TECHNICAL MEMORANDUM

SUBJECT: **Green River Basin Plan II**
Water Conservation Opportunities

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Introduction

In the arid west, water is recognized as a precious and finite resource and contemporary water management practices seek to resolve conflicts between limited supply and the demands of society. Water conservation measures involve increasing efficiency of use and reducing demand to stretch existing water supplies farther and prevent the need for undertaking expensive water development and augmentation programs which usually include major construction. Thus water conservation is many times a voluntary grassroots effort that has recently gained public attention and activism as well as local, state, and federal support and funding.

In the past, water conservation has typically focused on conservation opportunities involving irrigation because of the far greater consumptive use of the agricultural sector. Contemporary focus, however, has shifted to a more all-encompassing water conservation view with the aim of reducing water consumption in municipal, domestic, industrial, recreational, and environmental sectors along with agriculture (Texas Water Development Board, 2006). Water conservation opportunities are identified in each of the above listed water use sectors in this technical memorandum.

This memorandum identifies the plethora of water conservation opportunities available today, discusses the opportunities applicable to the Green River Basin, and finally recommends opportunities with the best economic, practical, and political components for implementation in the basin. This memo also discusses current water conservation programs and efforts in the Green River Basin.

Water Conservation Programs

This section discusses water management and conservation resources available to the Green River Basin. A comprehensive compilation of local, state, and federal agency and organization programs that provide planning, technical, and financial or administrative assistance for water management and conservation programs is given in the Water Management and Conservation Assistance Programs Directory. This document is a combined effort of the Western States Water Council, the Wyoming State Engineer's Office, the U.S. Bureau of Reclamation and the Natural Resources Conservation Service and is available at http://wwdc.state.wy.us/ wconsprog/wconsprog.html.

In addition to this directory, state water conservation tools such as watershed and municipal master plans and national programs through the National Resources Conservation Service (NRCS) Wyoming office are both available options for water conservation. Information on all of NRCS programs can be found on the NRCS website at http://www.wy.nrcs.usda.gov/ programs/index.html.

Water Conservation Opportunities General Information

Table 1 below provides a general list of the full spectrum of potential conservation opportunities and an evaluation of whether or not that measure is applicable to the Green River Basin. A detailed discussion of the applicability of each opportunity is discussed in the sections below.

Table 1 - Water Conservation Opportunities

Conservation Opportunity	Applicable to Green River Basin
Line Irrigation Canals and Ditches	X
Convert Flood Irrigation to Sprinkler	X
Altered Crop Management	X
Chemical Reservoir Coverings	
Vegetation Management	X
Water Efficient Fixtures and Appliances	X
Municipal Leak Detection & Repair	X
Municipal Water Meters	X
Public Outreach & Education	X
Xeriscaping	X
Municipal Reclamation & Recycling of Grey Water	X
Irrigation Reclamation & Recycling	X
Water Rate Structures	X
Irrigation Ditch Meters	X
Power Plant Modification	X
Riparian Maintenance	X
Program Coordination	X
Forest Timber Management	X
Reverse Osmosis	X
Conservation Studies	X
Decrease Surface Area of Reservoirs	X
Aquifer Storage & Recovery Programs	X
Water Right Transfers & Exchanges	X
Water Banking	X
Conjunctive Use	X
Regionalization of Public Water Supply Systems	
Rainwater Harvesting	X

Source: WWC Engineering, 2009; USEPA, 2002; Colorado Water Conservation Board, 2009

Agricultural Conservation Opportunities

Agriculture is the major water-consumer in Wyoming and thus the potential for conservation is great in this sector. Some good conservation ideas were identified by The Irrigation Association, an international organization that was started in 1949. Their handbook *Drought: A Handbook for Prevention and Action* states dedication to "promoting water and soil conservation through proper water management," and takes the following positions regarding long-range water conservation planning:

- Measure all water use.
- Price water so as to recognize its finite nature, provide financial incentives to users who conserve water, and provide financial penalties to users who waste water.
- Hold all water users responsible for protecting the quality of the water that they use.
- Create financial systems to reward users of efficient irrigation systems.
- Create national education programs regarding the "absolute necessity of supporting regulatory policies which reward conservation and efficient water use".
- Support water reclamation and reuse initiatives, particularly for irrigation, but also for municipal, industrial, and other water uses sectors.
- Increase support for developing new water sources, including new conveyance and storage systems and incorporating into development plans appropriate environmental concerns.
- Maintain water conservation planning as an ongoing program.
- Promote policies which allow for the lease, sale, or transfer of "established water rights" and/or the lease, sale, and transfer of water without jeopardizing established water rights, whenever possible (Irrigation Association, 2005).

