MEMORANDUM

Subject: **Bear River Basin Plan**
Task 3B. Surface Water Spreadsheet Model Development

Date: **September 18, 2000**

1.0 Introduction

The Wyoming Water Development Commission has undertaken statewide water basin planning efforts in selected river basins. The purpose of the statewide planning process is to provide decision makers with current, defensible data to allow them to manage water resources for the benefit of all the state=s citizens. The Bear River, because of its interstate nature, has been selected as an initial basin to catalogue its water resources.

The Bear River Spreadsheet Model is a complex spreadsheet which incorporates multiple diversions, reservoirs, gaging stations, and other water resources within the Bear River located in the extreme southwest corner of Wyoming. The model was developed following several months of effort and coordination with various state and local agencies and water officials. The purpose of the model is to provide a planning tool to the State of Wyoming for use in determining those river reaches in which flows may be available to Wyoming water users for future development.

1.1 Model Overview

Individual spreadsheet models were developed which reflect each of three hydrologic conditions: dry, normal, and wet year water supply. Each model relies on historical data from the 1971 to 1998 study period to estimate the hydrologic conditions, as discussed in the Task 3A Memorandum, ASurface Water Data Collection and Study Period Selection.@ Such factors as streamflow, diversions, and irrigation returns were analyzed to determine the type of hydrologic condition and are the basic input data to the model. The model does not explicitly account for water rights, appropriations, or compact allocations nor operate the river basin based on these legal constraints. It is assumed that the historic data reflect effects of any limitations which may have been placed upon water users by water rights restrictions.

To mathematically represent the Bear River system, the river system was divided into twelve reaches based primarily upon the location of USGS gaging stations. Other key locations, such as reservoirs or confluences with major tributaries, were also used to determine the extent of reaches. Each reach was then sub-divided by identifying a series of individual nodes representing locations where diversions occur, basin imports are added, tributaries converge, or other significant water resources features are located. Figure 1 presents a node diagram of the model developed for the Bear River.

At each node, a water budget computation is completed to determine the amount of water that flows downstream out of the node. Total flow into the node and diversions or other losses from the node are calculated. At non-storage nodes, the difference between inflow, including return flows, and diversions is the amount of flow available to the next node downstream. For storage nodes, an additional loss calculation for evaporation and the change in storage are evaluated. Also at storage nodes, any uncontrolled spill which occurs is added to the scheduled release to get total outflow. Mass balance, or water budget calculations, are repeated for all nodes in a reach, with the outflow of the last node being the inflow to the top node in the next reach.

For each reach, ungaged stream gains (e.g., ungaged tributaries, groundwater inflow, and return flows from unspecified diversions) and losses (e.g. seepage, evaporation, and unspecified diversions) are computed as the difference between average historical gage flows. Stream gains are input at the top of a reach to be available for diversion throughout the reach and losses are subtracted at the bottom of each reach.

Model output includes the target and actual diversions at each of the diversion points, streamflow at each of the Bear River Basin nodes, and evaluation of water emergency conditions as defined by the Bear River Compact. Estimates of impacts associated with various water projects can be analyzed by changing input data, as decreases in available streamflow or as changes to diversions occur. New storage projects that alter the timing of streamflows or shortages may also be evaluated. Complete model input and output for each of the dry, normal, and wet year conditions are included in Appendices A, B, and C, respectively.

1.2 Model Development

The model was developed using Microsoft[7] Excel 2000. It consists of a series of three-dimensional spreadsheets (i.e., workbooks) which can be thought of as a series of water commissioner-s worksheets; each page or worksheet contains the data or logic necessary to compute a separate task. Each entry (i.e., cell) in a workbook contains data or formulas which reference other cells on the same page or anywhere within the workbook. The function of each page (i.e., worksheet) is discussed in detail in subsequent sections of this memorandum.

Within the workbooks are macros written in Microsoft[7] Excel Visual Basic programming language. The primary function of the macros is to facilitate navigation within the workbook. There are no macros which complete computation of any formulas or results. In other words, whenever a number is input into any cell anywhere in the workbook, the entire workbook is recalculated and updated automatically.

The model was developed with the novice Excel user in mind. Every effort has been taken to lead the User through the model with interactive buttons and mouse-driven options. However, an elementary level of expertise in spreadsheet usage and programming is assumed. This document will not provide instructions in the use of Excel for this spreadsheet. Appendix G is provided as a guide to installing the model. Appendix H is provided as a programmer=s guide to assist in editing the Excel code and for future modifications to the model. In the next chapter, information and instructions on the use of the model are detailed.

2.0 Model Structure and Components

Each of the three hydrologically-conditioned Bear River Models is a three-dimensional spreadsheet (workbook) consisting of numerous individual pages (worksheets). Each worksheet is a component of the model and completes a specific task required for execution of the model. There are five basic types of worksheets:

1. *Navigation Worksheets*: these GUIs contain buttons used to move within the workbook;

2. *Input Worksheets*: facilitate input of raw data (USGS Gage data, Diversion Data, etc.);

3. *Computation Worksheets*: compute various components of the model (reservoir evaporation, irrigation return flows, etc.);

4. *Reach/Node Worksheets*: calculate node by node computations of the water budget; and

5. *Results Worksheets*: tabulate and present the model output.

In this chapter, each component of the Bear River Model is discussed in greater detail. A general discussion of each component includes a brief overview of the function. The discussion of each component also generally includes two sections:

1. Engineering Notes: Detailed discussion of methodologies, assumptions, and sources used in the development of that component; and

2. User Notes: AHow to@ instructions for model Users.

Programmer Notes, which are instructions and suggestions for programmers modifying the model, are included in Appendix H. These will assist state and local officials with any modifications of this model to analyze changed conditions or other applications in the Bear River Basin. Additionally, since this model may be a basis for developing spreadsheet models for other basins, this will serve as a guide for other consulting groups.

2.1 The Navigation Worksheets

A Graphical User Interface (GUI) was developed to assist the User in navigating around the spreadsheets. The initial navigation worksheet or GUI provides the User with an interactive interface to the Bear River Model. The GUI provides a brief tutorial, help screens, and information regarding the current model version (Figure 2). It is initialized by opening the Bear River Model file from within Excel. From the GUI, the User may select the appropriate model to evaluate the desired hydrologic condition (i.e., average dry, normal, or wet year).

User Notes:

Upon opening the Bear River Model file, the User is presented with several options:

1. HELP Provides a text file containing instructions and background information,

2. Dry Year Model: Open the Dry Year Model workbook,

3.	Normal Year Model:	Open the Normal Year Model workbook,
4.	Wet Year Model:	Open the Wet Year Model workbook,
5.	About Bear River Model	Obtain information pertaining to the current version of the model,
6.	Tutorial	Open a brief tutorial of the Bear River Model,
7.	Close the Bear River Model	Close any open workbooks.

Each hydrologically-conditioned model, after the GUI interface, has three main navigation worksheets. The Navigation Worksheets assist the User in moving around within the workbook. Each Navigation Worksheet contains buttons which enable the User to view any portion of the workbook. For Users experienced with Excel spreadsheets, all conventional spreadsheet navigation commands are still operative (e.g., page down, GOTO, etc.).

2.1.1 The Central Navigation Worksheet

The Central Navigation Worksheet is the Aheart@ of the model. From here, the User can Ajump@ to and from any worksheet in the model (Figure 3).

User Notes:

This is the first worksheet the User will see upon selection of a hydrologic condition from the GUI. From this worksheet, the User can access any other worksheet in the model. A series of buttons can be used to Ajump@ directly to any other location in the workbook. Figure 3 displays the Central Navigation Worksheet from the Normal Year Model.

The User can go to specific reaches by selecting the desired reach from the pull-down menu. When a reach is selected, a table is presented which tabulates all of the nodes in that reach and a brief description of it.

2.1.2 The Basin Map

User Notes:

The Basin Map Worksheet (Figure 4) provides a simple Astick diagram@ of the basin, which is a simplified version of Figure 1. This interactive screen allows the User to visually select a reach to which to Ajump@. To select a reach, simply click on any reach arrow or its name.

2.1.3 The Results Navigator

User Notes:

The Results Navigator (Figure 5) facilitates the selection of any of the following output tabulations:

- Estimated Outflow from each Node
- Estimated Outflow from each Reach
- Estimated Diversions at each Diversion Node
- Estimated Total Diversions from each Reach
- Compact Allocations: Upper Division
- Compact Allocations: Central Division

2.2 The Input Worksheets

2.2.1 Master List of Nodes: Matching Number and Name

The model is structured around nodes at which mass balance calculations are made and reaches that connect the nodes. Nodes are points on the river that represent such water resources features as USGS Gage locations, diversion headgates, confluences of the Bear River and its tributaries, or reservoirs. There are a total of 64 nodes in the model; 10 USGS gages, 36 named or key diversion points, 10 aggregated diversion points, and two fully modeled reservoirs (i.e., storage modeled and evaporation included). Also included are five node points, which are confluences of tributaries with the mainstem and Stewart Dam, which was modeled as a river node point but not as a reservoir.

Engineering Notes:

The delineation of a river basin by reaches and nodes is more an art than a science. The choice of nodes must consider the objectives of the study and the available data. It also must contain all the water resources feature that govern the operation of the basin. The analysis of results and their adequacy in addressing the objectives of the study are based on the input data and the configuration of the river basin by the computer model.

User Notes:

This worksheet presents a master list of all nodes included in the Bear River Model (Table 1). The list allows the User to view a simple, comprehensive listing of all nodes within the model, organized by reach and node number. This master list governs naming and numbering conventions on many worksheets, so changing the list must be carefully done and checked. Many of the calculations within the spreadsheet are dependent on the proper correlation of node names and numbers.

Note that the numbering convention used for node identification includes the reach number and the location of the node within it. For example, Node 10.05 is the fifth node in Reach 10. There are exceptions to this rule where a node has been added between existing nodes. In these cases, the numbering is not sequential, but the numbering system does not govern the flow connections in the system.

2.2.2 Gage Data

Monthly stream gage data were obtained from the USGS for each of the stream gages used in the model. Several of the gages contained incomplete records or missing data. Linear regression techniques were used to estimate missing values. A detailed discussion of this process is provided in the Task 3A Memorandum, Surface Water Data Collection and Study Period Selection.

A 1971 through 1998 study period was selected based largely upon review of the available data, the objectives of the model, and the historical development of the basin. Historic data were available at many of the USGS gaging stations for periods extending back to the early 1900's, however, measurement records were available at many of the key diversions in the Upper Division of the Bear River beginning in 1971.

Determination of dry, normal, and wet years was accomplished by plotting graphs of the ranked total annual streamflow at each gage. Based upon a combination of using natural breaks in the measured data and use of simple statistics, that is, the upper and lower 20% of the data; dry, normal, and wet years were selected for each gage. Average monthly values for each hydrologic condition were then computed at each gage as the basic streamflow input to the model.

Engineering Notes:

For a detailed discussion of the data filling and analysis associated with the USGS gaging data, see the Bear River Planning Study, Task 3A Memorandum. The analysis of Task 3A was based on a water year period. Because of return flow conditions in the development of the spreadsheet model, a calendar year basis for all data was selected. An analysis of the dry, normal, and wet year hydrologic condition was performed on the calendar year data to insure that dry years remain dry years, and similarly for the other two conditions. This was the case and, hence, although the annual volumes at the gage points changed slightly (less than 3 percent change in the three months as a percent of the annual total), the annual flows on a calendar year basis are used in the model.

Table 2 presents a summary of this effort and the determination of hydrologic conditions for each year of the study period. Appendix D includes the USGS data for the period of record at each gage. Average monthly values for each hydrologic condition were then computed at each gage as the basic streamflow input to the model (Table 3).

User Notes:

The Gaging Data Table presents the average historic gaging data for each hydrologic condition used in the model. Only the data pertaining to the hydrologic condition being modeled are included in each respective model. These data represent the discharge which can be expected to occur each month in an average dry, normal, or wet year at all the gages used in the model.

2.2.3 Diversion Data

The Bear River Commission publishes diversion records in each of its Biennial Reports. These records were compiled to form the basis of diversion data input to the model. A complete record of diversions exists for the entire basin for the study period of 1971 through 1998. Provisional diversion data reflecting recent years (1996 through 1998) were obtained from the Wyoming State Engineers Office and directly from the Bear River Commission. Following completion of the model, the Bear River Commission published the 1997-1998 Biennial Report which included finalized diversion data for that period. These data were compared to the provisional data and no significant differences were observed.

Estimates of monthly diversions at each of 36 key specific diversions (see Appendix E) were computed for each of the three hydrologic conditions based upon the annual condition presented in Table 2. Key diversions were defined as those locations where greater than 10 cfs are diverted from the river. Eight aggregated diversions for all other diversions in Wyoming were added to complete the water balance for the basin (Appendix F). Diversions within Utah and Idaho were aggregated and modeled as single nodes. All diversions that are specified in the Bear River Compact are included, either explicitly in the model or in the Results Worksheets as data inputs (Table 4).

Engineering Notes:

The following sections summarize the sources of data for each division.

