

This is a digital document from the collections of the *Wyoming Water Resources Data System (WRDS) Library*.

For additional information about this document and the document conversion process, please contact WRDS at wrd@uwyo.edu and include the phrase “**Digital Documents**” in your subject heading.

To view other documents please visit the WRDS Library online at:
<http://library.wrds.uwyo.edu>

Mailing Address:

Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:

Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651

Fax: (307) 766-3785

Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission
(<http://wwdc.state.wy.us>)

The Environmental and Recreational Water Use Handbook

State of Wyoming
Water Development Office
State of Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002

Prepared by

Harvey Economics
600 South Cherry Street, Suite 220
Denver, Colorado 80246
720.889.2755 fax 720.889.2752
www.harveyeconomics.com
he@harveyeconomics.com



Table of Contents

THE ENVIRONMENTAL AND RECREATIONAL WATER USE HANDBOOK

SECTION I: Handbook Overview

Categorization of environmental and recreational water uses	2
Spatial Distribution	3
Data Sources	4

SECTION II: Water Related Data Collection

Streams	5
Other Direct-flow Diversions	5
Reservoir Storage.....	6
Managed Lands.....	6
Additional Guidance for Incorporating Water Use Data	7

SECTION III: Existing Environmental Water Demands 9

Categorization of Environmental Uses.....	13
---	----

SECTION IV: Existing Recreational Water Demands 14

Categorization of Recreational Uses.....	16
--	----

SECTION V: Projecting Environmental and Recreational Water Demands

Future Environmental Water Demands.	17
Future Recreational Water Demands.....	17

SECTION VI: Assimilation of Recreational and Environmental Water Demand in the Wyoming River Basin Planning Process

Application of the water demand categories.....	19
Guidance for Aggregating Demands to Avoid Double Counting.....	19
An Example: The Upper Greybull River Basin.....	21

SECTION 1

Handbook Overview

The handbook begins with this introduction and includes protocols for river basin planning efforts that are relevant to both environmental and recreational water demand estimation. This is followed by detailed recommendations for addressing: existing and future environmental water demands and existing and future recreational water demands. The handbook addresses each element: Location of the water demands, magnitude of the water demands, relationship to traditional water uses, and exceptions to the guidelines.

The first step in estimating environmental and recreational water demands is to separate divertible environmental and recreational water demands from in-channel uses. In other words, if a diversion exists for a golf course, ski area or hot springs, those uses should be identified in specific terms and aggregated as sub-elements of other uses. For example, golf course diversions may be classified as agricultural, municipal or recreational water by the SEO, and should be included in the divertible demands for the appropriate category. Similarly, a permitted diversion for wetlands or grasslands or other environmental purposes should also be identified and noted separately. Divertible water uses with specific beneficial purposes that have received a water right in the State of Wyoming should be treated in the same way as traditional water uses. Existing uses, as well as projected future uses for these diversions should be identified and estimated in the basin planning process. Hence, the remainder of the handbook focuses on the in-channel environmental and recreational water uses.

The subsequent steps in addressing in-channel, non-divertible recreational and environmental water uses are described generally below:

- A. **Identification of uses.** The planner should search for the presence of specific recreational and environmental uses in the basin. These specific uses are listed in the handbook sections which follow, along with data sources for finding them. The magnitude and seasonality of these uses should be identified. Wyoming river basins vary tremendously as far as the presence or absence of these uses; if a use is known not to exist now or in the future in a basin, that should simply be noted.
- B. **Mapping the uses.** Locating the specific uses in the basin is the next step. This is important because the spatial location of recreational or environmental use vis-à-vis traditional, divertible uses will determine its ultimate relevance in the basin planning process. Usable, accurate GIS shape files are the goal here.
- C. **Locating traditional, divertible uses.** As part of the basic elements of Wyoming river basin planning, the location, type, magnitude and seasonality of traditional uses should be gathered and mapped. This is not part of the recreational and environmental handbook and will not be further addressed here. But this step must be performed to categorize the recreational and environmental uses. For this task, the practitioner is

strongly advised to work with hydrologic modelers familiar with, for example, irrigation diversions in this basin plan. Understanding the spatial location, magnitude and priority of traditional diversions is a foundational piece to understanding recreational and environmental demands in the basin planning context.

- D. *Categorization of recreational and environmental uses.* The next step is analytical. The planner must consider each of the recreational and environmental uses dynamically in the context of all other uses in proximity to determine if that particular use is protected, complementary or competing. These are defined in detail below.
- E. *Assimilation of recreational and environmental uses.* The last step is interpreting the recreational and environmental uses in an overall basin plan.

Categorization of environmental and recreational water uses

Environmental and recreational water uses consist of three categories which should be identified and distinguished as such in the Wyoming Basin planning processes:

- 1) *Protected water uses* – These are water uses which are both recognized and protected in some way from incursions by traditional water uses. The obvious example is an instream flow water right. However, protected wetlands, protected bypass flows, or any environmental water uses protected by Federal agencies through permit or water right, fall into the protected category. In addition, protected water uses may have a senior traditional water use diverter in a location which ensures the continuation of that non-divertible use.

Example: If the most senior water right downstream is larger than or equal to the recreational or environmental water use immediately above that senior water diversion in the stream system, that recreational water use is protected and should be recognized as such in the basin planning process.

- 2) *Complementary water uses* – These environmental and recreational water uses exist without explicit protection, but exist and will continue to exist typically by virtue of their location. Environmental water uses are often located at the highest reaches within a watershed, and intervening uses are very unlikely to occur. For example, environmental water uses which occur at high elevations or in a national forest high in the watershed are unlikely to be disturbed by water users below. Without future intervening water uses, those complementary water uses are likely to continue and should be recognized as such in the river basin planning process.
- 3) *Competing uses* – Competing uses are those environmental or recreational water uses which are in a location where other traditional water use diverters may constrain or eliminate the environmental or recreational use at any point in time. These water uses are incidental and subject to elimination. These uses should also be recognized in the basin planning process, but with the explicit understanding that such water uses can and will disappear when future appropriators step forward.

This categorization should be applied to both existing uses and future uses.

Spatial Distribution

Critical to the analysis of the interaction of recreational and environmental uses vs. other water demands is their relative spatial distribution. Thus, spatial information should be either compiled from existing sources or developed from primary data sources and brought into a common spatial platform for analysis. The recommended approach is to use a Geographic Information System (GIS), such as ArcView, to facilitate the desired spatial comparisons. This section reviews the compilation of GIS data - typically “shapefiles” – drawing from a pilot application of this approach applied to the Greybull River basin.

