Endangered, Threatened, Species of Special Concern
Northern Cricket Frog	State Endangered, Threatened, Species of Special Concern
Plains Leopard Frog	State Endangered, Threatened, Species of Special Concern
Preble's Meadow Jumping Mouse	State Endangered, Threatened, Species of Special Concern
Common Garter Snake	State Endangered, Threatened, Species of Special Concern
Wood Frog	State Endangered, Threatened, Species of Special Concern
Waterfowl Hunting / Viewing	Waterfowl Hunting/Viewing
Ducks unlimited projects	Waterfowl Hunting/Viewing
Audubon important bird areas	Waterfowl Hunting/Viewing
Colorado Outstanding Waters	
CWCB Instream Flow Water Rights	
CWCB Natural Lake Level Water Rights	
Eligible Wild and Scenic	
Active Bald Eagle Nests	
Wilderness Waters	

Since SWSI 2010, the Greenback Cutthroat Trout has been determined to only be located in the Arkansas Basin, with what was previously considered the Greenback Cutthroat Trout actually being another native cutthroat trout. This categorization and attribute will be updated with the new native cutthroat trout species name, once determined. (*Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout.* Metcalf, Stowell, Kennedy, Rogers, McDonald, Epp, Keepers, Cooper, Austin, and Martin. *Molecular Ecology*, Vol 21, Issue 21, pages 5194-5207, Nov 2012.)

The addition of the Focus Area number to the CWCB database provides a means to quantify the attributes by Focus Area. This approach provides a means to determine the approximate extent of each attribute in each Focus Area but does not create a spatial reference for the attribute's occurrence. For example, the database queries summarized stream segments to give totals for focus area, attribute, and project but do not indicate

when project protections overlap at a COMID stream segment level. The spatial linkage must be made using the COMID and attributes. The COMID values are one of the existing limitations to using this general approach. COMID values can be changed by the NHD in the future, which would cause errors in data retrievals from the existing data sets. A new framework with fixed spatial location data was needed for long term data integrity and analysis but beyond the scope of Phase I.

The spatial locations can be used to determine where there are gaps in the projects and protections for each attribute or group of attributes. A generic example of this is shown in Figure 3-3.

The MS Access database includes the list of current and planned projects within the South Platte basin. Several queries were made on the database to extract the list of projects by Focus Area and attribute. The entire list includes projects listed at “Stewardship” and “Instream Flow”. These types of projects cover large portions of the South Platte Basin but may not have specific protections to address threats to the attributes. For example, an instream flow right does not ensure adequate streamflow because such rights are typically junior to other water rights, and water flowing through public lands (considered stewardship) simply means that there is some level of land stewardship, as discussed below. These types of projects cover broad areas for the purpose of a general protection of aquatic attributes.

The database can also be queried for all projects in the South Platte Basin, excluding Stewardship and Instream Flow projects. The queries run to date result in fewer projects, which could be compared to attributes. Database queries can provide the total amount of the Focus Area covered by the project but not the location. The spatial location of each project can be identified using GIS.

The general basin-wide methodology is illustrated in Figure 3-3 and Figure 3-4. Due to the difficulties with data issues encountered in the general basin-wide methodology utilized in Phase I of the South Platte BIP and described above, a stream mile representation framework was developed in Phase II.

Figure 3-3- Illustration of General Basin-Wide Methodology

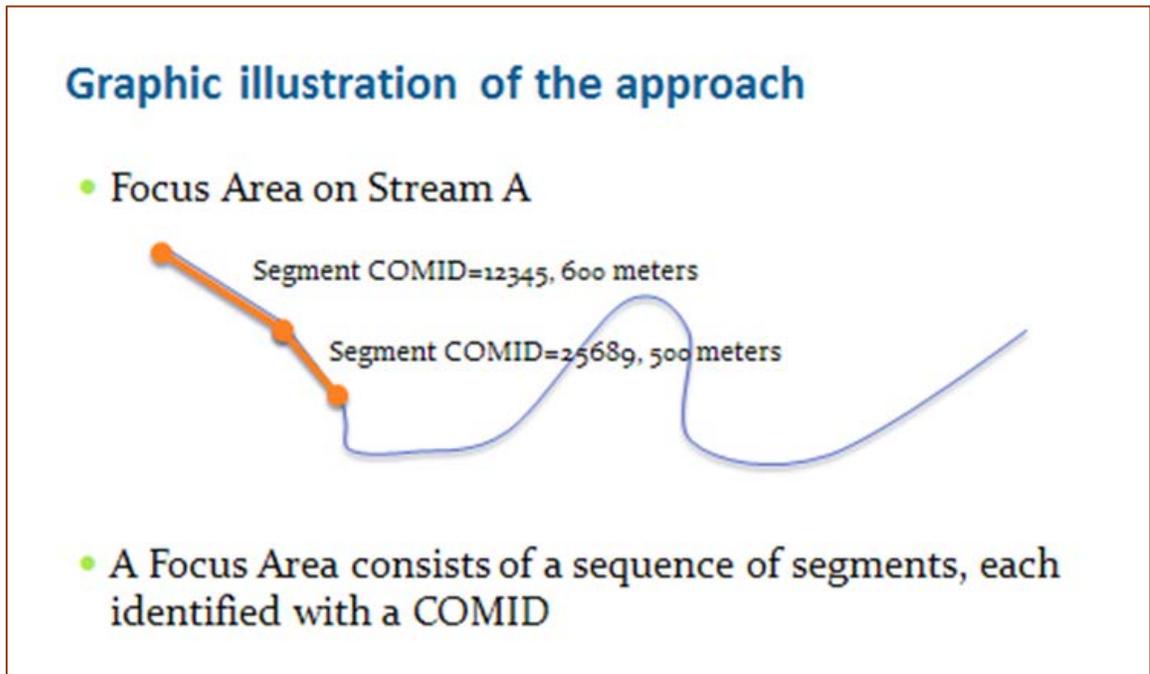
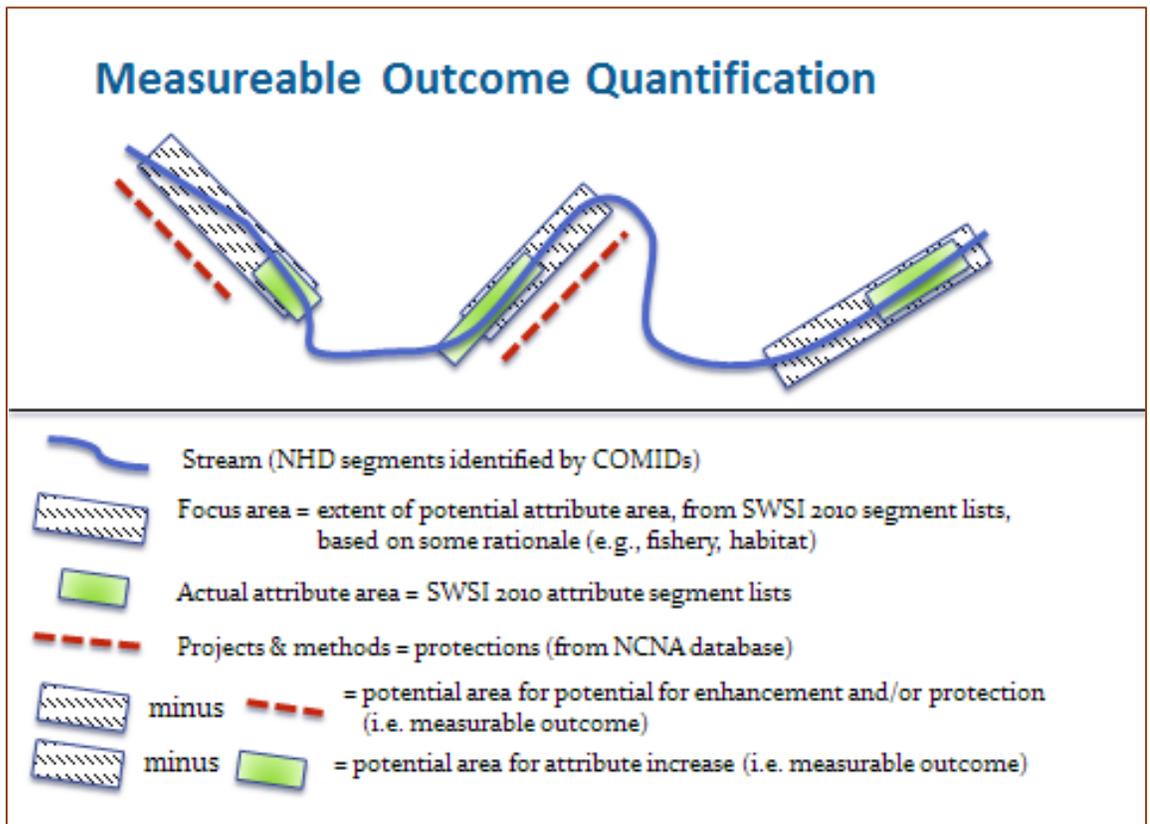


Figure 3-4 - Measurable Outcome Quantification



## 3.2 Stream Mile Representation Framework

In order to better assess the attributes, projects and protections in place or needed within the basin, a stream mile representation framework was developed during Phase II of the South Platte BIP. The Stream Mile Representation Framework allows for a fixed spatial analysis framework and a more streamlined assessment of attributes and projects at distinct spatial locations when the data needed for assessment is available.

For the general basin-wide methodology developed in Phase I of the South Platte BIP, significant time was spent attempting to utilize previous CWCB “Nonconsumptive Needs Analysis” data products, including GIS layers, NCNA Microsoft Access database, and spreadsheets. This effort identified significant limitations in the data and approach, which severely limit the effectiveness of analysis. The stream mile representation framework was developed to address the following limitations. The full list of limitations is included in the Stream Mile Representation Framework Overview Tech Memo attached as Appendix D-1. Some of these limitations include:

- Spatial data utilized the National Hydrograph Dataset (NHD) as the stream layer onto which other data were referenced. The NHD “COMID” identified was used as a database unique identifier for stream reaches and database relationships. The use of COMID results in stream segments with arbitrary lengths, COMID values may change based on the NHD version, and COMID is being phased out of the NHD datasets.
- Access to GIS or Microsoft Access is not as wide-spread as access to Excel and other user friendly interfaces.
- Extracted lists from the GIS and Access database were not tied to spatial information such as maps, making interpretation more difficult.
- The general Basin-Wide Methodology data analysis queries resulted in aggregated results such as “focus area X is 100 miles long and 30 miles have adequate productions for attribute Y”. These results are difficult to relate to local stream reach conditions and assessments.

A new Stream Mile Representation Framework approach was implemented in order to overcome the above issues and to allow analysis of goals and measurable outcomes in the future. The approach was vetted in concept through numerous conversations with stakeholders and subsequently was recommended to the South Platte/Metro Nonconsumptive Needs Committee on Oct 28, 2014. Based on positive feedback, the approach was implemented in the South Platte BIP Phase 2 in early 2015, focusing on several example areas that are discussed in this Appendix.

The Stream Mile Representation Framework represents the river in a spreadsheet format as relatively short segments that allow for a reasonable level of analysis. The segment length used in the framework was 0.1 mile long segments. The framework was completed for discrete stream reaches in the basin that coincide with streamflow gages for additional analysis, as is discussed in this appendix. In the final output of the framework for the example areas, each river or stream is represented as a column in Excel and each row corresponds to a 0.1-mile segment. Additional columns in Excel

represent data layers such as focus area, environmental and recreational attributes, project and methods, etc.

The Stream Mile Representation Framework allows anyone with simple spreadsheet tools to be able to access the data, without the need for database and GIS tools. Along with the stream of interest, additional data layers are represented in the framework, including focus areas, environmental attributes, projects, streamflow gages, and diversions. Additional detailed discussion regarding the development of the SMRF is included in the Stream Mile Representation Framework Overview Tech Memo attached as Appendix D-1. The benefits of the SMRF include:

- The river can be represented in a simple tabular format in Excel.
- Input data layers can be collected and managed using normal practices – using the data in the stream mile analysis involves steps explained in Appendix D-1 but do not impact stakeholder management of the original data.
- River segments are identified with stream (river) identifier, name, and stream mile, rather than abstract data like “COMID” or other internal GIS data.
- Overlapping data layers are clearly indicated as columns and values within columns.
- Analysis of each row/segment can occur with simple Excel formulas using agreed-upon metrics and science-based analysis
- Stakeholders that have familiarity with a stream reach can focus on everything that is occurring in that reach, rather than trying to extract analysis results for their reach from complex data queries.
- The framework supports inclusion of organizational jurisdictional extent and master plan extent, which will allow integration of local planning and project efforts with other data.
- Additional features can be placed on the river by assigning a stream mile either by processing with GIS or by adding to the Excel workbook.
- The stream mile can be recalculated if new input are made available (such as new version of SWRF layer from DWR).
- A variety of spatial data layers can be assembled to create the Excel file.
- The framework can be used to examine data anywhere within the South Platte Basin that has the appropriate data.

Limitations of the use of the stream mile representation include:

- The segment length of 0.1 miles is arbitrary and may introduce some error in analysis; however, many data layers are imprecise, and tenths of a mile precision have been used elsewhere with success (e.g., Colorado and San Juan Fish Recovery Programs, transportation mileage).
- Intermediate features that do not fall at .1-mile boundaries will not be precisely located for analysis, although precise locations can be indicated in the output (this has been done for stream gages and major diversions).
- Changes in the stream layer that is used as a basis for the stream miles, for example due to a stream channel moving from a flood, will cause the stream miles to be different in the future – this is viewed as part of normal data maintenance and the stream miles in the analysis are used to align data, not as

an absolute framework. This alignment will require similar GIS and database work in the future that was used to produce the SMRF for the example areas.

### 3.3 Stream Mile Representation Framework Overview

The SMRF workflow that was used to develop the South Platte Basin Implementation Plan (BIP) Phase II project is illustrated in Figure 3-5 below.

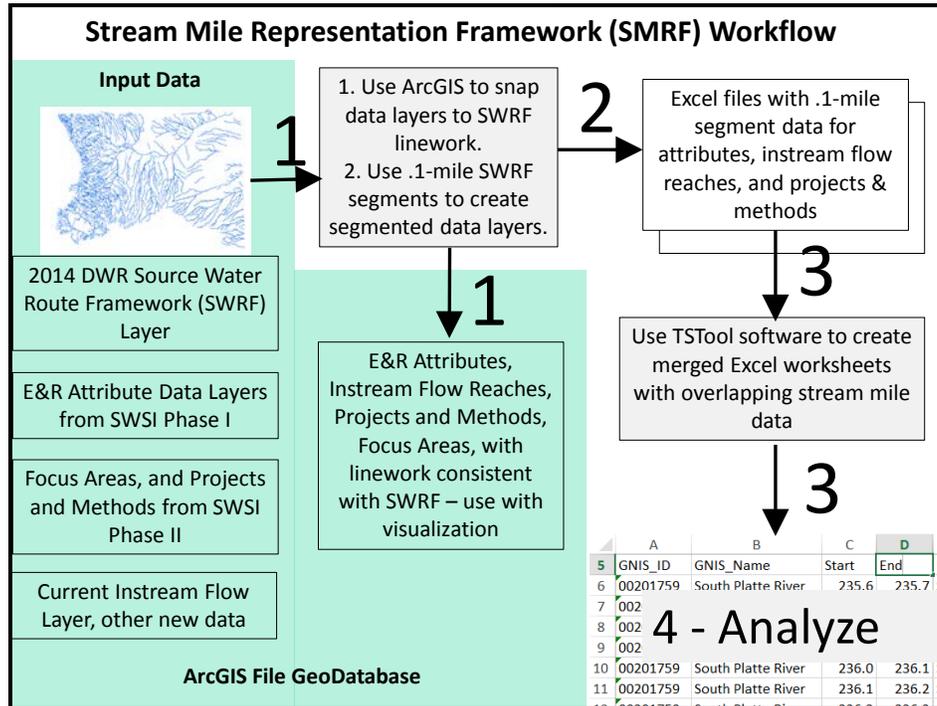


Figure 3-5 - Stream Mile Representation Framework Workflow Overview

ArcGIS software is used in steps 1 and 2 in Figure 3-5 to manage and process spatial data from multiple sources. Geographical Information System (GIS) processing is described in the BIP memorandum “Stream Mile Representation GIS Workflow Processing,” March, 2015, attached as Appendix D-2. Spatial data used in the analysis were inventoried in an Excel workbook, managed in an ArcGIS file geodatabase, and include the following:

- DWR SWRF layer
- all of the original data layers from the SWSI NCNA Phase I and II efforts, including focus areas, environmental and recreational attributes, and projects and methods
- recent instream flow reach layer from the CWCB
- historical and real-time stream gage locations from HydroBase
- major diversion structures located near the gage, from HydroBase

TSTool software developed for Colorado’s Decision Support Systems (CDSS) was used for step 3 in Figure 3-5 to assemble spatial data tables into the final Excel workbook. The TSTool process is described in the BIP memorandum “Stream Mile Representation

Framework TSTool Workflow Processing”, March 2015, attached as Appendix D-3. GIS data layers that were intersected are detailed in the data inventory table attached to Appendix D-3.

The result of the GIS and TSTool processes is an Excel workbook (step 4 in Figure 3-5) that includes environmental and recreational data, where rows represent 0.1-mile stream segments and columns are included for environmental and recreational attributes, instream flow reaches, projects and methods, locations of stream gages and diversion structures, and other data, as illustrated in Appendix D-1, showing the SMRF output for all example areas.

The BIP results provide a framework for visualizing and understanding environmental and recreational data and providing a platform for analysis. For example, daily streamflow time series can be analyzed to determine if available “wet water” is meeting the flow requirements for environmental and recreational attributes where flow data is available. The SMRF provides a framework to spatially represent environmental and recreational requirements at a local level to represent a variety of environmental and recreational data along stream reaches. This framework can be enhanced and applied to further understand environmental and recreational requirements and the challenges in meeting those requirements at a local scale. The framework can also provide a means for stakeholders to provide input, as described in the BIP memorandum “Stream Mile Representation Framework Stakeholder Data”, March 2015, attached as appendix D-4. Discussion of the use of the framework and related flow analyses for specific example locations is discussed in detail below in the Project Examples section.

## 4 Projects

There are various types of projects which protect or enhance environmental and recreational attributes. These projects include CWCB instream flows, channel restoration, stewardship, species re-introductions, and cooperative or multi-purpose projects.

Future projects and protections can be evaluated using the general approaches discussed above with the addition of other data. These other data include diversion structures, dry-up locations, flow and other project data. Diversion structures can be impediments to upstream migration by many of the fish species listed in the attribute table. The species have both downstream and upstream migration requirements in the life cycle. The young, larval fish drift downstream as they develop. The older life stages of fish move upstream during their life cycle. Any barriers to movement disrupt these migrations and can be a factor in decreasing population sizes. An example of a project that provides protection for these fish species is modification of diversions to accommodate fish passage. These modifications may range from change to the physical configuration of the structure to allow fish to swim upstream of the structure or the complete removal of structures that are no longer needed for diversion of the water. Two recent projects that illustrate these examples are the modification of the Green Ditch Diversion on Boulder Creek and the removal of the Josh Ames Diversion on the Cache la Poudre River. These individual projects may be very localized and change the physical

features on a very short section of river but allow the aquatic species access to many additional miles of rivers.

Another type of future project that can provide protections for the environmental attributes is the modification of dry-up points in the rivers. Like the diversion projects above, dry-up points can impact much larger river reaches. Projects that work to modify dry-up points provide continuous segments of habitat where discontinuous habitat now exists. Ideally, some additional streamflow monitoring stations could be implemented at river locations to determine flows in the river and facilitate administration of diversions and bypass flows.

Additional types of projects are listed below.

## 4.1 Instream Flows

Instream flow water rights and lake level water rights can only be held by the Colorado Water Conservation Board (CWCB). These water rights allow for the CWCB to hold a water right for a specific amount of instream flow within a specified reach or a specified lake level to assist in protecting the environment. An instream flow water right (ISF) is a relatively junior water right that can call for water to benefit instream flows within a specified reach. However, instream flow water rights can also be donated to the CWCB and converted for instream flow use. The donation of water rights can allow for more senior priorities to be used for instream flow purposes. The Colorado Water Trust is a non-profit organization that raises funds to buy water rights in identified reaches with needed flows that can be changed in water court and donated to the CWCB for instream flow purposes. The presence of an instream flow right in a reach does not guarantee streamflows, however, and does not necessarily translate into adequate protection in the reach. Additional detailed information is described by Pete Conovitz of Colorado Parks and Wildlife in the Instream Flow Protections in the South Platte Basin Technical Memorandum (January 2015), attached as Appendix D-5.

## 4.2 Channel Restoration

Channel restoration projects can benefit both in-stream aquatic habitat and species as well as riparian species such as wetlands and significant plant communities. In addition stream restoration can also benefit recreational uses such as fishing, flatwater boating, and kayaking. Channel restoration projects can also help to improve water quality in certain areas.

## 4.3 Stewardship Projects

Stewardship projects have protections that include areas near stream riparian areas and protect stream attributes for multiple uses. Examples of stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations (NGOs). These protections may cover multiple attributes in the areas where they are in place.

During the SWSI 2010 process, CWCB incorporated data from the Southwest Regional Gap Analysis Project (SRGAP)<sup>2</sup>, coordinated by U.S. Geological Survey (USGS) into the projects and methods database. The SRGAP created GIS data layers of land cover, native terrestrial vertebrate species, land stewardship, and management status values. The management status values quantify the relationship between land management and biodiversity throughout the state of Colorado. The four management status values are as described below (USGS 2010):

- Status 4 lands are where there are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.
- Status 3 lands comprise areas having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area.
- Status 2 lands are areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.
- Status 1 lands include areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

The stewardship projects currently included in the NCNA database have little information regarding which attributes the “stewardship” project is intended to protect. The only direct protections indicated by the stewardship projects are to riparian habitats, with all other attributes included as being indirectly protected. As the stewardship projects are land-focused and not stream focused, the level of protection afforded any specific attribute with respect to streamflows cannot be determined without significant additional work identifying and quantifying specific possible protections from specific stewardship projects.

## 4.4 Species Reintroduction

Species reintroduction projects allow for species to be reintroduced to habitat areas where their numbers may have declined. At times additional projects are needed to ensure protection along with species reintroduction projects. Examples of species reintroductions in the South Platte Basin include various projects that include reintroductions of the Boreal toad, cutthroat trout, and plains fish species.

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<sup>2</sup> United States Geological Survey. 2010. Southwest Regional Gap Analysis Project. <http://fwsnmcwru.nmsu.edu/swregap/Stewardship/Categorization.htm>

## 4.5 Cooperative and Multi-Purpose Projects

There are various other types of projects that can assist in protecting or enhancing environmental and recreational attributes. Many of these projects include multipurpose projects and partnerships which can assist in the cooperative operation and construction of projects. Project proponents of M&I projects and new Colorado River supply projects can work with environmental and recreational interests to potentially identify additional funding sources to construct projects that enhance attributes in the project area. Irrigation of agricultural lands and return flows from such irrigation often provide habitat or streamflows that can benefit environmental and recreational uses. Opportunities also exist for cooperative operation, optimization and enhancement of infrastructure to assist in enhancing environmental and recreational attributes. Some examples of cooperative or multi-purpose projects include:

- Recharge projects which provide wetland areas and wildlife habitat, specifically various Ducks Unlimited programs throughout the basin.
- Environmental or recreational pools or cooperative agreements with respect to storage reservoirs, providing streamflows that enhance or protect recreational or environmental instream flow needs.
- Diversion structure modification to continue operations benefiting the consumptive use, while maintaining flows or connectivity for environmental and recreational attributes near the diversion structure.

## 4.6 South Platte Basin Master Plans

There are various master plans throughout the South Platte Basin. These plans often include various projects that will assist in protecting or enhancing environmental and recreational flows. These plans include mechanisms for watersheds to work together in planning efforts. A brief review of the Master Plans was done in conjunction with the BIP, and the review is included in the Review of South Platte Basin Master Plans Memorandum (March 2015), attached as Appendix D-6.

## 4.7 Sufficiency of Projects

The sufficiency of the protections for many projects is unknown. The protection for a specific project and the attribute targeted is not included in either the GIS database or MS Access database. It appears from the previous work on SWSI 2010 and recent work completed by the CWCB contractors that the terms “projects” and “protections” were considered synonymous. If a project is present in a Focus Area then it is assumed that a protection was in place. An example of this is the attribute of CWCB instream flow, which can also be considered a protection. The sufficiency of the protection from the ISF is directly related to whether it can protect the streamflows during times of low flow. If there are water rights on the same stream reach that are senior to the ISF, these water rights may legally reduce flow below the specified minimum and therefore the ISF would not result in a physical protection of flows. Evaluation of these types of protections requires an analysis of streamflows at specific locations in the focus area. The analysis of the sufficiency of the protection was completed in specific reaches to the extent that data was available, using the stream mile representation framework and other data analyses.

Similar analyses could be completed in various other areas with significant additional resources, and additional data.

## 5 Project Examples

The proposed general basin-wide methodology and stream mile representation framework were applied in a limited manner to highlight example projects in each geographic area to illustrate how the attributes (or categories) and projects can meet the over-arching environmental and recreational goals. In the general basin-wide methodology there were discrepancies between the GIS data and the MS database with regards to projects (i.e. protection) as they relate to attributes within each Focus Area. The total stream miles generated using both data sources for a common attribute in a single Focus Area does not match. For example, a summary of the “Ducks Unlimited Projects” attribute generated from the GIS data base (SWSI 2010) results in identification of 161.5 miles in Focus Area 1 (lower South Platte River) with the attribute present. The query on the MS Access database for the “Ducks Unlimited Projects” resulted in no miles in Focus Area 1 (lower South Platte River) with the attribute present. Ducks Unlimited Projects appear to be attributes, not projects in the database. This is one example of the discrepancies between the older and newer databases that should be reconciled to ensure that the data contained in the newest database is correct.

For both the general basin-wide methodology and stream mile representation framework, there also exists a data gap for background data to determine the project status, project proponent, and the specific environmental or recreational benefit intended from the project. The level of detail available for the analysis is typically limited to a single line in a spreadsheet or data base with no citation to background data or original contact, interviewer, or proponent. These data should be provided to the BRT by CWCB or its contractor. The acquisition of these types of data is not in the scope of the current BIP.

The following sections include examples demonstrating a range of projects that have the potential to maintain or enhance environmental and recreational attributes in the candidate focus areas. Included is a general discussion of example projects based on the basin-wide methodology from Phase I. The section also contains additional descriptions of the Stream Mile Representation Framework and associated analyses. Some of the data needed for a complete analysis and evaluation are missing; however, professional judgment was used to review some of the examples to illustrate the process for environmental and recreational benefits. Additional examples could be analyzed in the future with specific direction from the environmental and recreational subcommittee and BRTs and additional data a funding resources.

### 5.1 Northern Colorado Region

There are various types of focus areas in the Northern Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Nineteen of the 34 focus areas in the South Platte located in the Northern Region. The descriptions of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern including plains fish, native minnow species,

common shiner, stonecat, and brassy minnow, cutthroat trout and lake chub; rare or imperiled riparian plant communities; and Wild and Scenic River designation.

- Recreational attributes including: Fishing, whitewater and flatwater boating, municipal recreational corridors, RICDs, State Wildlife Areas, Wild and Scenic River designation, and additional greenway benefits.

There are various projects throughout the Northern Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, fish passage projects, species reintroduction, instream flows, streamflow agreements, and various types of studies.

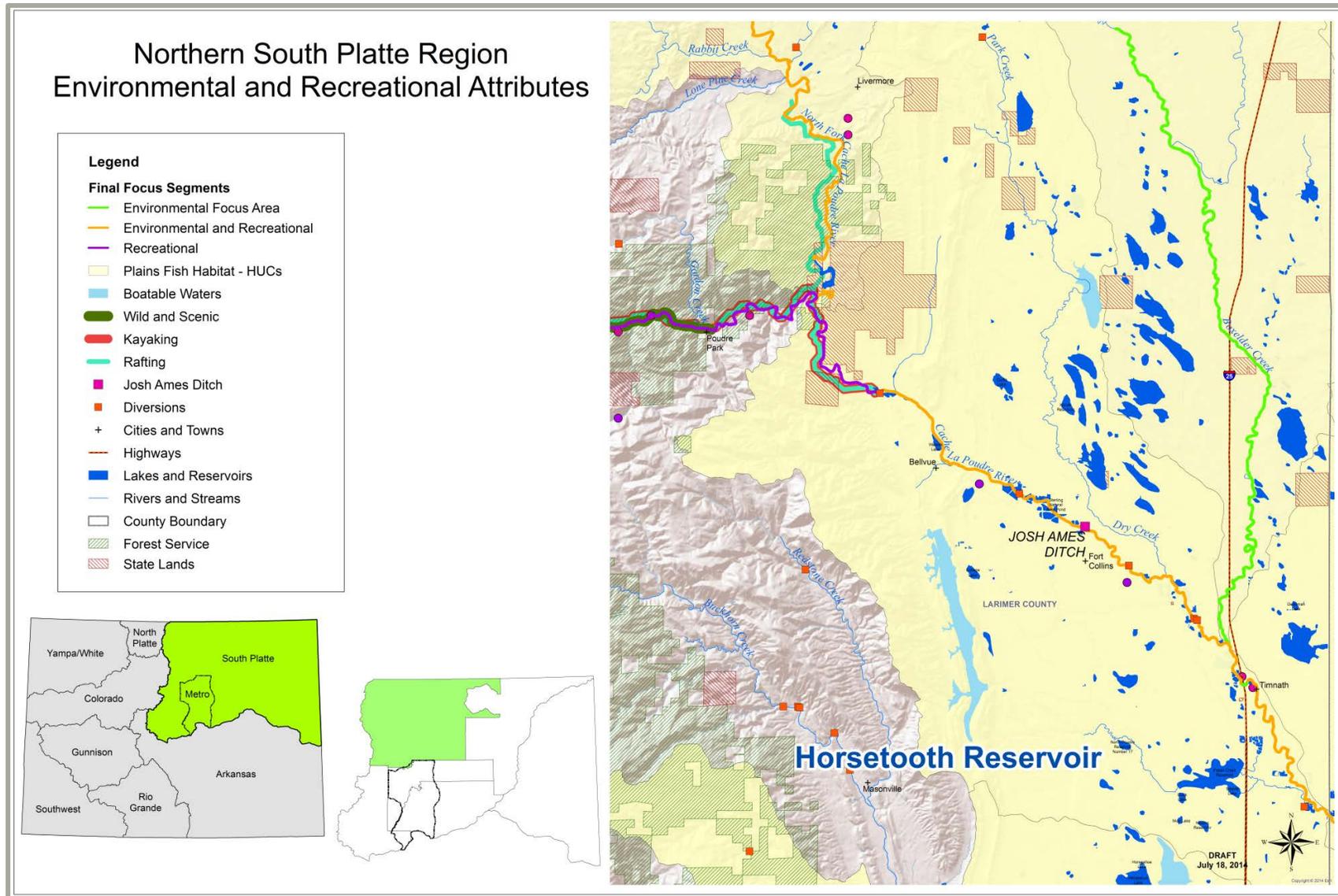
To demonstrate the types of projects within the Northern Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future project types within that area that may address the gap.