Upper Utah Section - Upper Division

- 1971-1998 data were obtained from tables published in the Bear River Commission Reports. Note that diversion records for the Hatch diversion began in 1992. These diversions are not explicitly modeled; however, their annual average totals are included in the Compact Allocation Worksheet in the results.

Wyoming Section - Upper Division

- 1971-1996 data were obtained from tables published in the Bear River Commission Reports.

- 1997-1998 data were obtained from preliminary diversion records provided by Jade Henderson, State Engineer's Cokeville Office. At the time that these data were provided, there was not yet a published Biennial Report for the period. In late April, 2000, the Bear River Commission published the 1997-1998 Biennial Report. Diversion records from these reports were spot checked against the preliminary data. This check resulted in no significant changes between the preliminary data and the published data.

Lower Utah Section - Upper Division

- 1971-1996 data were obtained from tables published in the Bear River Commission Reports.

- 1997-1999 date were obtained from preliminary diversion records provided by Don Barnett, Bear River Commission Office. At the time that these data were provide, Biennial Reports were not yet available for this period. In late April, 2000, the Bear River Commission published the 1997-1998 Biennial Report. Diversion records from these reports were spot checked against the preliminary data. This check resulted in no significant changes between the preliminary data and the published data.

Wyoming Section - Lower Division

- 1971-1996 data were obtained from tables published in the Bear River Commission Reports.

- 1997-1998 data were obtained from preliminary diversion records provided by Jade Henderson, State Engineer's Cokeville Office. At the time that these data were provided, there was not yet a published Biennial Report for the period. In late April, 2000, the Bear River Commission published the 1997-1998 Biennial Report. Diversion records from these reports were spot checked against the preliminary data. This check resulted in no significant changes between the preliminary data and the published data.

Wyoming Section - Central Division

- 1971-1996 date were obtained from tables published in the Bear River Commission Reports.

- 1997-1999 data were obtained from preliminary diversion records provided by Jade Henderson, State Engineer's Cokeville Office. At the time that these data were provided, Biennial Reports for this period were not yet available. In late April, 2000, the Bear River Commission published the 1997-1998 Biennial Report. Diversion records from these reports were spot checked against the preliminary data. This check resulted in no significant changes between the preliminary data and the published data.

Idaho Section - Central Division

- 1971-1996 data were obtained from tables published in the Bear River Commission Reports.
- 1997-1999 data were obtained from preliminary diversion records provided by Don Barnett, Bear River Commission Office. At the time that these data were provided, Biennial Reports for this period were not yet available. In late April, 2000, the Bear River Commission published the 1997-1998 Biennial Report. Diversion records from these reports were spot checked against the preliminary data. This check resulted in no significant changes between the preliminary data and the published data.

Bear River below Stewart Dam

- 1970-1999 data were provided by the PacifiCorp Office in Salt Lake City. The data were provided by Scott Johnson from that office. Records for the flow in the Bear River below Stewart Dam are published in the Bear River Commission Biennial Report only for the summer months. Since year-round data at this location was required for the model, PacifiCorp was contacted in order to obtain winter data at this gage. Although the summer records published in the Biennial Report varied slightly from those records provided by PacifiCorp, PacifiCorp's numbers for both summer and winter flows were used to keep consistency in the data source.

Rainbow Inlet

- 1971-1998 Data is from tables published in the Bear River Commission Reports.

Based upon the determination of hydrologic condition at each USGS gaging station conducted during Task 3A of the Bear River Planning Study, overall basin conditions were estimated (Table 2). Examination of Table 2 reveals that in general, the hydrologic conditions were very consistent throughout the basin. A row summarizing basin-wide hydrologic conditions for the Bear River Basin appears at the bottom of the table. From this selection of hydrologic year type, average monthly diversions for each of the three hydrologic conditions were determined.

Average monthly diversion data were computed based upon the basin-wide conditions (Appendix E). Average dry year diversions represent the average of diversions recorded during the six dry years (1977, 1979, 1988, 1990, 1992, and 1994), average normal year diversions represent the average of diversions during the nineteen normal years (1971-1976, 1978, 1980-1982, 1985, 1987, 1989, 1991, 1993, and 1995-1998), and average wet year diversions represent the average of diversions during the three wet years (1983, 1984, and 1986).

User Notes:

This worksheet provides a summary of the diversions which can be expected to occur at each node during a typical dry, normal, or wet year. This worksheet is a means of providing input data to the model; there are no computations conducted within it. Note that all nodes are listed in the table, even if no diversions occur at them. At the top of the worksheet are buttons which also take the User to a table summarizing the total monthly diversions in each reach.

2.2.4 Import and Export Data

The Broadbent Supply Ditch imports water from the Green River Basin. In 1999, it was fitted with a recorder and telemetry system which improved the ability to document this import. According to the 1999 Biennial Report, 24.8 acre-feet were imported for the period July 31 to the end of September.

Engineering Notes:

Average monthly historic data are lacking for the Broadbent Ditch because it was only recently equipped with gaging equipment. Based upon the 1999 Biennial Report, 24.8 acre-feet were imported over a 62 day period. This converts to an average of 0.2 cfs or an average of approximately 12 acre-feet per month. This value was used as the average monthly import for the Broadbent Ditch during the irrigation season in each hydrologic condition.

User Notes:

The Imports / Exports Table summarizes the monthly imports to or exports from other basins. In the Bear River Model, the only imports incorporated are those associated with the Broadbent Supply Ditch. There are no basin exports incorporated herein, although that capability exists at all nodes.

2.3 The Computation Worksheets

The spreadsheet model determines the water budget at node points along the river, reflecting inflows from gaged and ungaged tributaries and diversions from delivery points. The historic or estimated river headgate diversions are the demands that drive the model. The consumptive use portion of these diversions must be estimated along with the return flows. These return flows eventually return to the stream system and are available for future diversions.

2.3.1 Return Flows

The unused portion of a headgate diversion either returns to the river as surface runoff during the month it is diverted, or "deep percolates" into the alluvial aquifer. The deep percolation portion returns to the river through the aquifer but generally lags the time of diversion by several months, or even years. It is important for the model to simulate both the percent of headgate diversions that return to the river, and the timing of which this unused portion returns. In the Bear River Basin, water from the river is reused many times from the headwaters to the Great Salt Lake.

Diversion efficiency is the common measure of the portion of headgate diversion that is consumed, and therefore not returned to the river. Diversion efficiency for municipal and industrial use is the percent of headgate diversion that makes it to the treatment plant or industrial site. The remaining percent is lost during conveyance, and returns to the river as surface runoff or deep percolation. Diversions for agricultural use experience both conveyance losses and application losses, and both these loss percentages return to the river as surface runoff or deep percolation. Additional discussion of the consumptive use analysis and return flow study is contained in Tasks 2A, 2B, and 2C Memorandum, Bear River Planning Study.

Engineering Notes:

Table 5 shows the conveyance efficiencies estimated for the key ditch systems represented in the modeling effort for the upper division. The upper division aggregate ditch systems were assigned a conveyance efficiency of 65 percent, because they represent smaller ditches generally irrigating lands close to the river. Table 6 shows the conveyance efficiencies estimated for the key ditch systems represented in the modeling effort for the central division. The central division aggregate ditch systems were assigned a conveyance efficiency of 65 percent, again because they represent smaller ditches generally irrigating lands close to the river.

In addition to conveyance efficiencies, Table 5 shows the suggested application efficiency for the key ditch systems in the upper division. Because lands in the upper division are flood irrigated, the application efficiencies are all 55 percent. An application efficiency of 55 percent is also used for aggregated ditch systems. Table 6 shows the suggested application efficiency for the key ditch systems in the central division. An application efficiency of 65 percent was used for aggregated ditch systems in the central division, which represents an average of key ditch system efficiencies.

The model uses a diversion efficiency that represents the actual amount of headgate diversion used to satisfy crop consumptive use demands. It is calculated as the product of conveyance efficiency and application efficiency. The diversion efficiency is also provided in Tables 5 and 6.

User Notes:

This worksheet computes the return flows from irrigation diversions, mainly. For every node, the return flow is computed based upon estimates of consumptive use associated with the crops irrigated, the extent and location of the irrigated acreage, and canal losses. For clarification, all cells which can be modified by the User are highlighted in yellow. The features of this worksheet are discussed in the following sections. Figure 6 displays an example table from the Return Flows worksheet.

Total Diversions

These values are retrieved automatically from the Diversion Data tables.

Efficiency Pattern

The model applies one of 17 pre-determined irrigation efficiency patterns to the water diverted at each node. The efficiency patterns represent that portion of the diversion which is lost to the system as a consumption. The remainder are losses, e.g., conveyance and on-farm efficiency losses (e.g., flood vs sprinkler irrigation efficiency), which are returned to the system at other river points. For example, an efficiency pattern of 25 means that 75% of the water diverted eventually returns to the river either by surface or subsurface flow and that 25% is consumed. These patterns are included on the Options Tables worksheet of the model. By entering the number associated with a pattern in this cell, the efficiency pattern is applied.

Total Irrigation Returns

These data are computed by multiplying the Total Diversions by the selected Efficiency Pattern. For example, if a month shows a Total Diversion of 883 acre-feet and an Efficiency Pattern of 25 is selected, the Total Irrigation Returns from that diversion will be 662 acre-feet (883 x (1.0-.25) = 662) distributed in a temporal pattern as specified by the Return Pattern. It is assumed that there is not sufficient variation in the monthly efficiency to justify a monthly-varying pattern.

TO and Percent

This feature allows the User to define the node in the model where irrigation returns will return. Return locations were determined based upon field inspection, local knowledge, and/or aerial photographs. By entering the node number in the TO box, and the relative percentage of the Total Irrigation Returns that are expected to return to that node, the Total Irrigation Returns are distributed accordingly. Note that the percentages entered at each node must total 100% or an error message will appear warning the User that all returns have not been accounted.

Return Pattern

The Return Pattern feature allows the User to select between four different temporal patterns representing the lagged time effect of irrigation returns to the river. The four Return Patterns available are displayed in the Irrigation Return Lags section of the Options Table. Not all of the water diverted at a node returns to the river in the same month. The lags between the month in which a diversion occurs and the month the irrigation returns actually arrive in the river are estimated.

The Return Pattern feature first directs the model to account for that portion of irrigation returns occurring in the same month as the diversion. It then directs the model to add returns lagged from previous months. In this model, it was assumed that all irrigation returns will occur during the month it is diverted and within three additional months.

Irrigation Returns: Node Totals Table

This table collects all of the irrigation returns that have been sent to each Node and provides their sum. It is accessed via the AView ›Node Totals= Summary Table@ button located at the top of the worksheet.

Irrigation Returns: Reach Totals Table

This table collects all of the irrigation returns that have been sent to each Reach and provides their sum. It is accessed via the AView ›Reach Totals= Summary Table@ button located at the top of the worksheet.

2.3.2 Return Options Tables

These tables store the patterns specified in the Return Flow worksheet apart from the node by node calculations. They are stored in a separate worksheet than the Return Flows.

Engineering Notes:

The unused, or inefficient, portion of diversions are returned to the river either by direct surface runoff, or through the alluvial aquifer. For modeling purposes, an estimate must be made of both:

1. the location or locations on the river where the unused portion of diversions will return, and
2. the timing of those returns.

The irrigated acreage GIS theme was used to estimate these locations, shown in Table 7 for the upper division and Table 8 for the central division. In addition to the return flow node location in the river, Tables 7 and 8 show the return flow pattern used to represent each ditch system. Additional discussion of the return flow analysis is contained in Tasks 2A, 2B, and 2C Memorandum, Bear River Planning Study.

User Notes:

The Options Tables incorporate the information used in the computation of irrigation return flow quantities and their timing. The data in the first table, AIrrigation Return Patterns@, consist of the percentages of water diverted which eventually will return to the river and be made available to downstream users. The values entered under APattern Type@ are the amounts of water consumed or lost from the system.

The second worksheet table, AIrrigation Return Lags@, controls the timing of these returns. Flows diverted in any month can be lagged up to three months beyond the month in which they are diverted. For example, Return Pattern No. 1 is as follows:

Month	0	1	2	3	
Percent		50	15	25	10

For a diversion occurring in June, 50 percent of the Total Irrigation Returns (i.e., that portion not lost to consumptive use, evaporation, etc.) will return in June, 15 percent will return in July, 25 percent will return in August, and the remaining 10 percent will return in September.

2.3.3 Evaporative Losses

Evaporation losses occur from any free water surface in the Bear River Basin, however, in this model development the only calculated evaporation occurs at the two main reservoirs in the system; Sulphur Creek and Woodruff Narrows Reservoirs. Evaporative losses from the river surface are accounted for in the reach gain/loss calculations. Similarly, evaporation losses from Stewart Dam are accounted for in the reach gain/loss calculation for that reach.

In the Bear River Model, two reservoirs were modeled: Sulphur Creek Reservoir located on Sulphur Creek (Node 2.02), and Woodruff Narrows Reservoir located on the mainstem of the Bear River (Node 6.01). Pixley Dam (Node 8.01) and Stewart Dam (Node 12.04) are included in the model as node points only; no storage is allowed at the sites, nor evaporation losses calculated. Evaporation losses are included in the mass balance calculations at each reservoir node.