With each completed WWDC River Basin Water Plan, “GIS products” – digital shapefiles and metadata – are provided on the Wyoming State Water Plan website (<http://waterplan.state.wy.us/>) to furnish readers/GIS users with the basic data behind many of the Basin Plan figures. A shapefile or geodatabase file is a GIS data set used to represent a set of geographic features such as cities, streets, or counties. Shapefiles can represent point, line, or area features. Each feature in a shapefile represents a single geographic feature and its attributes. Shapefiles representing desired features are layered together to create a unique map.

WWDC GIS protocol includes providing metadata with each shapefile. Metadata are simply “data” about the data (i.e., shapefiles). If a shapefile is obtained from another source, the original metadata should come along with it. If a shapefile is created by the planner for a Basin Water Plan, new metadata need to be created. Metadata typically provide information such as the data source, an abstract, publication date, datum, coordinate system, type (point, polyline, or polygon), data processing description, quality, accuracy, and purpose. They may also include special instructions or recommendations such as how to obtain the data and how to best use the data (e.g., best scale), and statements about data modifications, alterations, and use restrictions. Alterations to original GIS data may be necessary in order to meet the requirements of the WWDC for the Basin Water Plan. Some possible examples are extent (clipped to specific basin boundary), coordinate system (changed for consistency purposes with other shapefiles), and format (changed to shapefile). Availability of shapefiles through WWDC differs by basin water plan. Current WWDC protocols should be used for GIS development related to recreational and environmental uses.

It is anticipated that the necessary mapping associated with traditional diversions will have been developed in association with other portions of a Basin Plan (or can be extracted from previous Basin Plan GIS products). A GIS layer for these traditional diversions is available from the SEO. In most cases, it will be necessary for the consultant to make a judgment as to which diversions should be included on the map. Large, senior rights should always be mapped, but if there are a great number of small, junior rights, they should not be mapped if there are so many that they detract from the usefulness of the mapping effort. The necessary mapping associated with recreational and environmental uses may come from secondary sources, e.g. the WWDC (Wyoming State Water Plan website); from primary sources (e.g. USFWS wetlands GIS shapefiles; SEO water rights points of diversion; Wyoming Game & Fish databases); or it may be necessary to develop GIS layers from available tabular data,

imagery, non-georeferenced diagrams or maps, etc. More detail as to sources is provided below.

Data Sources

For each of the environmental and recreational water uses to be inventoried for a Basin Plan, we will discuss:

- 1) Primary data source: Best current known source for locating specific data, i.e., visitor days, relative to a “given topic”, such as recreation. This would be the original data source and shapefiles that inform the report. GIS data source will also be provided if available. The planner should start with these.
- 2) Secondary data sources: Other suggestions for locating specific information if it is not available from the primary source. Previous basin plans, which can be found at <http://waterplan.state.wy.us/basins/7basins.html> provide an excellent starting point and a great deal of useful data. In particular, the technical memoranda, spreadsheet model and GIS products should be fully utilized. Secondary GIS data sources will be included here if available. WWDC is typically a secondary source here as well, but will only provide shapefiles if supplied by the Basin Plan consultants. For the Greybull River pilot study, for example, most data were extracted from the 2010 Wind/Bighorn River Basin Plan.
- 3) Parameters of use: The basic parameters of measurement for a given environmental or recreational water use, i.e. angler days or hunter days. When historical data are available (especially for recreational uses) they should be collected in order to improve projection efforts. Because the interactions between the water uses defined in the overall Basin Plan are chiefly a matter of water flow rates and volumes, these parameters should also be compiled for each use, if available. More detail is provided for each data collection topic.

It is important to recognize the dynamic nature of water use within Wyoming river basins and to be diligent in seeking out new data for basin plan updates. Do not assume that diversion locations, magnitudes or even purposes for the diversion have remained constant from a distant historical observation or that they will remain so in the future.

SECTION II

Water Related Data Collection

This section points out the data sources which the planner can look to for collecting water flow and seasonality information related to recreational and environmental uses.

Streams

Primary Data Source: U.S. Geological Survey (USGS), Wyoming Water Science Center: <http://wy.water.usgs.gov/>.

Primary GIS Data Source: USGS, <http://water.usgs.gov/maps.html> . Wyoming Geographic Information Science Center (WyGISC); <http://wygl.wygisc.org/DataServer/> or <http://wygl.wygisc.org/wygeolib/catalog/main/home.page>.

Secondary Data Source: WWDC (<http://waterplan.state.wy.us/basins/7basins.html>); under the Technical Memoranda, look for the Surface Water Hydrology Memo, which will have maps and will help the consultant identify important streams within the Basin; stream coverages and flow characteristics are typically well developed in other portions of a Basin Plan, in particular, the spreadsheet model.

Secondary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); under the main heading for the appropriate plan, go to GIS Products to find available metadata and shapefiles.

Parameters of Interest: Locations and general flow status (perennial, intermittent) are the primary parameters here, potentially including seasonal variations of flow.

Other Direct-flow Diversions

Primary Data Source: SEO (<http://seo.state.wy.us/>) can provide water rights, priority dates and headgate locations; SEO and WWDC (in association with Basin Plan development) for operational data.

Primary GIS Source: SEO can provide a diversion layer. Contact the GIS Section.

Secondary Data Source: WWDC (as developed for Basin Plans). Historical diversion data can be found in the technical memoranda for Agricultural Water Use, Domestic and Municipal Water Use and Industrial and Mining Water use.

Secondary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); under the main heading for the appropriate plan, go to GIS Products to find available metadata and shapefiles.

Parameters of Use: Of interest here are the actual diversion rates (cfs), which may be somewhat less than full permitted amounts, the seasonality of use, the associated water rights

(quantities and priorities) most of which can be extracted from the relevant databases developed for the respective use sectors. The focus for mapping efforts should be on large, senior diversion rights, in most cases. However, if a smaller diversion is closely tied to a crucial environmental or recreational use, it should also be mapped.

Reservoir Storage

Primary Data Source: SEO for water rights and headgate/impoundment locations (<https://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2fDefault.aspx>).