The previous Green River Basin Plan identified improved irrigation practices on the short list of water supply opportunities as a good water conservation measure (WSEO and States West Water Resources, 2000). Converting from flood irrigation to border and row irrigation or center pivot sprinklers saves considerable water otherwise lost due to evaporation from flooded fields and large amounts of ditch tailwater waste, field wastewater, and deep percolation past the crop root zone. Conversion from flood irrigation to sprinkler irrigation practices increases agricultural efficiency by 25% with that number increasing to 35% if the sprinkler irrigation system is low pressure (WSEO and States West Water Resources, 2000). Conversion to sprinkler irrigation also produces greater crop yields, increases water quality by reducing salt loading of field runoff, and allows more acreage to be irrigated.

A significant portion of water diverted for irrigation can be lost during conveyance to the field through seepage, deep percolation, phreatophytes, and evaporation. Water is typically diverted from the river or stream into a canal or ditch, which is generally of earth

construction and unlined. The soils of the Green River Basin are predominantly porous and water will quickly percolate through these granular soils. Losses of 10 percent in irrigation ditches and canals are considered typical and normal; any ditches with a loss rate greater than 10 percent are candidates for rehabilitation (WSEO and States West Water Resources, 2000). In the Green River Basin, there are a large number of ditches that exceed a 20 percent loss (Boyle *et al*, 2000).

Membrane liners have been used with good results on some of the large U.S.Bureau of Reclamation (USBR) canals around the state. Research has indicated that application of polyacrylamide (PAM) to the canal bottom and sides will reduce seepage losses and increase transmission efficiencies. Concrete, PVC incorporation, and fabrics are other more common and equally effective means of reducing seepage to surrounding soils. Increasing conveyance efficiency reduces maintenance, provides drought impact insurance, and improves water quality delivered to the farm. However, irrigation districts have very limited resources to expend on canal lining and covering efforts and thus the number and scope of conveyance improvement projects that can be undertaken in the Green River Basin are limited.

Table 2 lists the main agricultural structures in the Green River Basin that have complete or mostly-complete diversion data and their corresponding conveyance efficiencies. It is important to note that these conveyance ditches are in the higher percentile of conveyance ditches in terms of overall efficiency.

Table 2 - Explicit Structure Conveyance Efficiencies

Water District	Model ID	Structure Name	Conveyance Efficiency	Length of Canal**** Miles
3	15153348	Pine Grove Canal	80%	7
5	5005005	Anderson & Howard Canal	90%	15
5	5005085	La Barge No. 2 Ditch	80%	2
7	7000237	Gilligan & Iven Ditch	80%	2.5
7	7000663	Tibbals Ditch	90%	2.5
7	7000223	Fremont Ditch (Pine Creek)	90%	6
7	7000293	Highland Canal	60%	22
7	7000188	East Fork Canal	60%	8
7	7154143	Overland Ditch (East Fork River)	90%	6
8	8000215	First Mesa Canal	90%	13
08**	8153666	West Side Canal	75%	15
10	10000471	Musselman Ditch (Dist 10)	90%	2.5
10	10000917	Reardon Ditch	90%	4
10	10000610	South Piney Ditch	90%	10
10	10000715	Yankee Ditch	75%	4.5
10	10000301	Homestake Ditch	90%	3
10	10000943	North Piney Ditch	90%	10
11	11000124	Canyon Ditch (Green River)	90%	15
15	15153041	Black's Fork Canal	80%	32
15	15153048	Bridger Butte Canal	90%	8
15	15153440	Twin Butte Ditch (District 15)	90%	12
15*	15153084	Center Ditch	100%	5
15*	15153153	Fort Bridger Canal	100%	No data

* Based on the 2001 Green River Basin Plan, these ditches gain water en route to irrigated lands from upstream ditch leakage
** West Side efficiency estimated, described in the 2001 Green River Basin Plan as having significant seepage
*** Length of Canals from Tyrell and Russell, 2000.
Source: Draft WYRAG Memorandum, 2009

In addition to updating agricultural infrastructure, altering agricultural management practices may also save a considerable amount of water. A change in some areas to less water-intensive crops or, to a lesser extent, landscaping, would potentially reap savings in water consumption. This option should be held in reserve, since it has a high impact on accustomed ways of farming and life. Management strategies such as cropping systems featuring crops with a low consumptive irrigation requirement, application of soil amendments, crop residue management, conservation tillage, water recovery and reuse, and irrigation scheduling are all considerations for reducing water use on farms.