Engineering Notes:

Pan evaporation data for the Green River, Wyoming, weather station were obtained through the High Plains Climate Center located in Lincoln, NE. No pan evaporation data were available within the Bear River Basin. Because of its proximity to the Bear River Basin, the Green River weather station was assumed to be representative of the basin. The pan evaporation data were adjusted by a factor of 0.6 to estimate evaporation from reservoirs and lakes. Precipitation data for the Evanston, Wyoming weather station were obtained through the Water Resources Data System (WRDS). Using average monthly pan evaporation data and mean monthly precipitation data, the net monthly reservoir evaporation estimates were computed and input to the model. The average annual net evaporation rate was 33.25 inches per acre (Table 9).

User Notes:

Monthly gross evaporation (inches) and total precipitation (inches) data are included in the table. Pan evaporation data must be adjusted to represent lake surface evaporation prior to entry. The worksheet then computes the net evaporation in inches and applies this factor to the average annual lake surface area.

2.3.4 Node Tables

Each non-storage node is represented in the spreadsheet by an inflow section, which includes inflow from the upstream node, irrigation returns, ungaged gains, and imports, if applicable; and an outflow section, which includes ungaged losses and diversions, if applicable. The algebraic sum of these flows are then the net outflow from the node. In the case of storage nodes, evaporation is included as a loss and flow can either go to or come from storage. Again, the water balance is done for the node and outflow is calculated. Figure 7 displays the Node 1.01 Table (Lannon and Lone Mountain) as an example.

Engineering Notes:

This is the heart of the spreadsheet model where water budget calculations are performed for each node represented in the basin. Water balance is maintained in a river reach, or at least between reach gain/loss points, by performing the water budget calculations at each node until the outflow from the bottom node in each reach equals the gage flow at that point.

User Notes:

The Node Tables compute the flow available to downstream users (NET flow) using a water budget approach.

NET Flow = Total Node Inflow - Total Node Outflow

where:

Total Node Inflow = Flow from the node located upstream +
Irrigation Returns to this the node +
Ungaged reach gains (if available) +/-
Basin Imports/Exports

and

Total Node Outflow = Diversions from the node +
Ungaged Losses

The nodes must be organized in a consecutive order within each reach. Historic diversions at each node are automatically referenced from the Diversion Data worksheet. In the event that the historic demand cannot be met based upon available streamflow, the model will determine the amount that is available and enter that amount. In that event, a warning will be presented to inform the User that a diversion has been shorted.

2.3.5 Reach Gain/Loss

The Bear River Basin, although of limited geographic size and well-documented by data sources, could not be completely modeled explicitly. Not all water features, such as small tributaries and diversions, are included in the computer representation of the physical system. Therefore, many features are aggregated and modeled, while many others are lumped together between measured flow points in the river by a modeling construct called ungaged reach gains and losses. These ungaged gains and losses account for all water in the budget that is not explicitly named and become a measure of how well the system incorporates physical features.

Engineering Notes:

Ungaged gains to the model include sources such as inflow from un-modeled tributaries, return flows from un-modeled diversions and groundwater inflow. Ungaged losses include factors such as un-modeled diversions, seepage and evaporation from the river. These factors are computed on a reach-by-reach basis using a water budget approach:

Ungaged Gains/Losses = Difference between downstream and upstream gages +
Total diversions within the Reach -
Total irrigation return flows to the Reach +/-
Reservoir change in storage

The volume of ungaged gains and losses is a good measure of the adequacy of the model and the accuracy of the modeled features. If the volumes are high in comparison to the flow in the river or to diversions, then some major water features have not been modeled or have not been modeled correctly.

User Notes:

The worksheet collects all positive values (Reach Gains) and all negative values (Reach Losses) and creates the two Reach Summary Tables which are viewable with selection of the ASummary@ button. Table 10 displays the Ungaged Gains and Losses determined for the Normal Year condition.

In most cases, the Ungaged Reach Gains and Losses were computed for single reaches which are bound on both the upstream and downstream ends by gages. In those cases where the downstream end of a reach is not a gage, exceptions to this rule occur. These instances are discussed as follows:

A. Reaches 1, 2 and 3

Ungaged Gains and Losses were computed for the combined reaches and distributed between the upstream end of Reach 1 (Bear River) and Reach 2 (Sulphur Creek) in proportion to the ratio of the total annual discharges at the two upstream gages. For this computation, the water budget presented above consisted of the following terms:

Difference in Gaged Flows	=	Bear River at Evanston, WY (Gage 10016900) - Bear River near UT-WY State Line (Gage 10011500) - Sulphur Creek above Reservoir below La Chapelle Creek near Evanston, WY (Gage 10015700)
Total Diversions	=	Total Diversions Reach 1 + Total Diversions Reach 2 + Total Diversions Reach 3 + Change in Reservoir Storage (Sulphur Creek)
Total Return Flows	=	Total Returns Reach 1 + Total Returns Reach 2 + Total Returns Reach 3

B. Reaches 4 and 5

Ungaged Gains and Losses were computed for the combined reaches. Combined Gains were added to the upstream end of Reach 4 and combined Losses were taken at the downstream end of Reach 5. For this computation, the water budget presented above consisted of the following terms:

Difference in Gaged Flows	=	Bear River above Reservoir, near Woodruff, UT (Gage 10020100) - Bear River at Evanston, WY (Gage 10016900)
Total Diversions	=	Total Diversions Reach 4 + Total Diversions Reach 5
Total Return Flows	=	Total Returns Reach 4 + Total Returns Reach 5

C. Reaches 9, 10 and 11

Ungaged Gains and Losses were computed for the combined reaches and distributed between the upstream end of Reach 9 (Bear River) and Reach 10 (Smiths Fork) in proportion to the ratio of the total annual discharges at the two upstream gages. For this computation, the water budget presented above consisted of the following terms:

Difference in Gaged Flows	=	Bear River below Smiths Fork, near Cokeville, WY (USGS 10038000) - Smiths Fork near Border, WY (USGS 1003200) - Bear River below Pixley Dam, near Cokeville, WY (USGS 10028500)
Total Diversions	=	Total Diversions Reach 9 + Total Diversions Reach 10 + Total Diversions Reach 11
Total Return Flows	=	Total Returns Reach 9 + Total Returns Reach 10 + Total Returns Reach 11

2.4 The Reach/Node Worksheets

The following sections present information pertinent to each specific reach in the Bear River Model. Included in these sections are listings, issues and assumptions pertaining to each reach.

2.4.1 Reach 1

Reach 1 consists of the following nodes listed in the order they are placed in the model:

Node 1.00 USGS 10011500: Bear River near UT-WY State Line
Node 1.01 Lannon & Lone Mountain
Node 1.02 Hilliard West Side
Node 1.03 Bear Canal
Node 1.04 Crown & Pine Grove
Node 1.05 McGraw & Big Bend

Node 1.06 Lewis
Node 1.07 Meyers No. 2
Node 1.08 Meyers No. 1
Node 1.09 Meyers Irrigation
Node 1.10 Evanston Pipeline
Node 1.11 Booth
Node 1.12 Anel
Node 1.13 Evanston Water Supply
Node 1.15 AggDiv BR-1

This Reach is the upstream end of the Bear River Model. Inflow to Reach 1 at Node 1.00 (USGS Gaging Station 10011500) serves as the beginning of the water budget computations. The reach ends at the confluence with Sulphur Creek. Mill Creek is not modeled explicitly, however, a node has been added at the confluence with the Bear River (Node 1.18) to accommodate irrigation return flows which it conveys. Aggregate Diversion BR-1 (Node 1.15) represents the aggregated diversions which are not modeled individually. The diversion for Hilliard East Side is not explicitly modeled because it is above the most upstream gage, USGS 10011500. The diversion, though, is included in the summary tables and in the Compact Allocations calculations in the Results Worksheets.

2.4.2 Reach 2

Reach 2 consists of the following nodes:

Node 2.00 USGS 10015700: Sulphur Cr. ab Res.
Node 2.01 AggDiv SC-1/Broadbent
Node 2.02 Sulphur Creek Reservoir
Node 2.03 AggDiv SC-2

Reach 2 consists of nodes on Sulphur Creek including Sulphur Creek Reservoir. Inflow to the reach is defined as the flow at USGS Gaging Station 10015700 and the reach ends at the confluence with the Bear River. The target for Sulphur Creek Reservoir outflow has been set equal to the gage data measured at USGS Gaging Station 10015900. Changes in reservoir storage are computed as the difference between reservoir inflow (NET Flow at Node 2.01) and outflow (USGS Gaging Station 10015900) minus evaporative losses.

AggDiv SC-1/Broadbent (Node 2.01) and AggDiv SC-2 (Node 2.03) represent aggregated diversions which are not modeled individually. Basin imports to Sulphur Creek via the Broadbent Ditch are added at Node 2.01. Ungaged Reach Gains for Reach 2 were added to the model downstream of Sulphur Creek Reservoir at Node 2.03.

2.4.3 Reach 3

Reach 3 consists of the following nodes:

Node 3.00	Confluence Sulphur Creek / Bear River
Node 3.01	Evanston Water Ditch
Node 3.02	Rocky Mtn & Blyth

Reach 3 begins at the confluence of the Bear River and Sulphur Creek (Node 3.00) and ends at USGS Gaging Station 10016900. Ungaged losses in the reaches 1 through 3 are subtracted from the flow in this reach at Node 3.02.

2.4.4 Reach 4

Reach 4 consists of the following nodes:

Node 4.00	USGS 10016900: Bear R. at Evanston, WY
Node 4.01	John Simms
Node 4.02	S P Ramsey
Node 4.03	AggDiv Br-2

Reach 4 begins at the USGS Gaging Station 10016900 (Node 4.00) and ends at the confluence of the Bear River and Yellow Creek (Node 5.00). Aggregate Diversion BR-2 (Node 4.03) represents the aggregated diversions in the Upper Wyoming section of the Upper Division which are not modeled individually.

2.4.5 Reach 5

Reach 5 consists of the following nodes:

Node 5.00	Confluence Yellow Creek / Bear River
Node 5.01	Chapman Canal
Node 5.02	Morris Bros (Lower)
Node 5.03	AggDiv BR-3
Node 5.04	Tunnel

Reach 5 begins at the Confluence of the Bear River and Yellow Creek (Node 5.00) and ends at USGS Gaging Station 10020100. Yellow Creek is not modeled explicitly, however, a significant amount of irrigation returns are conveyed by it. Therefore, a node has been added at the confluence with the Bear River to accommodate these flows (Node 5.00). Aggregate Diversion BR-3 (Node 5.03) represents other aggregated diversions in the Upper Wyoming section of the Upper Division which are not modeled individually.

2.4.6 Reach 6

Reach 6 consists of the following nodes:

Node 6.00	USGS 10020100: Bear R. ab Res. near Woodruff, UT
Node 6.01	Woodruff Narrows Reservoir

Reach 6 consists of the USGS Gaging Station 10020100 and Woodruff Narrows Reservoir. Reservoir outflow equals gaging data measured at USGS Gaging Station 10020300. Changes in reservoir storage are computed as the difference between reservoir inflow (NET Flow at Node 6.00) and outflow (USGS Gaging Station 10020300) minus evaporative losses.

2.4.7 Reach 7

Reach 7 consists of the following nodes:

Node 7.00	USGS 10020300: Bear R. bel Res. near Woodruff, UT
Node 7.01	Francis Lee

Node 7.02 Bear River Canal
Node 7.03 Aggregate Utah Diversions
Node 7.04 Return Flows from Aggregate Utah Diversions

This reach begins with the Woodruff Narrows Outflow (Node 7.00) and ends at the USGS Gaging Station 10026500. It incorporates all of the Lower Utah diversions in the Upper Division at Node 7.03. None of the Lower Utah diversions were modeled individually.

2.4.8 Reach 8

Reach 8 consists of the following nodes:

Node 8.00 USGS 10026500: Bear R. near Randolph, UT
Node 8.02 BQ Dam
Node 8.01 Pixley Dam

Reach 8 begins at the USGS Gaging Station 10026500 and ends at Pixley Dam and includes all diversions from the two diversion dams. This is the last reach in the Upper Division.

2.4.9 Reach 9

Reach 9 consists of the following nodes:

Node 9.00 USGS 10028500: Bear R. bel Pixley Dam
Node 9.02 AggDiv BR-4
Node 9.01 Confluence Smiths Fork / Bear

This reach is the uppermost reach of the Central Division as defined in the Bear River Compact. It begins at the Pixley Dam outflow (Node 9.00) and ends at a node representing the confluence of the Bear River with Smiths Fork. Aggregate Diversion BR-4 (Node 9.02) represents the aggregated diversions which are not modeled individually.