Primary GIS Data: USGS. The SEO can provide a GIS layer with polygons of reservoirs for some basins. Contact the GIS Section. <http://seo.state.wy.us/>.

Secondary Data Source: WWDC (e.g. as developed for Basin Plans). Reservoirs are described in the Water Use from Storage Technical Memorandum, including sub basin, source, use and permitted capacity.

Secondary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); under the main heading for the appropriate plan, go to GIS Products to find available metadata and shapefiles.

Parameters of Use: Of interest here are the diversion rates (cfs), storage volumes (maximum and annual accrual), associated water rights, and any environmental or recreational limitations/requirements associated with the permitting and operation of storage facilities, e.g. bypass flows, minimum releases, minimum pools.

Managed Lands (Wilderness Areas, National Forests, Preserves, etc.)

The importance of these data are the land and water management provisions represented. For example, water development activities in designated Wilderness Areas are extremely unlikely, meaning environmental and recreational water uses are strongly protected from competing water uses. Therefore the mapping of these locations will help to inform the categorization of water uses.

Primary Data Source: The entity that manages the lands should be contacted for data. If available, the Resource Management Plan should be obtained.

Primary GIS Data Source: The managing entity may have GIS data.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); environmental and recreational technical memoranda.

Secondary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); under the main heading for the appropriate plan, go to GIS Products to find available metadata and shapefiles.

Parameters of Interest: The locations, existing boundaries and plans for expansion, management regulations and guidelines should be determined for all managed lands. Other data to be collected for these areas will vary and will be location dependent. Topics that should be considered for managed lands include, but are not limited to: hunting and fishing locations, rafting/boating locations, presence of sage grouse, presence of T&E species or candidates for endangered status, wetlands, wildlife habitat, and wildlife viewing opportunities. The managing agency will likely be the best source of information.

Additional Guidance for Incorporating Water Use Data

Experience from the Greybull River basin pilot study provided the following insights that should be considered for future basin plan mapping efforts:

- ❖ Current Basin Water Plans typically do not provide GIS data for recreational and environmental water uses. The current Platte River Basin Water Plan is the only one to provide shapefiles related to those uses, four of which relate to recreational uses and none for environmental uses.
- ❖ GIS data adopted from other than primary sources should be critically reviewed for accuracy. For example, the designated public recreational fishing sites presented in the Wind/Bighorn River Basin Plan were reviewed with the Greybull Valley Irrigation District Manager and one fishing site was found to have been mislocated by approximately two miles. Similarly, the “potential future water uses” shapefile contained erroneous locations or name designations, e.g. Little Wind River Nos. 1 & 2 projects were placed near Meeteetse, in the Greybull River basin.
- ❖ GIS data should also be critically reviewed for quality. For example, the reservoirs shapefile (for reservoirs with at least 500 ac-ft. of permitted storage capacity) presented in the Wind/Bighorn River Basin Plan did not contain three of the seven reservoirs listed in the Plan’s accompanying table (Table 1, Section 2, Task 3F - Water Use from Storage). Locations for the missing reservoirs were digitized from available mapping for our purposes.
- ❖ A rafting shapefile is not available through the Wyoming State Water Plan website. It was created based on plotting the information displayed in Figure 3 and Table 2 of the Recreational and Environmental Water Use technical memorandum of the 2010 Wind/Bighorn River Basin Water Plan.
- ❖ A shapefile for fishing sites, not available through WWDC, was created from a combination of visual inspection of the Wind/Bighorn Basin Water Plan report figure, other fishing sites designated on the Wyoming Game and Fish Department website (<http://gf.state.wy.us/web2011/fishing-1000428.aspx>), and personal communication with the Greybull Valley Irrigation District Manager (Sep. 2011).
- ❖ A shapefile for instream flow rights in Wyoming was obtained from the Wind/Bighorn Basin Water Plan. In describing the shapefile, the Basin Water Plan (“GIS Products”) states, “The instream flow shapefile was created by geo-referencing

and digitizing the instream flow mylar maps to the PLSS and the wyorivers.shp file at a scale of 1:100,000, to give the user a better understanding of the instream flow segments in the State of Wyoming. The instream flows are described by their temporary filing numbers and permit numbers (if approved by the State Engineer), the priority date of the instream flow and the length of the instream flow segment in miles.”

- ❖ Other recreational and environmental uses such as Federal reserved instream flow rights, aquatic and terrestrial (big game, fowl, etc.) habitat priority areas were also addressed in the Wind/Bighorn River Basin Plan, but no shapefiles for those uses were provided. As noted above, it may be necessary to develop shapefiles for select uses from available tabular data, imagery, non-georeferenced diagrams and maps, etc.

SECTION III

Existing Environmental Water Demands

This section identifies the primary and secondary data sources that can be accessed for existing environmental demand.

Identifying existing environmental water demands. As discussed above, past basin plans have looked at instream flows, reservoir bypass flows, minimum reservoir pools, wetlands, habitat, wildlife management areas, direct wildlife consumption and coalbed methane produced water. Discussions with WWDC regarding this project have led to the conclusion that wildlife consumption is quite small and quantification so speculative that it need not be included in future basin plans. We also determined that coalbed methane produced water would be more appropriately addressed in the water quality section of the basin plans and should not be addressed here.

In addition to these topics, threatened and endangered (T&E) species that are located in a given basin should be identified. Species that are under consideration for listing should also be identified. Although T&E species cannot be included in water demand projections, awareness of where they may be located contributes to future planning efforts, as any future development in these areas would be more difficult, and costly. Any other special environmental water uses should also be included, i.e. Wild and Scenic river segments. Each of the Wyoming river basins are unique and the relative importance of various environmental water demands within a particular basin should be considered by the consultant during the basin planning process.

The data sources provided below are current as of the publication of this document. However, additional sources are likely to become available over time as new GIS data are developed. While some data will be readily available, other data collection efforts will require more perseverance and imagination on the part of the consultant. This may not constitute a full listing of available data sources and the consultant should not be constrained by this list.

Instream flows (State)

Primary Data Source: SEO is one primary source for data for both approved instream flows and applications; <http://seo.state.wy.us/>. The WWDO Instream Flow Manager also tracks these data.

Primary GIS Data Source: The SEO has developed shapefiles. Contact the GIS Section. The WWDO Instream Flow Manager also maintains this information in an access data base, sharing information with the SEO and the Department of Game and Fish.