Municipal and Domestic Conservation Opportunities

Water meters, leak detection and repair in municipal systems, reclamation and

recycling of municipal grey water, and residential plumbing improvements are all proposed water conservation possibilities in the municipal and domestic domain of water use. Individual customer meters that track actual water use conserve municipal water and help determine if there are major losses in the distribution system through leaks. Many municipalities meter their public water systems, but some municipal systems do not and therefore users have little or no incentive to conserve water. As of 2007, five out of the twenty municipalities in the Green River Basin did not have water meters (these include Bairoil, Superior, Sylvan Bay Homeowners Association, LaBarge, and Pinedale; WWDC, 2007). The expense of installing meters can be seen as prohibitive and is unpopular politically. Some systems are requiring meters on new hookups and considering phasing in metering for the existing population. Conversely, some systems encourage water use during the winter months to prevent frozen pipes.

Reclamation and recycling efforts have not so far been emphasized in the basin given the high costs of reverse osmosis systems. The use of post conventional treated wastewater for irrigation of golf courses and public green spaces has been implemented in Cheyenne. However, a study for the Town of Rawlins showed that the treatment plant output water was too brackish to be used for long-term irrigation without further treatment and the towns in the Green River Basin may have a similar problem given the comparable characteristics of the water and soils of the region to Rawlins. Thus the two contributing factors of brackish treated wastewater and the high cost of desalinization adjoin to make municipal reclamation and recycling efforts currently unfeasible in the Green River Basin.

Municipal and domestic conservation also focuses on reducing use through individual water-saving efforts. Some of these efforts include installing more water-efficient plumbing fixtures and appliances and consciously reducing water use in cooking, cleaning, sanitation, air conditioning, and outdoor uses such as landscaping and swimming pools. Most of these efforts are voluntary, and most of the effort towards reducing water through these avenues is accomplished by public outreach and education for greater awareness and encouragement towards conservation. Another way to initiate individual water conservation measures is to implement water rates that reflect the finite nature of water and encourages individuals monetarily to conserve water. These rate structures should build in rate rewards for conservation efforts, but municipalities should expect a reduction in utility income should the conservation efforts be successful.

Within the above identified opportunities, the small size municipalities within the basin may have difficulty with certain improvements from a cost/benefit perspective; however, all the conservation options are valuable from a publicity and educational standpoint. Particularly costly for the municipalities are the infrastructure repair efforts, for which bonds and financing can be difficult to obtain unless water shortages are imminent. Another downfall of water conservation measures can be the hardening of municipal systems; more specifically the loss of flexibility to grow and meet changes in the demand of water due to the focus on conservation measures. Water conservation is important, but is not a replacement for good water planning for both future growth and climate change.

Industrial Conservation Opportunities

Industrial water use is important as industry employs a significant percent of the Basin's work force and constitutes a large portion of the Green River Basin's economy. Conservation by industry is constrained by cost-benefit ratios; the necessity of making a profit will outweigh voluntary water conservation measures; thus conservation by industry differs by industrial sector.

Power plant modification can reduce consumptive use. The two large power plants in the Green River Basin, Bridger and Naughton, both use an evaporative cooling mechanism with a combined annual consumptive use of 39,674 acre-feet per year (WWC Engineering, 2009). The Seven States Report suggests that most of this consumptive use could be eliminated if power plants were to retrofit to an air-cooled system (CH2MHill, 2008). The costs of such a modification ($1,000 to $4,000 per acre-foot recovered) do not look promising at the present time, but the opportunity certainly does exist. A hybrid system combining both wet and dry cooling capacities has the capacity to wet cool on hot days when dry cooling would not be efficient and dry cool the rest of the time to conserve water. Although such systems are very expensive to install, they can limit annual water use to 2 to 5 percent of that required for all-wet systems while still achieving hot weather efficiency and high-capacity as opposed to all-dry systems. The main obstacle to this significant reduction in consumptive water is the expense of installing these systems. In the long term, as water demand continues to increase and the unapportioned water in the basin, especially the state-owned 120,000 acre-feet in Fontenelle Reservoir, is contracted out, power companies may have to convert to more water-efficient cooling methods simply because there is no more supplemental water to obtain for their power generations facilities. Another conservation option would be reuse of cooling water.

A conservation tool that could be used by all industrial sectors is improvement and updating of transmission structures, plant equipment, and industry technology to newer, more water efficient methods. Retrofitting power plants to dry cooling methods is one such example of improving technology and plant equipment and lining or enclosing water ditches and canals is another example. However these improvements can get rather expensive and will most likely be driven by the price and scarcity of future water supplies.

Desalinization of brackish water, especially Wyoming coal bed methane (CBM) production water, could augment the usability of waste water. More information on this option can be found in the Water Augmentation Opportunities Technical Memoranda (WWC Engineering, 2009), which is a part of this report.