2.4.10 Reach 10

Reach 10 consists of the following nodes:

Node 10.01	USGS 10032000: Smiths Fork near Border, WY
Node 10.02	Button Flat
Node 10.03	Emelle
Node 10.04	Cooper
Node 10.05	Covey
Node 10.06	VH Canal
Node 10.07	Goodell
Node 10.08	Whites Water
Node 10.09	S Branch Irrigating
Node 10.10	AggDiv SF-1

This reach models the Smiths Fork which is tributary to the Bear River. Inflow to the reach is measured at the USGS Gaging Station 10032000 (Node 10.01) and ends at the confluence with the Bear River (Node 9.01). The diversion for Quinn Bourne is not explicitly modeled because it is above the most upstream gage, USGS 10032000. The diversion, though, is included in the summary tables and in the Compact Allocations calculations in the Results Worksheets. Aggregate Diversion SF-1 (Node 10.10) represents the aggregated diversions from the Smiths Fork which are not modeled individually.

2.4.11 Reach 11

Reach 11 consists of the following nodes:

Node 11.00	USGS 10038000: Bear R. bel Smiths Fork
Node 11.01	AggDiv BR-5
Node 11.02	Alonzo F. Sights
Node 11.03	Oscar E. Snyder
Node 11.04	Cook Brothers

This reach begins at the USGS Gage 10038000 downstream of Smiths Fork (Node 11.00) and ends at the USGS Gage 10039500 at the Wyoming / Idaho state line. Aggregate Diversion BR-5 (Node 11.01) represents the aggregated diversions of Wyoming in the Central Division which are not modeled individually.

2.4.12 Reach 12

Reach 12 consists of the following nodes:

Node 12.00	USGS 10039500: Bear R. at Border, WY
Node 12.01	Confluence Thomas Fork
Node 12.02	Aggregate Idaho Diversions
Node 12.03	Rainbow Inlet
Node 12.04	Stewart Dam

Reach 12 begins at the USGS gage 10039500 and ends downstream of Stewart Dam in Idaho. It includes flows diverted by the Rainbow Inlet (Node 12.03). Aggregate Diversion BR-5 (Node 12.02) represents 12 aggregated Idaho diversions which are not modeled individually.

2.5 The Results Worksheets

Several forms of model output can be accessed from the Summary Options worksheet. These include river flow data (nodes or reaches), target and actual diversions (nodes, reaches, or comparison to historic), and evaluations of Compact Allocations (Upper or Central Divisions).

2.5.1 Outflows

This worksheet summarizes the flows at all nodes in the model. The AOutflow Calculations: By Node@ table summarizes the net flow for all nodes. Note that this table is included with each model printout (Appendices A, B, and C). The nodes are grouped by reach. The AOutflow Calculations: By Reach@ table presents the net flow for each reach. Table 11 presents the Reach Summary Table from the Normal Year condition as an example. A comparison of flows at significant node points which are USGS Gaging locations is also included.

2.5.2 Diversions

This worksheet summarizes the diversions at all nodes in the model. The ASummary of Diversion Calculations: By Node@ tables summarizes the computed diversions which are made at each node.

The nodes are grouped by reach. Note that this table is not incorporated into this memo, but is included within the model printouts (Appendices A, B, and C). The ASummary of Diversion Calculations: By Reach@ table presents the total diversions taken within each reach. Table 12 presents the corresponding table from the Normal Year Model as an example. The AComparison of Estimated vs Historic Diversions@ table presents comparison results and would indicate if any shortages occurred to target diversion volumes (Table 13).

2.5.3 <u>Compact Allocations</u>

An effort was made to incorporate sufficient detail in the spreadsheet models to determine whether water emergency conditions exist as defined in the Bear River Compact for either the Upper or Central Divisions. The Water Commissioners worksheets for both divisions were computerized and all appropriate flows and diversions were tabulated. These tables determine whether an emergency condition exists; however, no attempt was made in the model to restrict diversions based on this determination.

<u>User Notes:</u>

The ABear River Commission Water Allocation: Upper Division@ table (Table 14) uses the Water Commissioner=s worksheet to determine if a water emergency exists in the Upper Division under the current scenario. If so, the worksheet computes the allocations for the Upper Utah, Upper Wyoming, Lower Utah, and Lower Wyoming sections, as defined in the Bear River Compact.

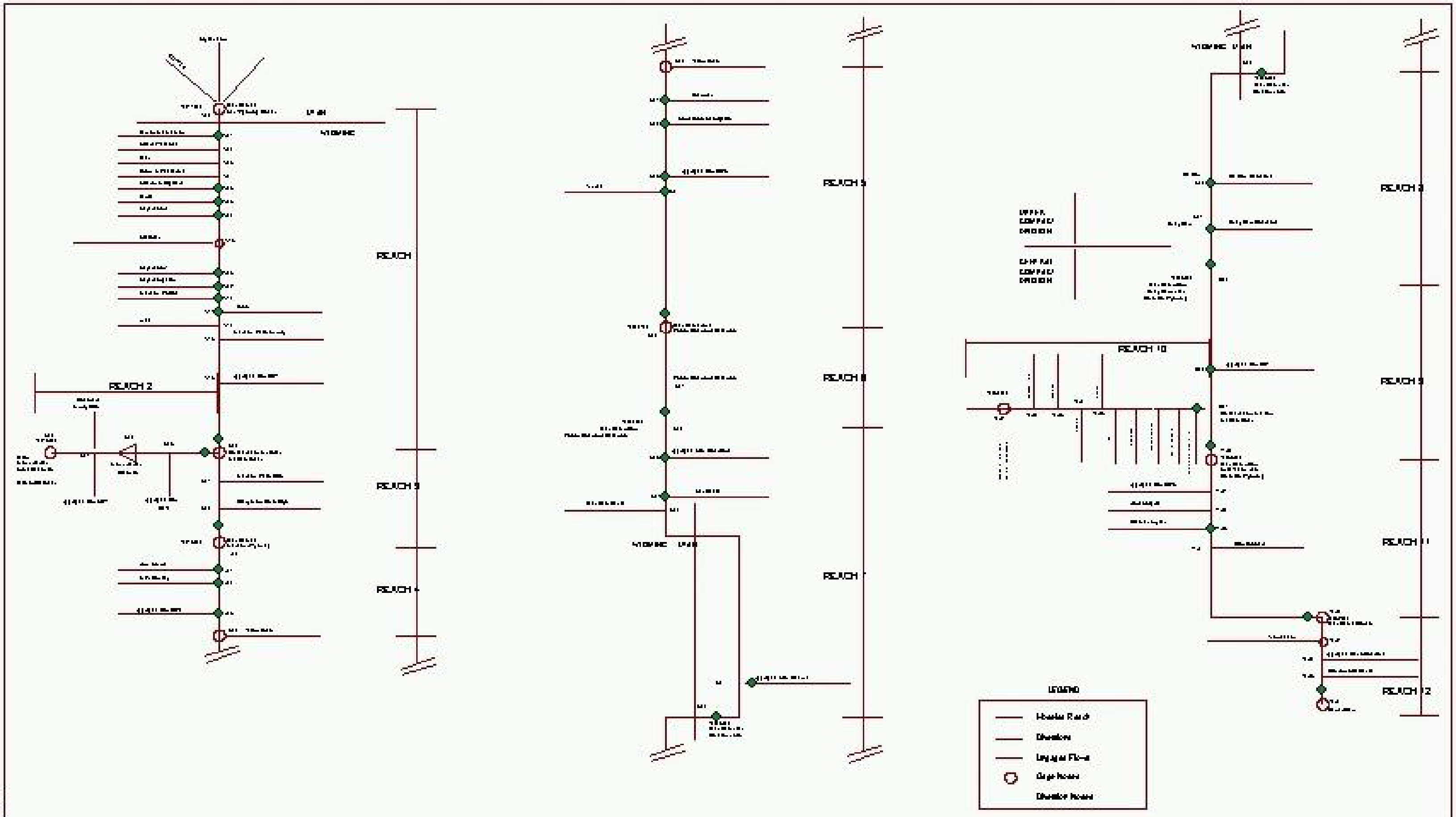
The ABear River Commission Water Allocation: Central Division@ table (Table 15) uses the Water Commissioner=s worksheet to determine if a water emergency exists in the Central Division under the current scenario. If so, the worksheet computes the allocations for the State of Wyoming and Idaho are computed as defined in the Bear River Compact.

3.0 Summary

A spreadsheet model of the Bear River Basin was developed which simulates the operation and flows in the Bear River system. All significant diversions were modeled in addition to two tributaries, Sulphur Creek and Smiths Fork. Prior to use, a full analysis and calibration of the model is required to insure that the results of model scenarios properly reflect the hydrology and operational aspects of the basin. The calibration effort is contained in the Task 3C Memorandum, Surface Water Model Calibration.

The value of this model to users in the basin is in assessing the impact of proposed projects to the flows in the river. By simulating the river operations with and without the project, the change in flows can be analyzed for project benefits and system costs. This will be discussed in detail in the Task 3D Memorandum, Available Surface Water Determination.