Secondary Data Source: WWDC (<http://wwdc.state.wy.us/>) and WGF (<http://wgfd.wyo.gov/web2011/home.aspx>) coordinate with the SEO to maintain a current database of instream flow data. However, the particular data tracked for instream flows may vary by agency. Contact staff for more information.

Secondary GIS Data Source: WGF has also developed GIS files for instream flows. These GIS files have been shared with the WWDO, contact agency staff to obtain files.

Parameters of Use: Existing water rights and pending applications should be documented. Priority date, cfs (flow range, min-max), stream reaches, and length are the primary parameters of use, potentially including seasonal schedules of flow.

Instream flows (federal reserved)

Primary Data Source: SEO is the primary source for data; <http://seo.state.wy.us/>.

Primary GIS Data Source: The SEO has an instream flow GIS layer which includes more than 300 court awarded instream flow segments and points. Contact the GIS Section.

Secondary Data Source: Federal agencies that hold permits.

Secondary GIS Data Source: Federal agencies that hold permits. WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); under the main heading for the appropriate plan, go to GIS Products to find available metadata and shapefiles. If GIS data are not available, consult the Environmental Technical Memoranda for illustrations from which shapefiles can be created.

Parameters of Use: Priority date, cfs and streamflow points or stream segments are the primary parameters of use, potentially including seasonal schedules of flow.

Reservoir bypass flows

Primary Data Source: The bypass flows are generally created as part of the permitting process. Contact the managing agency to determine if there are permitted bypass flows associated with the reservoir. If an Environmental Impact Statement (EIS) was completed prior to reservoir permitting, there will be documents that detail any agreements for bypass flows. The EIS will most likely have been ordered by either the Corps of Engineers or the Bureau of Land Management. If an internet search does not provide the needed documents, contact the local office of the appropriate agency to obtain a copy.

Primary GIS Data Source: GIS data may be available from the owner or operation. The EIS or other documentation may provide illustrations or data from which shapefiles can be created.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Water Use from Storage technical memorandum.

Secondary GIS Data Source: WWDC; look for GIS products after clicking on the appropriate basin plan at: <http://waterplan.state.wy.us/basins/7basins.html>.

Parameters of Use: Location, cfs and streamflow points or stream segments are the primary parameters of use, potentially including seasonal schedules of flow.

Wetlands

Primary Data Source: U.S. Fish and Wildlife Service (FWS), National Wetlands Inventory (NWI); <http://www.fws.gov/wetlands/>.

Primary GIS Data Source: Data through September 2011 can be obtained from <http://www.fws.gov/wetlands/Data/DataDownload.html>.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Secondary GIS Data Source: WWDC; look for GIS products after clicking on the appropriate basin plan at: <http://waterplan.state.wy.us/basins/7basins.html>. If GIS data are not available, consult the Environmental Technical Memoranda for illustrations from which shapefiles may be created.

Parameters of Use: Acres and location of those acres are the primary parameters of use, but if information is available on the quantities of water flowing into or necessary to sustain specific wetlands, or the seasonal importance of flows, that information should be compiled. In Wyoming, wetlands are often created and maintained as a result of flood irrigation of agricultural lands. The spatial representation of diversions, irrigated lands and wetlands will demonstrate this relationship and aid in classification of these environmental water uses.

Riparian and other wildlife habitat

Terrestrial and aquatic habitat:

Primary Data Source: Wyoming Game and Fish, <http://gf.state.wy.us/web2011/wildlife-1000055.aspx>.

Primary GIS Data Source: Wyoming Game and Fish, GIS Section.

Secondary Data Source: WWDC River Basin planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Secondary GIS Data Source: WWDC; Look for GIS products after clicking on the appropriate basin plan at: <http://waterplan.state.wy.us/basins/7basins.html>. If GIS data are not available, consult the Environmental Technical Memoranda for illustrations from which shapefiles can be created.

Parameters of Use: Acres, location of those acres and priority (crucial or enhancement area). Crucial and enhancement areas often overlap.

Big game habitat:

Primary Data Source: Wyoming Game and Fish, <http://gf.state.wy.us/web2011/wildlife-1000055.aspx>.

Primary GIS Data Source: Wyoming Game and Fish, GIS Section.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Secondary GIS Data Source: WWDC; look for GIS products after clicking on the appropriate basin plan at: <http://waterplan.state.wy.us/basins/7basins.html>. If GIS data are not available, consult the Environmental Technical Memoranda for illustrations from which shapefiles can be created.

Parameters of Use: Acres, location, herd and herd population.

Wildlife Management Areas

State of Wyoming:

Primary Data Source: Wyoming Game and Fish, <http://gf.state.wy.us/wildlife/access/gf/clickmap.asp>

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Parameters of Use: Locations and boundaries, management regulations and guidelines.

Federal:

Primary Data Source: U.S. FWS, Mountain Prairie Region <http://www.fws.gov/mountain-prairie/wy.html>.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Parameters of Use: Locations and boundaries, management regulations and guidelines.

Threatened and Endangered Species

Primary Data Source: U.S. FWS, Wyoming Ecological Services; lists wildlife, plants and critical habitat. Clickable map provides listings by county. http://www.fws.gov/wyominges/Pages/Species/Species_Endangered.html

Secondary Data Source: Ecological Services Wyoming Field Office (local office of USFWS). <http://www.fws.gov/wyominges/>.

Parameters of Use: Federally listed, proposed and candidate species, within the planning area should be identified. This should include wildlife, plants and critical habitat.

Wild and Scenic Rivers

Primary Data Source: National Wild and Scenic Rivers. Listing of rivers by state with designated reach data. <http://www.rivers.gov/wildriverslist.html>.

Primary GIS Data Source: <http://www.rivers.gov/maps.html>.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Environmental Water Use technical memorandum.

Secondary GIS Data Source: WWDC; Look for GIS products after clicking on the appropriate basin plan at: <http://waterplan.state.wy.us/basins/7basins.html>. If GIS data are not available, consult the Environmental Technical Memoranda for illustrations from which shapefiles can be created.

Unique and Irreplaceable Lands of Wyoming

The Wyoming State Geological Survey provides a GIS data file for Unique and Irreplaceable Lands of Wyoming that utilizes data from the Environmental Quality Council. These data should be downloaded to determine if any of these lands are within the planning area. If they are, they should be mapped and considered when analyzing current and projected water use. The GIS data can be found at: <http://www.wsgs.uwyo.edu/>.