### 5.1.1 Example Projects – Northern Region

An example project in the Northern Region that includes protection to both environmental and recreational attributes is the diversion structure modification project in the Cache La Poudre River from near the mouth of Poudre Canyon to the eastern edge of Fort Collins. Several individual projects are planned or ongoing to modify existing diversion structures in this section of river for fish passage. Some projects are removing structures that are no longer needed for diversion. Each structure modified provides additional miles of continuous aquatic habitat or recreational opportunities. The modification of the structures provides the opportunity for native non-game species to have continuous habitat connectivity. While these individual projects may open several miles of the river, other structures are still present and could be modified in the future. Many of these species are on the state threatened and endangered list. The continuous habitat provides additional protection for these attributes. In addition, the removal of structures and some modifications provide additional flat water boating opportunities in the urban corridor of the river. These projects directly address both environmental and recreational goals.

Some examples of these projects throughout the basin include the Green Ditch on Boulder Creek and the Josh Ames Ditch on the Cache la Poudre River.

Figure 5-1 shows the environmental and recreational focus areas and locations of the rare fish habitat, and recreational boating areas in part of the Northern region of the South Platte Basin. The data to evaluate the function of each structure in terms of fish or recreational passage is not in the current database and is beyond the scope of this BIP. Additional analyses using the Stream Mile Representation Framework could be completed in the future to evaluate these projects.



## 5.1.2 Example Area Analysis – St. Vrain Creek at Lyons

To demonstrate the stream mile representation framework described earlier in Appendix, the example area analyzed for the Northern Region is located on St. Vrain Creek near Lyons, Colorado.

### Stream Mile Representation Analysis

The gage analyzed within this reach is the St. Vrain Creek at Lyons gage (SVCLYOCO, 06724000). The section of river analyzed includes an approximately 7 mile stretch on St. Vrain Creek from the confluence of South St. Vrain Creek and North St. Vrain Creek. It also includes approximately 6 miles on both the South and North St. Vrain Creeks. The example area is shown in the map in **Figure 5-2**.

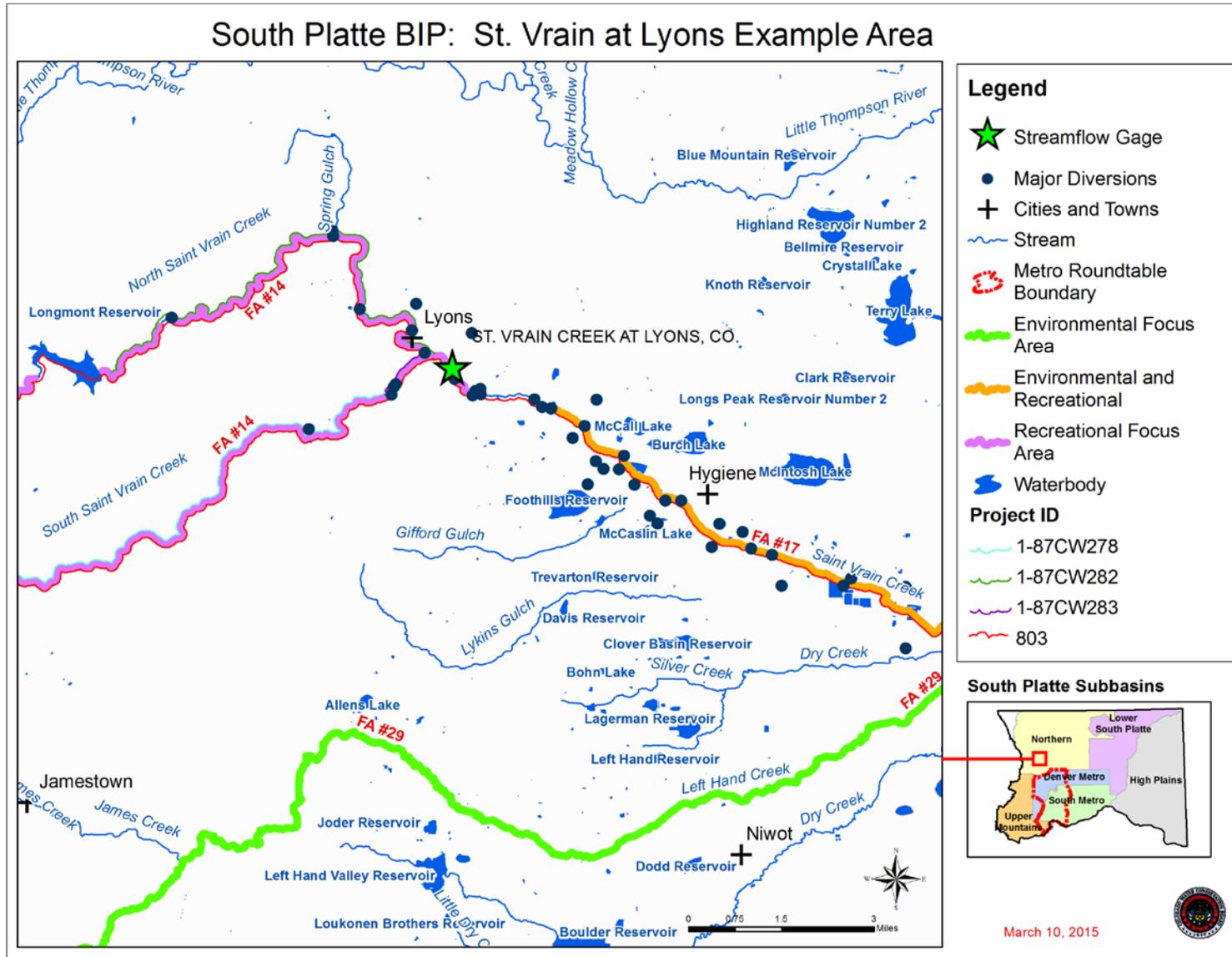


Figure 5-2 - St. Vrain at Lyons Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on [SouthPlatteBasin.com](http://SouthPlatteBasin.com). A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
  - Plains Fish State Endangered, Threatened, Species of Special Concern
  - State Endangered, Threatened, Species of Special Concern
  - Important Riparian Habitat
- Recreational:
  - Fishing
  - Recreation (boating)

The example area includes portions of Focus Area 14, a recreational focus area which includes North Saint Vrain Creek, from Horse Creek to Highway 36 and South Saint Vrain Creek from Middle Saint Vrain Creek to the confluence with the North Saint Vrain. The streamflow gage data analyzed in this example is within Focus Area 14. The example area also includes portions of Focus Area 17, an environmental and recreational focus area which includes Saint Vrain Creek from the James Ditch to the confluence of the Saint Vrain with the South Platte River. The example area also includes a short segment that is not in a focus area between Focus Areas 14 and 17 on Saint Vrain Creek.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

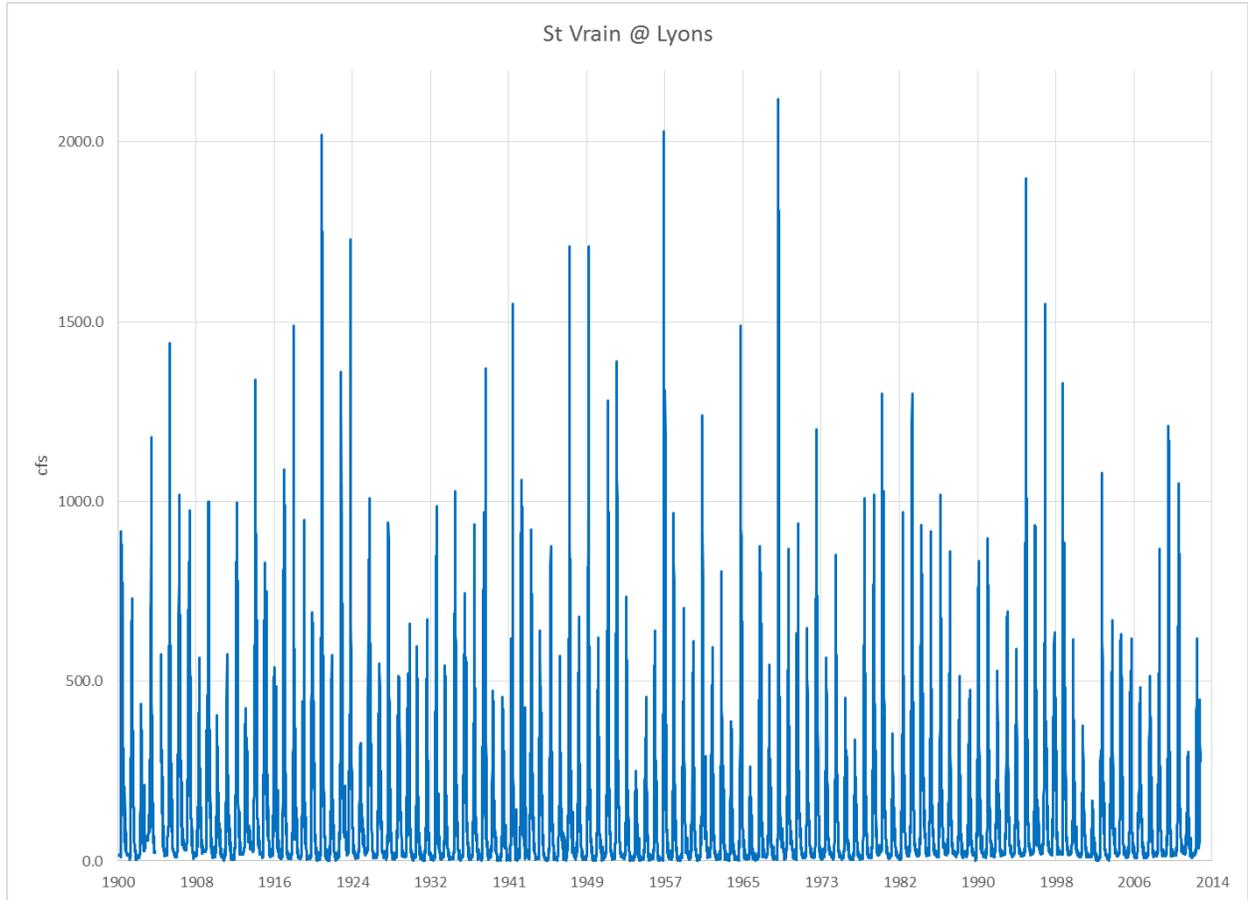
- Streamflow Enhancement Project (803) – The St. Vrain Creek Corridor Committee releases 1000 acre-feet per year to benefit minnows.
- Decreed Minimum Instream Flows – Including Division One Case Nos. 78W9362, 78W9363, 87CW278, 87CW281, 87CW282, and 87CW283.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include diversions for the Cities of Longmont and Lyons, as well as many other diversions for agriculture and municipal and industrial uses.

### Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the Lyons gage analyzed extended from 1900 until 2013. The general hydrograph over the period of record is shown in **Figure 5-3**.



**Figure 5-3 – Time Series Hydrograph of St. Vrain Creek at Lyons (Gage: SVCLYOCO, 06724000)**

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. No studies have been completed regarding specific flow requirements within the example area since the significant channel changes resulting from the September 2013 floods,. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. If such studies become available, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

The environmental minimum flows shown in the table below are based upon the minimum instream flows decreed in the reaches of the South and North Forks of the St. Vrain immediately above the gage. The minimum instream flows for the North and South Forks were combined to analyze the flow at the gage. The decreed instream flows should be compared to environmental flow recommendations if they become available. The minimum instream flows for the North Fork of the St. Vrain were decreed in Division 1 Case No. 87CW282. The minimum instream flows decreed in the South Fork segment

closest to the confluence with the North Fork were decreed in Division 1 Case No. 87CW283.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow based solely on the gage data was 124cfs, therefore a recommended flushing flow of 248 cfs was included in the analysis.<sup>3</sup> The flow rate and duration of flushing flows should be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is information anecdotally available on American Whitewater’s website regarding flows within specific reaches. There are anecdotal recommendations for both the North and South Forks of St. Vrain Creek above the confluence of these two forks. The recommendations were summed to estimate the range of anecdotally acceptable whitewater boating flows at the gage.

Table 4 shows the recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

Table 4 - St. Vrain Creek at Lyons - General Flow Recommendations (in cfs)

Month	Minimum Instream Flow			Flushing Flows	Anecdotal Recreational Minimum Flow			Anecdotal Recreational Maximum Flow		
	S Fork	N Fork	Combined at gage		S Fork	N Fork	Combined at gage	S Fork	N Fork	Combined at gage
January	4	3	7							
February	4	3	7							
March	4	3	7							
April	20	8	28							
May	20	21	41	~248	150	80	230	300	315	615
June	20	21	41	~248	150	80	230	300	315	615
July	20	21	41		150	80	230	300	315	615
August	20	14	34							
September	20	8	28							
October 1-14		8	20							
15-24	12	6	18							
25-31		4	16							
November	12	3	15							
December	4	3	7							

These general recommendations were compared to specific annual hydrographs, as well as the time series data. The decreed minimum instream flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the

<sup>3</sup> Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcce (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

following graphs. The recreational flows are indicated in the green and blue lines, for the minimum recreational recommended flow and maximum recreational flow, respectively. The annual hydrographs for 2002 through 2004 are shown in **Figure 5-4** through **Figure 5-5**.

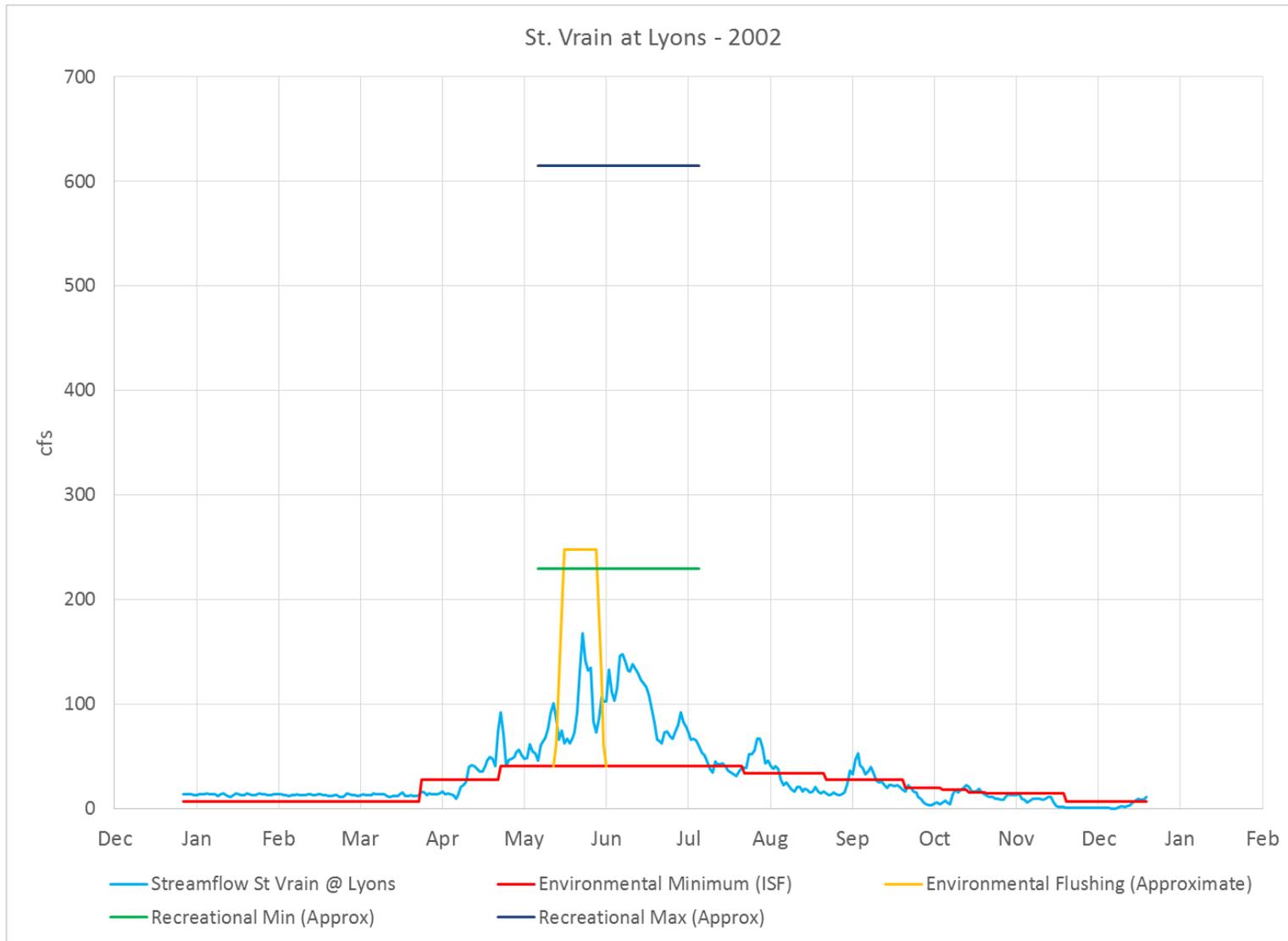
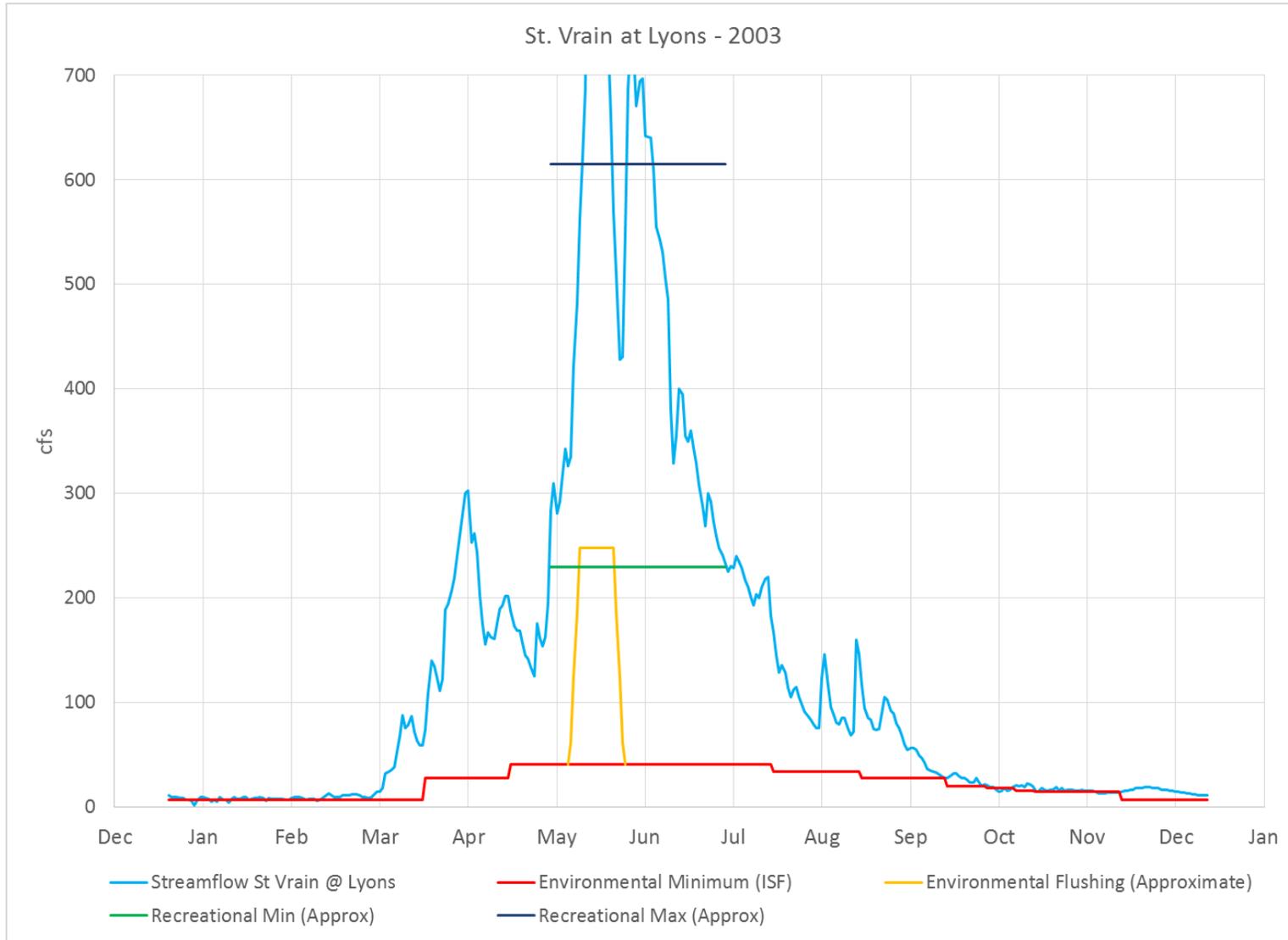


Figure 5-4 - Hydrograph comparison to available environmental and recreational flow information - 2002



**Figure 5-5 - Hydrograph comparison to available environmental and recreational flow information - 2003**

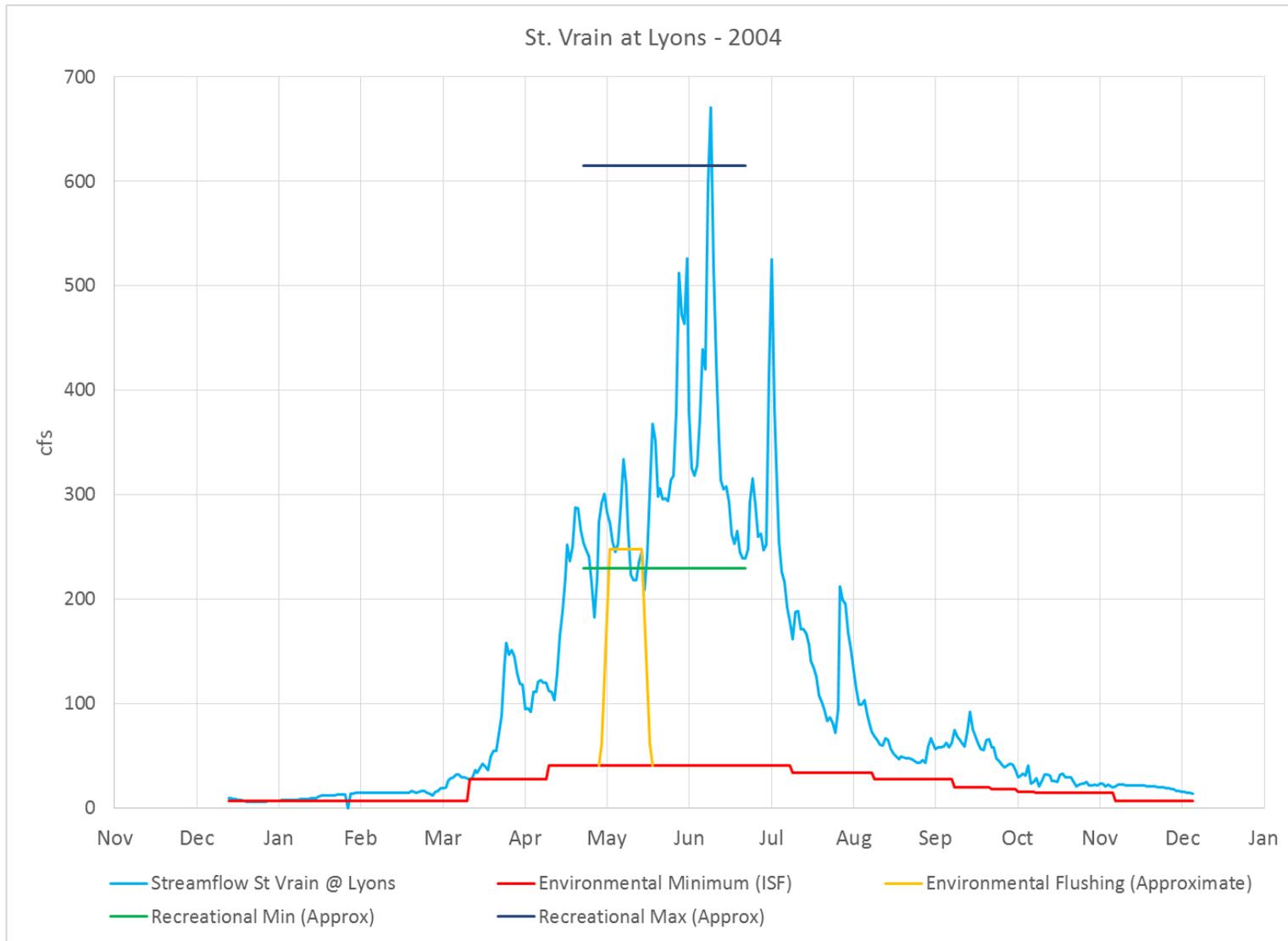
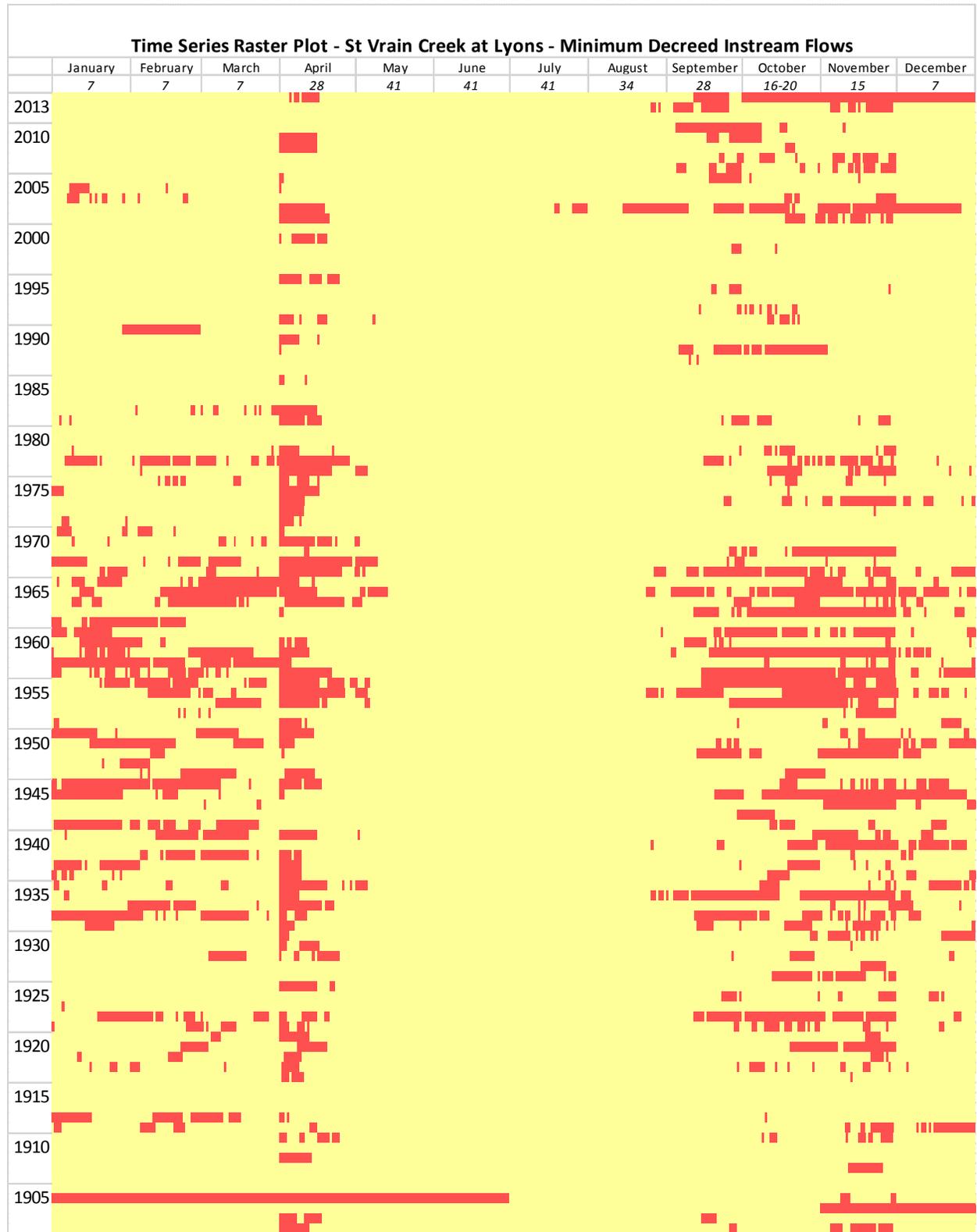


Figure 5-6 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the St. Vrain in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot can show flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the minimum instream flows from the CWCB decrees are met or not met by the available streamflows, a time-series raster plot was developed, as shown in **Figure 5-7**. The days when the minimum decreed instream flow rates were not met are indicated in red on the raster plot. The flows above the minimum instream flow rates are indicated in yellow on days on which streamflows were greater than the minimum instream flow rate. The minimum instream flows were decreed in 1988. Accordingly, the time series generally shows fewer days that the minimum flows were not met as compared to earlier in the period. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the instream flow requirements. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-7 - Time Series Raster Plot - St Vrain Creek at Lyons - Minimum Decreed Instream Flows**

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in **Figure 5-8**. The yellow on the plot shows times when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in most years there appears to be flushing flows available in this area, based on the Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.