FIGURES



NO SCALE

Anderson Consulting Engineers, Inc

BEAR RIVER

FLOW DIAGRAM

FIGURE

1

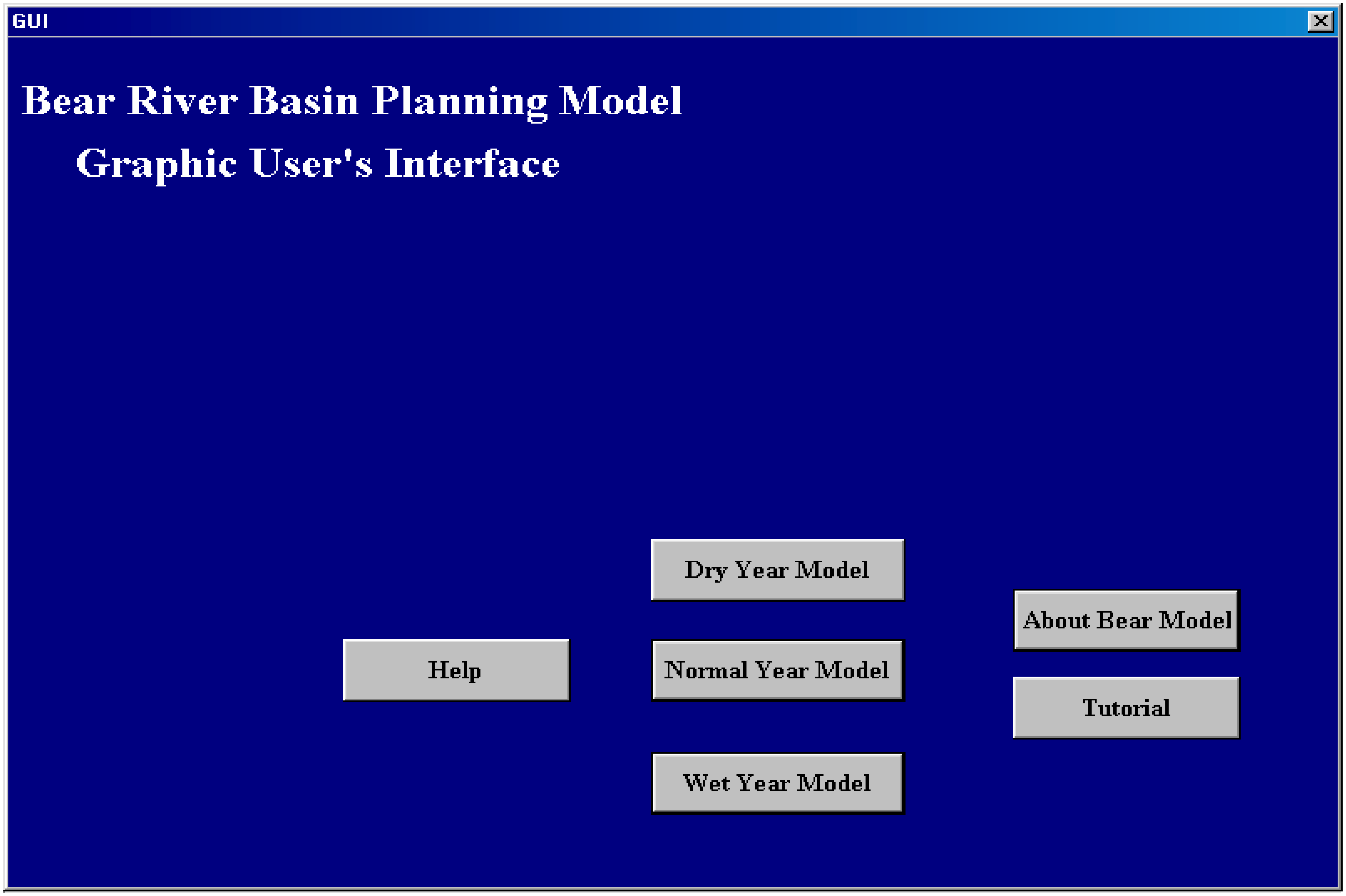


Figure 2. Graphical User's Interface (GUI) Main Page

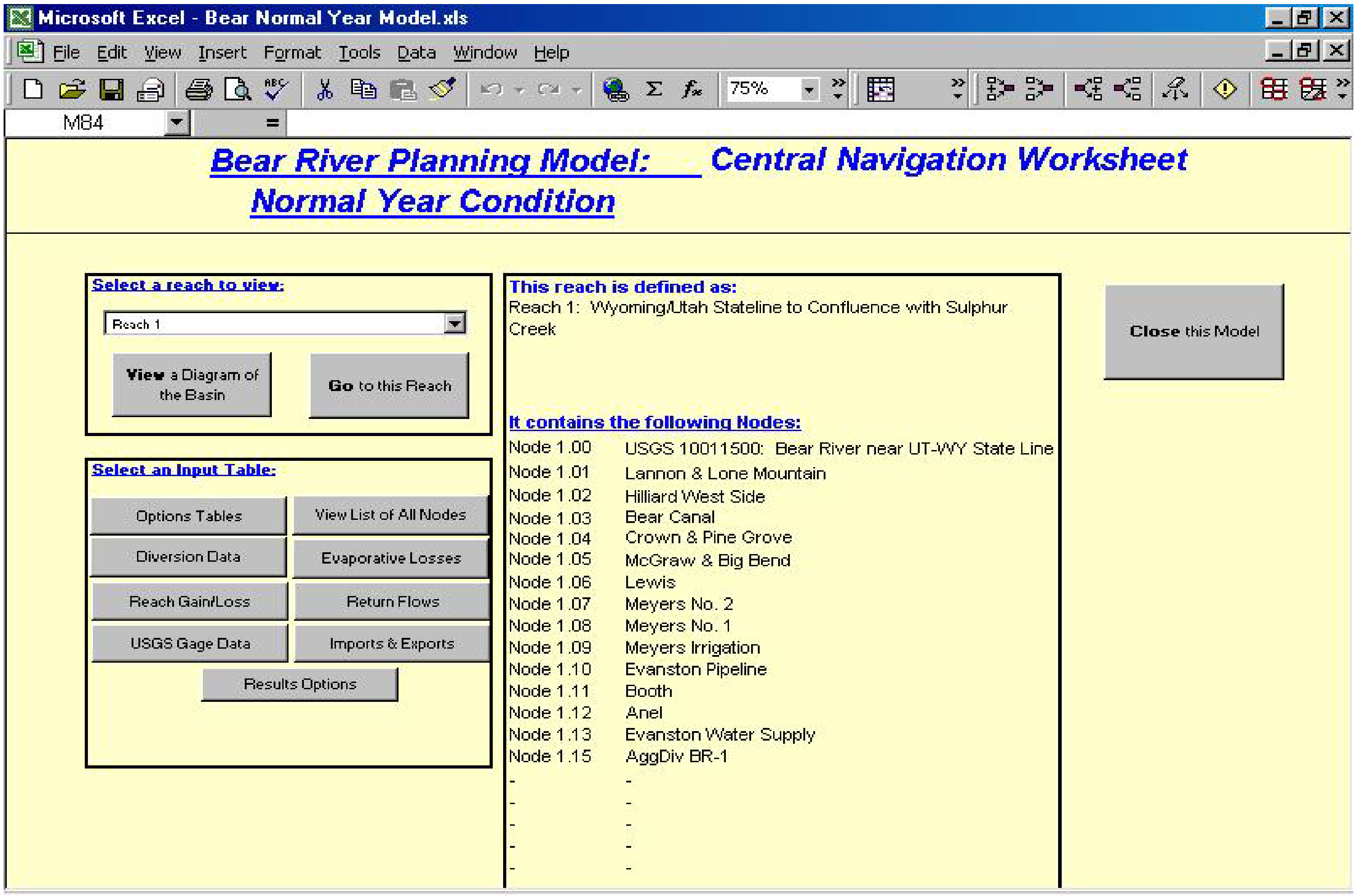


Figure 3. Central Navigation Worksheet

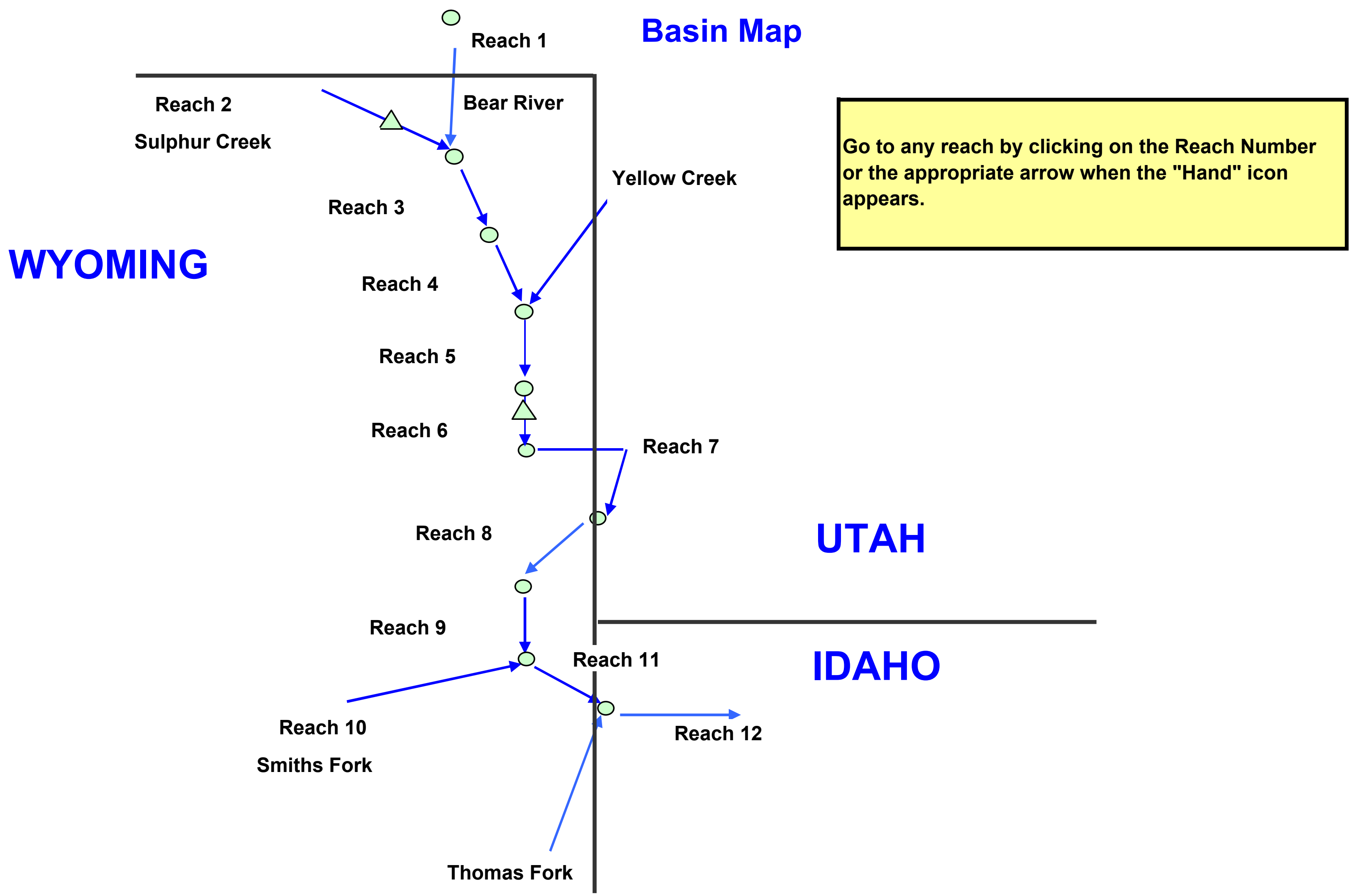


Figure 4. Bear River Basin Diagram (GUI)

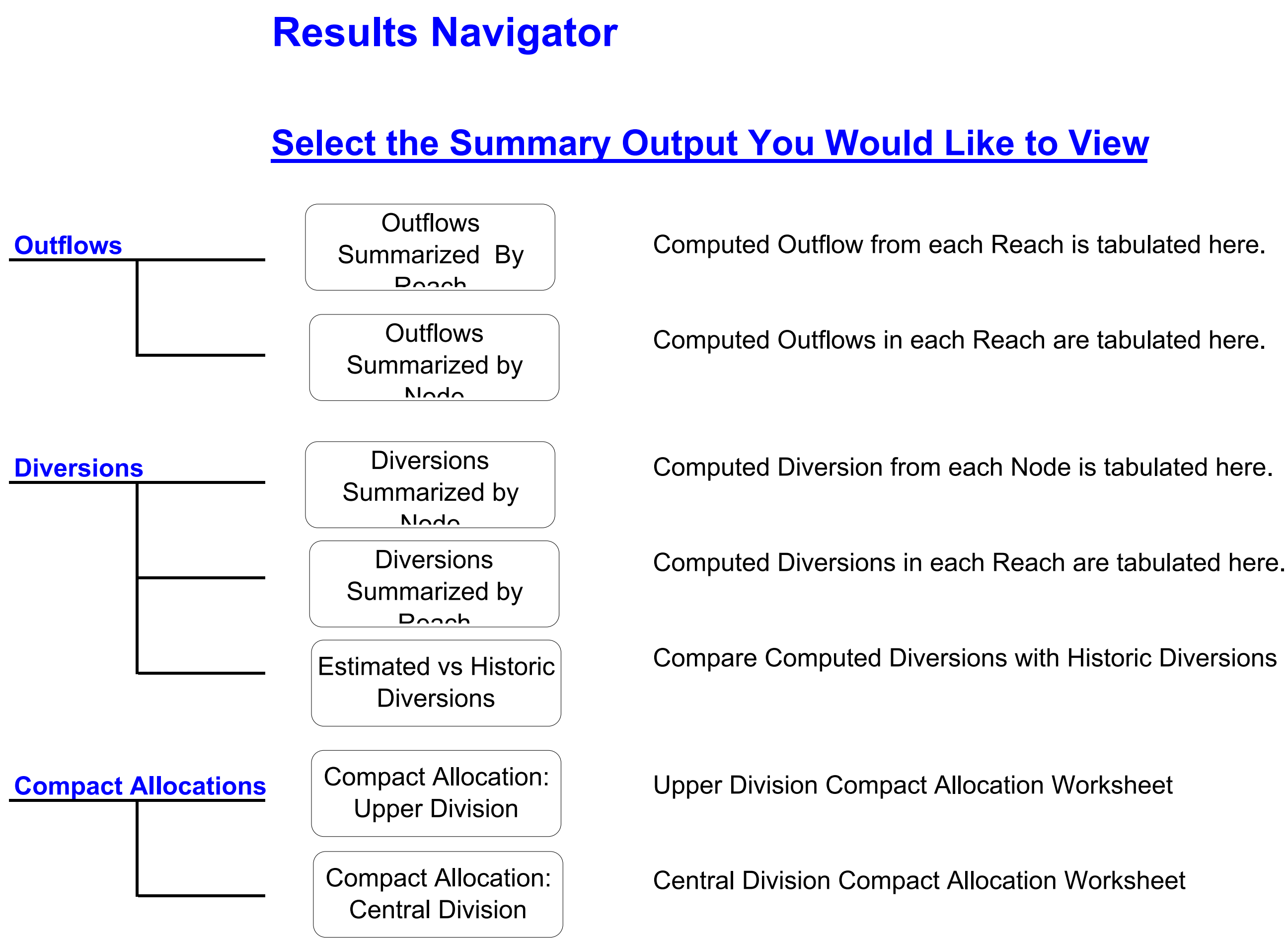


Figure 5. Bear River Basin Results Navigator Worksheet (GUI)

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Node 1.01	**Lannon & Lone Mountain**			**Efficiency Pattern =**				**25**							
	Total Diversions =			0	0	0	0	605	1106	953	474	549	0	0	0
	Total Irrigation Returns =			0	0	0	0	454	829	715	356	412	0	0	0
TO:	**TO:**	**Percent**		**Return Pattern =**				**1**							
(Lewis)	Node 1.06	30.0%		0	0	0	0	68	145	179	161	156	67	42	12
(Confluence Mill Cr.)	Node 1.18	70.0%		0	0	0	0	159	338	417	376	365	156	97	29
		0.0%		0	0	0	0	0	0	0	0	0	0	0	0
		0.0%		0	0	0	0	0	0	0	0	0	0	0	0
		100%		0	0	0	0	227	483	595	538	521	222	139	41

Figure 6. Example Return Flows Node Table

Node 1.01 Lannon & Lone Mountain

Inflow To This Node	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Node 1.01 Gage Inflow	3,772	3,734	9,086	18,667	51,377	62,215	22,668	6,311	5,701	4,052	3,509	3,838
Node 1.01 Irrigation Returns	0	0	0	0	0	0	0	0	0	0	0	0
NA Ungaged Gains	0	0	0	0	0	0	0	0	0	0	0	0
Node 1.01 Import/Export	0	0	0	0	0	0	0	0	0	0	0	0
Total Node 1.00 Inflow	**3,772**	**3,734**	**9,086**	**18,667**	**51,377**	**62,215**	**22,668**	**6,311**	**5,701**	**4,052**	**3,509**	**3,838**
Outflow From This Node												
NA Ungaged Losses	0	0	0	0	0	0	0	0	0	0	0	0
Node 1.01 Diversions	0	0	0	0	605	1,106	953	474	549	0	0	0
Total Node 1.01 Outflow	**0**	**0**	**0**	**0**	**605**	**1,106**	**953**	**474**	**549**	**0**	**0**	**0**
Node 1.01 NET Flow (In - Out)	**3,772**	**3,734**	**9,086**	**18,667**	**50,772**	**61,109**	**21,715**	**5,837**	**5,152**	**4,052**	**3,509**	**3,838**