Categorization of Environmental Uses

Once these environmental uses have been identified and mapped, a determination should be made as to whether use is either a protected, complementary or competing use. In order to make this determination, it is necessary to map associated demands described above. This visual representation is very helpful in the process of categorizing uses. Examples of each type of category are provided below.

Most instream flow rights, both federal reserved and state-based, both stream segments and discrete points, tend to be strongly concentrated in headwater areas, e.g. most federal rights are in National Forests, without upstream users. These uses are protected by virtue of their location.

Wetlands are often associated with major agricultural diversions. If these diversions are expected to continue into the foreseeable future, the wetlands will be protected by virtue of this complementary use.

Other habitat or wetlands may be located near existing diversions that may not continue due to increasing development or other causes. In this case, the environmental use would be considered competing and unprotected.

SECTION IV

Existing Recreational Water Demands

Establishing current recreational water needs is an important step in the basin planning process. Data availability can be limited, but it is important to go beyond on-line sources and to contact local resources, such as regional Wyoming Game and Fish (WGF) offices, local tourism officials and local offices of federal agencies such as BLM and the U.S. FWS. These sources will provide information as to the most important and most utilized recreation sites in the area. They may also be able to provide user day or visitation data. This quantification is required in order to project future demand.

For existing recreational use, there are two necessary steps. One is to determine activity days for the various recreational activities in the basin. This will provide a gauge of how important these various pursuits are to the economy of the basin.

Second, the consultant will need to identify the specific locations for each of these activities. In a given basin there are likely to be too many stream reaches where fishing occurs for the consultant to identify and examine each one. Instead, the prime locations should be located and mapped. This will allow the consultant to determine the current and likely future status of important fishing locations. This same approach should be used for all recreational activities.

Fishing

Primary Data Sources: WGF collects data on fishing permits that includes where the purchaser resides. These data will provide some information for the consultant, but further research will be required.¹ For fishing permit data, contact WGF at 307.777.4683. Creel surveys of particular river segments are also available from WGF and sometimes include angler days. <http://gf.state.wy.us/web2011/fishing-1000428.aspx>.

BLM provides data on public fishing access locations and other information. As of 2012, GIS downloads and shapefiles were available only for the Pinedale Field Office. http://www.blm.gov/wy/st/en/resources/public_room/gis/datagis.html.

A National Survey of Fishing, Hunting, and Wildlife-Associated Recreation is conducted every 5 years and provides statewide data. These data may be used in conjunction with fishing license and other data to estimate fishing days at the basin level. State reports are available at: <http://www.census.gov/prod/www/abs/fishing.html>.

Reservoir management should be contacted to see if they have any angler day data.

¹ WWDC has requested that two questions be included in the fishing license application: How many days per year do you fish? Where do you fish most often? Please name the river, stream, lake, reservoir or other fishing location. As of 2011, WGF is planning to do a creel survey in 2012. WWDC has also requested that respondents be asked how many days they fish each year by basin. If these data become available, it will be helpful in determining angler days for basin planning.

Primary GIS Data Source: WyGIS (includes shapefiles), <http://wygl.wygisc.org/wygeolib/>. Fishing locations in Wyoming and Blue Ribbon Streams.

Secondary Data Source: WWDC Basin Planning; the Platte River Basin Plan is the only existing plan that provides fishing access sites as a shapefile and the only existing Basin Plan that offers shapefiles for recreational use.

Secondary GIS Data Source: As of 2012, GIS downloads and shapefiles were available for fishing locations only for the Pinedale Field Office.

http://www.blm.gov/wy/st/en/resources/public_room/gis/datagis.html.

Parameters of Use: Angler days by basin along with important fishing locations, including Blue Ribbon Streams, (reservoirs, lakes and stream segments), designated public access points, and relevant seasonal patterns of use.

Boating

Rafting/Kayaking

Primary Data Source: Data available from American Whitewater's National River Database at <http://www.americanwhitewater.org/content/River/state-summary/state/WY/>. Local whitewater groups should also be contacted if they exist.

Primary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); GIS products. If shapefiles are not available, the Recreational Water Use technical memorandum may provide a source for these data files.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Recreational Water Use technical memorandum.

Secondary GIS Data Source: Not available at this time. Check with WyGIS for new sources of GIS data. If no digital data are available, go to WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); the Recreational Water Use technical memorandum may have illustrations from which shapefiles can be created.

Parameters of Use: Designated rafting locations, rafter days by location, access points, and relevant seasonal patterns of use.

Motor and Sail boating

Primary Data Source: Contact reservoir management to estimate usage.

Secondary Data Source: Statewide Wyoming motor boating estimates can be found at: <http://www.responsivemanagement.com/download/reports/BoatingTrendsIntheUS-dist.pdf>. : WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Recreational Water Use technical memorandum.

Parameters of Use: Boater days, current and historical, access points, and relevant reservoir level and seasonal patterns of use.

Waterfowl hunting

Primary Data Source: WGF publishes an annual report that includes waterfowl harvest and hunter days by region. <http://gf.state.wy.us/web2011/HUNTING-1000474.aspx>.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Recreational Water Use technical memorandum.

Parameters of Use: Hunter days and harvest by location and historical data.

Water-based destinations

Primary Data Source: Data sources will depend on the site. National Park visitor data can be found at <http://www.nature.nps.gov/stats/>. Wyoming State Park visitor data can be found at <http://wyoparks.state.wy.us/Planning/Index.aspx>. For any other destinations, contact the managing agency.

Primary GIS Data Source: Contact the managing agency to see if available. Also, WyGIS; <http://wygl.wygisc.org/wygeolib/catalog/search/search.page>.

Secondary Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); Recreational Water Use technical memorandum.

Secondary GIS Data Source: WWDC River Basin Planning (<http://waterplan.state.wy.us/basins/7basins.html>); GIS products. If shapefiles are not available, the Recreational Water Use technical memorandum may have illustrations from which shapefiles can be created.

Parameters of Use: Location and boundaries, types of activities, such as camping, swimming visitor days, current and historical.

Categorization of Recreational Uses

After the data have been collected, they will need to be placed on a consolidated map. This map should then be examined, along with a map indicating traditional diversions and basin uses, or a combined map can be generated. The planner will analyze this information to determine how these recreational demands work in a dynamic water rights system. This will allow the consultant to categorize the critical recreational areas as either, protected, complementary or competing.