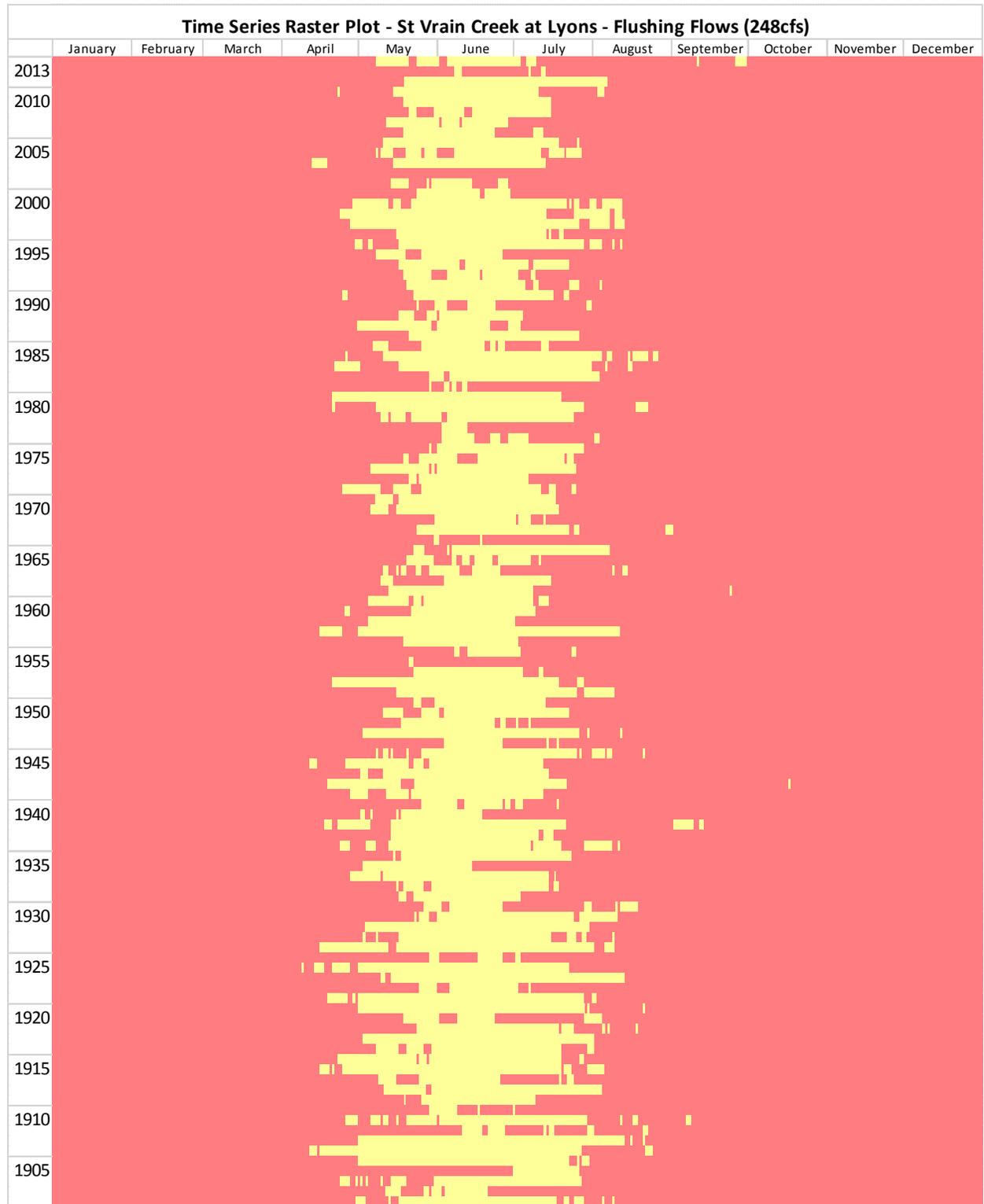
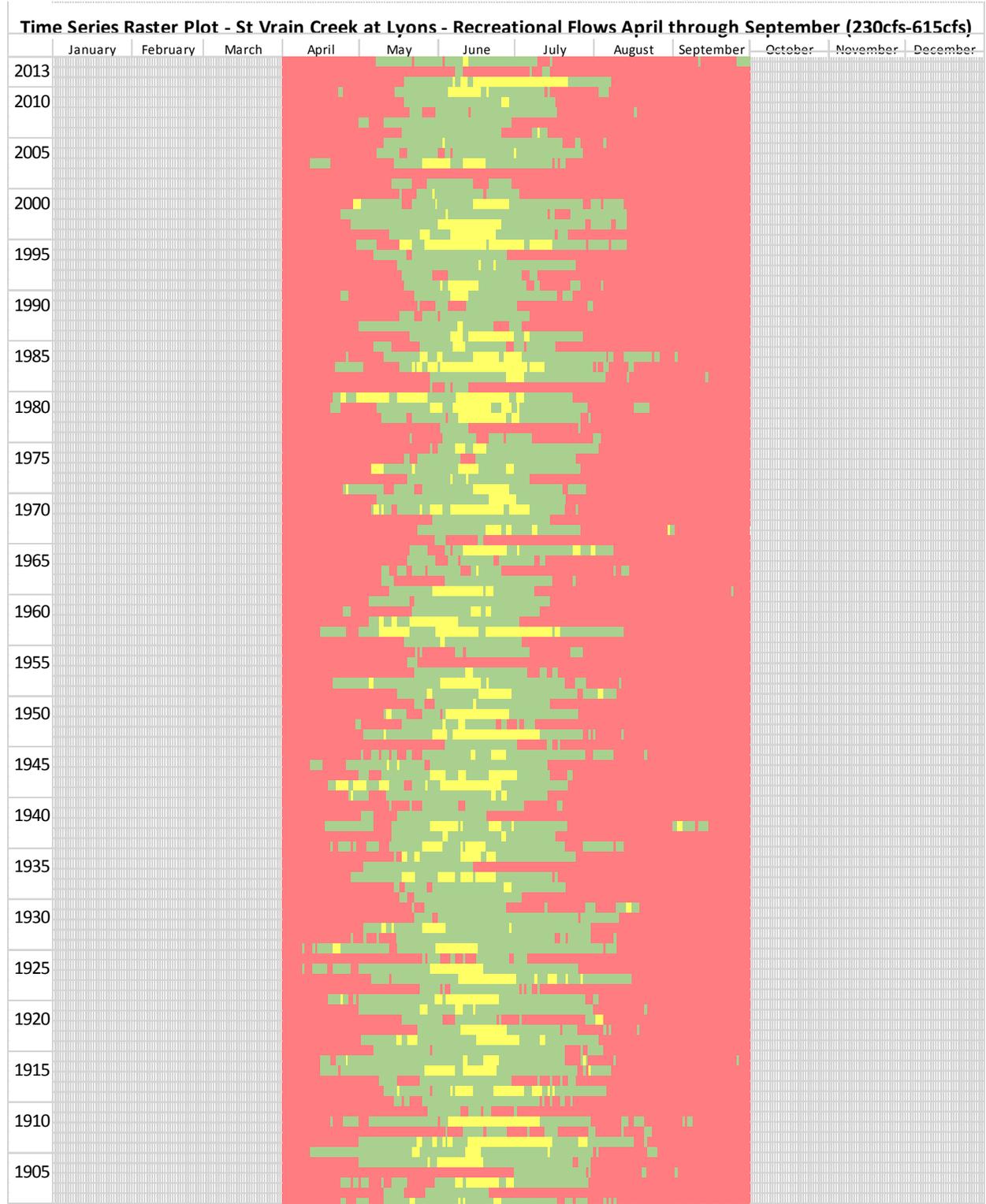


Figure 5-8 - Time Series Raster Plot - St Vrain Creek at Lyons - Flushing Flows (248cfs)

To demonstrate the times when the anecdotal recreational flows are met or exceeded, a time-series raster plot was developed, as shown in **Figure 5-9**. The green on the plot shows times when the flow is between the generally recommended recreational flows of 230 cfs to 615 cfs from April through October. The red in the plot shows times when the flow is less than the generally recommended minimum recreational flows. The yellow in the plot shows times when the flow is greater than the generally recommended maximum recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.



**Figure 5-9 - Time Series Raster Plot - St Vrain Creek at Lyons - Recreational Flows April through September (230cfs-615cfs)**

## General Discussion and Recommendations

In general, the analysis of streamflows on the St. Vrain at Lyons indicates the streamflows may be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the St. Vrain. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. With the significant changes in the channel after the September 2013 floods, assessments should be made regarding the requirements of aquatic and riparian ecosystems in the area. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are also helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix G) shows that there is potentially availability for surface water development at times in the St. Vrain at Lyons. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears that times of lengthy flushing flows, greater than preferred recreational flows and adequate minimum instream flows may coincide with times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Stream channel modifications – Particularly following the September 2013 floods on the St. Vrain, channel restoration could significantly benefit the aquatic and riparian habitat in the example area. The St. Vrain Master Plan indicated various types and locations of specific stream channel modifications that may benefit environmental and recreational needs as well as assist in future flood mitigation.
- Fish Passage – There are various examples of fish passageways near the example area. Additional diversion structures could be modified in the future to assist with stream channel connectivity in the area.
- Operational Flow Agreements - There are some examples of operational flow agreements in the example area. The St. Vrain Creek Corridor Committee releases 1000 acre-feet per year to benefit minnows. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data

and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum instream flows shown in this analysis are specifically from settled upon decreed CWCB instream flows. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach. In addition, the minimum instream flows are located on two tributaries upstream of the subject gage. Aggregating the instream flows to compare against the gage data may not reliably show if the instream flows were met previously, as there are diversion structures upstream of the gage, but downstream of the minimum instream flow reaches. These diversions could be taken into account in future work to fully assess the flows at the gage location.

## 5.2 Upper Mountain Region (Headwaters Areas)

There are various types of focus areas in the Upper Mountain Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Fourteen of the 34 focus areas in the South Platte located in the Upper Mountain Region. The types of focus areas in the region include:

- Environmental attributes including: Significant, imperiled and rare wetland and riparian plant species and plant communities, habitat for federal and state endangered, threatened and species of concern including native minnow species, trout, cutthroat trout and lake chub;
- Recreational attributes including: Fishing including Gold Medal Fisheries, whitewater boating, State Wildlife Areas, Eleven Mile Canyon National Forest Recreation Area, and waterfowl hunting and viewing.

The rationale for inclusion of many of these Focus Areas is the presence of significant, imperiled and rare/wetland plant species and plant communities. These plant communities are the result of the natural stream systems in the area, topography, and geology.

There are various projects throughout the Upper Mountain Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, stewardship projects, instream flows, streamflow agreements, and various types of studies.

To demonstrate the types of projects within the Upper Mountain Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

### 5.2.1 Example Projects – Upper Mountain Region

Examples of projects in the Upper Mountain Region addressing rare plant communities include CPW, CWCB, NCNA interviewed, stewardship, and ISF in Park County are present in most of the Park County Focus Areas. There are a total of 325 miles of the South Platte Basin with the rare plant communities attribute present and a total of 156 miles in the Park County Focus Areas. However, the sufficiency of these projects for protecting the attributes has not been assessed.

These projects may provide protection for the rare plants and significant plant communities attributes in the following ways. Future projects that can provide protections to these plant communities include maintaining the hydrologic conditions that formed and support these plant communities. These protections include continued irrigation on parcels where the plant communities may be irrigation-dependent due to lowering groundwater tables in the area and maintaining the natural surface water-groundwater interactions where those natural characteristics protect the plant communities. These types of projects can also provide benefit to recreational uses in the area, including fishing and boating.

Some examples of current projects that currently provide some protections to these plant communities include stewardship programs in the area, instream flow water rights, stream restoration projects (including Lower Tarryall Creek, Middle Fork at Buffalo Peaks State Wildlife Area, and Five-Mile Creek), and the South Platte Protection Plan. There are other similar planned projects in the area.

These types of projects address the goals of maintaining and enhancing important wetland and riparian plant communities. Figure 5-10 shows the environmental and recreational focus areas and locations of the rare aquatic-dependent plants in Park County.

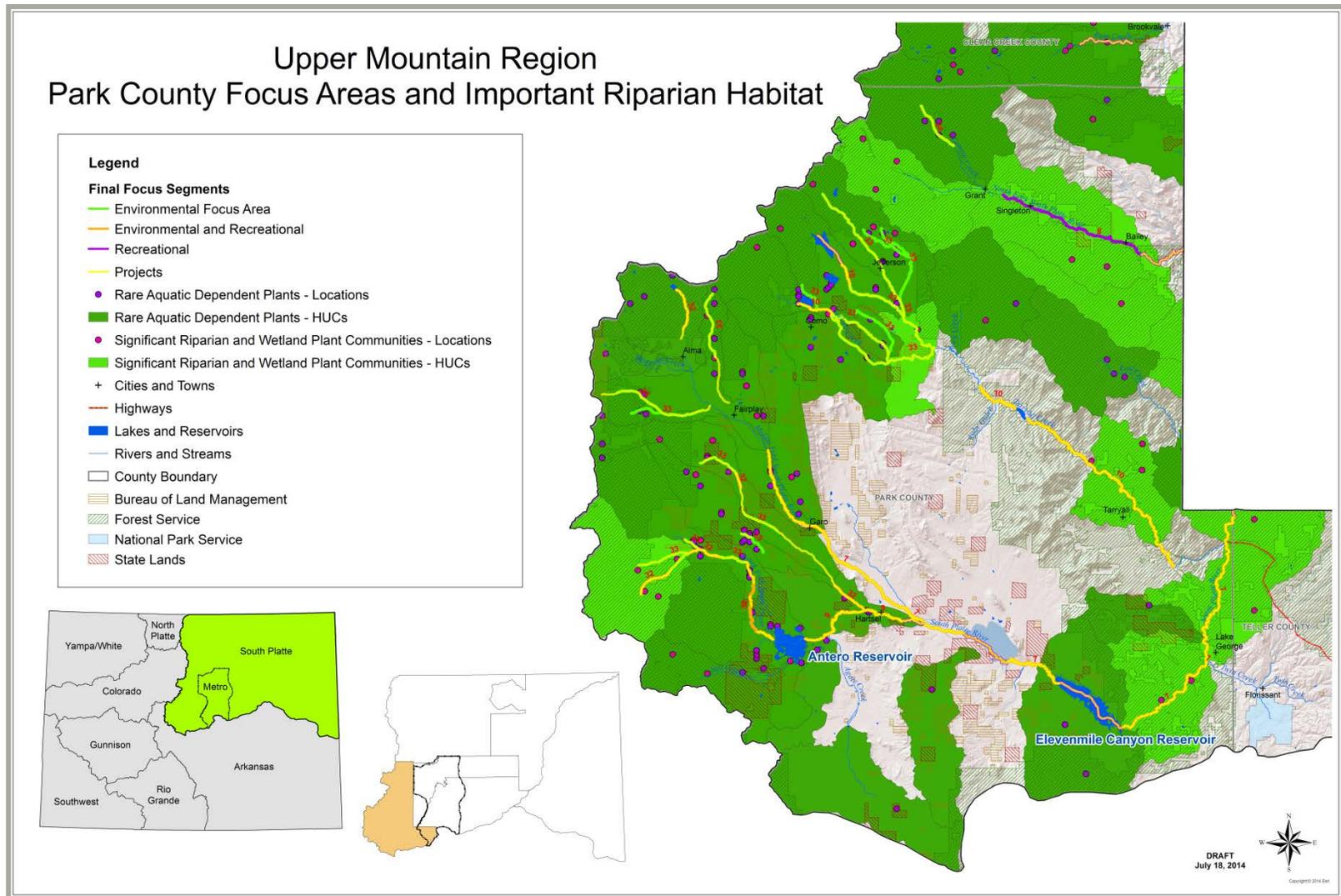


Figure 5-10. Park County Important Riparian Habitat

## 5.2.2 Example Area Analysis – South Platte River above Elevenmile Reservoir

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Upper Mountain Region is located on the South Platte River, above Elevenmile Reservoir.

### Stream Mile Representation Analysis

The gage analyzed within this reach is the South Platte above Elevenmile gage (PLAHARCO, 06695000). The section of river analyzed includes an approximately 12 mile stretch on the South Platte River including Spinney Reservoir and Elevenmile Reservoir. The example area is shown in the map in Figure 5-11.

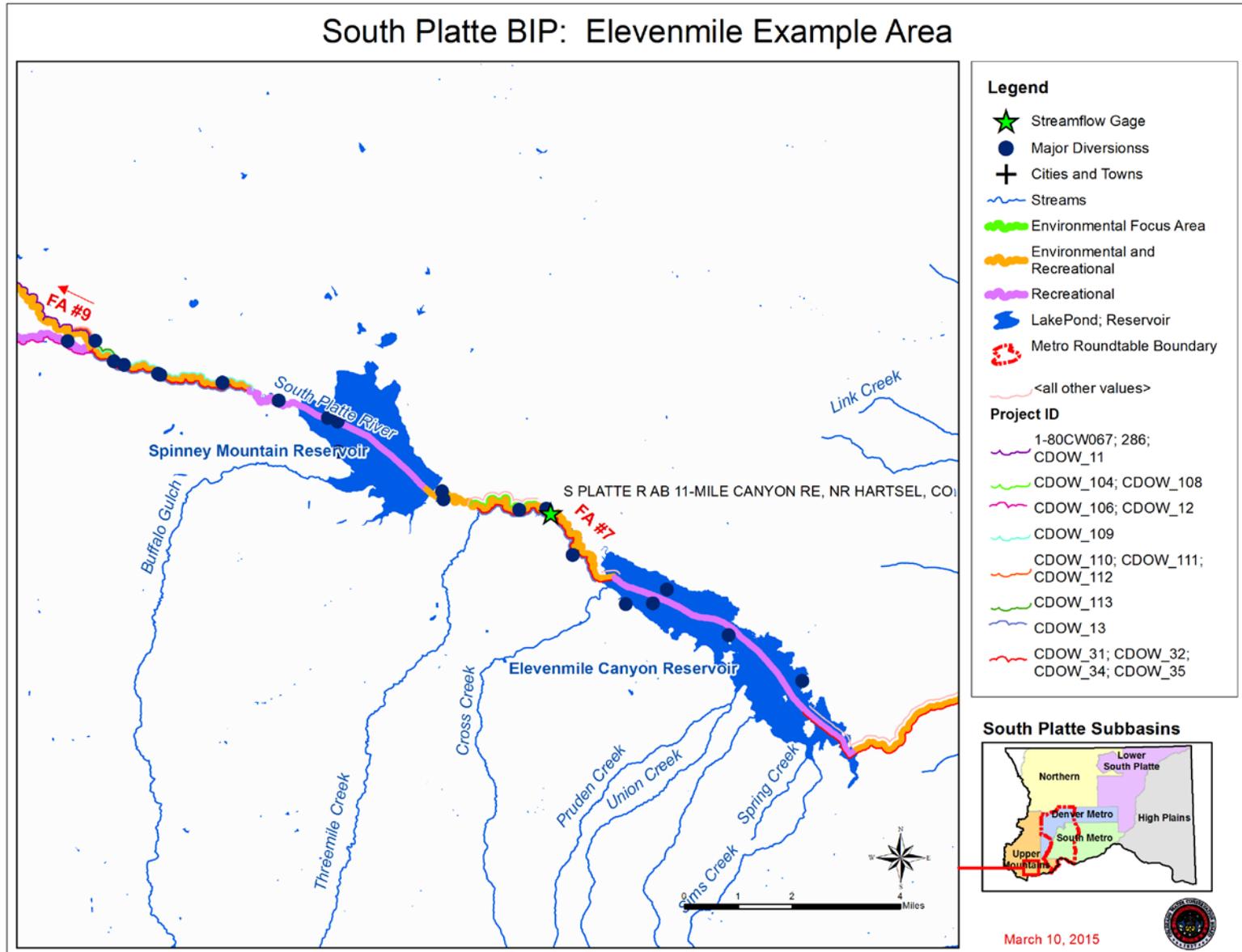


Figure 5-11 - Elevenmile Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on [SouthPlatteBasin.com](http://SouthPlatteBasin.com). A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
  - Plains Fish State Endangered, Threatened, Species of Special Concern
  - State Endangered, Threatened, Species of Special Concern
  - Important Riparian Habitat, including Significant Plant Species
- Recreational:
  - Fishing (including Gold Medal Streams and Lakes)
  - Recreation (boating)

The example area includes portions of Focus Area 7, an environmental and recreational focus area which includes portions of the South Platte River from the Middle and South Fork Confluence to Chatfield Reservoir. Focus Area 7 also includes portions of the Middle Fork from the Crooked Creek confluence to the confluence with the South Fork of the South Platte River. The streamflow gage data analyzed in this example is within Focus Area 7. Focus Area 9, an environmental and recreational focus area located upstream of the example area on the South Fork of the South Platte River below Antero Reservoir.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

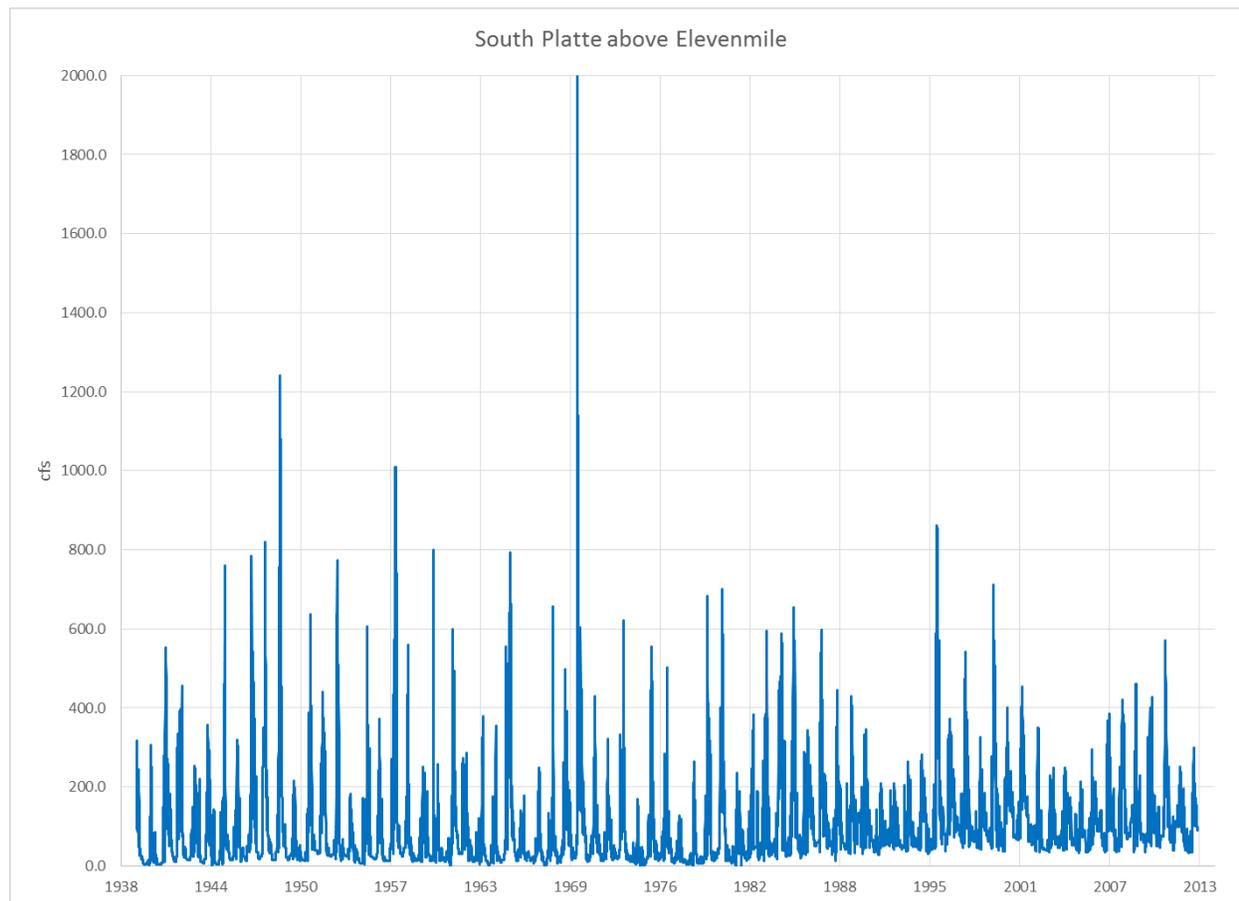
- The South Platte Protection Plan – Includes flow recommendations for environmental and recreational needs, operational agreements, and some restoration and channel work.
- Various Restoration Projects – including the Hayman Fire Restoration, Trumbull Trout Habitat Restoration, Happy Meadow's/Sportsman's Paradise River Restoration, Buffalo Peaks Ranch Fish Habitat, Santa Maria Ranch Riparian Restoration, Five Mile Creek Channel Reconstruction, South Fork Project, Middle Fork South Platte Restoration, Dream Stream Projects, Upper South Platte Stream Restoration.
- Fish Habitat Projects - including identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Decreed Minimum Instream Flow – Division One Case No. 80CW067, on the Middle Fork of the South Platte River.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include various diversions for agriculture and municipal and industrial uses. There are also two on-channel reservoirs in the area, Spinney Reservoir and Elevenmile Reservoir.

## Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte at Elevenmile gage analyzed extended from 1939 until 2013. The general hydrograph over the period of record is shown in Figure 5-12.



**Figure 5-12 - Time Series Hydrograph of South Platte above Elevenmile (PLAHARCO, 06695000)**

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

The environmental minimum flows shown in the table below are based upon the information presented in the South Platte Protection Plan.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. Currently the flows shown in the analysis are based upon the recommended flows of 50-100 cfs, with a minimum of 32 cfs based upon the South Platte Protection Plan. If additional studies become, the additional streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were also no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow during the non-winter months was determined to be 95 cfs, therefore a recommended flushing flow of 190 cfs was included in the analysis.<sup>4</sup> The flow rate and duration of flushing flows should be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is information anecdotally available from the South Platte Protection Plan and from information on American Whitewater's website regarding flows near the gage.

Table 5 - South Platte River above Elevenmile - General Flow Recommendations (in cfs) Table 5 below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

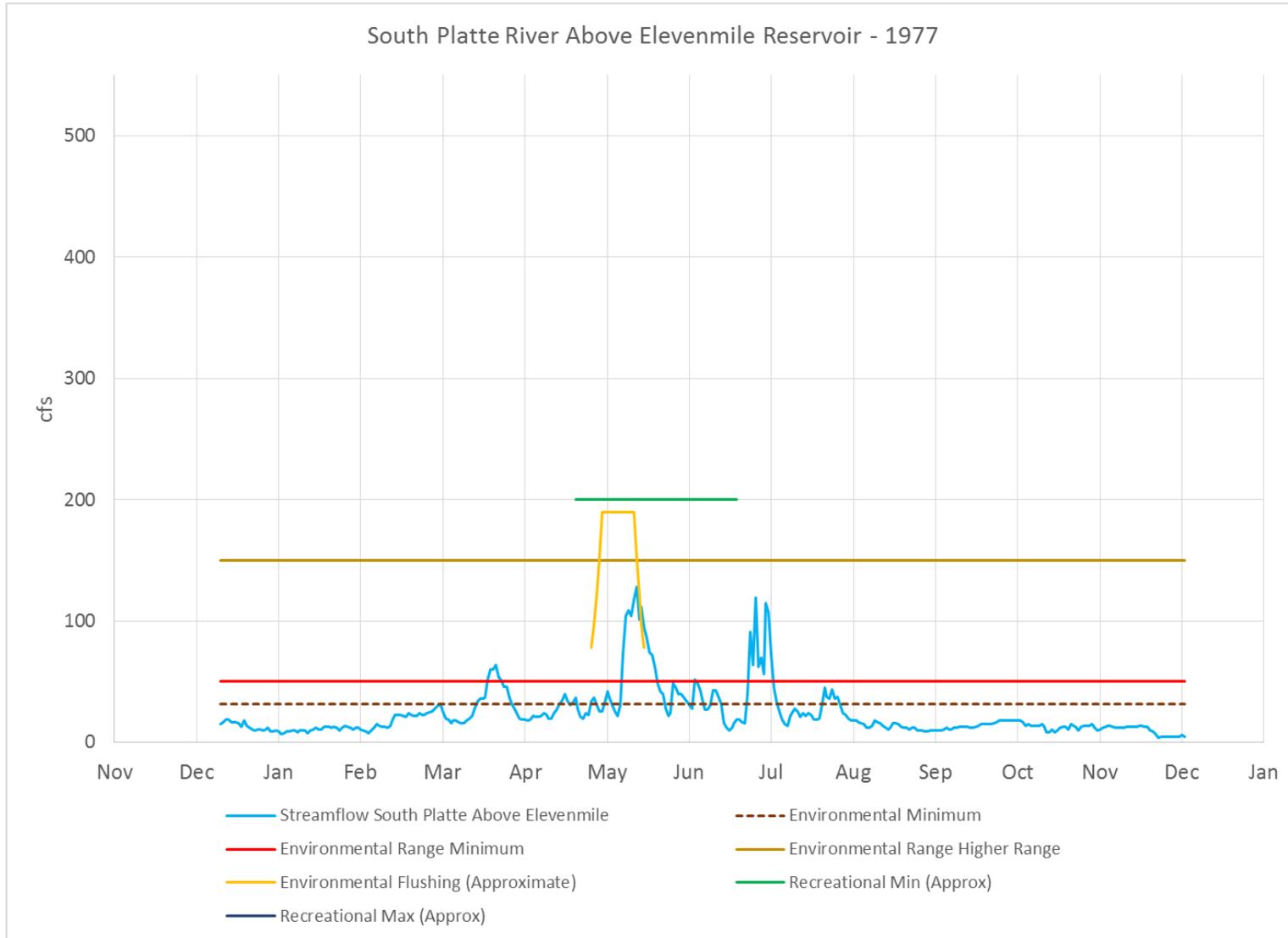
**Table 5 - South Platte River above Elevenmile - General Flow Recommendations (in cfs)**

Month	Recommended Environmental Flow			Flushing Flows	Anecdotal Recreational Minimum Flow	Anecdotal Recreational Maximum Flow
	Env Minimum	Env Range Minimum	Env Range Higher			
January	32	50	150			
February	32	50	150			
March	32	50	150			
April	32	50	150			
May	32	50	150	~190	200	1000
June	32	50	150	~190	200	1000
July	32	50	150		200	1000
August	32	50	150			
September	32	50	150			
October	32	50	150			
November	32	50	150			
December	32	50	150			

These general recommendations were compared to specific annual hydrographs, as well as the time series data. The environmental minimum operational flow from the South Platte Protection Plan are indicated by the dashed orange line in the following graphs. The recommended range of flows are indicated by the red line (lower end of range) and the brown line (higher end of range) in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The minimum recreational recommended flow is indicated by the green line, and the maximum is not shown on the scale of the graphs. The annual hydrographs for 1977, 1978, and 2002 through 2004 are shown in Figure 5-13 through Figure 5-17. Spinney Reservoir was built in 1981, therefore

<sup>4</sup> Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcz (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

the hydrographs from 1977 and 1978 demonstrate the flows prior to the upstream reservoir being completed.