Figure 7. Example Node Table

TABLES

Table 1. Master List of Node Numbers and their Names

Node 1.00	USGS 10011500: Bear River near UT-WY State Line
Node 1.01	Lannon & Lone Mountain
Node 1.02	Hilliard West Side
Node 1.03	Bear Canal
Node 1.04	Crown & Pine Grove
Node 1.05	McGraw & Big Bend
Node 1.06	Lewis
Node 1.07	Meyers No. 2
Node 1.08	Meyers No. 1
Node 1.09	Meyers Irrigation
Node 1.10	Evanston Pipeline
Node 1.11	Booth
Node 1.12	Anel
Node 1.13	Evanston Water Supply
Node 1.15	AggDiv BR-1
Node 1.18	Confluence Mill Cr.
Node 2.00	USGS 10015700: Sulphur Cr. ab Res.Bl.La Chapelle Cr.Nr.Evanston,WY
Node 2.01	AggDiv SC-1/Broadbent
Node 2.02	Sulphur Creek Reservoir
Node 2.03	AggDiv SC-2
Node 3.00	Confluence Sulphur Creek / Bear River
Node 3.01	Evanston Water Ditch
Node 3.02	Rocky Mtn & Blyth
Node 4.00	USGS 10016900: Bear R. at Evanston, WY
Node 4.01	John Simms
Node 4.02	S P Ramsey
Node 4.03	AggDiv BR-2
Node 5.00	Confluence Yellow Creek / Bear River
Node 5.01	Chapman Canal
Node 5.02	Morris Bros (Lower)
Node 5.03	AggDiv BR-3
Node 5.04	Tunnel
Node 6.00	USGS 10020100: Bear R. ab res. nr Woodruff, UT
Node 6.01	Woodruff Narrows Reservoir
Node 7.00	USGS 10020300: Bear R. bel res. nr Woodruff, UT
Node 7.01	Francis Lee
Node 7.02	Bear River Canal
Node 7.03	Aggregate Utah Diversions
Node 8.00	USGS 10026500: Bear R. nr Randolph, UT
Node 8.01	Pixley Dam
Node 8.02	BQ Dam

Node 9.00	USGS 10028500: Bear R. bel Pixley Dam, near Cokeville, WY
Node 9.01	Confluence Smiths Fork / Bear
Node 9.02	AggDiv BR-4
Node 10.01	USGS 1003200: Smiths Fork nr Border,WY
Node 10.02	Button Flat
Node 10.03	Emelle
Node 10.04	Cooper
Node 10.05	Covey
Node 10.06	VH Canal
Node 10.07	Goodell
Node 10.08	Whites Water
Node 10.09	S Branch Irrigating
Node 10.10	AggDiv SF-1
Node 11.00	USGS 10038000: Bear R. bel Smiths Fork, nr Cokeville, WY
Node 11.01	AggDiv BR-5
Node 11.02	Alonzo F. Sights
Node 11.03	Oscar E. Snyder
Node 11.04	Cook Brothers
Node 12.00	USGS 10039500: Bear R. at Border, WY
Node 12.01	Confluence Thomas Fork
Node 12.02	Aggregate Idaho Diversions
Node 12.03	Rainbow Inlet
Node 12.04	Stewart Dam

Table 2. Characterization of Wet , Normal, and Dry Years for Bear River Model Index Gages and Diversion Data Analysis

Gage Number	Gage Name	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
10011500	Bear River near Utah-Wyoming State Line																												
10015700	Sulphur Creek ab. Reservoir bl. La Chapelle Cr nr Evanston, WY																												
10016900	Bear River at Evanston, WY																												
10020100	Bear River above Reservoir, nr Woodruff, UT																												
10020300	Bear River below Reservoir, nr Woodruff, UT																												
10026500	Bear River near Randolph, UT																												
10028500	Bear River below Pixley Dam nr Cokeville, WY																												
10032000	Smiths Fork near Border, WY																												
10038000	Bear River bel Smiths Fork, nr Cokeville, WY																												
10039500	Bear River at Border, WY																												
--	**Condition applied to diversion data**																												

NOTE: Analysis is based upon the study period (1971 to 1998)
Hydrologic conditions applied to diversions were determined based upon review of overall basin conditions.

Dry year

Normal Year

Wet year

Table 3. Summary of average Dry , Normal , and Wet Year Streamflow at USGS Gaging Stations

USGS Gage	Gage Name	Hydrologic Condition	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
10011500	Bear River near UT-WY State Line	Dry	2440	2043	2277	6495	29835	23208	7595	3577	2653	2895	2578	2433	80123
		Normal	2743	2372	2931	7026	37050	54949	20000	6311	5701	4495	3630	3056	139083
		Wet	3490	2928	3933	5895	39968	90965	42370	10855	9580	7183	5090	4435	209983
10015700	Sulphur Cr. ab Res.Bl.La Chapelle Cr.Nr.Evanston,WY	Dry	96	97	468	639	644	363	65	34	12	51	102	115	2417
		Normal	181	218	765	1934	2539	936	257	75	82	129	181	160	6987
		Wet	135	277	833	2064	6925	2586	443	299	237	268	392	277	13800
10015900	Sulphur Creek below Reservoir near Evanston, WY	Dry	46	20	635	1785	2792	1958	1918	1410	1049	191	130	151	11613
		Normal	344	422	995	2682	4854	2976	1280	1559	1177	670	532	308	16290
		Wet	368	663	1133	2707	6620	1897	1307	2230	1813	1591	218	1474	18739
10016900	Bear R. at Evanston, WY	Dry	2104	2085	6685	13571	27361	18256	3495	1556	843	941	1031	1384	75956
		Normal	4168	4225	10391	21921	53606	54331	14865	3051	3304	4877	4941	4373	169863
		Wet	6598	9306	19285	26056	83172	109371	27715	12344	11697	12137	9014	8525	305546
10020100	Bear R. ab res. nr Woodruff, UT	Dry	2235	2189	6618	10311	23649	17156	1753	921	703	8	1714	1820	65535
		Normal	4675	4753	11805	23201	56136	55594	16253	2648	2955	5517	5329	4784	178020
		Wet	7157	10093	20917	30450	99873	129040	28523	13477	12223	13163	9777	9247	351753
10020300	Bear R. bel res. nr Woodruff, UT	Dry	1073	1020	1156	3146	24891	38200	5776	1610	986	713	685	833	77858
		Normal	3447	3544	7158	20048	53673	60309	22031	4371	4119	4150	3578	3365	178700
		Wet	5380	5070	17060	28007	86843	118550	32507	12770	10720	12720	11997	7410	316907
10026500	Bear R. nr Randolph, UT	Dry	2754	2491	3976	3553	4671	15145	6144	2015	1212	1905	2678	2634	41960
		Normal	6813	7466	16963	28230	45971	45408	22712	8299	5639	7878	7925	6901	187501
		Wet	7440	10970	25900	40057	91273	118957	40397	18237	15613	18183	17330	10410	368843
10028500	Bear R. bel Pixley Dam, near Cokeville, WY	Dry	1972	1665	3744	3934	1693	7601	6842	2572	1492	1735	2255	1959	31514
		Normal	4745	4836	11520	18627	40023	38213	25526	9038	5950	6162	5932	5260	158477
		Wet	6098	7736	20226	32192	73447	81000	40990	20293	18027	15040	13319	8975	300008
10032000	Smiths Fork nr Border,WY	Dry	3606	3243	3847	8503	16611	13589	6937	5109	4162	4226	3706	3366	65606
		Normal	3671	3237	3669	9074	34070	39604	20052	10016	6728	5648	4668	4172	130121
		Wet	5009	4450	8638	12126	49692	64272	29466	13370	8624	7667	6148	5258	195645
10038000	Bear R. bel Smiths Fork, nr Cokeville, WY	Dry	8301	7510	12018	14142	21507	26874	15875	7679	6429	6998	8477	7884	120335
		Normal	13649	13859	28008	52402	88566	92123	50178	19419	14348	16943	16393	14929	372552
		Wet	17153	20767	48313	74707	150067	201367	81780	39187	34513	36877	33080	23500	667853
10039500	Bear R. at Border, WY	Dry	8348	7587	12348	13549	18140	22467	14131	6274	5638	6792	8400	8060	108481
		Normal	14320	14374	28460	55596	89113	91543	50541	19337	13898	17291	16919	15260	377182
		Wet	18950	22400	51690	75760	145567	206667	81847	37510	32103	34320	32543	24390	672493

Table 4.   Summary of Average Dry , Normal , and Wet Year Diversion Data

NODE	DIVERSION NAME	CONDITION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Node 1.01	Lannon & Lone Mountain	Dry Year	0	0	0	0	886	1010	554	115	85	0	0	0
		Normal Year	0	0	0	0	633	1087	922	450	502	0	0	0
		Wet Year	0	0	0	0	419	918	893	476	348	0	0	0
Node 1.02	Hilliard West Side	Dry Year	0	0	0	0	975	1720	911	201	184	0	0	0
		Normal Year	0	0	0	0	244	1467	1698	393	701	0	0	0
		Wet Year	0	0	0	0	383	1054	1161	812	439	0	0	0
Node 1.03	Bear Canal	Dry Year	0	0	0	0	2071	3456	1886	551	384	0	0	0
		Normal Year	0	0	0	0	565	3712	3112	715	1068	0	0	0
		Wet Year	0	0	0	0	525	2044	3560	1161	1142	0	0	0
Node 1.04	Crown & Pine Grove	Dry Year	0	0	0	0	770	1479	725	207	181	0	0	0
		Normal Year	0	0	0	0	438	1571	1375	605	456	0	0	0
		Wet Year	0	0	0	0	463	1675	1524	673	196	0	0	0
Node 1.05	McGraw & Big Bend	Dry Year	0	0	0	0	1044	1105	422	200	107	0	0	0
		Normal Year	0	0	0	0	999	1775	931	648	397	0	0	0
		Wet Year	0	0	0	0	305	1767	1377	811	756	0	0	0
Node 1.06	Lewis	Dry Year	0	0	0	0	152	333	370	116	37	0	0	0
		Normal Year	0	0	0	0	92	354	442	287	139	0	0	0
		Wet Year	0	0	0	0	161	353	414	355	182	0	0	0
Node 1.07	Meyers No. 2	Dry Year	0	0	0	0	90	277	373	184	121	0	0	0
		Normal Year	0	0	0	0	35	185	363	333	195	0	0	0
		Wet Year	0	0	0	0	15	91	357	380	169	0	0	0
Node 1.08	Meyers No. 1	Dry Year	0	0	0	0	170	233	226	168	59	0	0	0
		Normal Year	0	0	0	0	72	236	310	221	74	0	0	0
		Wet Year	0	0	0	0	19	30	305	278	73	0	0	0
Node 1.09	Meyers Irrigation	Dry Year	0	0	0	0	230	248	204	121	46	0	0	0
		Normal Year	0	0	0	0	80	336	297	206	92	0	0	0
		Wet Year	0	0	0	0	0	143	319	225	28	0	0	0
Node 1.10	Evanston Pipeline	Average Year	0	0	0	0	342	519	719	652	464	0	0	0
Node 1.11	Booth	Dry Year	0	0	0	0	437	757	502	335	169	0	0	0
		Normal Year	0	0	0	0	297	745	766	557	404	0	0	0
		Wet Year	0	0	0	0	202	693	951	567	407	0	0	0
Node 1.12	Anel	Dry Year	0	0	0	0	226	336	208	57	21	0	0	0
		Normal Year	0	0	0	0	229	737	347	162	136	0	0	0
		Wet Year	0	0	0	0	153	235	405	77	202	0	0	0
Node 1.13	Evanston Water Supply	Dry Year	0	0	0	0	141	282	257	181	57	0	0	0
		Normal Year	0	0	0	0	77	372	409	317	166	0	0	0
		Wet Year	0	0	0	0	64	87	130	165	106	0	0	0
Node 3.01	Evanston Water Ditch	Dry Year	0	0	0	0	616	1197	895	603	336	0	0	0
		Normal Year	0	0	0	0	213	1165	1077	884	351	0	0	0
		Wet Year	0	0	0	0	0	356	848	560	118	0	0	0
Node 3.02	Rocky Mtn & Blyth	Dry Year	0	0	0	0	474	600	344	214	170	0	0	0
		Normal Year	0	0	0	0	505	836	554	296	288	0	0	0
		Wet Year	0	0	0	0	102	484	886	762	499	0	0	0
Node 4.01	John Simms	Dry Year	0	0	0	0	627	616	428	298	193	0	0	0
		Normal Year	0	0	0	0	599	990	546	478	451	0	0	0
		Wet Year	0	0	0	0	353	695	483	507	352	0	0	0
Node 4.02	S P Ramsey	Dry Year	0	0	0	0	635	747	311	227	116	0	0	0