SECTION V

Projecting Environmental and Recreational Water Demands

Future Environmental Water Demands.

Future environmental demands will be influenced and determined primarily by governmental or permitting and regulatory activity. Instream flow permits can be issued by the SEO only for the protection of fisheries, but these permits can also be issued by federal agencies. An increase in these permits will increase environmental demands. New reservoir construction can also bring additional bypass flows or minimum reservoir pool requirements. Federal regulations regarding wetlands, habitat and management areas or threatened and endangered species may also increase this demand.

The consultant should contact local authorities and local offices of federal agencies to identify any potential projects or proposed regulations within the basin that could impact future environmental water demands.

Once these projected environmental water demands are identified, they should be mapped using GIS, quantified and categorized. These future uses should then be aggregated with existing environmental uses to portray total future environmental uses.

Future Recreational Water Demands

Future recreational water demands will be driven by a variety of factors and will vary by basin. Many factors should be considered when making recreational water demand projections. These factors include the perception of Wyoming as a tourism location, demographics, economics, the quality of the resource, planned investment and environmental conditions.

The projections of recreational water demands can be indicated by projecting user days, such as boating days, angler days, hunter days and visitor days within a basin. These user days can be compared to existing user days, water requirements and location to prepare projections. To project user days, each of the factors which drive change should be examined, as described below.

Basin-specific factors, such as planned investment in recreational amenities, or the quality of the recreational amenity over time, should be considered. Competing recreational resources nearby should be taken into account. Existing local projections and viewpoints should be gathered.

Wyoming draws visitors from across the country, with the majority coming from western states. In 2009, about 38 percent of overnight visitors came from Wyoming and the surrounding states. About 32 percent came from the remaining western states and 30 percent

from the eastern U.S.² Therefore, it is likely that population growth in the West will tend to increase the demand for water-based recreation in the State.

Future demographic and economic conditions should be considered in these projections. Besides population growth, age distribution and proximity to the Basin will also affect future recreational activity. Income and wealth influence visitation as well.

This type of visitation analysis is typically outside the scope of basin planning efforts. The planning will need to determine at what level of detail these projections should be performed. If the recreational demands are not likely to be important, less level of detail should be applied. At a minimum, the planner should consider projected population growth in Wyoming and the surrounding region. Environmental water use projections should also be considered when developing recreational projections. If the environmental projections show that various environmental uses are threatened by future development, this would tend to negatively impact recreation. For example, a loss of habitat and wetlands would have a negative impact on waterfowl hunting and reduced stream flows would tend to decrease angler days.

² Strategic Marketing & Research, Inc. *2009 Overnight Visitor Profile Research – Full Year Report.*

SECTION VI

Assimilation of Recreational and Environmental Water Demand in the Wyoming River Basin Planning Process

Once the existing and projected recreational and environmental water uses have been estimated, the process for incorporating these demands into the basin plan must begin. Two questions arise:

- 1) How are the different categories of recreational and environmental water use treated in the basin plan?
- 2) How should the water volume requirements be combined, if at all, with the traditional uses?

Application of the water demand categories

Protected uses, either environmental or recreational, have the same force and effect as if they had a water right. These protected uses must be considered alongside traditional uses so that, when evaluating water development potential, they are not ignored. Protected uses have an associated water right and should be included in demand projections.

Complementary uses may be protected by virtue of their location or by an existing water right that is explicitly for another purpose. These recreational and environmental demands are a by-product of traditional water diversions and will not compete with them. These also should be considered in future basin and project planning.

Competing uses are unprotected and could disappear if future appropriators obtain rights to the water currently meeting a recreational or environmental need. As a result, these uses should be noted in the basin plans, but not included in future projections.

Guidance for Aggregating Demands to Avoid Double Counting

Recreational and environmental water demands are generally non-consumptive (or minimally consumptive) uses. As a result, adding those demands to traditional uses would tend to overstate demands. However, for protected and complementary uses, the recreational and environmental uses must be reported. Protected uses should be added to traditional demands to derive total basin requirements. Complementary uses should be reflected in a footnote to tables or graphs, but not included in the totals. These uses simply indicate that certain waters have multiple uses.

A summary of the spatial analysis should be presented in Chapter Nine (Strategies and Recommendations) of the Basin Plan. This summary should pull together the information

presented in the Environmental Water Use and Recreational Water Use technical memoranda. The consultant should discuss future opportunities and challenges related to environmental and recreational water uses in the basin.

An Example: The Upper Greybull River Basin

To test this new approach for estimating recreational and environmental water use, the HE Team conducted a pilot study in the Greybull River Basin (GRB), a sub-basin within the Wind/Bighorn River Basin (WBH). The WBH basin plan was updated in 2010 and much of the data used for the pilot study was available from that update. In addition to the WBH plan, the HE Team interviewed Lee Allen, manager of the Greybull River Irrigation District and collected NEPA documents related to the construction of Greybull Valley Reservoir. The intent of this pilot study was not to collect new data, but rather to demonstrate how data could be spatially presented to improve the understanding of environmental and recreational water use within the GRB.

Much of GRB lies within southeastern Park County with about 25 percent in western Big Horn County. Meeteetse (population 421) and Burlington (population 205) are the only towns in the sub-basin. Meeteetse diverts water from the Wood River and treats it for its 219 water accounts. Burlington is served by groundwater.

Within the GRB, there are three reservoirs: the Upper Sunshine, Lower Sunshine, and Greybull Valley Reservoir (also known as Roach Gulch). The Upper Sunshine Reservoir (USR) was completed in 1938 and is an off-channel reservoir. Available flows from the Greybull River are conveyed by the Upper Sunshine Supply Canal. The Lower Sunshine Reservoir was completed in 1972 and is supplied by the USR and Wood River. The total capacity of the two Sunshine reservoirs is about 112,000 AF.

This small basin includes many of the recreational and environmental uses that will be common to most basin plans including designated rafting and fishing sites, reservoirs with recreational use, instream and bypass flow stream segments, and wetlands.

Figure 1 depicts results from this pilot study. It presents a graphical tool for the evaluation of recreational and environmental uses with respect to basin geography and other water use sectors. Modifications will likely be necessary to accommodate the special circumstances of other basins, but this serves as an example and point-of-departure for application elsewhere. The objective is to layer environmental and recreational (and associated) data (shapefiles) together to produce a map that shows how the various uses are spatially interrelated.