**Figure 5-13 - Hydrograph comparison to available environmental and recreational flow information – 1977**

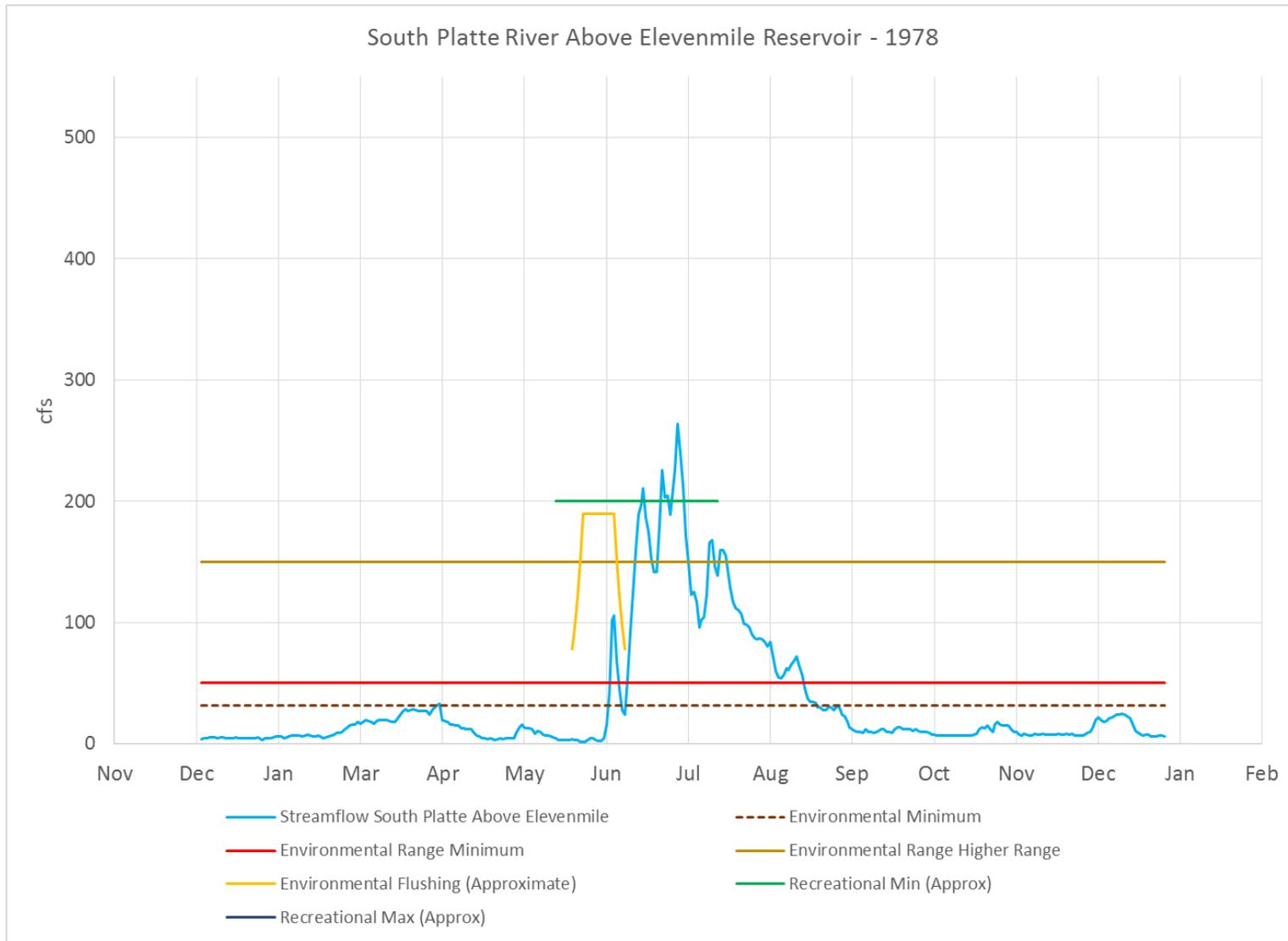
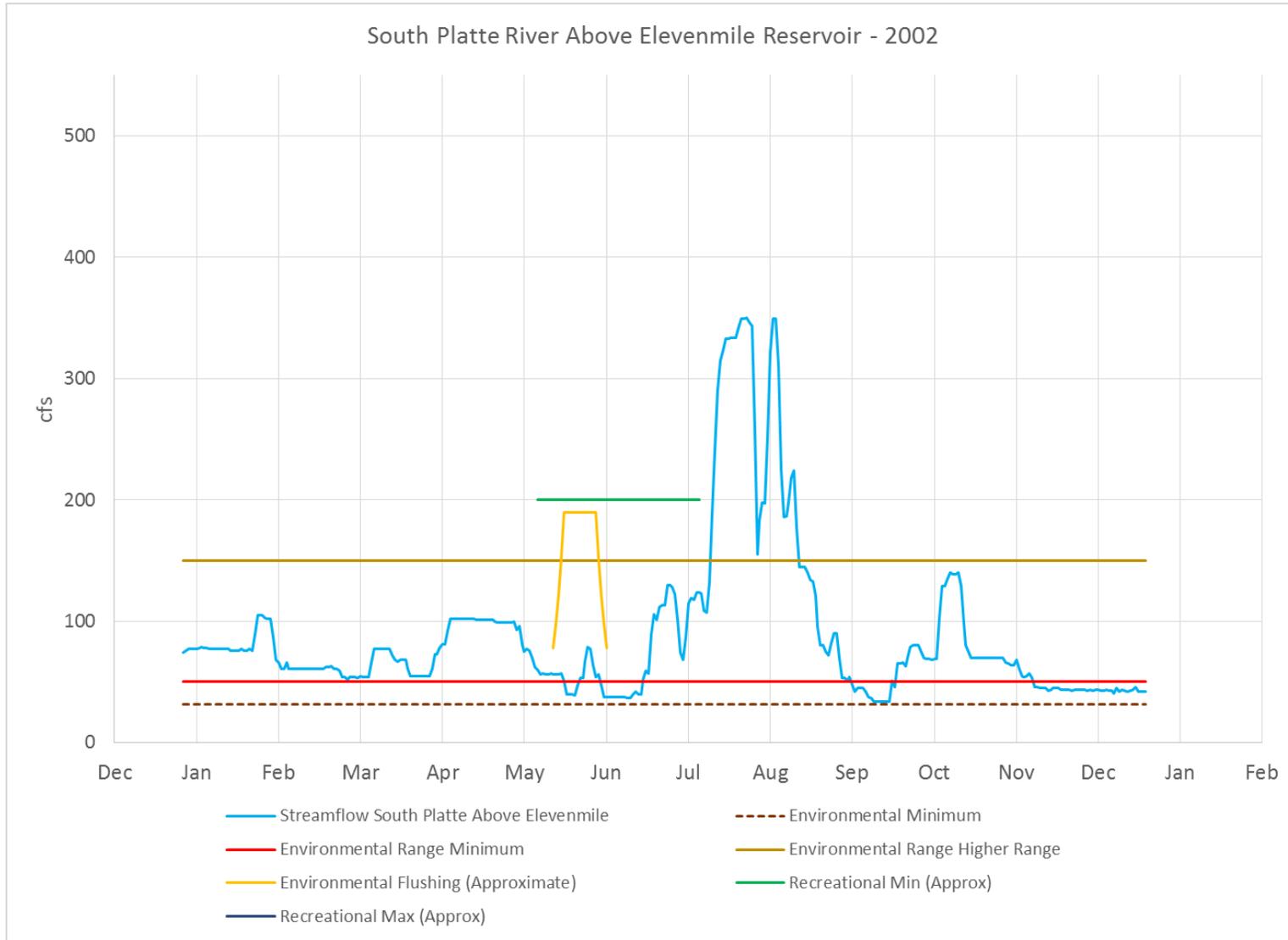


Figure 5-14 - Hydrograph comparison to available environmental and recreational flow information – 1978



**Figure 5-15 - Hydrograph comparison to available environmental and recreational flow information – 2002**

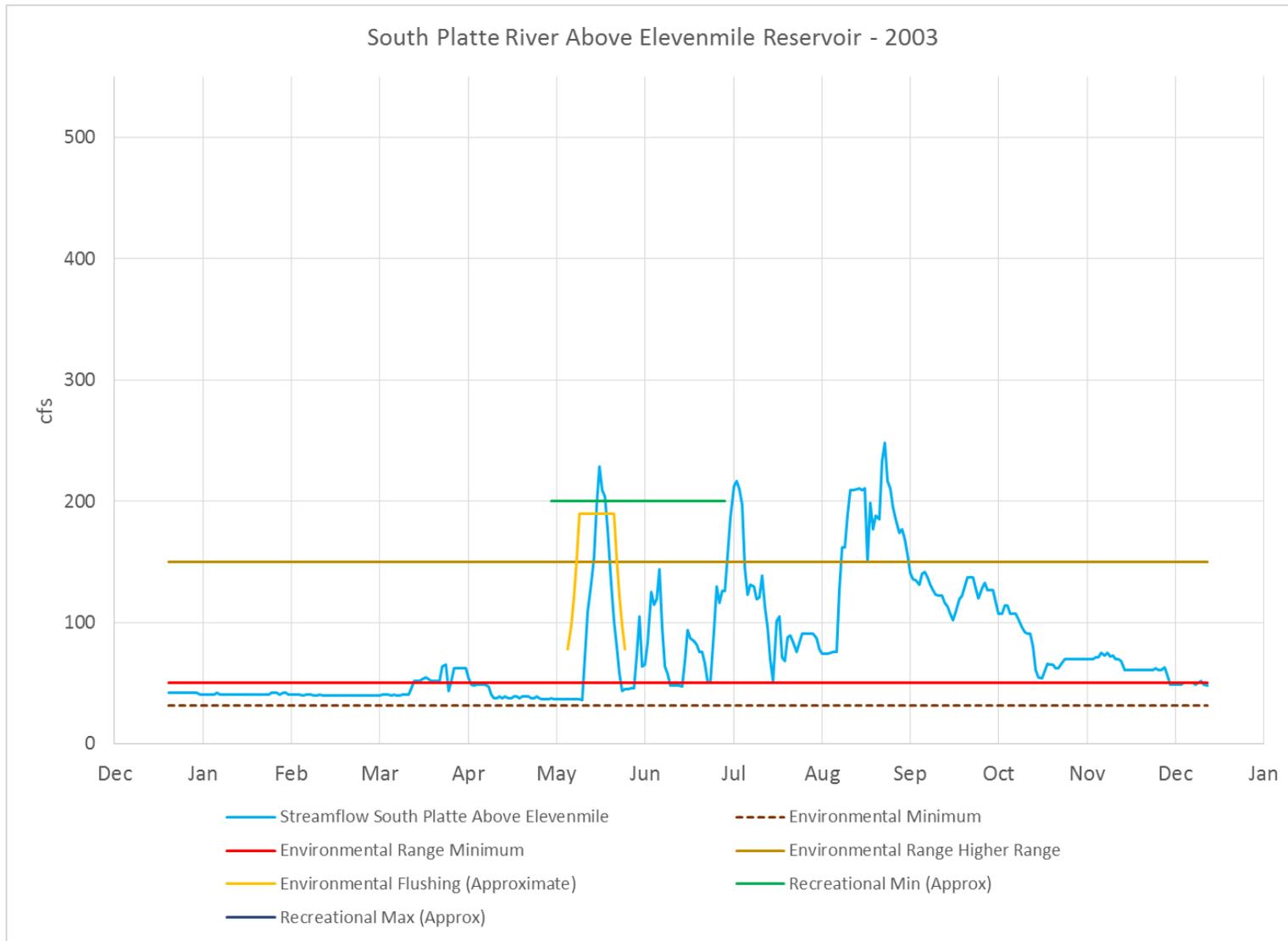


Figure 5-16 - Hydrograph comparison to available environmental and recreational flow information - 2003

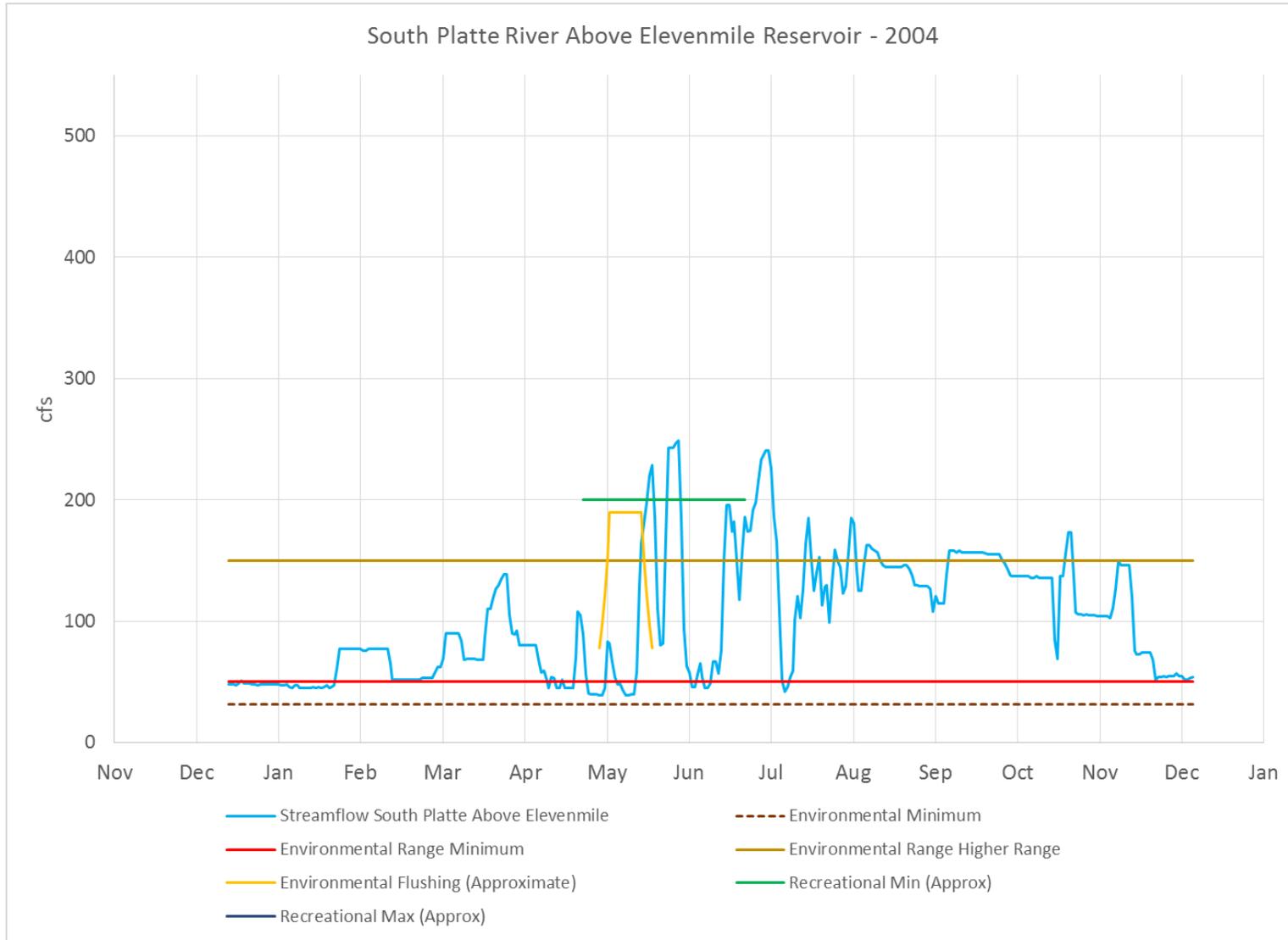


Figure 5-17 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the South Platte in South Park in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot shows flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the various minimum flows from the South Platte Operational Agreement are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-18. The days when the minimum flow rates were not met are indicated in red on the raster plot. The flows between the recommended range of 50-150cfs are shown in green on the plot. The flows between the minimum of 32cfs and 50cfs are shown in orange on the plot. The flows above the recommended flow rates are indicated in blue on the plot.

Spinney Reservoir upstream of the gage was completed in 1981, at which time some winter flows began to improve. In the late 1980s, there was cooperation regarding stream flows and operations in the area, prior to the South Platte Protection Plan being finalized. Accordingly, the time series generally shows fewer days that the minimum flows were not met as compared to earlier in the period. This plot shows times when there are opportunities to potentially increase the flows in the river to fall into the recommended range more frequently. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-18 - Time Series Raster Plot – South Platte above Elevenmile - Minimum Recommended Flows**

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-19. The yellow indicates days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in most years there appears to be flushing flows available in this area, based on the Tennant method, although the duration may not be of long enough duration in some years. Additional work to determine the required flushing flow rates, duration and frequency is needed. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



Figure 5-19 - Time Series Raster Plot - South Platte above Elevenmile - Flushing Flows (190cfs)

To demonstrate the times when the anecdotal recreational flows are met or exceeded, a time-series raster plot was developed, as shown in Figure 5-20. The green shows days when the flow is between the generally recommended recreational flows of greater than 200 cfs from April through October. The red in the plot shows times when the flow is less than the generally recommended minimum recreational flows. The blue in the plot shows days when the flow is greater than the generally recommended maximum recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.

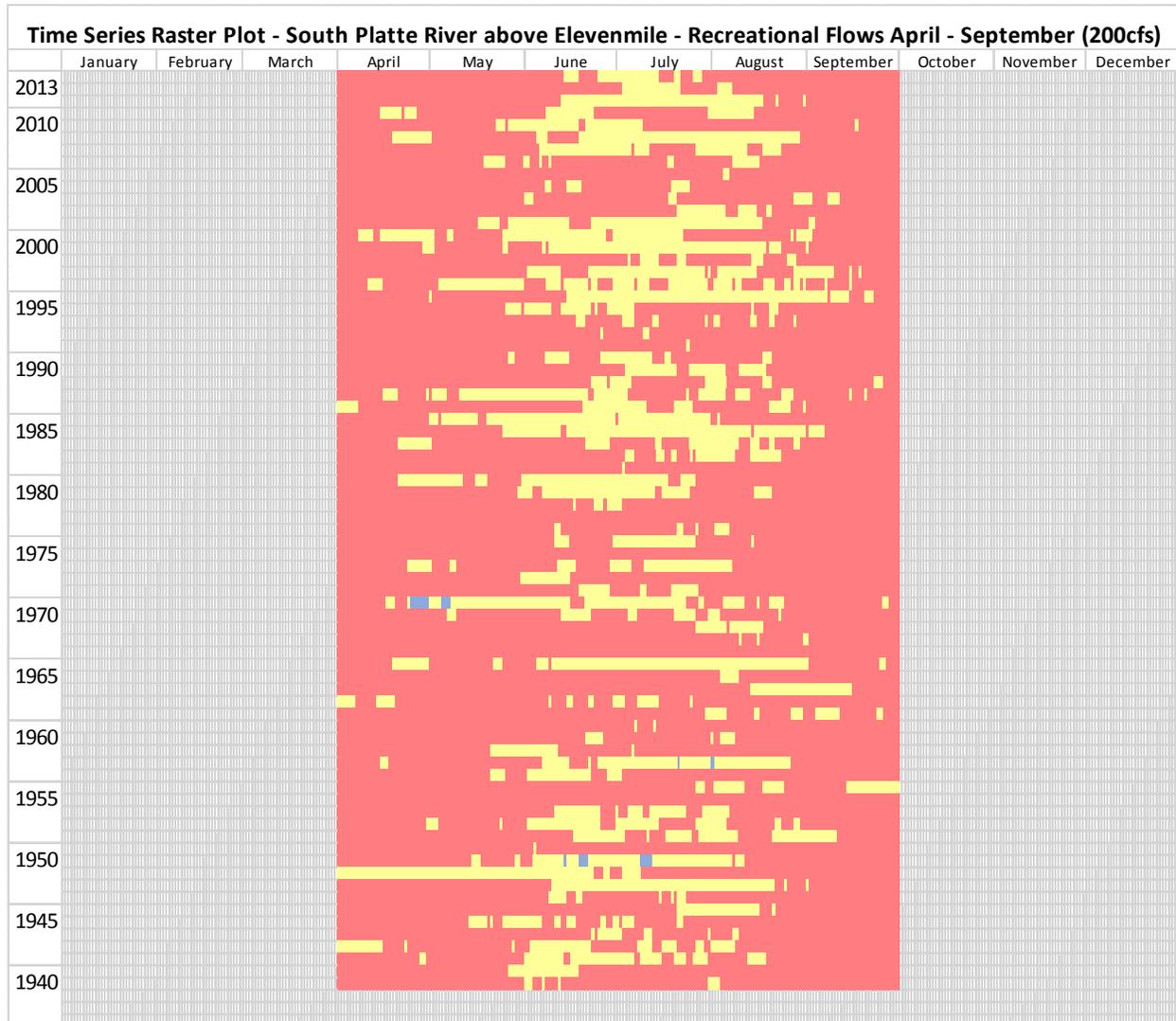


Figure 5-20 - Time Series Raster Plot – South Platte above Elevenmile - Recreational Flows April through September (200cfs)

## General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte River above Elevenmile Reservoir indicates that at times, streamflows may be present in this area to meet the general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte above Elevenmile. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. In addition, streamflows necessary for recreational needs should be more fully assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional environmental, recreational or municipal and industrial projects. The plots demonstrate how the addition of Spinney Reservoir generally allows the minimum instream flows to be met more of the time, generally demonstrate the flushing flows are available in most years and for longer durations, and recreational preferred flows also exist for longer durations.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Stream Channel Modifications – There are various ongoing and planned projects in the example area to restore stream channels and riparian habitat. Continuing these projects in specific areas where habitat restoration is needed is important to sustain the environmental and recreational attributes in the area.
- Fish Passage – There are various examples of fish passageways near the example area. Additional diversion structures could be modified in the future to assist with stream channel connectivity in the area.
- Operational Flow Agreements – The South Platte Protection Plan suggests operational flows that help to meet minimum flows in the example area. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects have been indicated by members of the environmental and recreational subcommittee. These projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum flows shown in this analysis are based on suggested flows from the South Platte Protection Plan. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach.

## 5.3 Metro Region

There are various types of focus areas in the Metro Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Five of the 34 focus areas in the South Platte located in the Metro Region. The types of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern; and rare or imperiled riparian plant communities.
- Recreational attributes including: Fishing, whitewater boating, municipal recreational corridor, and State Wildlife Areas.

There are various projects throughout the Metro Region addressing environmental and recreational needs. Project types in the region include stream and riparian restoration, streamflow agreements, and various types of studies.

To demonstrate the types of projects within the Metro Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

### 5.3.1 Example Projects – Metro Region

There are several projects in the Metro Corridor that focus on the Metro Denver Greenways. These projects range from recreational and riparian improvements along the South Platte to flow protection with Chatfield Reallocation. Specific projects from the GIS data include Chatfield Reallocation Program, expansion/enhancement to Confluence Park, recreational and riparian improvements along the South Platte, River North Greenway Master Plan, River South Greenway Master Plan, and Westerly Creek Greenway Master Plan.

The projects listed above account for a total of approximately 15 miles in the Metro Corridor with restoration programs out of a total of approximately 23 miles in the South Denver Metro Corridor Focus Area. These types of projects provide protections for multiple attributes including riparian plant communities, recreation, and fishing. These projects also directly address the recreational goals of the plan as well as water quality concerns along the Metro Corridor.

Some specific examples of these types of projects include:

- The Big Dry Creek Greenway Project which included creek corridor clean up and bank stabilization, habitat rehabilitation, access to parks as well as wetland and riparian forest enhancements. The project does not specifically state which attributes would be the focal point of the project, however, attributes such as rare aquatic dependent plants, fishing and recreational corridors would likely benefit.
- Stream habitat work at the Carson Nature Center, which helps to improve riparian conditions. This project enhances plant, fish and wildlife attributes, as well as greenway usage along the stream corridor. Figure 5-21 shows the environmental and recreational focus areas and locations of the rare aquatic-dependent plant, fishing and recreational corridors in the Metro Corridor.

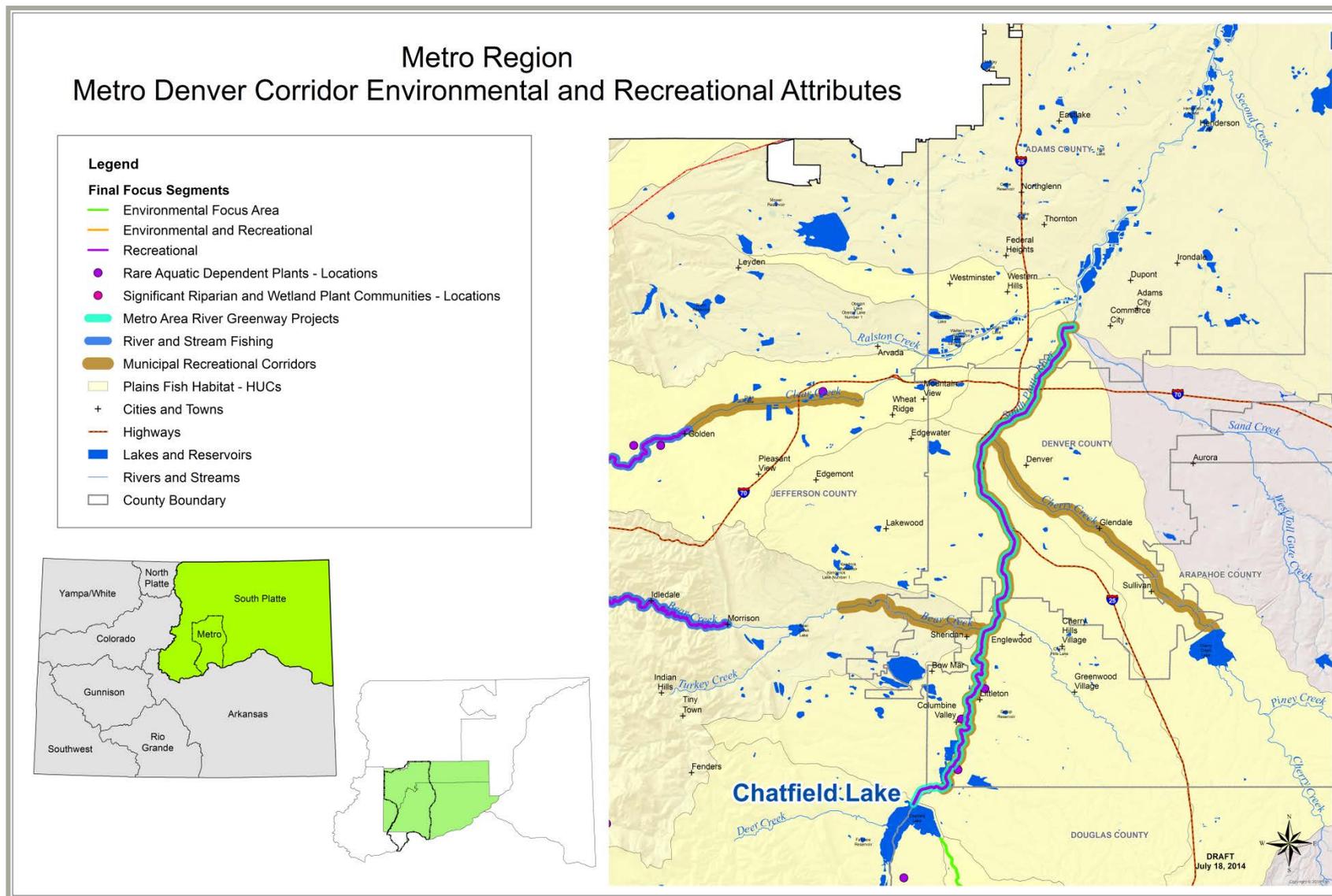


Figure 5-21. South Platte Metro Corridor Environmental and Recreational Enhancements

### 5.3.2 Example Area Analysis – South Platte River below Chatfield Reservoir

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Metro Region is located on the South Platte River, below Chatfield Reservoir.

#### Stream Mile Representation Framework

The gage analyzed within this reach is the South Platte River below Chatfield gage (PLACHACO). The section of river analyzed includes an approximately 12 mile stretch on South Platte River from Chatfield Reservoir downstream. The example area is shown in the map in Figure 5-22.

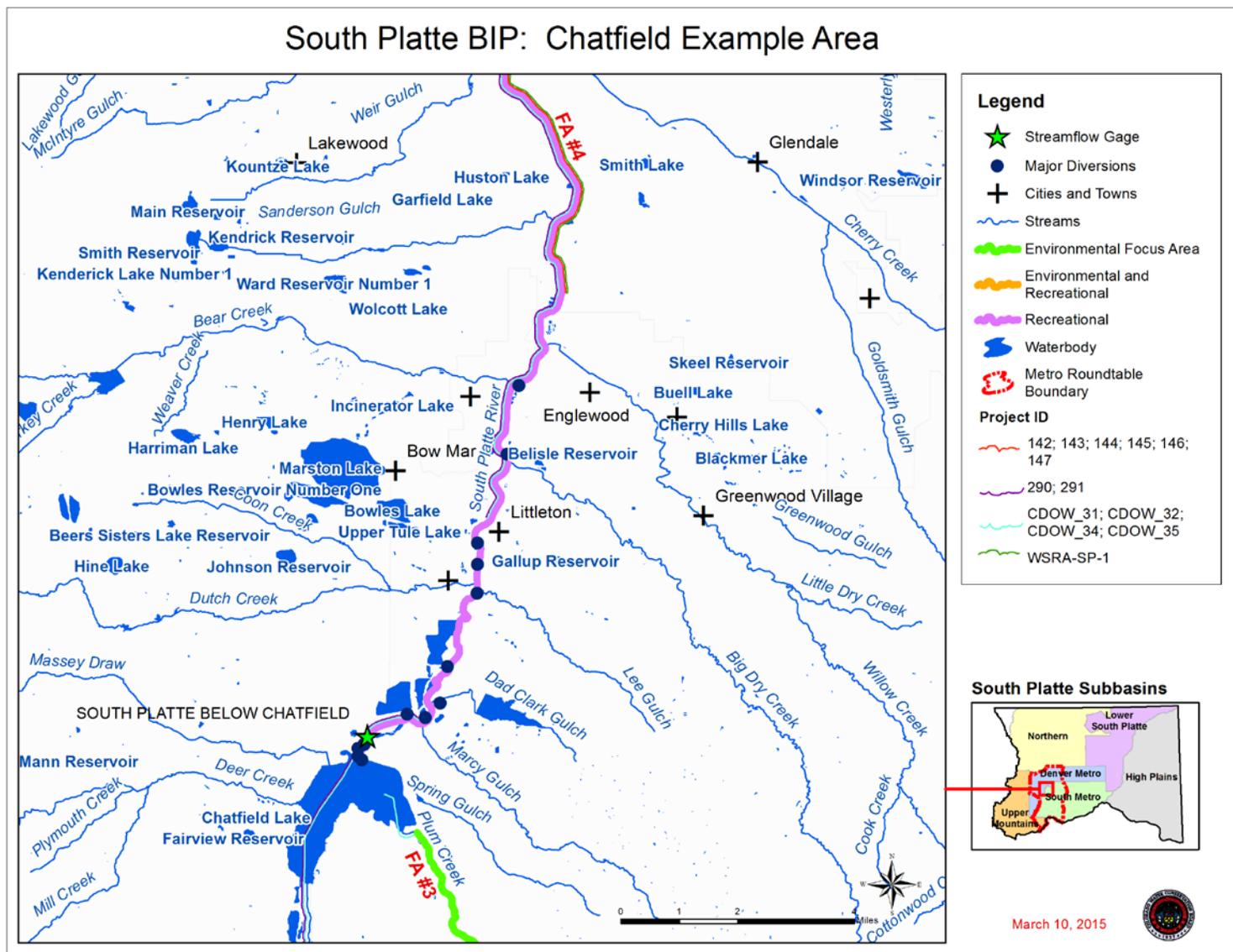


Figure 5-22 - Metro Region Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on [SouthPlatteBasin.com](http://SouthPlatteBasin.com). A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
  - Plains Fish State Endangered, Threatened, Species of Special Concern
  - State Endangered, Threatened, Species of Special Concern
  - Important Riparian Habitat
- Recreational:
  - Fishing
  - Recreation (boating)

The example area includes portions of Focus Area 4, a recreational focus area which includes the South Platte River from Chatfield downstream to Sand Creek. The streamflow gage data analyzed in this example is within Focus Area 4.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

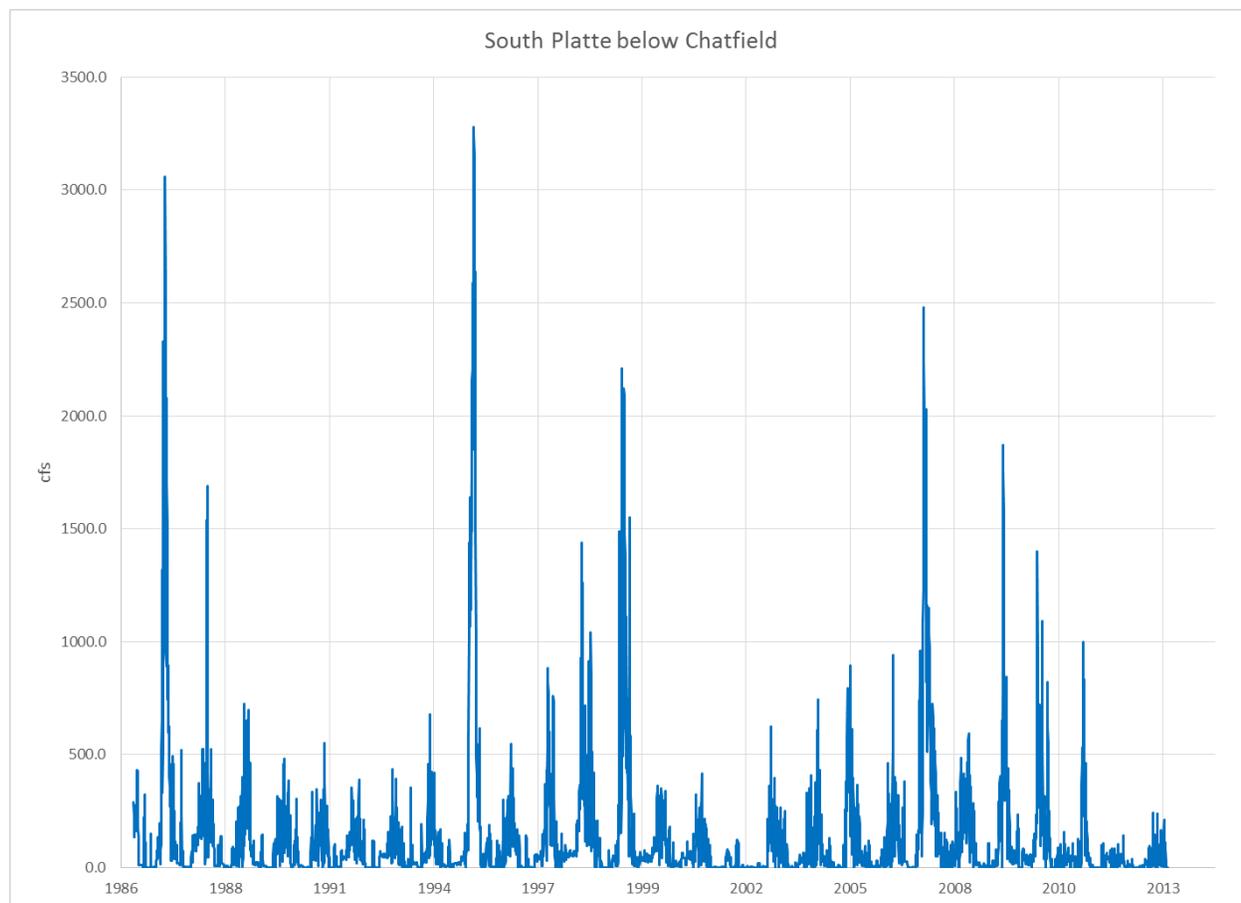
- Stream Channel Restoration Projects – Including Greenway Master Plans, Confluence Park enhancement and expansion, and various other planned restoration projects.
- Chatfield Reallocation Project – Includes potential dedicated storage for environmental needs downstream.
- Fish Habitat Projects including Plains Fish Monitoring, Identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

There are various diversions in the area, as shown in the map. These diversions include diversions for the Cities of Englewood, Littleton, and Denver, as well as many other diversions for agriculture and municipal and industrial uses.

### Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte below Chatfield gage analyzed extended from 1986 until 2013. The general hydrograph over the period of record is shown in Figure 5-23.



**Figure 5-23 – Time Series Hydrograph of South Platte below Chatfield (Gage: PLACHACO)**

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. The environmental minimum flows shown in the table below are based upon the minimum recommended flows from two studies done in the area. One study was completed By Miller and Associates to review the recommendations for the Chatfield Reallocation Project<sup>5</sup>, and one study done by Ecological Resource Consultants, Inc. (ERC) for a reach below Chatfield comparing required flows in conjunction with a stream restoration project<sup>6</sup>. The minimum flow study indicated a flow requirement of approximately 30 cfs. The recommended flows by the Miller and Associates report indicated flows below Chatfield of 30cfs would be adequate

<sup>5</sup> *A Minimum Flow Study of the South Platte River, Downstream of Chatfield Reservoir*, prepared for Centennial Water and Sanitation District, prepared by W.J.Miller and Associates (May 1991).

<sup>6</sup> Technical Memorandum regarding South Platte River - Minimum Instream Flow Calculations, prepared for Denver Trout Unlimited, prepared by Ecological Resources Inc. (April 2014).

at most transects studied. If additional studies become available in the future, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined. The mean flow during the non-winter months was determined to be approximately 228cfs, therefore a recommended flushing flow of 268 cfs was included in the analysis.<sup>7</sup> The duration of flushing flows would be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies found suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. However, there is two decreed boat chutes in the example area, Boat Chute #4 and Boat Chute # 10, decreed by the City of Littleton for 100cfs in Case No. 94CW273. This is the minimum recreational flow used for this example analysis. If additional recreational studies become available, these flows can be added into the analysis.

The table below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

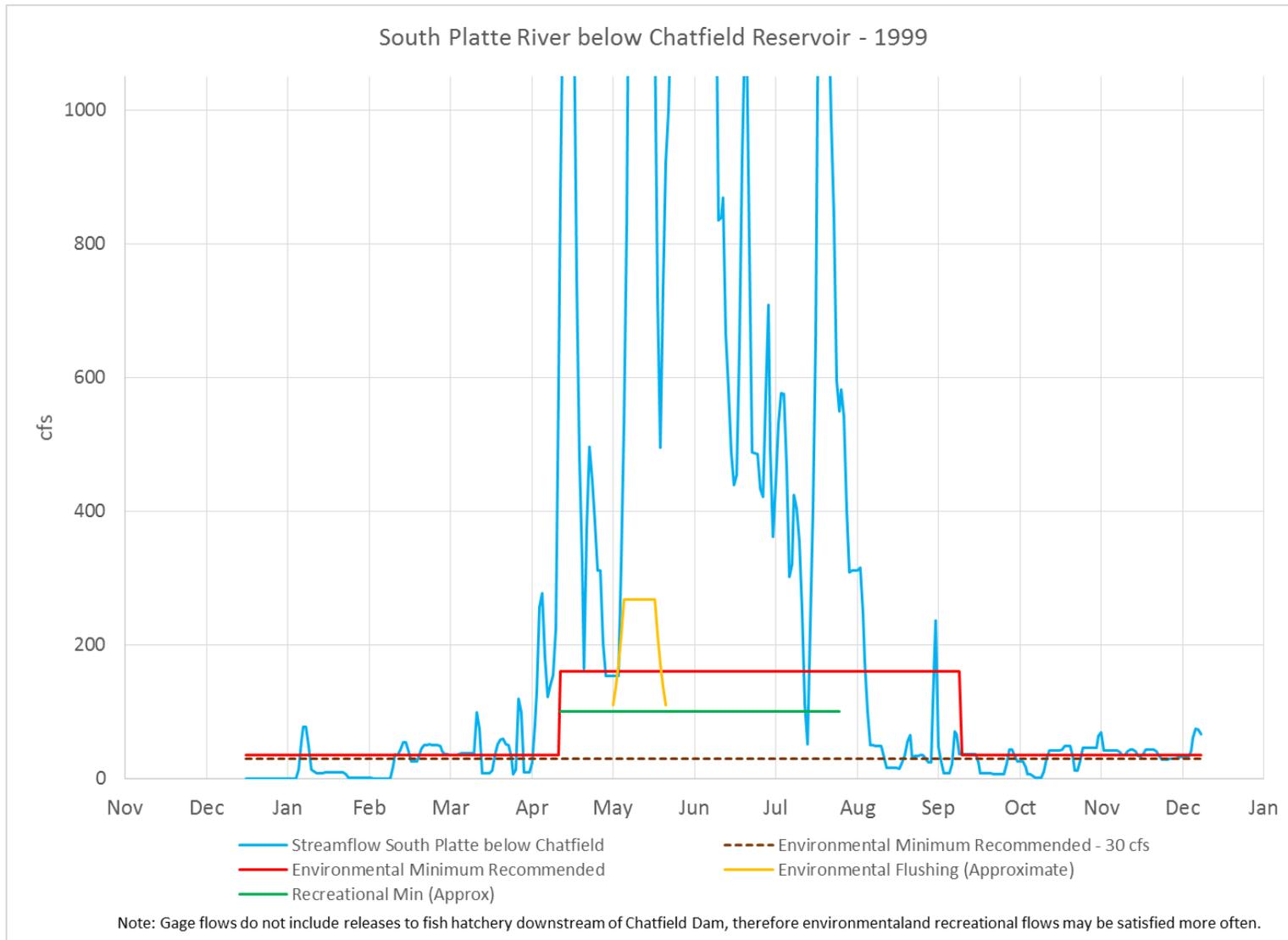
**Table 6 - South Platte River below Chatfield - General Flow Recommendations (in cfs)**

Month	Recommended Environmental Flow		Flushing Flows	Boat Chute Recreational Minimum	Anecdotal Recreational Maximum
	Miller and Associates Study	ERC Study (2012 Channel)			
January	30	35			
February	30	35			
March	30	35			
April	30	35			
May	30	160	~268	100	3000
June	30	160	~268	100	3000
July	30	160		100	3000
August	30	160			
September	30	160			
October	30	35			
November	30	35			
December	30	35			

These recommendations were compared to specific annual hydrographs, as well as the time series data. The minimum flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The recreational flows are indicated in the green and blue lines, for the minimum recreational recommended flow and maximum recreational flow, respectively. The annual

<sup>7</sup> Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcce (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

hydrographs for 1999, and 2002 through 2004 are shown in Figure 5-24 through Figure 5-27.



**Figure 5-24 - Hydrograph comparison to available environmental and recreational flow information - 1999**

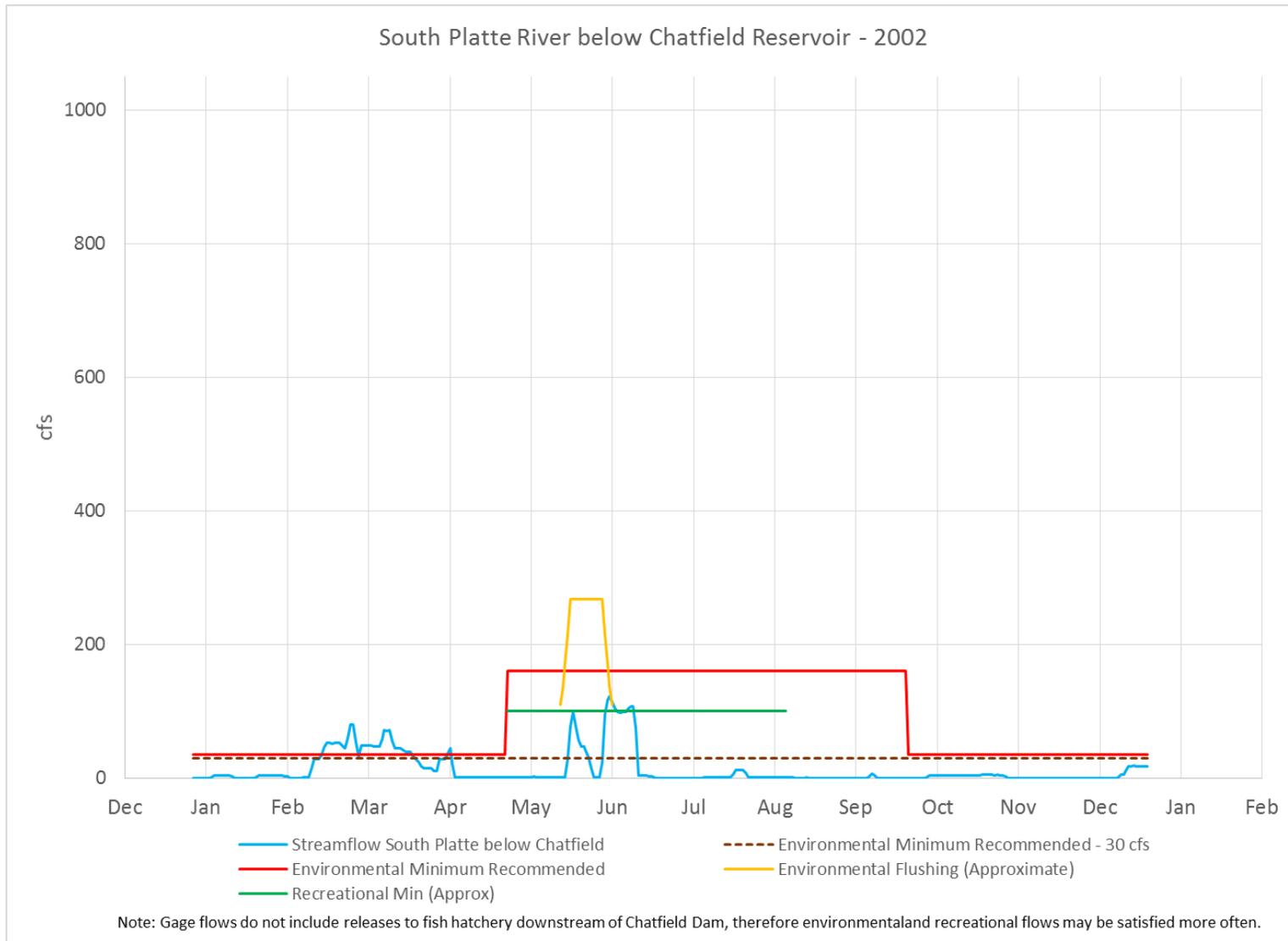
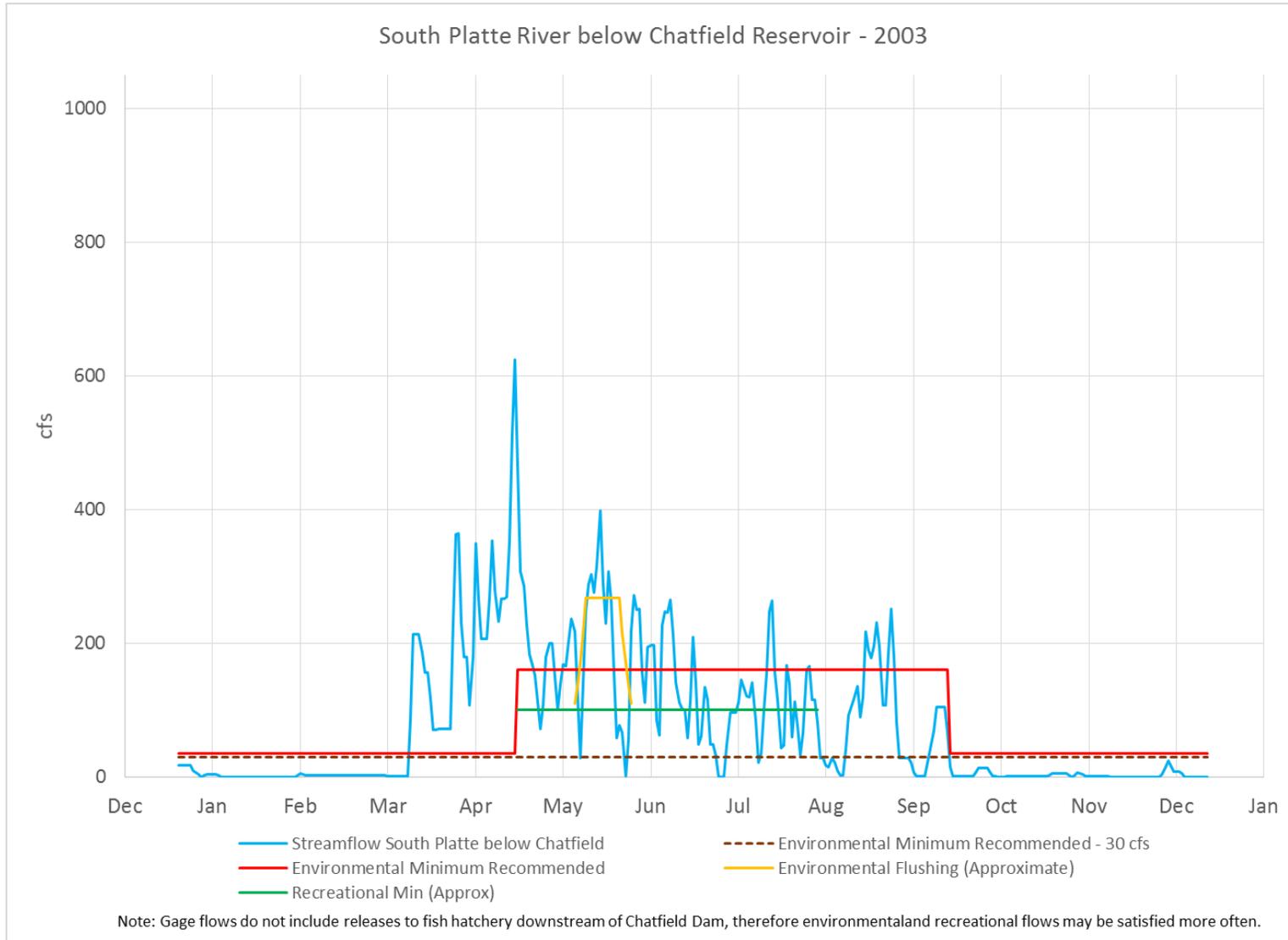
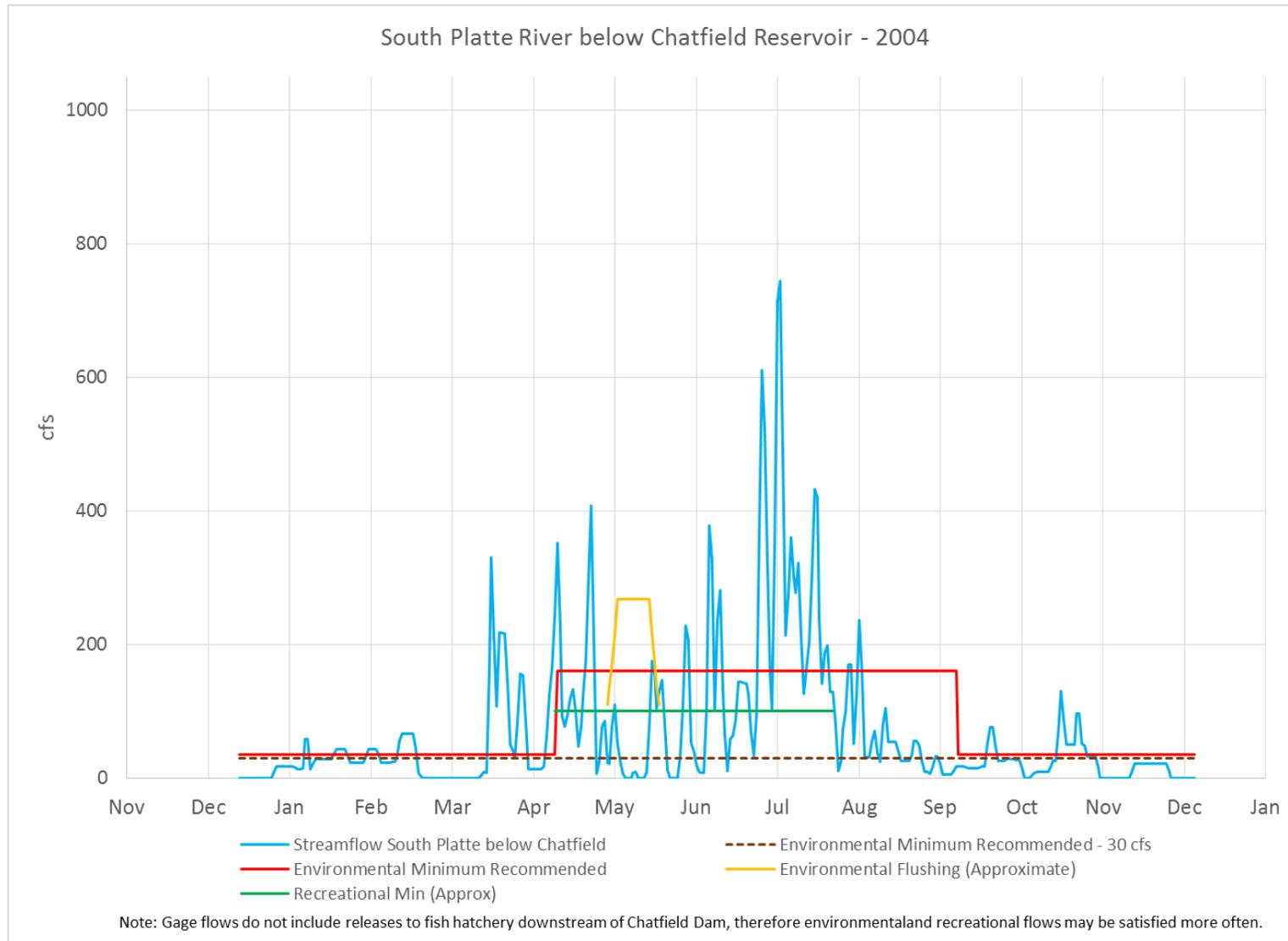


Figure 5-25 - Hydrograph comparison to available environmental and recreational flow information - 2002



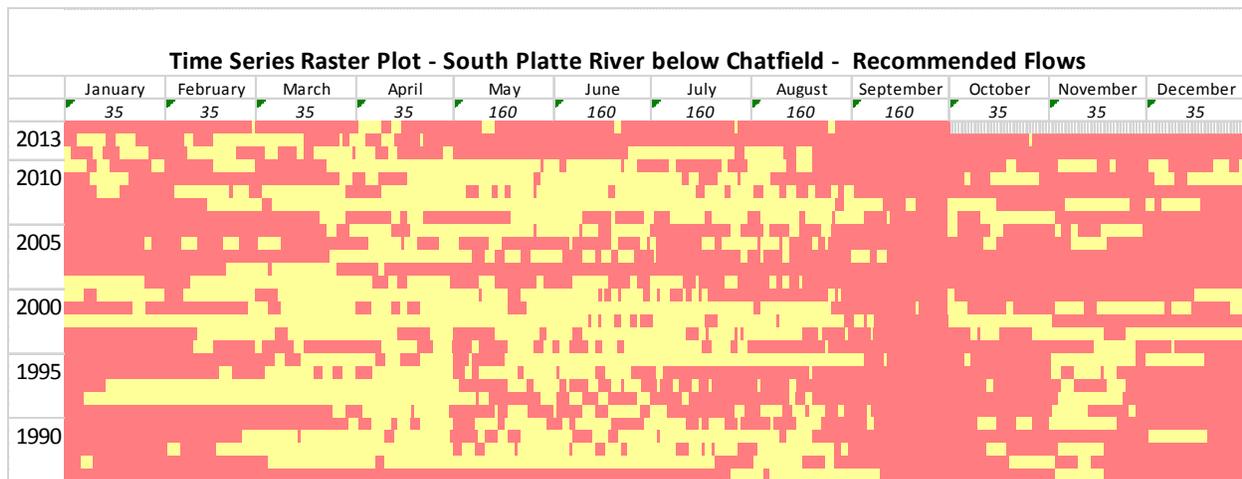
**Figure 5-26 - Hydrograph comparison to available environmental and recreational flow information - 2003**



**Figure 5-27 - Hydrograph comparison to available environmental and recreational flow information - 2004**

In addition to comparing the flows in the South Platte below Chatfield in specific years, time series raster plots were developed to demonstrate the flows over the period of record. A raster plot shows flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

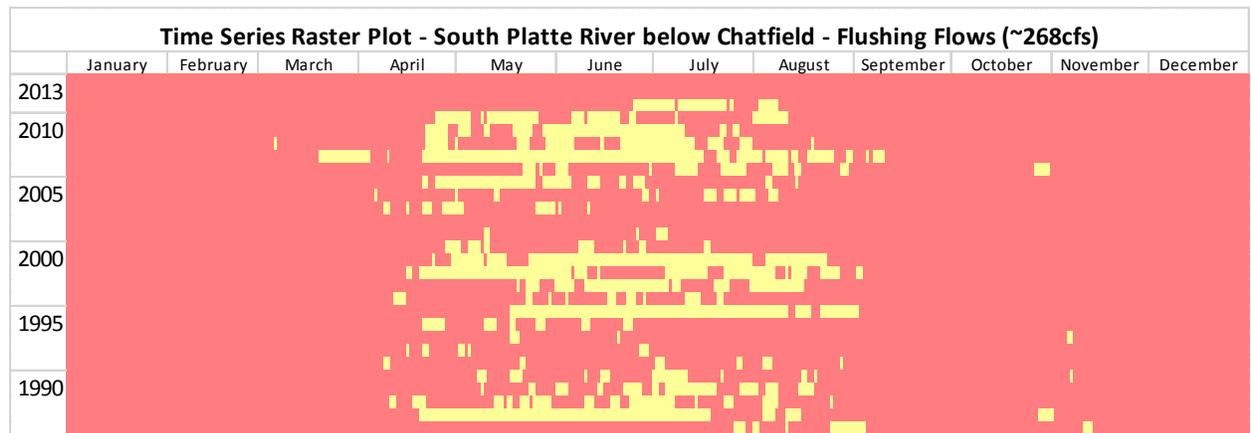
To demonstrate days when the recommended minimum flows are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-28. The days when the minimum decreed instream flow rates were not met are indicated in red on the raster plot. The flows above the minimum flow rates are indicated in yellow on the raster plot. The minimum recommended flows shown are from the ERC report compared to the channel in 2012. In the ERC report the channel restoration allowed for significantly lower flows to adequately provide flows in low flow times, for only one test transect. However, the gage at this location does not include the flows released from Chatfield for the fish hatchery downstream of the dam. The releases to the hatchery should be added in for assessment of locations below the location where the flows from the hatchery re-join the South Platte. Additional studies are needed to determine the needed flows throughout the example area. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the environmental needs. If additional required flow studies and information become available, similar plots could be used to compare the streamflows to the more specific needs of aquatic and riparian habitat determined by such studies in additional locations. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-28 - Time Series Raster Plot – South Platte below Chatfield - Minimum Recommended Flows**

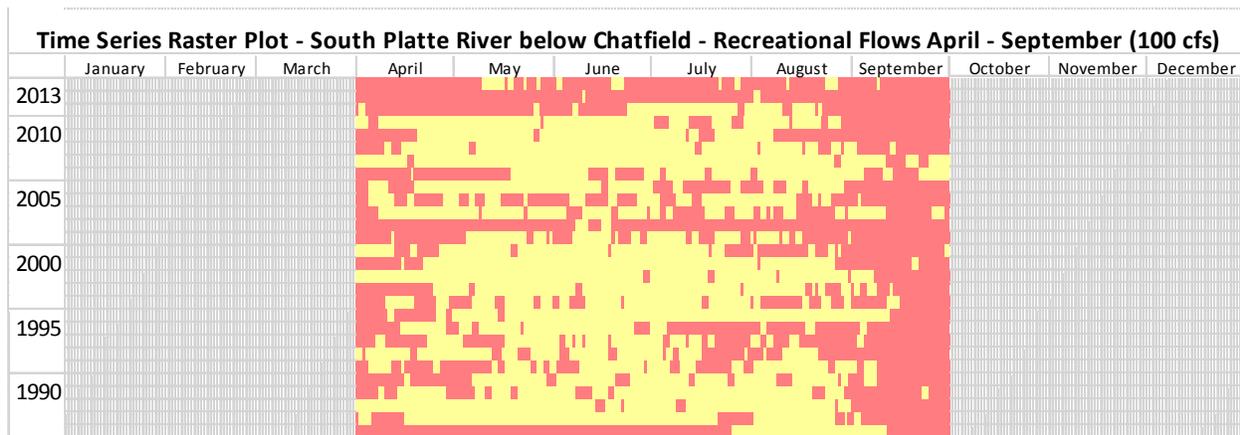
To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-29. The yellow on the plot indicates days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, there appears to be flushing flows available in this area in some years, based on the general Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed.

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. Additionally the needed occurrences of these flows should be determined. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-29 - Time Series Raster Plot – South Platte River below Chatfield - Flushing Flows (268cfs)**

To demonstrate the times when the recommended recreational flows are met or exceeded based on the City of Littleton Boat Chute decree, a time-series raster plot was developed, as shown in Figure 5-30. The yellow in the plot indicates days when the flows are greater than the Littleton Boat Chute decreed rate of 100 cfs from April through October. The red in the plot shows times when the flow is less than the recommended recreational flows. This plot shows times when there are opportunities to potentially increase the flows in the river to meet recreational needs. If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.



**Figure 5-30 - Time Series Raster Plot – South Platte River below Chatfield - Recreational Flows April through September (100cfs)**

### General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte below Chatfield indicates the streamflows may be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. a. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix G) shows that there is potentially availability for surface water development at times in the South Platte below Chatfield. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears

that times of lengthy flushing flows, more than preferred recreational flows and adequate minimum instream flows may coincide with times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Stream Channel Modifications – The Greenway projects and other channel restoration projects have helped to enhance this reach. As shown in the flow evaluation study by ERC, the environmental flow needs can be lessened if the proper channel restoration is put into place. However for these projects to work throughout the example area they must link together to create continuous habitat that is benefitted by environmental flows.
- Operational Flow Agreements – There is currently planned operational and multi-purpose agreements being considered as part of the Chatfield reallocation project. Additional operational agreements could be pursued in the future to assist with minimum flows, flushing flows and recreational flows. Studies to determine the amount of beneficial flow should be conducted to assist with determining how these operational agreements could benefit the environmental and recreational attributes.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area.

The minimum flows shown in this analysis are specifically from recommendations from location specific studies of needed environmental flows. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach. In addition, the flows shown in the streamflow analysis do not include flows from the fish hatchery, these should be included in any assessment downstream of where the fish hatchery flows back into the South Platte River.

## 5.4 Plains (Lower South Platte Region)

There are various types of focus areas in the Lower South Platte Region with multiple project types in place, planned or needed to protect or enhance the environmental and recreational attributes. Two of the 34 focus areas in the South Platte located in the Lower South Platte Region. The types of focus areas in the region include:

- Environmental attributes including: Habitat for federal and state endangered, threatened and species of concern including plains fish; and rare or imperiled riparian plant communities.
- Recreational attributes including: Wildlife viewing and hunting.