Recreational and Environmental Conservation Opportunities

Recreation, as a low consumer of water, has few conservation opportunities but generally benefits from water conservation in other sectors with increased flows in streams and rivers and higher elevations in reservoirs and lakes. Golf courses could transfer to irrigation with reclaimed municipal grey water but the defects of water quality and the transmission requirements of some golf courses provide obstacles to this effort.

Environmental interests, like recreational interests, benefit from conservation in other sectors by leaving more water in rivers, lakes, reservoirs, and streams around the basin. One main conservation technique that should continue to be practiced and has provided a considerable benefit to the environment is flood irrigation in the Upper Green River Basin reaches. As detailed above in the agricultural conservation opportunities section, conversion of flood irrigation to sprinkler irrigation generally increases irrigation efficiency and eliminates large amounts of water waste. However, although this conversion may be beneficial in the Lower Green River Basin and various sub basins that make up the greater Green River Basin, it may have a detrimental effect on both the environment and late season stream flows if implemented in the Upper Green River Basin (Boyle *et al*, 2000).

During spring runoff season from late March to early June, most of the irrigation water that is diverted from upper reach streams and spread around the surrounding land is returned to the river. An estimated 75 percent of the irrigation water is returned to the system either by overland return flow or by underground flow (42 and 33 percents, respectively) with the remaining 25 percent consumed by vegetation, crops, and evaporation (WSEO and States West Water Resources, 2000). This current management of upper reach water has many benefits to the entire Green River Basin.

Underground return flow provides benefits to water quality, storage, and runoff timing. This type of return flow generally moves through alluvial aquifers that act like an underground storage reservoir with the capacity to store as much as 1.33 acre-feet of water per surface acre of land. Thus spring runoff, which otherwise would have flowed uncontrolled downstream, is reduced to a slower and more constant flow that lasts much longer. The percolation of irrigation water into alluvial aquifers and subsequent underground flow filters the water, improving water quality. Alluvial aquifer storage has many environmental and conservational benefits including reduced evaporation, allowing reuse of the same water several times, increasing overall efficiency, providing forage production on the land surface, and providing storage, delayed release, and regulated flows without major costly construction projects (WSEO and States West Water Resources, 2000).

Flood irrigation practices also improve water quality by slowing down the velocity of water flows, causing the water to deposit its sediment load and reducing turbidity. In addition, the reduction of stream flooding in the spring and consequent decreased flow velocities due to flood irrigation practices over historical time has created an equilibrium in upper reach streams that if upset may cause stream bank erosion, water quality degradation, and much lower late season flows. Thus flood irrigation practices are not entirely wasteful and careful consideration of the environment and impacts of conversions to other irrigation methods should be done before any transition is made.

Vegetation management is a recent conservation method which focuses on the removal of invasive, water-guzzling plants. Salt cedar, also known as Tamarisk, is widespread the Colorado River Basin and is notorious for the large amounts of water they consume. Wyoming is currently involved in a joint effort on Tamarisk Removal which is in a study, evaluation, and planning stage and consists of testing biological control methods by

the Wyoming Weed and Pest Control District in Sweetwater County (Wille and Duncan, 2009). Biological control methods include the introduction of a leaf-feeding beetle from China that targets and damages salt cedar. The Tamarisk infestation in the Green River Basin does not appear to be as dense as downstream areas, and there is hope that these alternative control methods such as Chinese Beetles (*Diorhabda elongate*) and arsenal herbicide ($250 per acre) will control the problem, both of which efforts have the potential to conserve water (Shields, 2009).

Best Opportunities and Recommendations

Flow availability work reported in the Available Surface Water Determination Technical Memorandum provides estimated amounts of available water supply at specific locations in the basin, which under normal to wet hydrologic conditions generally shows at least a small surplus (Frantz, 2009). This is unlike the situation in several other Wyoming basins, such as the North Platte Basin where shortages are chronic and widespread. We think the State's financial resources would be best spent on actions such as:

1. Supporting local efforts and initiatives toward water conservation, particularly as irrigation districts consider conveyance improvements which may be beyond their means financially but of benefit to the basin as a whole.

2. Continuing to make conservation an opportunity that is evaluated in Wyoming Water Development Commission Municipal Master Plans and Watershed Planning Studies.

3. Continuing to monitor the conservation studies and efforts of others, particularly in the Lower Colorado River Basin.

4. Continuing to widen public education and outreach programs. In some cases, local conservation efforts could avoid or delay the need for capital projects.

5. The best water conservation effort is to simply be a good water manager – in the field or at home. Individuals, municipal planners, conservation districts, etc, should all be conscious about water conservation and commit to discovering and implementing best management practices.

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