The water uses shown on Figure 1 are grouped in the legend based on their “protection” status, i.e. whether the use has a Wyoming water right, is provided for as a condition of a permit, or is simply present in the basin with no official status. (For example, had Federal reserved instream flow rights been included on Figure 1, they would have been grouped with other water-righted uses.)

Ditch diversions are displayed, using graduated symbols to show the magnitude of appropriations, which serve to emphasize where the majority of the water is being diverted. (The data table on the figure provides additional information.) This becomes important, for example, when evaluating wetlands that are connected to irrigated acreage, such as those in the lower portion of the basin.

The orange symbols represent those water uses for which there are no direct water rights, but uses that are protected indirectly from other traditional water uses because of other permits. Bypass flows are minimum flows that are required to pass the point of diversion (e.g., the Sunshine Supply Canal, point 17 on Figure 1), commonly included as a condition in the permit for the associated diversion. The bypass has no water right, but is afforded indirect protection, based on an associated diversion's water right. Similarly, a minimum storage pool is not a protected water right, but because of the associated reservoir's water right to fill, it is protected more than an unpermitted water use.

Unpermitted water uses are represented by red symbols in Figure 1, and as the name indicates, have neither attached water rights, nor protective associated permits. Those uses are unprotected against competing uses and are dependent on nature and management of other water uses.

Figure 1.
Greybull River Basin Recreational and Environmental Water Use

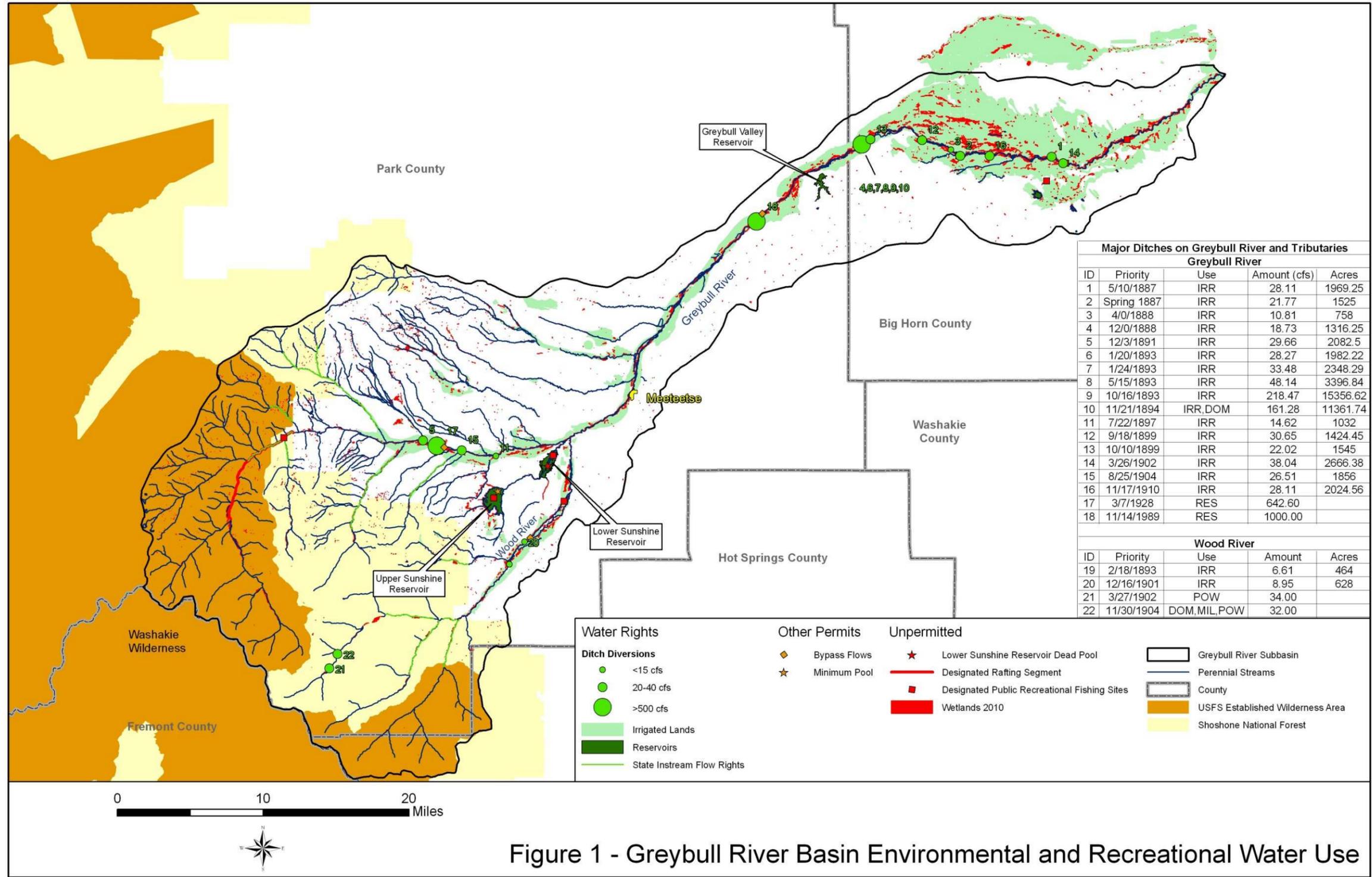


Figure 1 - Greybull River Basin Environmental and Recreational Water Use

Interpreting the map. A careful analysis of the spatial representation of data will allow the consultant to properly classify water uses as protected, complementary or competing.

Geography. Environmental and recreational water uses, like all other water uses, are ultimately dependent upon natural climate cycles to provide the necessary water. For non-consumptive uses in headwater areas, use will be primarily limited only by natural conditions. With the exception of general land-use management (e.g. logging, grazing), there are few management or planning decisions that will either enhance or compromise these uses, which are protected from negative impacts of other water uses simply by the geometry of the basin. Some of these uses may have Wyoming water rights, but their geographic location provides their most fundamental protection.

In Figure 1, geographically protected uses are located in the headwaters of the Greybull and Wood Rivers and their tributaries. Future development is legally precluded in the Washakie Wilderness Area at the far left in the figure. While it is possible that Special Use permits could be granted elsewhere in Shoshone National Forest that would compromise environmental and recreational uses, such permits typically require extensive environmental review and commonly include protective conditions.