		Normal Year	0	0	0	0	465	1127	662	406	430	0	0	0
		Wet Year	0	0	0	0	229	686	759	194	142	0	0	0
Node 5.01	Chapman Canal	Dry Year	0	0	0	0	5825	5838	1937	612	383	0	0	0
		Normal Year	0	0	0	0	5209	8040	4187	1595	1402	0	0	0
		Wet Year	0	0	0	0	2965	3247	2532	642	417	0	0	0
Node 5.02	Morris Bros (Lower)	Dry Year	0	0	0	0	143	179	116	52	80	0	0	0
		Normal Year	0	0	0	0	152	253	87	57	59	0	0	0
		Wet Year	0	0	0	0	743	793	744	65	72	0	0	0
Node 5.04	Tunnel	Dry Year	0	0	0	0	575	1173	376	120	81	0	0	0
		Normal Year	0	0	0	0	557	1602	552	216	194	0	0	0
		Wet Year	0	0	0	0	245	1581	559	210	259	0	0	0
Node 6.01	Woodruff Narrows	Dry Year	0	0	0	0	34757	11242	7608	6697	5940	0	0	0
		Normal Year	0	0	0	0	34351	26750	21457	19138	17901	0	0	0
		Wet Year	0	0	0	0	62273	58430	53250	51947	54207	0	0	0
Node 7.01	Francis Lee	Dry Year	0	0	0	0	1923	2797	555	168	97	0	0	0
		Normal Year	0	0	0	0	1524	2999	1484	544	436	0	0	0
		Wet Year	0	0	0	0	1091	2831	1236	37	301	0	0	0
Node 7.02	Bear River Canal	Dry Year	0	0	0	0	2922	3797	752	134	100	0	0	0
		Normal Year	0	0	0	0	2424	4872	1803	295	487	0	0	0
		Wet Year	0	0	0	0	1851	3991	1802	262	150	0	0	0
Node 7.03	Total Lower Utah	Dry Year	0	0	0	0	30744	54918	11019	3291	2604	0	0	0
		Normal Year	0	0	0	0	34210	60344	27279	3794	5317	0	0	0
		Wet Year	0	0	0	0	25661	65985	23764	1708	1572	0	0	0
Node 8.01	Pixley Diversions	Dry Year	0	0	0	0	2276	3466	925	46	95	0	0	0
		Normal Year	0	0	0	0	2464	4003	913	24	151	0	0	0
		Wet Year	0	0	0	0	5224	6427	639	79	18	0	0	0
Node 8.02	BQ Diversions	Dry Year	0	0	0	0	3325	7815	1625	77	22	0	0	0
		Normal Year	0	0	0	0	2612	6924	2411	123	11	0	0	0
		Wet Year	0	0	0	0	6014	10403	1721	194	0	0	0	0
Node 10.02	Button Flat	Dry Year	0	0	0	0	44	160	162	50	0	0	0	0
		Normal Year	0	0	0	0	89	186	236	172	71	0	0	0
		Wet Year	0	0	0	0	0	245	63	22	17	0	0	0
Node 10.03	Emelle	Dry Year	0	0	0	0	186	816	675	242	28	0	0	0
		Normal Year	0	0	0	0	116	842	817	606	54	0	0	0
		Wet Year	0	0	0	0	0	404	761	491	42	0	0	0
Node 10.04	Cooper	Dry Year	0	0	0	0	335	462	284	114	0	0	0	0
		Normal Year	0	0	0	0	277	472	295	73	26	0	0	0
		Wet Year	0	0	0	0	530	1038	29	5	0	0	0	0
Node 10.05	Covey	Dry Year	0	0	0	0	2878	3745	2327	973	423	0	0	0
		Normal Year	0	0	0	0	2518	5914	5306	3122	1236	0	0	0
		Wet Year	0	0	0	0	2292	4594	4166	3189	1443	0	0	0
Node 10.06	VH Canal	Dry Year	0	0	0	0	314	569	484	435	172	0	0	0
		Normal Year	0	0	0	0	425	689	660	654	491	0	0	0
		Wet Year	0	0	0	0	385	865	723	906	427	0	0	0
Node 10.07	Goodell	Dry Year	0	0	0	0	196	360	384	278	171	0	0	0
		Normal Year	0	0	0	0	238	418	478	416	329	0	0	0
		Wet Year	0	0	0	0	26	195	309	266	68	0	0	0
Node 10.08	Whites Water	Dry Year	0	0	0	0	729	1095	836	454	243	0	0	0
		Normal Year	0	0	0	0	830	1865	1427	1215	520	0	0	0
		Wet Year	0	0	0	0	1118	2078	1941	1251	534	0	0	0
Node 10.09	S Branch Irrigating	Dry Year	0	0	0	0	1017	940	457	95	38	0	0	0
		Normal Year	0	0	0	0	854	1213	645	592	242	0	0	0
		Wet Year	0	0	0	0	1811	3790	1938	568	107	0	0	0

Node 11.02	Alonzo F. Sights	Dry Year	0	0	0	0	400	746	524	234	27	0	0	0
		Normal Year	0	0	0	0	647	1238	770	325	98	0	0	0
		Wet Year	0	0	0	0	656	3592	582	184	0	0	0	0
Node 11.03	Oscar E. Snyder	Dry Year	0	0	0	0	461	942	588	381	260	0	0	0
		Normal Year	0	0	0	0	654	1593	1196	347	298	0	0	0
		Wet Year	0	0	0	0	1054	3275	1214	356	286	0	0	0
Node 11.04	Cook Brothers	Dry Year	0	0	0	0	1906	2084	1141	1323	796	0	0	0
		Normal Year	0	0	0	0	1247	3135	1514	1060	1391	0	0	0
		Wet Year	0	0	0	0	1531	4163	1041	274	455	0	0	0
Node 12.02	Total Idaho	Dry Year	0	0	0	0	16439	18876	10008	5570	5224	0	0	0
		Normal Year	0	0	0	0	14094	27139	14878	7282	6947	0	0	0
		Wet Year	0	0	0	0	11487	28680	13788	7071	5008	0	0	0
Node 12.03	Rainbow	Dry Year	6943	6552	15002	14541	8640	3435	3663	1478	1444	2793	5329	4903
		Normal Year	11163	11530	27234	52840	82646	67552	39806	16195	11167	15798	15436	13133
		Wet Year	16672	20510	53741	89788	174526	197474	76965	39597	35047	36646	34007	21810
Node 12.04	Stewart Dam	Dry Year	581	644	624	451	490	666	663	796	706	721	407	309
		Normal Year	299	291	485	378	646	2506	1004	691	949	659	513	422
		Wet Year	188	201	495	430	1084	17187	13762	640	742	511	384	314

The following diversions are not modeled explicitely in the Bear River Model. They are included in the evaluation of Compact Allocations and Water Emergencies

	Hilliard East Side	Dry Year	0	0	0	0	296	1238	1122	32	87	0	0	0
		Normal Year	0	0	0	0	34	534	1462	417	477	0	0	0
		Wet Year	0	0	0	0	0	77	1226	520	412	0	0	0
	Quinn Bourne	Dry Year	0	0	0	0	311	340	168	57	14	0	0	0
		Normal Year	0	0	0	0	237	446	398	216	75	0	0	0
		Wet Year	0	0	0	0	178	580	722	467	50	0	0	0
	Upper Utah	Dry Year	0	0	0	0	413	908	542	262	91	0	0	0
	= sum Hatch + Hovarka	Normal Year	0	0	0	0	249	1062	823	462	132	0	0	0
		Wet Year	0	0	0	0	105	858	988	654	376	0	0	0

Table 5. Upper Division Diversion Efficiencies

Model Node ID	Diversion Name	Conveyance Efficiency	Application Efficiency	Diversion Efficiency	Irrigation Methods
1.14	Hilliard East Fork	40%	55%	22%	100 % Flood
1.01	Lannon and Lone Mountain	45%	55%	25%	100 % Flood
1.02	Hilliard West Side	40%	55%	22%	100 % Flood
1.03	Bear Canal	40%	55%	22%	100 % Flood
1.04	Crown and Pine Grove	50%	55%	27%	100 % Flood
1.05	McGraw (and Big Bend)	55%	55%	30%	100 % Flood
1.06	Lewis	55%	55%	30%	100 % Flood
1.07	Myers No 2	50%	55%	27%	100 % Flood
1.08	Myers No 1	50%	55%	27%	100 % Flood
1.09	Myers Irrigation	55%	55%	30%	100 % Flood
1.11	Booth	50%	55%	27%	100 % Flood
1.12	Anel	55%	55%	30%	100 % Flood
1.13	Evanston Water Supply	50%	55%	27%	100 % Flood
3.01	Evanston Water Ditch	65%	55%	36%	100 % Flood
3.02	Rocky Mountain Blythe	65%	55%	36%	100 % Flood
4.01	John Simms	65%	55%	36%	100 % Flood
4.02	SP Ramsey	60%	55%	33%	100 % Flood
5.01	Chapman (Wyoming portion)	50%	55%	27%	100 % Flood
5.02	Morris Brothers	65%	55%	36%	100 % Flood
5.03	Tunnel	65%	55%	36%	100 % Flood
7.01	Francis Lee	60%	55%	33%	100 % Flood
7.02	Bear River Canal	60%	55%	33%	100 % Flood
Varies	Aggregate Systems	65%	55%	36%	100 % Flood

Table 6. Central Division Diversion Efficiencies

Model Node ID	Diversion Name	Conveyance Efficiency	Application Efficiency	Diversion Efficiency	Irrigation Methods
7.03	Utah Aggregate Ditches	45%	65%	30%	67 % Flood33 % Center Pivot Sprinkler
8.01	Pixley Dam	55%	60%	33%	90 % Flood10 % Center Pivot Sprinkler
10.02	Button Flat	65%	55%	36%	100 % Flood
10.03	Emelle	65%	55%	36%	100 % Flood
10.04	Cooper	65%	55%	36%	100 % Flood
10.05	Covey	45%	65%	30%	70 % Flood30 % Center Pivot Sprinkler
10.06	VH Canal	55%	85%	47%	100 % Center Pivot Sprinkler
10.07	Goodell	55%	85%	47%	100 % Center Pivot Sprinkler
10.08	Whites Water	60%	65%	40%	60 % Flood40 % Hand-line Sprinkler
10.09	S. Branch Irrigating	60%	70%	42%	40 % Flood60 % Hand-line Sprinkler
11.01	Alonzo F. Sights	65%	65%	42%	60 % Flood40 % Hand-line Sprinkler
11.02	Oscar E. Snyder	65%	55%	36%	100 % Flood
11.03	Cook Brothers	65%	55%	36%	100 % Flood
Varies	Aggregate Systems	65%	65%	42%	67 % Flood33 % Center Pivot Sprinkler

Table 7. Upper Division Return Flow Locations and Patterns

Model Node ID	Diversion Name	Return Nodes	Return Pattern
1.14	Hilliard East Fork	100 % Ag-Sulphur Creek bl Reservoir	1
1.01	Lannon and Lone Mountain	30 % Lewis Ditch70 % Confluence with Mill Ck	2
1.02	Hilliard West Side	100 % Sulphur Creek Reservoir	1
1.03	Bear Canal	60 % Sulphur Creek Reservoir40% Ag-Sulphur Creek bl Reservoir	1
1.04	Crown and Pine Grove	25 % Lewis25 % Confluence with Mill Ck50 % Myers No 2	2
1.05	McGraw (and Big Bend)	100 % Lewis	2
1.06	Lewis	100 % Myers No 1	2
1.07	Myers No 2	100 % Myers No 1	2
1.08	Myers No 1	50 % Booth50% Ag-Sulphur Creek bl Reservoir	2
1.09	Myers Irrigation	100 % Anel	2
1.11	Booth	100 %Evanston Water Ditch	2
1.12	Anel	100 % Ag-Bear River between Mill Creek and Sulphur Creek	2
1.13	Evanston Water Supply	50 % Rocky Mountain Blythe50% John Simms	2
1.15	Ag-Bear River between Mill Creek and Sul	100 % Confluence Bear and Sulphur Creek	2
2.04	Ag-Sulphur Creek Above Reservoir	100 % Sulphur Creek Res.	2
2.03	Ag-Sulphur Creek Below Reservoir	100 % Confluence Bear and Sulphur Creek	2
3.01	Evanston Water Ditch	100 % Rocky Mountain Blythe	2
3.02	Rocky Mountain Blythe	70 % John Simms30 % SP Ramsey	2
4.01	John Simms	50 % SP Ramsey50 % Ag-Bear River between Sulphur and Yellow Creeks	2
4.02	SP Ramsey (also called Adin Brown)	50% Ag-Bear River between Sulphur and Yellow Creeks50% Chapman	2
4.03	Ag-Bear River between Sulphur and Yellov	100 % Chapman	2
5.01	Chapman	100 % Woodruff Narrows (WY)	2
5.02	Morris Brothers	30 % Ag-Bear River between Yellow Creek and Woodruff70 % Woodruff Narrows	2
5.04	Ag-Bear River between Yellow Creek and '	100 % Tunnel	2
5.03	Tunnel	100 % Woodruff Narrows	2
7.01	Francis Lee	100 % Ag- Utah Diversions	1
7.02	Bear River Canal	100 % Ag-Utah Diversion	1