There are various projects throughout the Lower South Platte Region addressing environmental and recreational needs. Project types in the region include species reintroduction, and various types of studies.

To demonstrate the types of projects within the Lower South Platte Region, specific existing projects are highlighted. In addition, the stream mile representation framework previously discussed was used to generally analyze the environmental and recreational needs and the existing and future projects within that area that may address the gap.

#### 5.4.1 Example Projects – Lower South Platte Region

There are various example projects in the Lower South Platte, including recharge projects, reservoirs and a species reintroduction project. The Colorado Parks and Wildlife (CPW) Tamarack recharge project retimes water flows that occur during high flow periods to times when flows are needed to meet Colorado's requirements under the Three States Agreement for the Platte River Recovery and Implementation Program (PRRIP). The (PRRIP) allows for water users within Colorado to continue to develop new supplies while still meeting the needs of downstream federally listed endangered species. The Ducks Unlimited recharge projects throughout the area cooperatively provide replacement water to wells in augmentation plans while also providing wildlife habitat and recharge flows that can benefit environmental and recreational needs. These and various other recharge projects in the region have the potential to increase wetland habitat and streamflows in the area. The Ducks Unlimited projects are currently indicated in the available data to affect the stream reaches in approximately 161 miles of the 212 miles present in the focus area in this region.<sup>8</sup> Julesburg Reservoir and North Sterling Reservoir are examples of water supply reservoirs for agricultural users on the lower South Platte River that also provide flatwater boating and waterfowl hunting and viewing.

The plains fish reintroduction project in the lower South Platte reintroduces several species, including common shiner, brassy minnow, plains minnow and suckermouth minnow to the lower South Platte where they are not currently present. These species are all on the state threatened and endangered species list. Based on the GIS data available, the common shiner is currently shown in 19 miles out of the total 212 miles in the lower South Platte focus area. Plains minnow is currently shown in 61 miles out of 212 miles. This project is intended to increase the habitat available to these species. The plains fish reintroduction is listed in 172 miles of the focus areas.

The reintroduction project alone may not fully protect the species. Additional protections could be provided by addressing the habitat fragmentation caused by diversion structures and dry-up points (Figure 5-31). These types of physical features can limit the amount of habitat available to plains fish species. These fish species require contiguous, year round habitat to complete their life cycle. Features that prevent fish movement disrupt their life cycle and can result in lower population sizes. Possible projects that could address the habitat fragmentation include cooperatively coordinated fish

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<sup>8</sup> The Ducks Unlimited Project data is indicated as being present in the entire HUC. This highlights the stream reach associated with that HUC. The actual project may affect fewer stream miles based on location of the project within the HUC and other hydrological operations in the area. The project may also affect more stream miles due to the increased streamflows downstream of the recharge project.

passageways and other structural solutions including storage and recharge to limit the number of days of dry-up on the river.

The recharge projects, including the Ducks Unlimited Projects, directly address the goal for enhancing water bird and waterfowl viewing and hunting. The various reservoirs throughout the area directly address flatwater boating goals and indirectly address wildlife habitat and waterfowl viewing and hunting goals. The plains fish reintroduction project directly addresses the environmental goal for state threatened and endangered species. Figure 5-31 shows the focus areas and locations of the DU projects, recharge sites, reservoirs, rare fish habitat, dry-up points and diversion structures in the Lower South Platte Basin. The data to specifically evaluate the hydrology and tradeoffs for environmental flows, recreational uses and wildlife habitat is not currently available within the existing databases. The evaluation of the hydrology is not currently in the scope of this BIP. Additional work could be undertaken in the future in priority focus areas to determine the hydrology and potential possible impacts and benefits, if such data is available. Additional analyses may assist in future decisions regarding tradeoffs in managing this area which has historically been highly managed and modified from natural flows. Additional analysis may allow for consideration of tradeoffs including costs, engineering, feasibility, and water rights administration of such projects. The methodology described in Appendix D can be used to assess where projects may benefit attributes in the future when sufficient data becomes available.

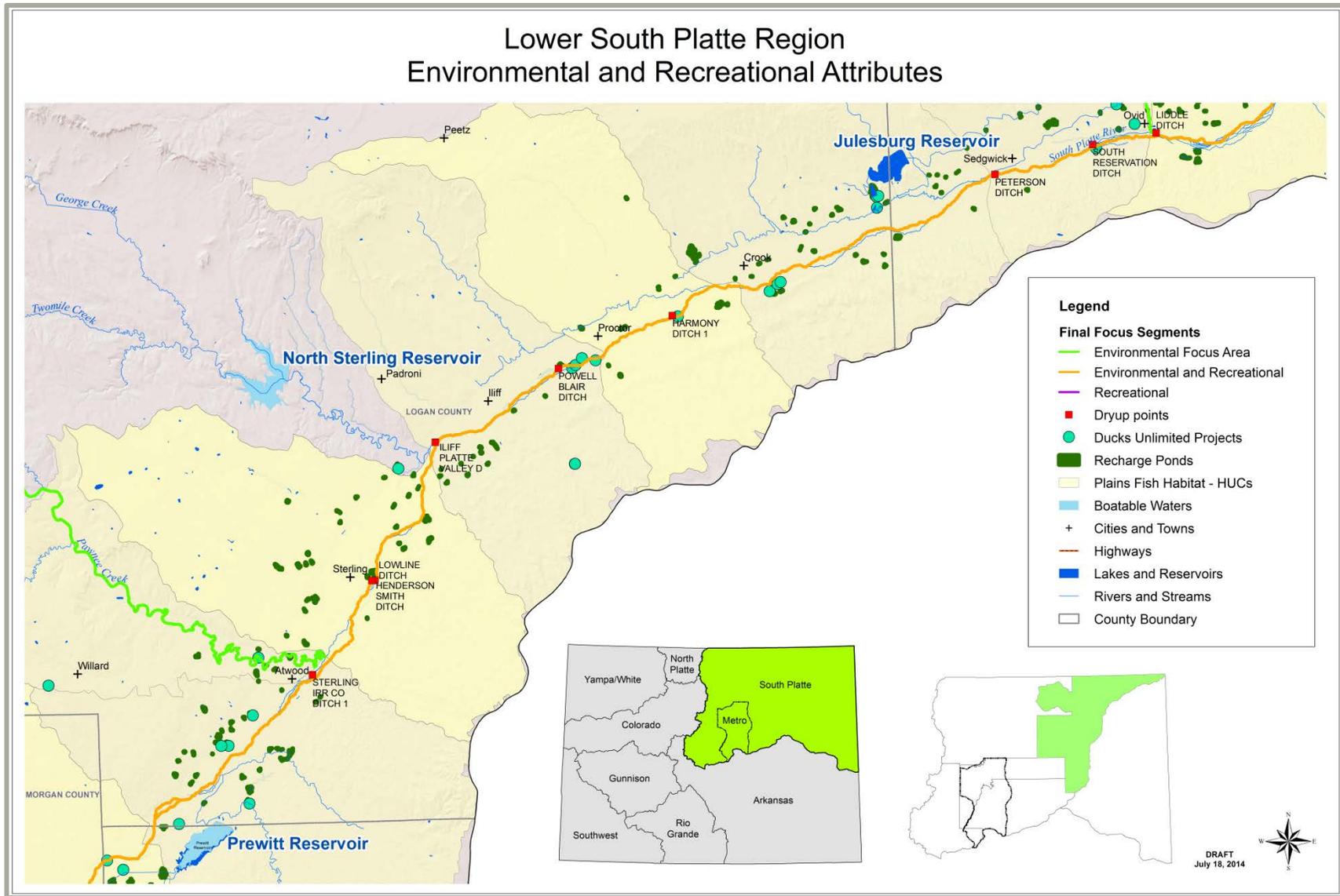


Figure 5-31 - Lower South Platte Plains Fish Habitat

## 5.4.2 Example Area Analysis – South Platte River at Balzac

To demonstrate the stream mile representation methodology described earlier in this Appendix, the example area analyzed for the Lower South Platte Region is located on the South Platte River at Balzac.

### Stream Mile Representation Framework

The gage analyzed within this reach is the South Platte River below Chatfield gage (PLABALCO , 06759910). The section of river analyzed includes an approximately 20 mile stretch on South Platte River from approximately Snyder downstream to the Sterling No. 1 Ditch. The example area is shown in the map in Figure 5-32.

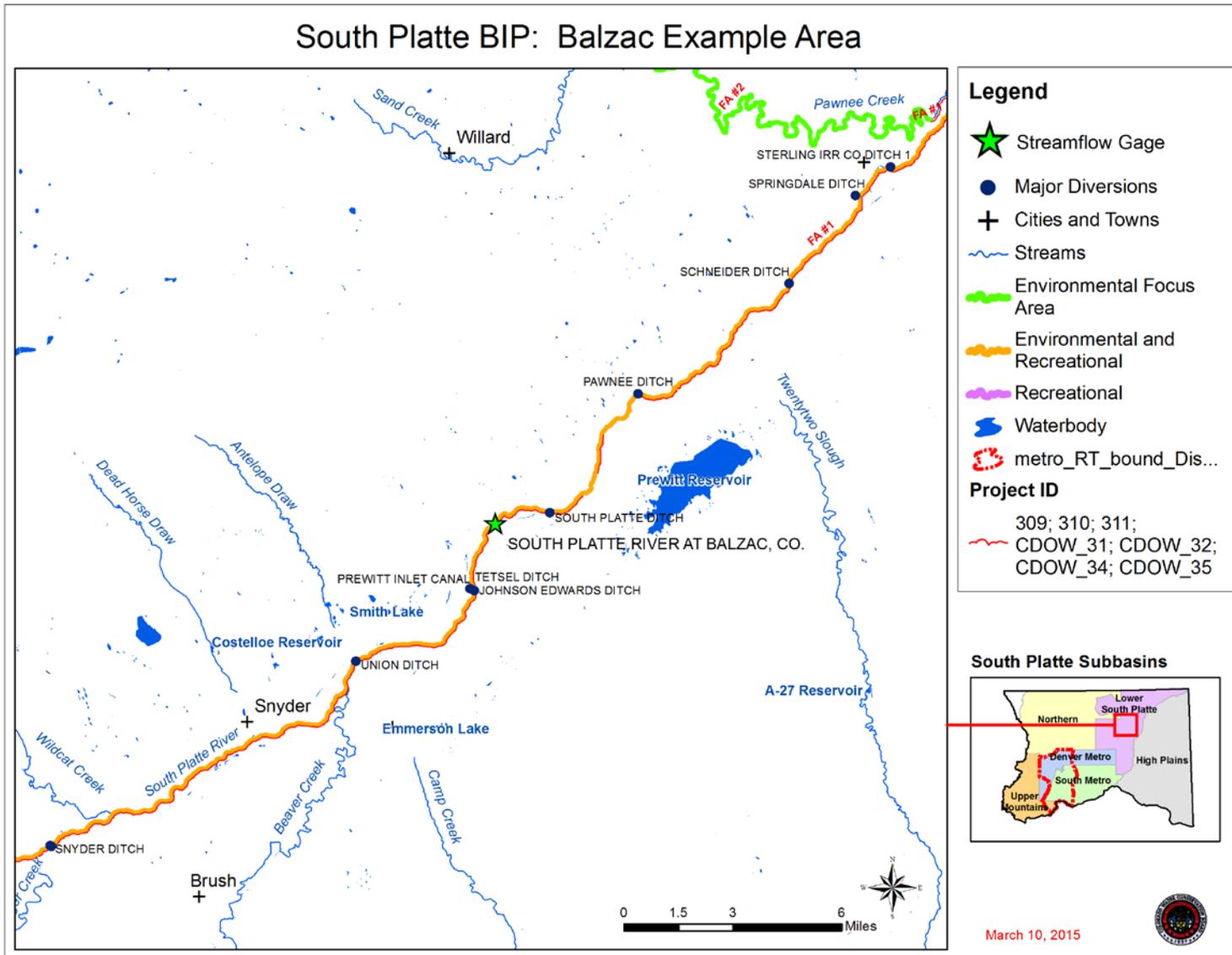


Figure 5-32 – Lower South Platte Region Example Area Map

The portion of the stream mile representation framework spreadsheet for this stretch of river is shown in Appendix D-7, with the full spreadsheet available on [SouthPlatteBasin.com](http://SouthPlatteBasin.com). A brief summary of the items shown in the stream mile representation follows.

The attribute categories located in the example area include:

- Environmental:
  - Plains Fish State Endangered, Threatened, Species of Special Concern
  - State Endangered, Threatened, Species of Special Concern
  - Important Riparian Habitat
- Recreational:
  - Fishing
  - Recreation (wildlife viewing and hunting, boating)

The example area includes portions of Focus Area 1, an environmental and recreational focus area which includes the South Platte River from the South Boundary of Weld County to the State Line. The streamflow gage data analyzed in the Lower South Platte Region example is within Focus Area 1.

Based upon the stream mile representation and available project data with available spatial data, the projects upstream and downstream from the streamflow gage include:

- Land Conservation Projects - Ducks Unlimited has easements along river, additional land conservation projects
- Wetland Restoration Projects – Ducks unlimited has partnered with agricultural users to provide wetland habitat in conjunction with recharge projects, additional wetland restoration projects.
- Tamarack Project – Recharge project developed to help meet the needs of downstream endangered species.
- Fish Habitat Projects including Plains Fish Monitoring, Identification of and modification to barriers to fish passage on the South Platte and tributaries, and species reintroduction.
- Stewardship Projects – Stewardship projects include areas protected by federal or state agencies, landowner agreements, and non-governmental organizations. These projects typically provide riparian habitat protection rather than streamflow benefits.

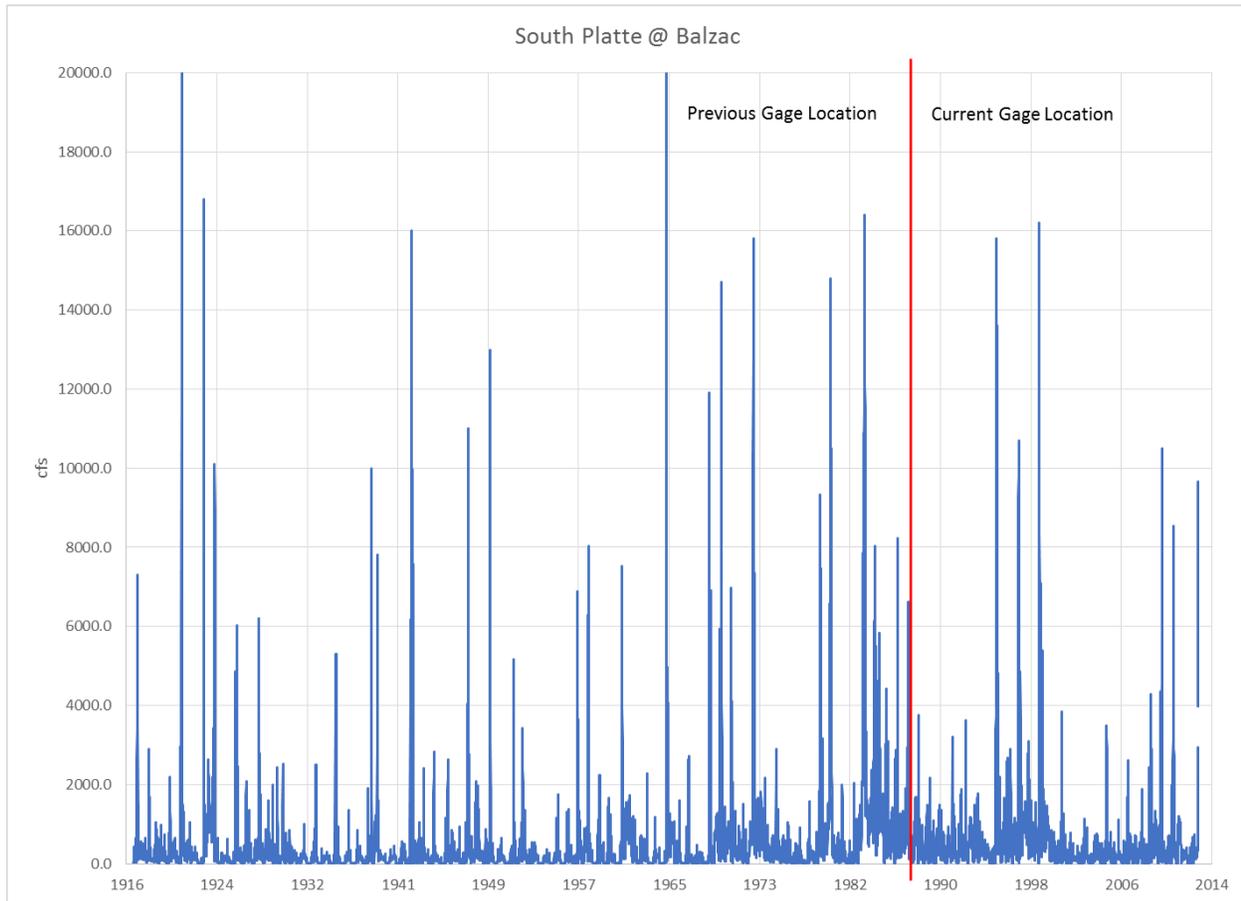
There are various diversions in the area, as shown in the map. These diversions include diversions for the North Sterling and Prewitt Reservoirs, as well as many other diversions for agriculture uses.

### Streamflow Analysis

To analyze the streamflow available to the various attributes at the gage location, streamflows were analyzed in various ways.

The period of record for the South Platte at Balzac gage analyzed extended from 1917 until 2013. The gage is currently located at the Cooper Bridge. In October of 1987, the

gage was moved to its present location at the Cooper Bridge from the previous location approximately 5 miles downstream, known as the Balzac Bridge. Diversions from Prewitt Reservoir and a few small irrigation ditches occur between the old Balzac Bridge and Cooper Bridge locations. The general hydrograph over the period of record is shown in Figure 5-33. The red line on the hydrograph shows when the gage moved upstream.



**Figure 5-33 – Time Series Hydrograph of South Platte at Balzac (Gage: PLABALCO)**

The hydrograph was disaggregated on a yearly basis to examine certain flow requirements for environmental and recreational needs.

Site and species specific studies are needed to determine the minimum flow needed to sustain the native species. Flow regimes necessary to support aquatic species are extremely site specific, and the flow regimes can change significantly with a change in channel shape and function. Results from hydraulic modeling must be assessed in conjunction with biologic assessments of the study area. There are no studies indicating specific environmental flows in the example gage location. The environmental minimum flows shown in the table below are based upon general information regarding plains fish species<sup>9</sup>. The minimum flow study indicated depths of 7.9 to 11.8 inches and velocities of

<sup>9</sup> *Plains Minnow (Hybognathus placitus): A Technical Conservation Assessment*, prepared for the USDA Forest Service, Rocky Mountain Region, prepared by Miller Ecological Consultants, Inc. Peer Review Administered by American Fisheries Society, (May 2005)

0.3 to 1.3 feet per second for suitable habitat. The study indicates the fish move into deeper pools during higher or lower flows. At the gage location, based on discharge measurements, it appears the higher end of the range is achieved at this location at approximately 20cfs. However, the nature of the sand bed of the river in this area greatly impacts the channel cross-section. Additionally, based on the Tennant Method for very general required environmental flows, approximately 30% of the mean annual flow is required at a minimum for good habitat. This flow rate would be approximately 149cfs. If additional studies become available in the future, the streamflow requirements for aquatic and riparian needs can be added into the analysis.

There were no studies specifically indicating required flushing flows in the area. Flushing flows are needed to move sediment downstream, creating diverse aquatic habitat, as well as to aid in life cycle functions of species. Therefore general recommendations based on the Tennant method for flushing flows of 200% of the annual mean flow were determined.<sup>10</sup> The mean flow during the non-winter months was determined to be approximately 496 cfs, therefore a recommended flushing flow of 993 cfs was included in the analysis. The duration of flushing flows would be determined from additional hydraulic analyses based on specific channel characteristics at the project locations.

There are no studies found suggesting specific recreational flow recommendations in the South Platte basin, nor in this reach. Therefore, no recreational flows were compared for this example area. If additional recreational studies become available, these flows can be added into the analysis.

The table below shows the general recommendations based on these sources. Refinements should be made with site-specific studies before using these values to plan or implement projects.

**Table 7 - South Platte River at Balzac - General Flow Recommendations (in cfs)**

Month	Recommended Environmental Flow		Flushing Flows
	Based on Plains Fish Habitat	Based on Tennant Method	
January	20	149	
February	20	149	
March	20	149	
April	20	149	
May	20	149	~993
June	20	149	~993
July	20	149	
August	20	149	
September	20	149	
October	20	149	
November	20	149	
December	32	50	

<sup>10</sup> Tennant method or “Montana” method for determining flushing flows. General description of the Tennant Method can be found in *The flushing flow problem: Defining and evaluating objective*, Kondolf, Wilcox, (Water Resources Research, August 1996) and *Hydrological Low Flow Indices and their Uses*, Pyrcie (Watershed Science Center, 2004). Additional literature states the annual natural streamflow should be used and additional analyses should be used to determine appropriate flushing flows.

These recommendations were compared to specific annual hydrographs, as well as the time series data. The minimum flows are indicated by the red line in the following graphs. The flushing flows are indicated by the yellow line in the following graphs. The annual hydrographs for 1999 and 2002 through 2004 are shown in Figure 5-34 through Figure 5-37.

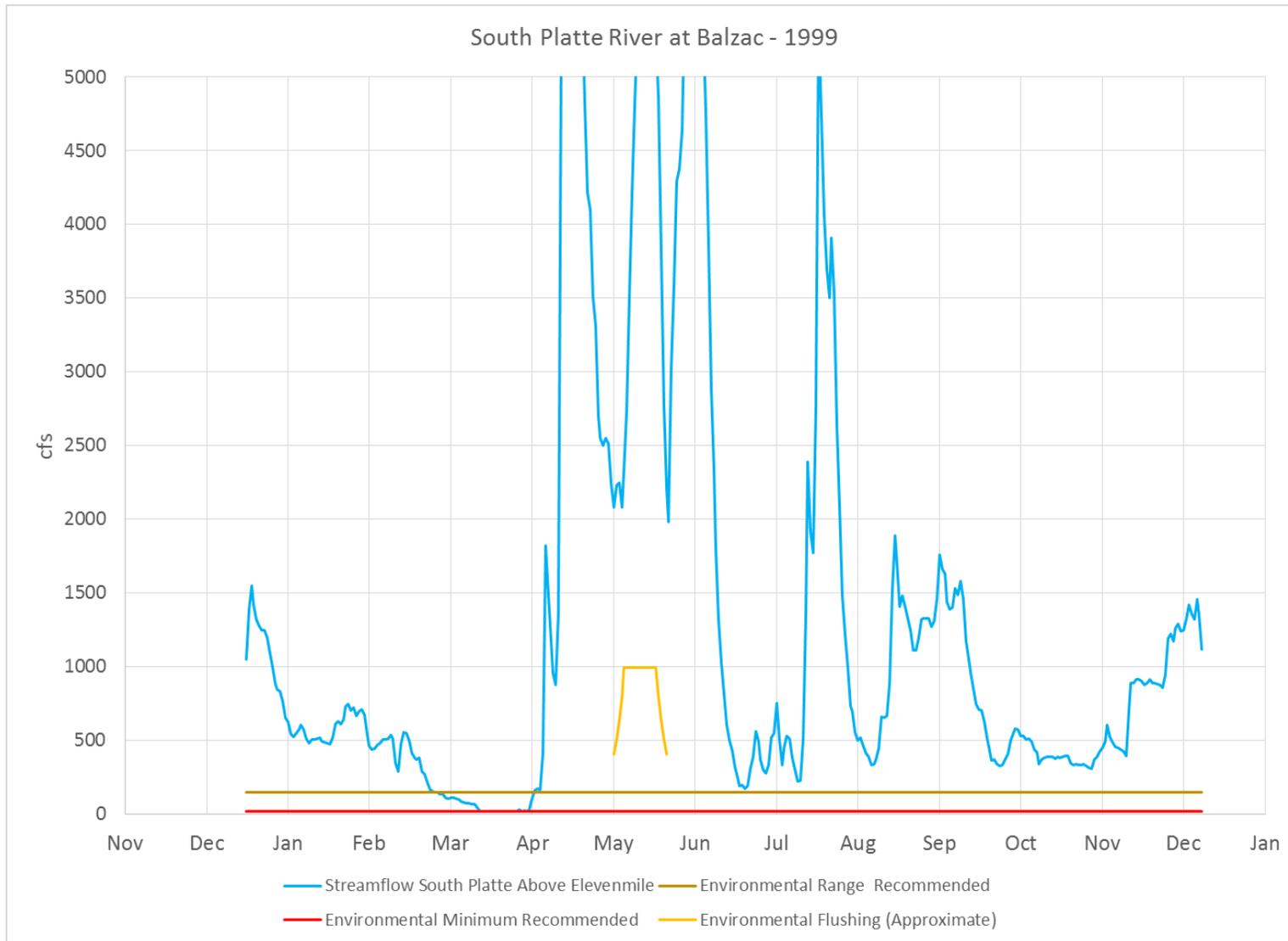
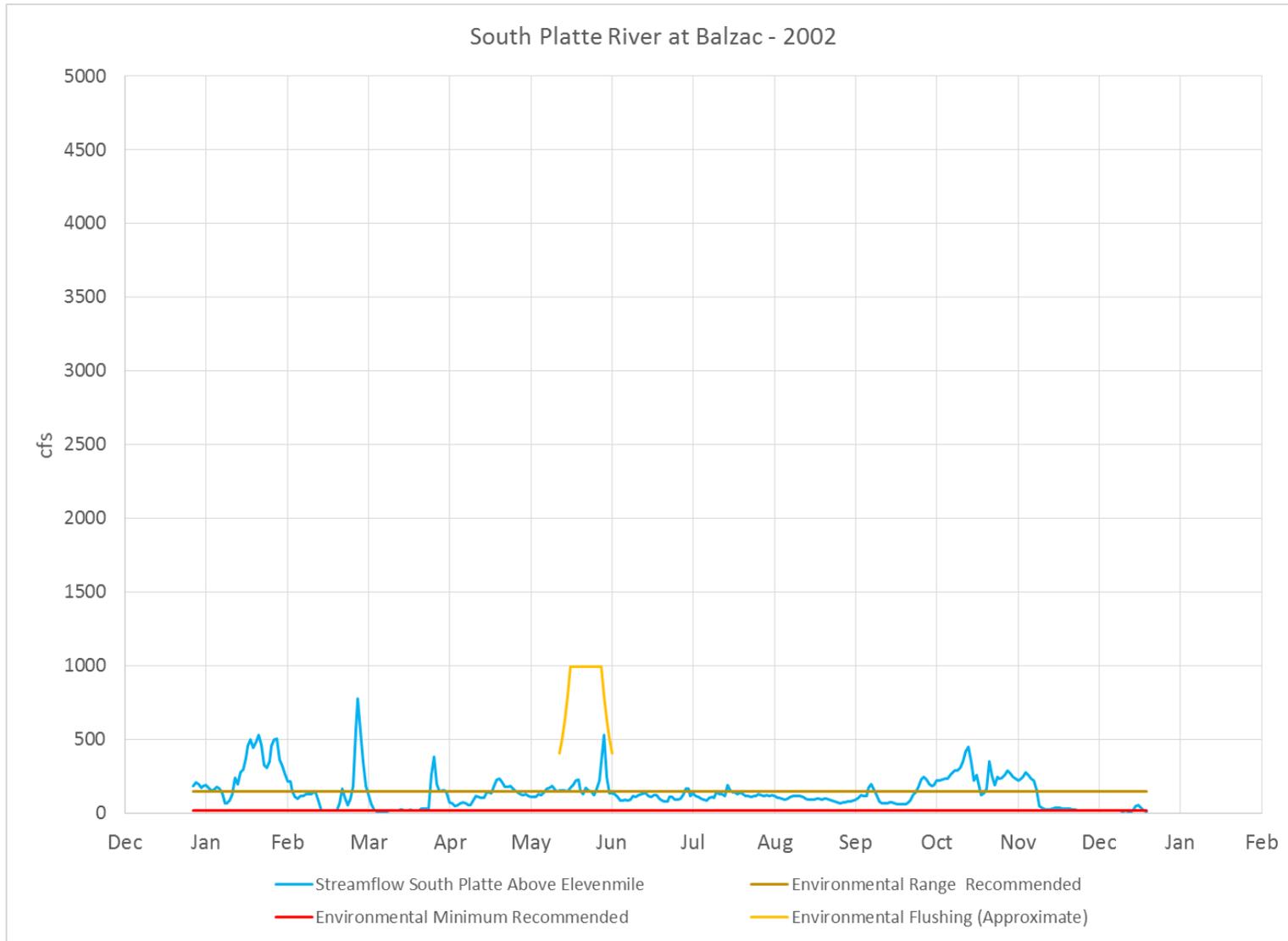


Figure 5-34 - Hydrograph comparison to available environmental and recreational flow information - 1999



**Figure 5-35 - Hydrograph comparison to available environmental and recreational flow information - 2002**

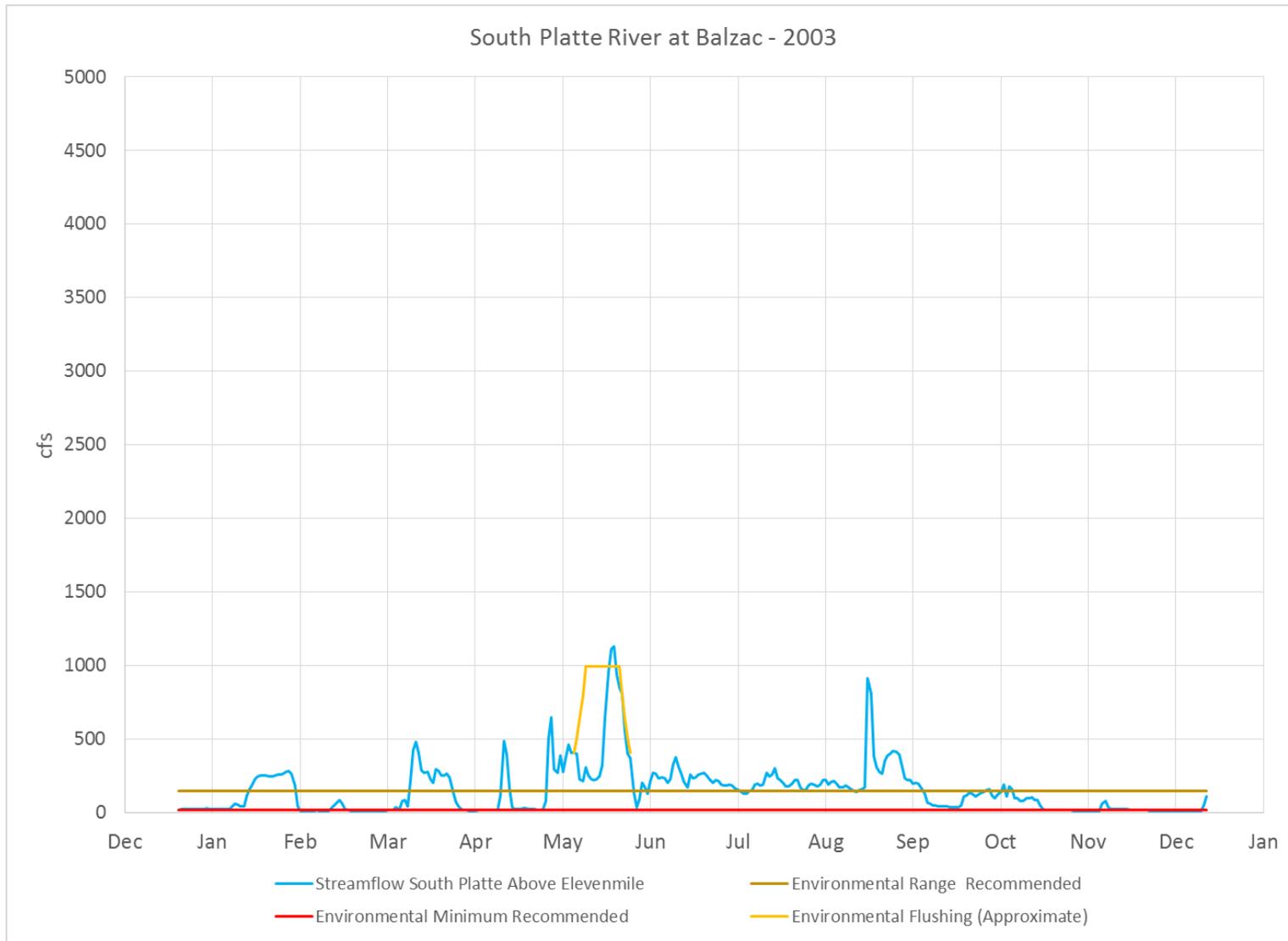


Figure 5-36 - Hydrograph comparison to available environmental and recreational flow information - 2003