There are two water-righted diversions in the Forest on the upper Wood River. The first is for power, milling, and domestic use and the second is for power only. These diversions are interpreted to represent no significant consumptive use. Environmental and recreational uses downstream of these rights are not subject to compromise by virtue of the exercise of these rights.

East of the National Forest, such geographic “protection” of environmental and recreational uses is less extensive, but would still apply to such uses as wetland habitat and fishing/boating recreation associated with small reservoirs on intermittent streams that are not typically subject to priority regulation for downstream water rights. For example, many of the red dots denoting wetlands on Figure 1 are the result of local water accumulations subject only to natural availability.

Although not specifically a geographic condition, the 3,000 AF dead-storage pool in Lower Sunshine Reservoir falls into this category conceptually, in that it exists regardless of other water use demands within the basin. Any environmental or recreational use supported by this pool is strongly protected from interference by other water uses.

Water rights. Environmental and recreational uses that occur under Wyoming water rights have explicit standing in the priority structure. However, due to the relatively recent recognition of such uses as beneficial under Wyoming water law (e.g. state instream flow rights); these uses will be generally junior in priority to other water-righted uses in the basin. As noted above, while a water right provides a formal place in the structure of water-use regulation, an upstream location and non-consumptive nature of use may be far more important than a junior priority water right, in terms of the actual protection of the water supply.

For environmental and recreational uses with water rights, their relative priority, with respect to upstream uses, should be identified. The priority of downstream uses will also be relevant for diversion-based environmental and recreational water rights. Absent upstream senior priorities, the use enjoys the same “geographic” protection as discussed in the previous section. If there are upstream seniors, the environmental or recreational use will be dependent upon the availability of streamflow in excess of senior demands (and on the return flows from upstream uses, discussed below), which will vary seasonally. In some cases, diversion timing will also be important. For example, snowmaking most often occurs after agricultural diversions have been cut off.

In Figure 1, the environmental recreational uses with water rights are identified by the green color code, graduated circles for diversions (sized in proportion to the permitted flow rate), shaded shapes for irrigated land and reservoirs, and shaded stream segments for state instream flow rights. Not all water rights are shown. For example, many of the small red dots representing wetlands are likely associated with permitted stock reservoirs. The objective here was to depict the largest rights, which are those most likely to control the availability of water in the stream system.

Permits and Operational Requirements. In some cases, an environmental or recreational use will be secured through permitting requirements attached to another use. For example, requirements for minimum storage pools, minimum bypass or storage releases, and development of wetlands to provide mitigation in association with a diversion or storage facility, may provide substantial protection for the derivative environmental or recreational uses, without those uses sharing full water-right status. These types of requirements may appear in permitting documents, may be included as conditions in a water right, or may be a function of operating agreements and plans of various types.

The associations between permit requirements for individual uses, and the degree of protection provided, should be identified, along with the water-right and operational parameters of the “host” use.

For the Greybull River pilot (Figure 1) this type of “protection” is color coded in orange, and is represented by minimum bypass requirements for diversions to the Upper (5 cfs) and Lower (15 cfs) Sunshine Reservoirs and to the Greybull Valley Reservoir (aka Roach Gulch Reservoir (50 cfs), and by the minimum pool requirement (5,000 ac-ft) for the Upper Sunshine Reservoir. The environmental and recreational uses for which the water supply is provided or enhanced through these permit requirements include: aquatic habitat, flat-water and stream fishing, boating and other water-related recreation.

In the case of Lower Sunshine Reservoir, there is provision for release of the minimum pool under special circumstances. This is the type of special condition that should be included in the analysis to qualify the protection offered by permit requirements.

Complementary Uses. Often, environmental and recreational uses enjoy no explicit protection through water right or permit requirement, but by virtue of the location and

nature of use, they are sustained through their association with other uses.

With respect to in-channel (or in-reservoir) use, the nature of this relationship is defined geographically. A fishery immediately above a major, senior irrigation diversion, for example, benefits from the regulatory calls exercised by that appropriation. This is a seasonal protection, however, and the non-irrigation-season availability of streamflow may be substantially less, e.g. if an upstream storage right comes into priority.

Similarly, an environmental or recreational use, whether in-channel or off-channel, that is dependent upon the return flows from an irrigation diversion is secure to the extent the water demands of the irrigation appropriation are met. In Wyoming, such return-flows-based environmental uses are quite common, occurring as a function of the inevitable “waste” associated with low-efficiency flood irrigation. With respect to in-channel environmental and recreational uses, of course, this protection is limited to the reach above the next downstream diversion (depending upon the available flow), whereas off-channel uses like the wetlands (and hunting) associated with irrigation conveyance and application facilities are sufficiently integrated with the host use as to not be susceptible to intervening diversions.

The protection afforded to complementary environmental and recreational uses can be substantial, as the host appropriations may have senior diversion rights, may have developed water storage projects to secure their diversions, etc. In addition to surface return flows directly feeding streamflow and wetlands, return flows to groundwater commonly serve to sustain streamflows well beyond the periods of contemporaneous diversion. These are the types of associations of interest to the evaluation of the interactions between environmental or recreational use and other basin water use sectors.

The associations between other uses in the basin and the maintenance of water supplies for the environmental or recreational use under examination, and the degree of protection provided, should be identified and evaluated.

In the Greybull River example, complementary uses include:

- 1) Wetlands conspicuously associated with irrigated lands and any associated hunting/fishing/trapping recreational use;
- 2) Fisheries, fishing, boating, etc. associated with channels in which water is present at the demands of diversion appropriations; and
- 3) Fisheries and flat-water recreation associated with reservoirs.

Competing uses. An environmental or recreational use with a water right has equal standing with any other use, but, as noted above, will typically have a relatively junior priority. More commonly, absent a water right or permit requirement, these uses rarely have explicit protection of their water supply in the sense of being able to demand a

supply to the detriment of a traditional use, or even to compete with an entirely new use that receives a water right. For example, the fishery below a major diversion is dependent upon streamflows in excess of the demands at the diversion. Rafting opportunities below a major reservoir may be dependent upon irrigation-demand driven release decisions to provide necessary flow rates.

In our Greybull River example, the reach of the river most subject to compromised flows is below the major diversion at the Bighorn/Park County line and above the lowest reaches of the river where irrigation return flows come in. Environmental and recreational uses in this area should be classified as competing and as such may be eliminated by existing or future water right holders.