Table 8. Central Division Return Flow Locations and Patterns

Model Node ID	Diversion Name	Return Nodes	Return Pattern
7.03	Ag-Utah diversion	25 % Node 7.04 70% USGS 26500 5% Pixley	2
8.01	Pixley Dam	100 % Confluence with Smiths Fork	2
8.02	Ag-Bear River between Twin Fork and Smiths Fork	100 % Confluence with Smiths Fork	2
10.01	Quinn Bourne	100 % Button Flat	2
10.02	Button Flat	100 %Emelle	2
10.03	Emelle	50 % Cooper Ditch 50 % Covey	2
10.04	Cooper	100% Covey	2
10.05	Covey	10 % White Water90 % Confluence Bear and Smiths Fork	1
10.06	VH Canal	100 % White Water	1
10.07	Goodell	100 % White Water	1
10.08	Whites Water	100 % Ag-Bear River below Smiths Fork	2
10.09	S. Branch Irrigating	100 % Ag-Bear River below Smiths Fork	2
10.10	Ag-Smiths Fork	100 % Ag-Bear River below Smiths Fork	2
11.04	Ag-Bear River below Smiths Fork	40 % Alonzo F. Sights40 % Oscar E. Snyder20 % Cook Brothers	2
11.01	Alonzo F. Sights	50 % Oscar E. Snyder50 % Cook Brothers	2
11.02	Oscar E. Snyder	50 % Cook Brothers50 % Bear River at Border Gage (1003950)	2
11.03	Cook Brothers	50 % Bear River at Border Gage50% Ag-Idaho Diversions	2

Table 9. Summary of Net Evaporation Calculations

Mean Monthly Data (Green River, WY)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Monthly Gross Pan Evaporation (inches)	2.53	2.44	2.67	3.24	4.27	5.73	6.29	5.61	4.09	2.83	2.26	2.63	44.6
Average Monthly Precipitation (inches)	1.11	1.03	0.94	0.92	1.16	1.20	1.05	0.89	0.75	0.79	0.69	0.83	11.3
Average Net Evaporation (inches)	1.42	1.41	1.73	2.32	3.12	4.53	5.24	4.72	3.34	2.04	1.57	1.80	33.2

Table 10. Summary of Ungaged Reach Gains and Losses for the Normal Hydrologic Conditions

Ungaged Reach Gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reach 1, 2 & 3	1081	1431	6466	12228	15308	7661	2606	0	0	0	357	936
Reach 4 & 5	507	528	1413	1288	6328	8156	4465	554	512	327	291	410
Reach 6		0	0	0	0	0	0	0	0	0	0	0
Reach 7	3366	3922	9805	8182	24962	41735	22679	3924	5049	3029	4046	3475
Reach 8	0	0	0	0	0	0	0	0	0	0	0	0
Reach 9 & 10	5233	5786	12819	24717	19196	26146	16230	7019	3837	4611	5551	5445
Reach 11	672	515	451	3194	1186	658	0	0	0	0	33	252
Reach 12	0	0	0	0	3665	0	0	0	1122	0	0	0

Ungaged Reach Losses

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reach 1, 2 & 3	0	0	0	0	0	0	0	2289	1474	1417	0	0
Reach 4 & 5	0	0	0	0	0	0	0	0	0	0	0	0
Reach 6	0	0	0	0	0	0	0	0	0	0	0	0
Reach 7	0	0	0	0	0	0	0	0	0	0	0	0
Reach 8	2067	2630	5444	9603	14650	25580	14220	7373	3492	2483	2273	1641
Reach 9 & 10	0	0	0	0	0	0	0	0	0	0	0	0
Reach 11	0	0	0	0	0	0	1661	3595	2107	1080	0	0
Reach 12	2859	2553	740	2378	0	4912	3207	492	0	1940	1341	1705

Table 11. Summary of Reach Outflow During Normal Hydrologic Conditions

Reach	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	USGS Average [1,2]	Gage Number
Reach 1	3772	3734	9086	18659	48550	51850	13527	3064	2660	5072	4203	3985	168163	NA	NA
Reach 2	396	491	1305	3251	5239	2387	187	1291	1547	864	657	386	18001	NA	NA
Reach 3	4168	4225	10391	21921	53606	54331	14865	3051	3304	4877	4941	4373	184054	173976	10016900
Reach 4	4675	4753	11805	23207	59253	61165	18869	3266	3361	5330	5272	4783	205739	NA	NA
Reach 5	4675	4753	11805	23199	56646	57017	16545	2688	3069	5494	5325	4783	195999	178652	10020100
Reach 6	3447	3544	7158	20048	53673	60309	22031	4371	4119	4150	3578	3365	189793	178678	10020300
Reach 7	6813	7466	16963	28230	41780	36818	16660	5823	4378	7625	7832	6901	187289	173837	10026500
Reach 8	4745	4836	11520	18627	40023	38213	25526	9038	5950	6162	5932	5260	175831	143213	10028500
Reach 9	13649	13859	28008	52402	88566	92123	50178	19419	14348	16943	16393	14929	420817	367111	10038000
Reach 10	7177	7113	12258	25622	41323	44000	19130	7845	6920	9170	8606	7872	197038	NA	NA
Reach 11	14320	14374	28460	55596	89113	91543	50541	19337	13898	17291	16919	15260	426652	366840	10039500
Reach 12	299	291	485	378	646	2506	1004	691	949	659	513	422	8844	10094	PP&L

Note 1 USGS Average = average annual streamflow (ac-ft) for entire study period (1971 - 1998).
Note 2 NA = Reach does not terminate at a gaging station.

Table 12. Total Diversions per each Reach During Normal Hydrologic Conditions

Reach	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reach 1	0	0	0	7	4,289	14,168	13,797	6,320	5,410	8	0	0	44,562
Reach 2	0	0	0	20	452	1,640	1,972	940	249	22	0	0	5,295
Reach 3	0	0	0	0	717	2,001	1,631	1,180	639	0	0	0	5,949
Reach 4	0	0	0	10	1,285	2,920	2,173	1,343	1,002	11	0	0	8,789
Reach 5	0	0	0	4	3,412	6,237	3,167	1,278	1,009	5	0	0	14,849
Reach 6	0	0	0	0	0	0	0	0	0	0	0	0	0
Reach 7	0	0	0	0	38,158	68,215	30,566	4,633	6,239	0	0	0	150,385
Reach 8	0	0	0	0	5,077	10,927	3,324	147	162	0	0	0	18,927
Reach 9	0	0	0	7	414	1,570	1,947	835	219	8	0	0	4,998
Reach 10	0	0	0	12	6,305	14,872	13,784	8,588	3,448	14	0	0	47,286
Reach 11	0	0	0	8	3,057	7,902	5,880	2,761	2,057	10	0	0	21,606
Reach 12	11,163	11,530	27,234	52,840	96,740	94,691	54,683	23,476	18,115	15,798	15,436	13,133	459,206

Table 13. Comparison of Estimated vs Historic Diversions during Normal Hydrologic Conditions

Node	Name	Historic	Estimated	Difference	% Diff
Node 1.01	Lannon & Lone Mountain	3,594	3,594	0	0.0
Node 1.02	Hilliard West Side	4,503	4,503	0	0.0
Node 1.03	Bear Canal	9,171	9,171	0	0.0
Node 1.04	Crown & Pine Grove	4,444	4,444	0	0.0
Node 1.05	McGraw & Big Bend	4,750	4,750	0	0.0
Node 1.06	Lewis	1,315	1,315	0	0.0
Node 1.07	Meyers No. 2	1,111	1,111	0	0.0
Node 1.08	Meyers No. 1	913	913	0	0.0
Node 1.09	Meyers Irrigation	1,011	1,011	0	0.0
Node 1.10	Evanston Pipeline	2,695	2,695	0	0.0
Node 1.11	Booth	2,769	2,769	0	0.0
Node 1.12	Anel	1,610	1,610	0	0.0
Node 1.13	Evanston Water Supply	1,341	1,341	0	0.0
Node 1.15	AggDiv BR-1	1,837	1,837	0	0.0
Node 2.03	AggDiv SC-2	5,304	5,304	0	0.0
Node 3.01	Evanston Water Ditch	3,690	3,690	0	0.0
Node 3.02	Rocky Mtn & Blyth	2,479	2,479	0	0.0
Node 4.01	John Simms	3,063	3,063	0	0.0
Node 4.02	S P Ramsey	3,089	3,089	0	0.0
Node 4.03	AggDiv BR-2	2,596	2,596	0	0.0
Node 5.01	Chapman Canal	10,217	10,217	0	0.0
Node 5.02	Morris Bros (Lower)	607	607	0	0.0
Node 5.03	AggDiv BR-3	1,169	1,169	0	0.0
Node 5.04	Tunnel	3,121	3,121	0	0.0
Node 7.01	Francis Lee	6,987	6,987	0	0.0
Node 7.02	Bear River Canal	9,880	9,880	0	0.0
Node 7.03	Aggregate Utah Diversions	130,944	130,944	0	0.0
Node 8.02	BQ Dam	12,081	12,081	0	0.0
Node 9.02	AggDiv BR-4	4,955	4,955	0	0.0
Node 10.02	Button Flat	755	755	0	0.0
Node 10.03	Emelle	2,435	2,435	0	0.0
Node 10.04	Cooper	1,143	1,143	0	0.0
Node 10.05	Covey	18,097	18,097	0	0.0
Node 10.06	VH Canal	2,919	2,919	0	0.0
Node 10.07	Goodell	1,879	1,879	0	0.0
Node 10.08	Whites Water	5,857	5,857	0	0.0
Node 10.09	S Branch Irrigating	3,545	3,545	0	0.0
Node 10.10	AggDiv SF-1	8,974	8,974	0	0.0
Node 11.01	AggDiv BR-5	6,110	6,110	0	0.0
Node 11.02	Alonzo F. Sights	3,077	3,077	0	0.0
Node 11.03	Oscar E. Snyder	4,088	4,088	0	0.0
Node 11.04	Cook Brothers	8,348	8,348	0	0.0
Node 12.02	Aggregate Idaho Diversions	70,340	70,340	0	0.0
Node 12.03	Rainbow Inlet	364,499	364,499	0	0.0

Table 14. Bear River Commission Water Allocation Worksheet: Upper Division (Normal Hydrologic Conditions)

Normal Year
Bear River Commission Water Allocation
Upper Division

	May	Jun	Jul	Aug	Sep	
	168.9	759.9	674.6	372.3	78.6	Upper Utah Section Diversion (1)
	10,165	26,939	22,844	11,022	8,280	Upper Wyoming Section Diversion
	3,632	(2,074)	(4,155)	(1,092)	(841)	Woodruff Narrows Reservoir Change in Storage Water
	38,158	68,215	30,566	4,633	6,239	Lower Utah Section Diversions
	5,077	10,927	3,324	147	162	Lower Wyoming Section Diversions
	46,326	46,821	30,912	11,359	7,201	Bear River Below Pixley Dam
	103,526	151,587	84,165	26,442	21,120	**Total Upper Division Divertible Flow (ac-ft)**
	1,683.7	2,547.5	1,368.8	430.0	354.9	**(cfs)**
Is Total Upper Division Divertible Flow less than 1250 cfs?If so, Water Emergency (W.E.) exists.	**No W.E.**	**No W.E.**	**No W.E.**	**W.E.**	**W.E.**	
				159	127	Upper Utah Section Allocation
				13,036	10,412	Upper Wyoming Allocation
				10,709	8,554	Lower Utah Section Allocation
				2,538	2,028	Lower Wyoming Section Allocation

NOTE: (1) Upper Utah Division is not modeled explicitly in this model. Diversion data are included here for computation of Compact allocations.

Table 15. Bear River Commission Water Allocation Worksheet: Central Division (Normal Hydrologic Conditions)

Bear River Commission Water Allocation
Central Division

	May	Jun	Jul	Aug	Sep	
	9,409	23,804	21,358	11,988	5,567	(1) Wyoming Diversions
	+	+	+	+	+	
	14,094	27,139	14,878	7,282	6,947	(2) Idaho Diversions
	+	+	+	+	+	
	83,291	70,058	40,810	16,886	12,117	(3) Rainbow Inlet Canal plus Bear River Main Stem Flow below Stewart Dam
	=	=	=	=	=	
	106,795	121,001	77,046	36,155	24,631	Total Central Division Divertible Flow (ac-ft)
Is Total Divertible Flow (2) < 870 cfs? If so, Water Emergency (W.E.) exists.	1,736.9	2,033.5	1,253.0	607.6	413.9	(cfs)
				W.E.	W.E.	
OR						
	34,070	39,604	20,052	10,016	6,728	Flow of Bear River at Border Gaging Station (ac-ft)
Is Flow at Border < 350 cfs?If so, Water Emergency (W.E.) exists.	572.6	665.6	326.1	168.3	113.1	(cfs)
			W.E.	W.E.	W.E.	
			33,130	15,547	10,591	Allocation in the State of Wyoming
			43,916	20,609	14,039	Allocation in the State of Idaho