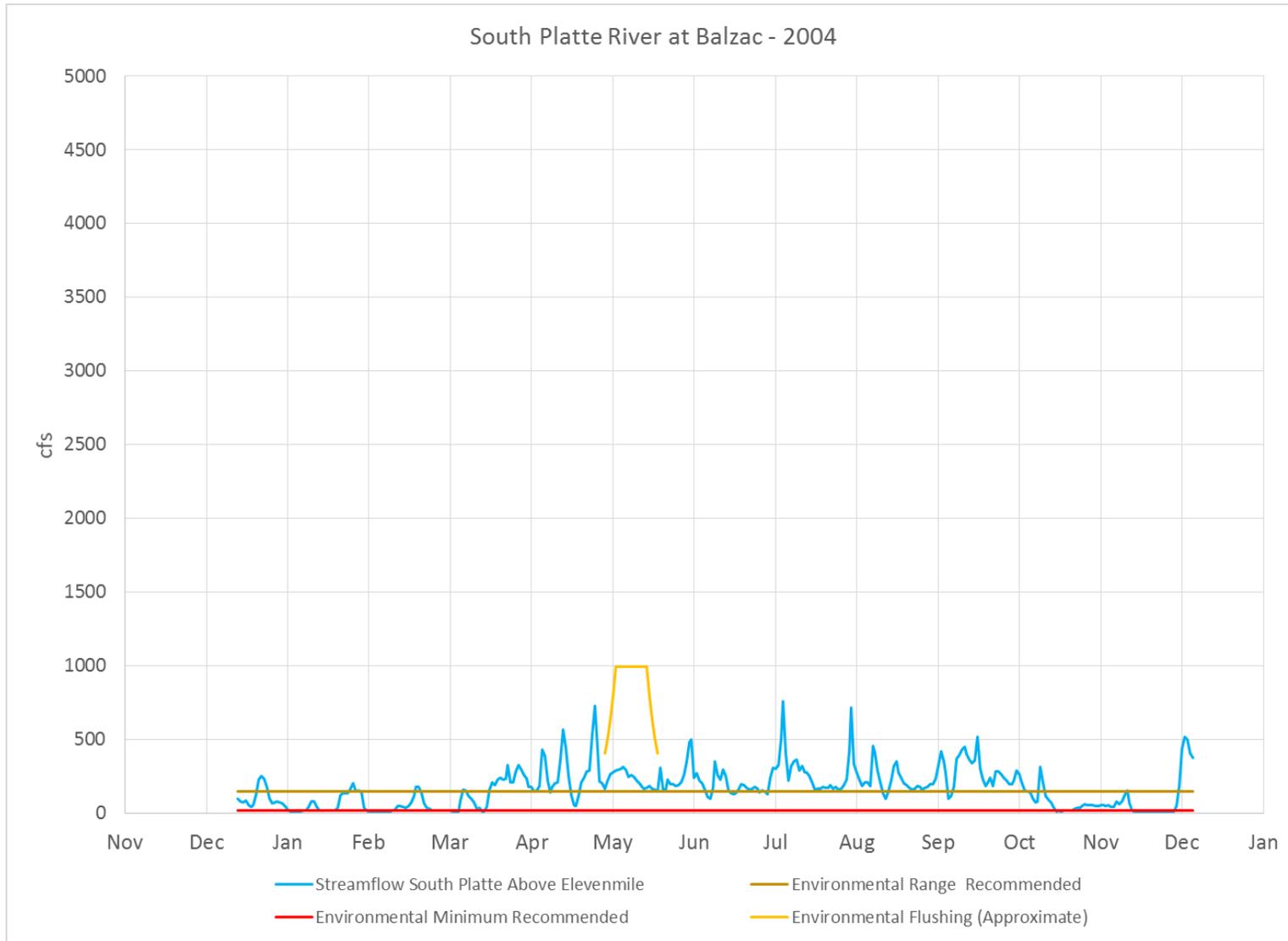
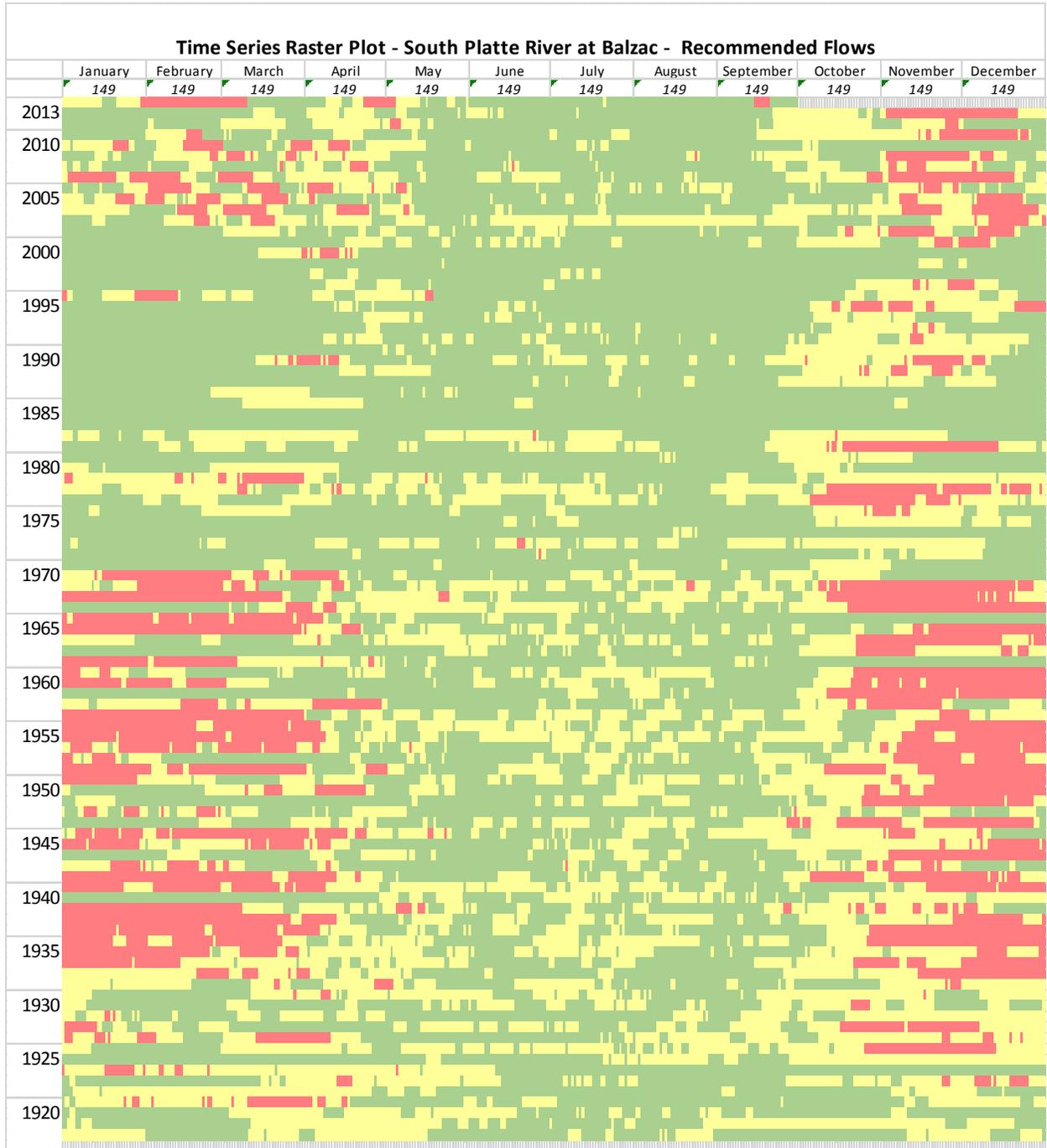


Figure 5-37 - Hydrograph comparison to available environmental and recreational flow information - 2004

In addition to comparing the flows in the South Platte at Balzac in specific years, time series raster plots were developed to look at the flows over the period of record. A raster plot demonstrates flows as different colors, based on specific parameters that take the flow recommendations into consideration. A time-series raster plot can assist in giving planners a quick snapshot of flows with respect to certain environmental and recreational considerations. The time series raster plots shown below were developed to graphically demonstrate how the various general flow recommendations described above are met based on the time series data for the gage.

To demonstrate the times when the recommended minimum flows are met or not met by the available streamflows, a time-series raster plot was developed, as shown in Figure 5-38. The days when the minimum flow rates were not met are indicated in red on the raster plot. The days when the flows between the minimum from the plains fish species and the minimum based on the Tennant method are shown in orange. The flows above the minimum flow rates are indicated in green on the plot.

Additional studies are needed to determine the needed flows throughout the example area. This plot shows times when there are opportunities to potentially increase the flows in the river to meet the environmental needs. If additional required flow studies and information become available, similar plots could be used to compare the streamflows to the more specific needs of aquatic and riparian habitat determined by such studies in additional locations. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-38 - Time Series Raster Plot – South Platte at Balzac - Minimum Recommended Flows**

To demonstrate the times when the flushing flows recommendations are met or not met, a time-series raster plot was developed, as shown in Figure 5-39. The yellow in the plot shows days when the flow is greater than the generally recommended flushing flows. The red in the plot shows times when the flow is less than the generally recommended flushing flows. In general, in many years there appears to be flushing flows available in this area, based on the general Tennant method. Additional work to determine the required flushing flow rates, duration and frequency is needed.

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs of aquatic and riparian habitat determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess the aquatic and riparian environment.



**Figure 5-39 - Time Series Raster Plot – South Platte River and Balzac - Flushing Flows (993 cfs)**

If additional required flow studies and information become available, similar plots could be used to compare the actual streamflows to the more specific needs or recreational uses determined by such studies. These types of studies are recommended in areas where this methodology is intended to be used to assess recreational flows of the stream.

## General Discussion and Recommendations

In general, the analysis of streamflows on the South Platte at Balzac indicates the streamflows may, at times, be present in this area to meet the very general flow recommendations presented above. However, significant additional flow study information is necessary to determine if these recommendations are adequate for environmental and recreational protection.

There is a great amount of additional data needed to fully assess the environmental and recreational protections that exist and may be needed in the example area on the South Platte. Studies that relate the channel form and function to the streamflows can make assessment of flows in the area more robust. In addition, streamflows necessary for recreational needs should be assessed.

The time-series raster plots are helpful in assessing what flows may be needed or available for additional municipal and industrial projects. The Surface Water Availability Analysis (detailed in Appendix \_\_) shows that there is potentially availability for surface water development at times in the South Platte at Balzac. Comparing to the raster plots once additional work has been done to fully assess the flows required for environmental and recreational needs can show times when additional diversions may not negatively impact the minimum flows, flushing flows or recreational flows. It appears that times of lengthy flushing flows and adequate minimum instream flows may coincide with some years during which the Surface Water Availability Analysis shows times of legal and physical availability. Additional daily analysis and comparison should be done to ensure the times generally shown in the raster plot and the summarized annual availability coincide, before determination is made that additional diversions may not impact environmental and recreational flows.

Specific types of projects that may help to protect or enhance the environmental and recreational flows in the area include:

- Fish Passage – Various diversions in the area dry-up the river, cooperative operational agreements to assist in fish passage around or through these diversion points in the future may help with stream connectivity.
- Operational Flow Agreements – One of the conceptual projects is intended to assist with flows in the lower river for agricultural users, cooperative operational agreements could be made to deliver such water at times when this could benefit both agricultural and environmental uses.
- Land Conservations and Habitat Restoration – Many of the projects in the area help to maintain environmental attributes including cooperative recharge projects and maintaining agriculture in the area.

Additional projects should be added into the stream mile representation for analysis of the effect of projects within the area. Specific spatial data, as well as specific flow data and completion date would be beneficial in determining when and to what degree these projects have benefited the example area. The actual needs of the aquatic and riparian habitat should be specifically studied in this area if additional project recommendations are to be made to protect and enhance the environmental attributes in this reach.

## 5.5 Project Example Summary

The methodology and stream mile representation framework described in detail in this section can be used in other locations throughout the South Platte Basin or the State. Hydrological data and flow studies are essential in assessing the environmental and recreational gap and the projects needed to maintain or enhance the environmental and recreational attributes. This framework can assist the BRTs and others in assessing these items.

## 6 Environmental and Recreational Projects List

Environmental and recreational projects in the South Platte Basin based upon SWSI 2010 are listed in Table 8. Some refinements to the projects list from SWSI 2010 have been included, although more refinements to the list and specificity of the projects are needed. All projects should include spatial data and additional descriptions of the projects to assist in identifying sufficiency of protections in the future. Additional projects have been included in Table 9 and include those recommended for inclusion by members of the environmental and recreational subcommittee of the Metro and South Platte Basin Roundtables during the BIP process.

**Table 8 - Environmental and Recreational Projects (based on SWSI 2010)**

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
231	West Gold Remediation	NCNA Interviewed	Project	"Chicago Creek, upstream of confluence with Clear Creek"	Completed	Christine Crouse	Built water diversion to separate drainage from mine tailings to protect water quality in Chicago Creek
223	Lombard Mine Cleanup and Mill Site Removal	NCNA Interviewed	Project	"Cumberland Gulch, upstream of confluence with Fall River"	Completed	Christine Crouse	Reshaping two mine dumps and burying wood waste from mill building
232	Minnesota Mine Remediation	NCNA Interviewed	Project	"Lion Creek, above confluence with West Fork Clear Creek"	Planned	Christine Crouse	"Spring seeping contaminated water from underground collapsed mine, plan to use passive remediation using an alkaline barrier to neutralize iron, zinc, and aluminum flowing out of spring"
309	Land conservation	NCNA Interviewed	Project		Ongoing		DU holds many easements on the river
310	Land conservation	NCNA Interviewed	Project		Planned		"Plan to protect additional 27,000 acres, which would include the water rights"
311	Seasonal wetland habitat restoration	NCNA Interviewed	Project		Ongoing		"Needs programs to control noxious weeds, lower priority than main stem."
312	Riparian habitat improvement education and outreach	NCNA Interviewed	Project		Ongoing		
313	South Platte Protection Plan	NCNA Interviewed	Information		Completed	Becky Long, South Platte Enhancement Board, David*	Implemented in 1997 to protect values in lieu of USFS making a W&S determination.
335	Tarryall Reservoir Enlargement	CPW	Project		Planned	CDOW	Presented in concept
336	Montgomery Reservoir Enlargement	NCNA Interviewed	Project		Planned	CDOW	Presented in concept
337	Tamarack Project	CPW	Project		Completed	CDOW	
801	Riparian restoration project	NCNA Interviewed					
803	St. Vrain Creek Corridor Committee releases 1000 AF/yr to benefit minnows	NCNA Interviewed	flow protection				
176	Bard Creek Instream Habitat Structures	NCNA Interviewed	Project	Bard Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
chr_f_51	River Restoration - Riparian Re-vegetation	CWCB	Project	Bear Creek	Planned	"Wendy Hawthorne, Groundwork Denver"	

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
cwrp_13	River Restoration Design	CWCB	Plan	below Chatfield	Planned	"Cecily Mui, South Suburban Parks and Recreation"	South Suburban Park
CDOW_5	Channel Restoration	CDOW	Stream and Riparian Restoration	Big T at Glade Park	completed	Ben Swigle - CDOW	
CDOW_6	Channel Restoration	CDOW	Stream and Riparian Restoration	Big Thompson at Narrows SWA	Planned	Ben Swigle - CDOW	
CDOW_39	Big Thompson Stream Restoration Phase 1	CDOW	Restoration	.1 segment upstream of the Mall Street Bridge below Olympus Dam	Completed	CDOW	Channel Restoration (0.1 miles) including vortex structures, pool excavation, boulder clusters
168	Big Thompson River Instream Fish Habitat Project	NCNA Interviewed	Project	Big Thompson River above Waltonia	Completed	Carl Chambers	ADA fishing access and Instream Fish Habitat Improvements
282	Minimum flow releases from Olympus Dam - BOR and NCWCD	NCNA Interviewed	Flow Protection	Big Thompson River from Estes Park to Dillon Tunnel	Ongoing	Larry Howard	Flows are specified by season and are defined as the lesser of the specified flow or the inflow into Lake Estes
263	Barrier Construction	NCNA Interviewed	Project	Black Hollow Creek	Completed	Kelly Larkin	Barrier construction for Greenbacks
CDOW_28	Fish Passage study	CDOW	Study	Boulder Creek	Ongoing	Ashley Ficke - CU Boulder	Study on ability of different fish species to pass through diversion structures under varying flows and temperatures.
162	Bull Pond Livestock Fencing Project	NCNA Interviewed	Project	Bull Pond	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
268	Investigating operations change	NCNA Interviewed	Flow Protection	Cache La Poudre	Planned	Amy Beatie	"Planning effort, looking at different operation efforts to leave more water in the river; next to new GOCO-funded path"
45	Cache la Poudre bank stabilization	NCNA Interviewed	Water Quality Protection	Cache la Poudre (near I-25)	Completed	Becky Pierce	Created wetlands and excavated sediment
166	Dutch George bank Stabilization	NCNA Interviewed	Project	Cache La Poudre River at Dutch George	Completed	Carl Chambers	Bank Stabilization
167	Kelly Flats Campground Bank Stabilization	NCNA Interviewed	Project	Cache La Poudre River at Kelly Flats Campground	Completed	Carl Chambers	Bank Stabilization
165	Mountain Park Campground Fish Habitat Project	NCNA Interviewed	Project	Cache La Poudre River at Mountain Park Campground	Completed	Carl Chambers	Instream Fish Habitat Structures
203	Cherry Creek Basin Water Quality Authority	NCNA Interviewed	Water Quality Protection	Cherry Creek Reservoir	Completed	Aurora Water Resources	water quality management and projects within to promote water quality downstream of Cherry Creek Reservoir
234	Courtney-Ryley-Cooper	NCNA Interviewed	Project	Clear Creek	Completed	Christine Crouse	"Rafting and fishing spot, habitat improvement and disabled access"

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
287	Golden Mile habitat improvement for fisheries - focused on brown trout mainly	NCNA Interviewed	Project	Clear Creek - Golden - just above RICD	Completed	David Nickum	
CDOW_25	Alvarado Bridge Replacement	CDOW	Project	Clear Creek @ Lawson	Completed	Clear Creek County	Replaced 4-culvert bridge with span, allowing movement of fish
218	McClellan Mine Remediation	NCNA Interviewed	Project	Clear Creek at Dumont	Completed	Christine Crouse	"McClellan: remediation of orphan mine site on Clear Creek. Material removed, remainder capped. Raft launching site built."
169	Como Creek Fishery Habitat Structures	NCNA Interviewed	Project	Como Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
221	General Herkimer Mill Site	NCNA Interviewed	Project	Confluence of Clear Creek and Spring Gulch	Completed	Christine Crouse	"Mine waste remediation, controlling run-off"
156	Corral Creek fish Structures	NCNA Interviewed	Project	Corral Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_8	Craig Creek (VanHall Property)	CDOW	Project	Craig Creek	Planned	Freestone Aquatics	Channel improvements, sediment transport, Planned
186	Creedmore Lakes Livestock Fencing Project	NCNA Interviewed	Project	Creedmore Lakes	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
47	"East Plum Creek wetlands restoration, channel restoration work."	NCNA Interviewed	Project	East Plum Creek	Completed	Becky Pierce	"Created wetlands, and installed in-stream structure to re-channel stream for Prebles Jumping Mouse"
164	Elkhorn Creek Instream Fish Habitat	NCNA Interviewed	Project	Elkhorn Creek	Completed	Carl Chambers	Instream Fish Habitat Structures and Bank Stabilization
36	Five-Mile Creek Channel Reconstruction	NCNA Interviewed	Project	Five-Mile Creek	Completed	Mark Beardsley	Stream Restoration
cwrp_9	"River Restoration - channel reconfiguration, riparian re-vegetation"	CWCB	Project	Fourmile Creek	Completed	"Dieter Erdmann, Colorado Open Lands"	
24	Pettee Ranch Riparian Restoration	NCNA Interviewed	Project	Four-Mile Creek	Completed	Mark Beardsley	Riparian restoration of grazing impacts
25	Four-Mile Creek / Denver Water Channel Reconstruction	NCNA Interviewed	Project	Four-Mile Creek	Completed	Mark Beardsley	Reconstruction of 3 mile channelized creek to 5 mile meandering stream. Part of larger wetlands restoration project.
35	Four-Mile Creek / Denver Water Channel Reconstruction #2	NCNA Interviewed	Project	Four-Mile Creek	Completed	Denver Water	90 acre Wetlands restoration. Part of a larger restoration project
224	Silver Age/Ship Ahoy	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	"Clean water diversion project to prevent contamination of the headwaters from 40,000 cubic yard Silver Age mine waste pile"

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
225	Gilson Gulch	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	An erosion and sediment control project designed to protect Clear Creek from metals and acidity associated with mine waste in the upper portions of the watershed
226	Silver Cycle	NCNA Interviewed	Project	Gilson Gulch	Ongoing	Christine Crouse	A mine waste consolidation and reclamation project designed to remove mine waste and stabilize the channel of Gilson Gulch
227	Mine Drainage Treatment Demonstration Project	NCNA Interviewed	Project	Gilson Gulch	Planned	Christine Crouse	A planned project to treat the base flow of Gilson Gulch using state-of-the-art passive mine drainage treatment techniques
175	Grizzly Gulch Riparian Restoration	NCNA Interviewed	Project	Grizzly Gulch	Completed	Carl Chambers	Stream Stabilization and Riparian Restoration
235	Grizzly Gulch Habitat Improvement	NCNA Interviewed	Project	Grizzly Gulch	Completed	Christine Crouse	"Habitat improvement for greenback, mine remediation, maintenance of chemical barrier protecting greenbacks from Brook Trout"
CDOW_27	Reintroduction of Native Trout	CDOW	Project	Grizzly Gulch	Planned	Paul Winkle - CDOW	Planned introduction of Native Trout
148	Gross Reservoir Minimum Release	NCNA Interviewed	Flow Protection	Gross Reservoir	Completed	Denver Water	Denver Water Minimum Instream Flows
285	Potential Environmental Pool	NCNA Interviewed	Flow Protection	Gross Reservoir	Planned	David Nickum - Colorado Trout Unlimited	
283	Minimum release from Idylwyde Dam of 7.0 cfs	NCNA Interviewed	Flow Protection	Idylwyde Dam - City of Loveland USFS easement	Ongoing	Larry Howard - Larimer County Municipalities	
chr4_4	"River Restoration - riparian Re-vegetation, sedimentation mitigation"	CWCB	Project	James Creek	Completed	"Colleen Williams, James Creek Watershed Initiative"	
288	Improve fish habitat and recreational opportunities	NCNA Interviewed	Project	Jefferson County - one mile of stream along Highway 6	Planned	David Nickum	
150	L.C. Pump Station to Chatfield Reservoir instream flows	NCNA Interviewed	Flow Protection	L.C. Pump Station to Chatfield Reservoir	Completed	Denver Water	Denver Water Minimum Instream Flows
CDOW_15	Greenback Cutthroat Recovery Project	CDOW	Habitat	La Poudre Pass, Corral, Neota, Willow, Hague, Chapin Creeks as well as Baker Gulch and the upper South Fork of the Cache la Poudre.	Planned	USFS, CDOW	The USFS decision in the Long Draw EIS to protect and reclaim the headwaters of the Cache la Poudre for greenback cutthroat recovery. Planned
222	Dibbins Mill and Sydney	NCNA	Project	Leavenworth Creek	Completed	Christine	"Mine waste remediation, controlling run-

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Tunnels Remediation	Interviewed				Crouse	off"
CDOW_3 8	Left Hand Creek Restoration	CDOW	Restoration	Left Hand Creek	Completed	CDOW	Channel Restoration (0.9 miles)
sev_1	"River Restoration - riparian Re-vegetation, sedimentation mitigation"	CWCB	Project	Lefthand Creek	Completed	"Colleen Williams, James Creek Watershed Initiative"	
155	Little Beaver Creek Fish Structures	NCNA Interviewed	Project	Little Beaver Creek (Between Comanche Peak Wilderness and Confluence of the South Fork of the Cache La Poudre River)	Completed	Carl Chambers	Instream Fish Habitat Structures
177	Little James Creek Bank Stabilization	NCNA Interviewed	Project	Little James Creek	Completed	Carl Chambers	Bank Stabilization and Mine Tailings cleanup
CDOW_2 4	USACE flood control study	CDOW	Study	Lower Poudre River below Fort Collins	Ongoing	USACE	US Army Corps flood control study - Poudre River at Greeley.
CDOW_2 9	Tamarack Recharge Study	CDOW	Study	Lower South Platte at Tamarack SWA	Ongoing	John Stednick - CSU	Study on how recharge projects affect physical habitat during winter flow conditions.
14	Puma Hills River Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
15	Allen Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
16	Bennis Ranch Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
17	Tarryall State Wildlife Area Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
18	Tarryall Reservoir Outlet Channel Reconstruction	NCNA Interviewed	Project	Lower Tarryall Creek	Completed	Mark Beardsley	"Channel Reconstruction and Stabilization, and some riparian protection"
CDOW_9	Lower Allen Ranch	CDOW	Project	Lower Tarryall Creek	Planned	Flywater	Channel improvements, sediment transport, riparian improvements, Planned
228	Lower Trail Creek Remediation	NCNA Interviewed	Project	Lower Trail Creek near confluence with Clear Creek	Ongoing	Christine Crouse	Abandoned mine remediation to project watershed
CDOW_1 1	Middle Fork South Platte Restoration	CDOW	Project	M Fk. South Platte	ongoing	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Ongoing and completed. See Attached List
142	River North Greenway	NCNA	Information	Metro Denver	Completed	Jeff Shoemaker	master plan for recreation use on the

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
	Master Plan	Interviewed		Greenways			Metro North South Platte
143	Westerly Creek Greenway Master Plan	NCNA Interviewed	Information	Metro Denver Greenways	Planned	Jeff Shoemaker	master plan for recreation use on Westerly Creek
144	Recreational and Riparian Improvements along the South Platte	NCNA Interviewed	Project	Metro Denver Greenways	Completed	Jeff Shoemaker	habitat enhancements and recreation enhancements along the Metro South Platte
145	Expansion / Enhancement to Confluence Park	NCNA Interviewed	Project	Metro Denver Greenways	Completed	Jeff Shoemaker	habitat enhancements and recreation enhancements to Confluence Park
146	Chatfield Reallocation Program	NCNA Interviewed	Flow Protection	Metro Denver Greenways	Planned	Jeff Shoemaker	storage water in Chatfield for releases into South Platte for recreation use
147	River South Greenway Master Plan	NCNA Interviewed	Information	Metro Denver Greenways	Completed	Jeff Shoemaker	master plan for recreation use on the Metro South Platte
20	McDaniel Ranch Riparian Restoration	NCNA Interviewed	Project	Michigan Creek	Completed	Mark Beardsley	Riparian Restoration of Ranching impacts
cwrp_3	"River Restoration - Channel reconfiguration, Riparian re-vegetation"	CWCB	Project	Middle Boulder Creek	Completed	"Roger Svendsen, Boulder Flycasters TU"	
CDOW_3	Channel Restoration	CDOW	Stream and Riparian Restoration	Middle Boulder Creek @ Rogers Park	Completed	Ben Swigle - CDOW	
CDOW_7	Channel Restoration	CDOW	Stream and Riparian Restoration	Middle Boulder Creek above Barker Reservoir	Planned	Ben Swigle - CDOW	
CDOW_4	Greenback Cutthroat Waters	CDOW	Study	Middle Boulder Creek from confluence with Boulder Creek to headwaters	Planned	Ben Swigle - CDOW	
286	Buffalo Peak Ranch fishery restoration - channel modification to provide better habitat restoration for brown trout	NCNA Interviewed	Project	Middle Fork at Buffalo Peaks SWA	Completed	David Nickum and Ecological Resource Consultants	
22	Buffalo Peaks Ranch Fish Habitat	NCNA Interviewed	Project	Middle Fork of South Platte	Completed	Mark Beardsley	"Fish Habitat in channel work, bank stabilization, public access"
23	Santa Maria Ranch Riparian Restoration	NCNA Interviewed	Project	Middle Fork of South Platte	Completed	Mark Beardsley	Riparian restoration and Channel reconstruction
21	Fairplay Beach Stream Restoration	NCNA Interviewed	Project	Middle Fork of South Platte in Fairplay	Completed	Mark Beardsley	Riparian Restoration of Placer mining impacts
170	Middle St. Vrain River Fish Structures	NCNA Interviewed	Project	Middle St. Vrain River at Camp Dick	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_36	Habitat improvements projects	CDOW	Structural	NF Republican	Planned	CDOW	Habitat Improvement projects for Stonecat within the NF republican watershed

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_30	Dr. Falke Study	CDOW	Study	NF Republican and Arikaree River	Completed	Jeff Falke - University of Oregon	Study on native fish population and habitat in NF Republican River Basin.
233	Aorta Mine Remediation	NCNA Interviewed	Project	North Empire Creek	Planned	Christine Crouse	"Seeping mine was draining into North Empire Creek, now goes into pipe under a landfill. Project will make improvements to inlet of that pipe"
CDOW_26	Realignment of State Highway 119	CDOW	Project	North Fork Clear Creek	Planned	Holly Huyck-CDOT	Treat mine wastes, cap tailings piles, improve fish habitat
1	Lazy River Stream Restoration	NCNA Interviewed	Project	North Fork of South Platte	Completed	David Bennet	Added vortex weirs
34	North Fork Fish Channel	NCNA Interviewed	Project	North Fork of South Platte (just below Antero)	Completed	Denver Water	Created alternate channel for fish movement
159	North Fork of the Cache La Poudre River Instream Fish Habitat	NCNA Interviewed	Project	North Fork of the Cache La Poudre River	Completed	Carl Chambers	Instream Fish Habitat Structures
289	Halligan-Seaman Shared Vision Planning	NCNA Interviewed	Project/Flow Protection	North Fork of the Poudre	Ongoing	City of Greeley, City of Ft. Collins	
163	North Lone Pine Creek Fencing Project	NCNA Interviewed	Project	North Lone Pine Creek	Completed	Carl Chambers	Livestock Fencing to promote wetland recovery
158	Pennock Creek Instream Fish Habitat	NCNA Interviewed	Project	Pennock Creek	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_33	Boreal toad reintroduction	CDOW	Species reintroduction	Poudre River Basin from Big South Confluence to Headwaters	Ongoing	CDOW	Reintroduction of Boreal Toads in Cameron Pass Area
CDOW_19	Diversion structure modifications for bypass flows	CDOW	Structural	Poudre River - Watson hatchery to Fossil Creek	Planned	CDOW	Create ability to bypass low flows through diversion structures on Poudre river, including the CDOW Watson
CDOW_14	NISP EIS Impacts Study	CDOW	EIS Study	Poudre River below Canyon Mouth	Ongoing	NCWCD	An assessment of the Lower Poudre river corridor as the habitat changes relative to water levels for both riparian areas and fish habitat is currently underway associated with this project. Ongoing
CDOW_17	Anderson Engineering 2-D modeling	CDOW	Study	Poudre River below Canyon Mouth	Completed	NCWCD	Groundwater modeling in support of proposed NISP project
CDOW_21	JOP Enhancement	CDOW	Flow Agreement	Poudre River below Joe Wright Reservoir	Planned	CDOW	Exchange of Greeley owned Laramie Tunnel water into Chambers Lake to enhance existing wintertime JOP flows.
CDOW_23	Poudre River stream restoration - below Watson Lake diversion structure	CDOW	Restoration	Poudre River below Watson Lake SWA	Planned	CDOW	Channel restoration and design of low flow channel to improve habitat and channel function at low flow
CDOW_20	Minimum instream flows - Poudre River	CDOW	Flow Agreement	Poudre River in Fort Collins	Planned	CDOW	Potential agreement to maintain 25 cfs at the Poudre River Lincoln St. gage from Nov. - April

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_16	Joint Operating Plan (JOP)	CDOW	Flow Agreement	Poudre River Mainstem	Completed	CDOW	Operating agreement between CDOW, Fort Collins and Greeley to provide minimum wintertime flows in Poudre River.
CDOW_18	Physical habitat modeling	CDOW	Study	Poudre River, North Fork	Completed	City of Greeley	Technical report by Bill Miller in support of proposed Halligan Seaman project
sev_22	River Restoration - Riparian Re-vegetation	CWCB	Project	Rock Creek	Planned	"Ed Self, Wildlands Restoration Volunteers"	
802	Various bank stabilization and riparian restoration projects	NCNA Interviewed	Restoration	S Boulder Creek			
CDOW_12	South Fork South Platte Restoration	CDOW	Project	S Fk. South Platte	Planned	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Planned and completed
46	Saint Vrain stream realignment and wetland enhancement	NCNA Interviewed	Project	Saint Vrain (near Longmont)	Completed	Becky Pierce	"Realigned stream channel, wetland mitigation and enhancement"
CDOW_2	South Boulder Creek Channel Restoration	CDOW	Stream and Riparian Restoration	South Boulder Creek between Pinecliff and Moffat Tunnel	Completed	Ben Swigle - CDOW	
172	Jumbo Mountain Picnic Ground Bank Stabilization	NCNA Interviewed	Project	South Boulder Creek at Jumbo Mountain Picnic Ground	Completed	Carl Chambers	Bank Stabilization and Instream Fish Habitat Structures
CDOW_1	Channel Restoration	CDOW	Restoration/Diversion Reconstruction	South Boulder Creek between South Boulder Road and 1 mile west of Hwy 36.	Completed	Ben Swigle - CDOW	
284	Fish passage on diversion structures	NCNA Interviewed	Project	South Boulder Creek from Gross Reservoir to Mouth	Completed	David Nickum - Colorado Trout Unlimited	
154	South Fork of Cache La Poudre River Fish Structures	NCNA Interviewed	Project	South Fork of Cache La Poudre River	Completed	Carl Chambers	Instream Fish Habitat Structures
CDOW_13	Upper South Platte Stream Restoration	CDOW	Project	South Platte	Planned	CDOW - Matt Kondratieff	Adult Salmonid Habitat, channel improvements, sediment transport, riparian improvements, Planned
CDOW_34	Identification and modification of barriers to fish passage on South Platte	CDOW	Study	South Platte	Planned	CDOW	Identification of South Platte mainstem and tributary diversion structures that are barriers to fish passage. Propose collaboration with structure owners to investigate feasibility and funding of structure modification to allow for fish passage.

Appendix D – Environmental and Recreational Assessment Methodology and Framework  
 South Platte Basin Implementation Plan

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
26	South Platte Protection Plan #3 - Eleven Mile Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Release of minimum instream flows necessary for fishery habitat
27	South Platte Protection Plan #4 – Cheesman Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Release of minimum instream flows necessary for fishery habitat
28	South Platte Protection Plan #5 - Outflow Ramping from Eleven Mile / Cheesman Reservoir / Roberts Tunnel	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Outflow Ramping Agreement (ie reservoir outflow fluctuation agreements by percent of change)
29	South Platte Protection Plan #6 - Channel work on North Fork	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Commitment to consult Colorado Division of Wildlife in any channel work and to maintain or enhance structural habitat for trout.
30	South Platte Protection Plan #7 - Planning meetings b/t Operators and fisheries and whitewater interests	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	Commitment to consult fisheries and recreation interests regarding upcoming operations.
31	South Platte Protection Plan #8 - New operating and monitoring equipment	NCNA Interviewed	Information	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	Denver Water	"Install low flow valve at Eleven Mile Reservoir, install stream temp. monitors at Eleven Mile and Cheesman Reservoirs, and SNOTEL gages in the basin"
32	South Platte Protection Plan #2 - Spinney Mountain Reservoir	NCNA Interviewed	Flow Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Completed	City of Aurora	Release of minimum instream flows necessary for fishery habitat

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
33	South Platte Protection Plan #9 - Stream Channel Maintenance	NCNA Interviewed	Water Quality Protection	South Platte (from Eleven-mile reservoir outlet to confluence with the North Platte) and North Platte (from Insmont to confluence with South Platte)	Planned	Kevin Bayer	"Monitor Sediment levels, and where necessary develop in-channel projects to stabilize banks and erosion resulting from the 2002 Hayman fire."
153	Happy Meadows/ Sportsman's Paradise River Restoration	NCNA Interviewed	Project	South Platte at Happy Meadows	Completed	Carol Ekarius	riparian and river restoration
131	Trumbull Trout Habitat Enhancement	NCNA Interviewed	Project	South Platte below Horse Creek	Completed	Steve Dougherty	Improve trout habitat in river and provide better public access
WSRA-SP-1	South Platte River Recreation and Habitat Feasibility Study	WSRA	Study	South Platte River	Ongoing	Eric	Restoration Study
chr_f_22	Happy Meadows Campground River Restoration Design	CWCB	Plan	South Platte River near Lake George	Completed	"Carol Ekarius, Coalition for the Upper South Platte"	
103	Hayman Fire Restoration	NCNA Interviewed	Information	South Platte River upstream of Michigan Creek	Planned	Steve Dougherty	Doing Hydro assessment in regards to sediment impacts from the Hayman Fire. Also removal of low-head dam.
290	Chatfield Reallocation	NCNA Interviewed	Project/Flow Protection	South Platte through Metro Area	Ongoing	CWCB	
291	Metro Area River Restoration Proposals	NCNA Interviewed	Project	South Platte through Metro Area	Planned	CWCB	
CDOW_31	Plains Fish Monitoring	CDOW	Monitoring	South Platte/ Republican	Ongoing	CDOW	Ongoing monitoring of native fish populations in North Fork and Republican River basins.
CDOW_35	Plains fish reintroduction	CDOW	Species reintroduction	South Platte/ Republican	Planned	CDOW	Reintroduction of native plains fish species including Brassy Minnow, Northern Redbelly Dace, Common Shiner, Plains Minnow, Suckermouth Minnow
CDOW_32	Special Status Plains Fish Species - State Conservation Plan	CDOW	Monitoring/Study/Conservation Plan	South Platte/ Republican (& Arkansas)	Completed	CDOW	Plan for all designated State Threatened and State Endangered native plains fish.
48	Mayer Ranch Park mitigation project	NCNA Interviewed	Project	South Turkey Creek	Completed	Becky Pierce	Channel reconstruction to mitigate incised stream.
149	Strontia Springs Reservoir to L.C. Pump Station instream flows	NCNA Interviewed	Flow Protection	Strontia Springs Reservoir to L.C. Pump Station	Completed	Denver Water	Denver Water Minimum Instream Flows
12	Lazy River Stream Stabilization	NCNA Interviewed	Project	Tarryall Creek	Completed	Mark Beardsley	Stream Stabilization with Rock
13	Eagle Rock Ranch Stream Stabilization	NCNA Interviewed	Project	Tarryall Creek	Completed	Mark Beardsley	Stream Stabilization with Rock
CDOW_37	Tarryall Project	CDOW	Restoration	Tarryall Creek	Completed	CDOW	Channel and Riparian restoration (0.6 miles)

Appendix D – Environmental and Recreational Assessment Methodology and Framework  
 South Platte Basin Implementation Plan

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
cwrp_1	River Restoration - Riparian Re-vegetation	CWCB	Project	Tarryall Creek near Jefferson	Completed	"Dieter Erdmann, Colorado Open Lands"	
CDOW_10	Trail Creek Restoration	CDOW	Project	Trail Creek	Planned	CUSP - Carol Ekarius	Channel improvements, sediment transport, riparian improvements, Planned
173	Tributary of West Fork of Clear Creek Bank Stabilization	NCNA Interviewed	Project	Tributary of West Fork of Clear Creek	Completed	Carl Chambers	Bank Stabilization and Instream Fish Habitat Structures
174	Reintroduction of Native Cutthroat Trout	NCNA Interviewed	Project	Tributary of West Fork of Clear Creek	Planned	Carl Chambers	Planned Reintroduction of Native Cutthroat Trout
chrp_42	River Restoration - Riparian Re-vegetation	CWCB	Project	Upper Rock Creek	Completed	"Ed Self, Wildlands Restoration Volunteers"	
19	Cline Ranch Riparian Restoration	NCNA Interviewed	Project	Upper Tarryall Creek	Completed	Mark Beardsley	Riparian Restoration of Ranching and Placer mining impacts
229	Upper Trail Creek Remediation	NCNA Interviewed	Project	Upper Trail Creek	Completed	Christine Crouse	Mine remediation to prevent acid mine drainage
CDOW_105	Knight-Imler Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 415892E, 4324356N, Downstream: 416521E, 4322089N	Completed	CDOW	2002, 1.2mi
CDOW_102	Antero Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 423008E, 4316108N, Downstream: 423513E, 4316072N	Completed	CDOW	1999, 0.7mi
CDOW_106	Hartsel Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 429621E, 4319613N, Downstream: 430562E, 4319239N	Completed	CDOW	2002, 1mi
CDOW_111	Middle Fork of South Platte River (Phase 1)	CDOW	Restoration	Upstream: 435539E, 4318654N, Downstream: 435811E, 4318497N	Completed	CDOW	2007, 0.5mi
CDOW_110	Middle Fork side-channel Project, Middle Fork of South Platte River	CDOW	Restoration	Upstream: 435539E, 4318654N, Downstream: 435904E, 4318299N	Completed	CDOW	2006, 0.6mi
CDOW_112	Middle Fork of South Platte River (Phase 1 continued)	CDOW	Restoration	Upstream: 435811E, 4318497N, Downstream: 435918E, 4318290N	Completed	CDOW	2008, 0.2mi
CDOW_113	Dream Stream (Phase 1), South Platte River	CDOW	Restoration	Upstream: 436205E, 4317880N, Downstream: 436644E, 4317668N	Completed	CDOW	1991, 0.4mi

<b>SWSI NCNA Database Projects (no ISF or Stewardship)</b>							
ProjectID	ProjectName	ProjectCategory	ProjectType	ProjectLocation	ProjectStatus	ProjectContact	ProjectNote
CDOW_107	Aurora Project, South Platte River	CDOW	Restoration	Upstream: 440995E, 4316473N, Downstream: 441837E, 4316347N	Completed	CDOW	2003, 1mi
CDOW_114	Buckley Ranch Project, South Platte River	CDOW	Restoration	Upstream: 446523E, 4313949N, Downstream: 446817E, 4313806N	Completed	CDOW	1993, 0.4mi
CDOW_101	Dream Stream (Phase 2), South Platte River	CDOW	Restoration	Upstream: 446817E, 4313806N, Downstream: 446897E, 4313763N	Completed	CDOW	1998, 0.2mi
CDOW_109	South Fork Project, South Fork of South Platte River	CDOW	Restoration	Upstream: 446897E, 4313763N, Downstream: 435955E, 4318057N	Completed	CDOW	2005, 1.7mi
CDOW_104	Dream Stream (Phase 3), South Platte River	CDOW	Restoration	Upstream: 446897E, 4313763N, Downstream: 447885E, 4313638N	Completed	CDOW	2001, 0.9mi
CDOW_103	Threemile Creek, Creek Project, Tributary to South Platte River	CDOW	Restoration	Upstream: 447474E, 4313277N, Downstream: 447592E, 4313211N	Completed	CDOW	2000, 0.5mi
CDOW_108	Dream Stream (Phase 4), South Platte River	CDOW	Restoration	Upstream: 447885E, 4313638N, Downstream: 448492E, 4313429N	Completed	CDOW	2004, 0.3mi
219	Little 6 #1	NCNA Interviewed	Project	Virginia Canyon upstream from confluence with Clear Creek	Completed	Christine Crouse	Offsite removal of mine waste and erosion control
220	Little 6 #2	NCNA Interviewed	Project	Virginia Canyon upstream from confluence with Clear Creek	Completed	Christine Crouse	"Mine waste remediation, controlling run-off"
230	Doctor Mine Remediation	NCNA Interviewed	Project	West Fork Clear Creek	Completed	Christine Crouse	"Habitat improvement for greenback, mine remediation, maintenance of chemical barrier protecting greenbacks from Brook Trout"
cwrp_7	Greenway Master Plan	CWCB	Plan	Westerly Creek	Ongoing	"Brian Hyde, Westerly Creek Connection"	

**Table 9 - Additional Identified Environmental and Recreational Projects**

<b>Additional Identified Projects</b>							
<b>ProjectID</b>	<b>ProjectName</b>	<b>ProjectCategory</b>	<b>ProjectType</b>	<b>ProjectLocation</b>	<b>ProjectStatus</b>	<b>ProjectContact</b>	<b>ProjectNote</b>
	Whitney & Eaton Ditches Fish Passage Project	CPW	Fish Passage	Poudre River: Whitney & Eaton ditches near Frank SWA	Proposed	CPW	Stakeholders include Whitney Ditch Co., Eaton Ditch Co., CPW, Larimer County, Windsor, and Greeley
	Boxelder Ditch Fish Passage Project	CPW	Fish Passage	Poudre River: Boxelder Ditch / Fossil Creek Reservoir Diversion near ELC	Planned	CPW	Stakeholders include Fort Collins and CPW
	Big Valley Reach Fish Passage Project	USFWS	Fish Passage	Big Thompson River: Southside Ditch, Loudon Ditch, and George Rist Ditch	Proposed	CPW	Stakeholders include USFWS, Big Thompson River Restoration Coalition, CPW, private land owners, South Side Ditch Company
	Meadows & South Ledge Fish Passage Project	USFWS	Fish Passage	St. Vrain Creek: Meadows Ditch and S. Ledge Ditch	Proposed	CPW	Stakeholders include USFWS, Boulder County, ditch companies, Crane & Associates, and CPW
	Green Ditch Fish Passage Project	USFWS	Fish Passage	Boulder Creek: Green Ditch	Planned	CPW	Stakeholders include USFWS, Boulder Open Space and Mountain Parks, and CPW
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Upper/Lower Square Tops Lake and Duck Creek	Proposed	CPW	Introduction of Native Trout
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Rock Creek	Proposed	CPW	Introduction of Native Trout
	Middle Fork of South Platte River (Phase 2)	CPW	Restoration	Upstream: 435415E, 4318627N, Downstream: 436015E, 4318251N	Completed	CPW	2009, 0.2mi
	Middle Fork of South Platte River (Phase 3)	CPW	Restoration	Upstream: 435246E, 4318865N, Downstream: 435415E, 4318627N	Completed	CPW	2010, 0.3mi
	Middle Fork of South Platte River (Phase 4)	CPW	Restoration	Upstream: 435154E, 4318861N, Downstream: 435246E, 4318865N	Completed	CPW	2011, 0.3mi

<b>Additional Identified Projects</b>							
<b>ProjectID</b>	<b>ProjectName</b>	<b>ProjectCategory</b>	<b>ProjectType</b>	<b>ProjectLocation</b>	<b>ProjectStatus</b>	<b>ProjectContact</b>	<b>ProjectNote</b>
	Clear Creek/Twin Tunnels Project, Clear Creek	CPW/CDOT	Restoration	Clear Creek	Ongoing	CPW	Stakeholders include CPW and CDOT
	Dream Stream (Phase 5), South Platte River	CPW	Restoration	Upstream: 448492E 4313429N, Downstream: 449579E 4313398N	Ongoing	CPW	Stakeholders include CPW and Park County, began Fall 2013, 1.5mi
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Dry Gulch - trib to upper Clear Creek, Clear Cr. County	Planned	CPW	Introduction of Native Trout
	Greenback Cutthroat Recovery Project	CPW	Species reintroduction	Herman Gulch - trib to upper Clear Creek, Clear Cr. Co	Planned	CPW	Introduction of Native Trout
	Big Thompson Stream Restoration Phase 2	CDOW	Restoration	0.2 mile segment downstream of stream gage below Olympus dam	Completed	CDOW	Channel Restoration (0.2 miles) including vortex structures, pool excavation, boulder clusters, root wads, log spurs, spawning channel, riparian plantings, reduction of channel width with fill material
	Greeley Poudre Greenway		Project	Poudre	Planned	Becky Safraik , Greeley	Channel improvements, gravel pit storage, greenway
	Fort Collins Poudre River restoration and enhancement project		Stream and Riparian Restoration	Poudre	Planned	John Stokes, Fort Collins Natural Areas Director	Complete master plan and segments are being completed
	Josh Ames Dam Removal Project		Stream and Riparian Restoration	Poudre	Completed 2013	Fort Collins	Completed partially with WSRA grant
	North Fork Poudre Eagles Nest Restoration Project		Habitat Restoration	Poudre	Planned	CO Trout Unlimited, Larimer County Open Lands	Ongoing, long-term Rocky Mountain Flycasters (Colo Trout Unlimited) project in cooperation with Larimer county Open Lands (now part of Larimer Co. Dept Nat. Resources).
	Park County Prioritization Process		Flow/Lake Level	Park County	Planning	Park County Advisory Board on the Environment	Prioritization process of streams and natural lakes that could benefit from in-stream flow and natural lake level water rights.
	Sugar Creek Sediment Mitigation Project		Species Habitat	Sugar Creek Watershed in Douglas County			5-Year Plan Sugar Creek Watershed in Douglas County – confluence with SP River about 10 miles upstream from Strontia Springs - center of the project area is near coordinates 105°10'00" and 39°18'00" (NAD83). Preble's Meadow Jumping Mouse Habitat

Appendix D – Environmental and Recreational Assessment Methodology and Framework  
 South Platte Basin Implementation Plan

<b>Additional Identified Projects</b>							
<b>ProjectID</b>	<b>ProjectName</b>	<b>ProjectCategory</b>	<b>ProjectType</b>	<b>ProjectLocation</b>	<b>ProjectStatus</b>	<b>ProjectContact</b>	<b>ProjectNote</b>
	CUSP Projects			Upper South Platte			various projects, list being refined
	South Park Groundwater and Surface Water Quality Baseline Study		Study	Upper South Platte	Completed	Park County Land & Water Trust Fund	Develop a multi-year baseline of water quality in South Park before energy exploration & development.
	Mine Assessment Project in Headwaters of South Platte		Study	Upper South Platte	Completed	CWCB Healthy Rivers Fund grant, LWTF, & CUSP	Identified the water-quality impacts of historical mining and impacts from the acid rock drainage throughout the watershed. North Fork of the Upper South Platte – mines plus iron fens in Hall Valley & Geneva Creek areas Middle Fork of the Upper South Platte – mines, mills, settling ponds and surface water bodies in Montgomery, Buckskin and Mosquito Gulches South Fork of the Upper South Platte – Weston Pass Mining District and mines around Fourmile Creek headwaters
	Park County Land & Water Trust Fund Projects			Upper South Platte			various projects, list being refined
	Park County Trout Population Monitoring: Habitat Use and Migration Patterns in South Park Streams		Monitoring	Upper South Platte	In Progress	CPW, CO Trout Unlimited, EcoMetrics, South Park National Heritage Area, & LWTF	Provide a scientific basis for planning and designing stream restoration and habitat improvement projects that support quality trout stream fisheries in the Middle and South Forks from Fairplay to Antero & Spinney Reservoirs.
	Park County Water Resources Inventory and Strategic Plan: Assessment of Functional Condition and Identification of Priorities for Restoration and Protection		Study	North and Middle Forks of the South Platte and Tarryall Creek	In Progress	CWCB Healthy Rivers grant, CPW Wetlands Program, LWTF, SPNHA, CUSP	This is a basin-wide assessment that will rate the functional condition and restoration potential of stream and wetland habitats on the North and Middle Forks of the South Platte and Tarryall Creek. It will produce an organized set of priority preservation and restoration projects on properties where the causes of degradation or impairment can be resolved and where protection from future impacts is possible. The study team will include local, state and federal agencies. This project is an on-the-ground match for an EPA grant project by Colorado Natural Heritage Area to develop a web-based wetlands planning toolbox using Park County as an example area in the toolbox.

## 7 Additional Analyses Needed

The examples and projects discussed in this Appendix indicate some projects that may provide protections to environmental and recreational attributes. In addition to the presence or absence of protections in focus areas, various other items can impact the shortage or gap for environmental and recreational needs. Changes in river conditions due to climate change or increased uses in the basin could result in reduced streamflows and further impair wildlife habitat. Changes in channel form and function can both impact and benefit habitat. The trend of irrigated agricultural lands being dried up can impact the amount and location of environmental and recreational needs in the Basin. These trends and conditions can be further analyzed with the framework discussed in this section. Additional analyses to determine these impacts may be performed in the future.

There is significant additional information, data and analyses needed to better understand and quantify the environmental and recreational needs, the benefit from existing and planned projects, the potential impact from general trends and other projects, and the protections in place or needed to protect or enhance environmental and recreational attributes within the South Platte Basin. This Appendix and related sub-appendices discuss specific additional data needs and analysis constraints that should be addressed in the future. The additional information, data and analyses needed generally includes:

- Better data and information regarding attributes and projects, including spatial information, attribute assessments, habitat assessments, and recreational assessments.
- Better assessment of ecological habitat and streamflow requirements and preferred recreational flows.
- Integration of other existing and not yet available environmental and recreational data.
- Specific additional analyses with regard to the Stream Mile Representation Framework are detailed in the Overview in Appendix D-1 and include:
  - Scale the SMRF to a wider area, including reviewing and enhancing the SMRF processes and focusing on automation and quality control.
  - Integrate the SMRF with quantitative analysis of environmental and recreational needs and gap.

Generally, additional data, better data and better data management is needed basin-wide to adequately assess the needs of and requirements for maintaining and enhancing environmental and recreational attributes. Full understanding of environmental and recreational issues will not be possible until “wet water” environmental flow requirements are better understood. Therefore, it is recommended that analysis of streamflow and other data occur and be referenced to the SMRF. Modeling such as Colorado’s Decision Support Systems (CDSS) basin models and point flow models, once available, could provide estimates of flows at locations intermediate to stream gages and such data could likewise be referenced to the SMRF. The integration of wet water analyses similar to the analyses performed in the example areas in Section 5 of this Appendix, with spatial

context to 0.1-mile resolution will provide a powerful tool for evaluating environmental and recreational needs and gaps, and the impacts of projects such as Identified Projects and Processes (IPPs).

## 8 Challenges to Assessment

A number of challenges exist in the evaluation of the impacts of municipal and industrial projects on environmental and recreational attributes, including:

- The project is currently in the permitting process which limits the ability to evaluate the project independent of the permitting process.
- The project sponsor/proponent is concerned about serving its customers and not necessarily concerned about the impacts of project on other system components (environment, recreation, agriculture) and therefore is not considering a multi-purpose project.
- The project sponsor or proponents may not have previously worked with other organizations and/or do not know of such organizations which may be available to work cooperatively to benefit multiple purposes.
- The funding needed to consider impacts and ways to improve a project is not available.
- The data or analysis does not exist to sufficiently evaluate impacts or potential multi-purpose benefits of the project.
- The additional challenges and limitations listed above regarding the methodology and framework.

## 9 Data Gaps

Data gaps exist in the data sources needed to fully implement the methodology and framework described in this appendix. These data gaps include discrepancies between the GIS shapefiles and Microsoft Access databases. There is also additional data not included in these data sets such as detailed project descriptions, project objectives by attribute, implementation schedules, and expected outcomes. There are also areas where more information or studies are needed. Studies such as specific assessments of what is needed for specific environmental and recreational attributes at specific locations are needed. Additional studies could be performed under future projects to determine the sufficiency of projects to protect attributes.

### 9.1 Data Limitations

There are various data limitations for appropriately assessing the current state of the environmental and recreational attributes and projects, as well as assessing what is needed to maintain or enhance the attributes. These limitations include:

1. The current data for assessing projects and protections exists in the SWSI 2010 GIS data, the CWCB MS Access database and new focus areas approved by the BRTs, and provided by various sources. The main limitation for the analysis of attributes, Focus Areas, projects and protections is the lack of a common, consistent and

comprehensive database. The discrepancies found between the SWSI 2010 GIS data and the MS Access database demonstrates the need for a thorough, systematic and comprehensive review and correction of the data. While some limited database improvements have been made, a full database reconstruction is beyond the scope for the BIP and should be completed at the State level since it appears to the present in all basins. It is recommended that the discrepancies in the multiple data sources be reconciled in the near term.

2. The determination of measurable outcomes requires very specific data for the presence of attributes, any factors that currently limit the attribute, a quantification of what would be needed to remove the limitations and projects that specifically target the attribute or attributes. An example of such data is:

Attribute “A” exists in 20 miles out of Focus Area “XYZ”. Focus Area “XYZ” is 60 miles long. Attribute “A” requires 30 miles of contiguous, connected habitat to maintain a viable population. The objective of specific projects is to increase the presence of Attribute “A” by 10 miles to provide habitat to sustain the population. Project “ABC” is would remove a barrier to passage that would reconnect 5 miles of habitat to the existing 20 miles of habitat. An additional future project to connect another 5 miles of stream is needed to meet the goal of 30 miles of habitat.

The data needed for the above example would include:

- Population estimates for the species by stream reach.
- Identification of specific barriers that fragment habitat.
- A determination of the amount of continuous habitat associated with each fragmentation point.
- Determination of the flow requirements for the species throughout the reach.
- Measurement of flows within the reach.
- Identification of projects that could modify the barriers so passage is possible.
- An implementation plan and schedule for each project.

With all available data, the Stream Mile Representation Framework and other hydrological assessments discussed above could be used to analyze the attributes at additional locations throughout the basin and the state.

3. The above types of data are not provided in the current database at the level of detail needed to determine whether a project provides sufficient protection to meet a measureable objective. In general, a protection can be inferred, however, sufficiency cannot. It is recommended that the background information from the NCNA interviews and project descriptions be acquired, documented and assimilated into a Meta data set to support the database. It is assumed that this information exists or did exist at one time when the SWSI 2010 report was completed.
4. New data was compiled as part of the BIP process. All newly compiled data should be subject to the same scrutiny and review as the existing database. Any new data should include as much detail as possible on the attributes, project objectives, project description and metadata to trace the data to the originating entity. If possible, any

hardcopy information should be converted to digital format (either searchable PDF, spreadsheet or database file format). A master list of all new data should be maintained with the existing database files to reduce the effort needed by contractors or BRTs to implement future versions of the BIP.

5. Additionally, recreational flows data is very limited for the South Platte Basin. Additional studies are needed to determine the flows needed for recreational use, and the economic benefit from such recreation. American Whitewater is developing a “boatable days” analysis that could provide the BRTs with a valid tool to evaluate baseline and future scenarios for a given river reach in the context of the “boatable days” metric developed by American Whitewater. The boatable days metric describes the number of days a river reach can be used for recreational boating based on a range of acceptable and optimal flow criteria (determined through standard flow-evaluation surveys of river users). Given the uncertainty of future hydrological scenarios, the tool allows the user to perform a simple sensitivity analysis using historic flow data. This can be done using a user-provided monthly percent reduction/increase file, or by reductions of the historic flows. The purpose of this is to help identify when a reach will see a noticeable reduction in boatable days as well as the general magnitude of flow reduction that causes a loss of recreational opportunities. Once determined, recreational flow recommendations can be used with the framework presented in this Appendix.

## 9.2 Recommendations

There are several recommendations to address the data limitations discussed above. These recommendations are discussed below for both short-term and long-term recommendations.

- Continue to document to the degree possible the discrepancies between the GIS database from SWSI 2010 and the MS Access database.
- Continue to document the current status of mapped focus areas and associated attributes.
- Continue to document limitations of using the current database for determination of sustainability.
- Continue to document the limitations of using the existing project data for determining the level of protection provided for the attributes by project.
- Continue to document the additional studies and assessments needed to fully understand existing environmental and recreational habitat extents, aquatic and riparian species needs and flow requirements.
- Comprehensive, systematic, review and update of the multiple databases to provide a complete data set for future evaluations.
- Develop and implement a quality assurance protocol for data entry, data analysis, and data documentation for all data in the database.
- Extend the Stream Mile Representation Framework to other example areas within the South Platte Basin, and potentially basin-wide, collecting the appropriate data and information needed.

- Continue to integrate the Stream Mile Representation Framework with specific quantitative analyses of the existing environmental and recreational habitat extents, aquatic and riparian species needs and flow requirements.

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