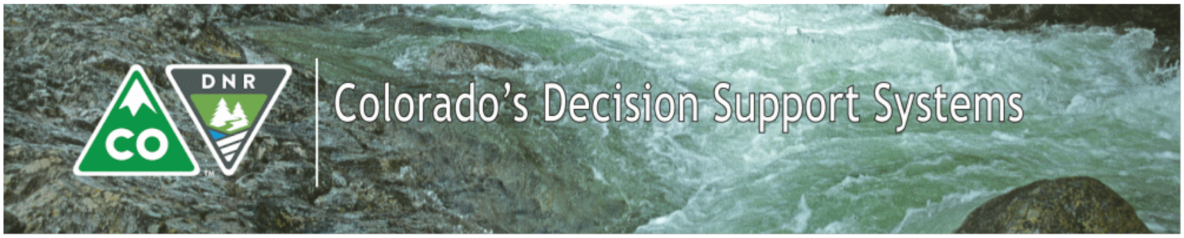

State of Colorado's
Water Supply Model (StateMod)
Version 15

The State of Colorado's Stream Simulation Model (StateMod) is a water allocation and accounting model capable of making comparative analyses of various historical and future water management policies in a river basin. It is designed to be applied to any river basin through appropriate input data preparation. The following sections are available in this manual:

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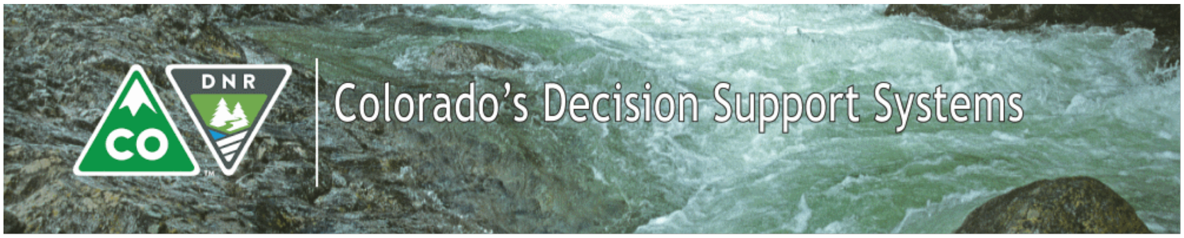
Last updated: March, 2016



Disclaimer

This program is furnished by The State of Colorado (State) and is accepted and used by the recipient upon the expressed understanding that the State makes no warranties, express or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information and data contained in this program or furnished in connection therewith, and the State shall be under no liability whatsoever to any person by reason of any use made thereof.
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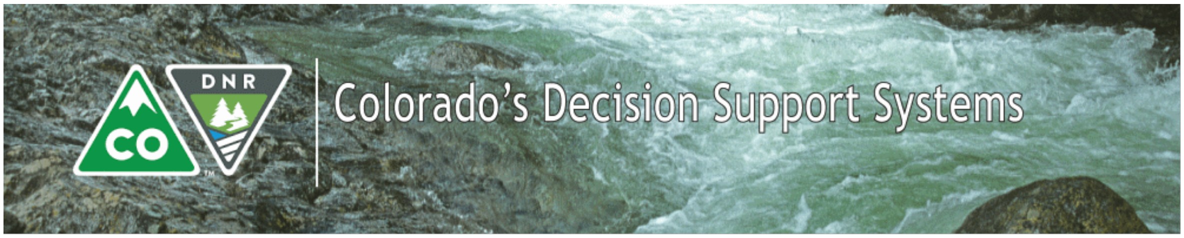


1.0 Acknowledgment

The State of Colorado's Stream Simulation Model (StateMod) was developed from a model developed previously for the State of Colorado as part of the Green Mountain Pump Back and Exchange Project (Boyle Engineering Corporation, 1986). The model enhancement, support, and renaming by the State of Colorado occurred to provide additional capabilities. Since the State of Colorado took over the maintenance of the StateMod program, the model has undergone numerous enhancements using the following version scheme:

Version XX.YY.ZZ,

Where:

XX is the major version,
YY is a new functionality, and
ZZ is a correction

As presented below**,** key enhancement occurred in 1988 to allow a daily time step, 1989 to include wells, 2001 to allow variable efficiency, 2006 to include plans (augmentation, administration, re-use, Term & Condition, etc.) and 2007 to allow four land use types (SW Flood, SW Sprinkler, GW Flood and GW Sprinkler) under a single ditch system. With each major enhancement significant effort has been made to maintain existing file formats and processes so that historic applications can be duplicated.

In general, a new primary version number (e.g. 10.x) was initiated whenever an existing input format, output format, new process, new compiler or extensive testing was added. Similarly relatively minor enhancements that do not impact existing formats or process get in a new sub version number (e.g. 10.12).

Major StateMod Enhancements

Version	Year	Areas of Key Enhancements
1.	1986	Original Development
2. – 4.	1995	Baseflow module enhancement New reporting capabilities
5.	1996	Allow multiple replacement reservoirs and reoperate for non-downstream return flows
6.	1996	Enhanced binary file reporting. New reporting capabilities
7.	1997	Treat Instream flows as a Reach Linked model capability
8.	1998	Daily simulation capability
9.	1999	Well simulation capability
10.	2001	Variable efficiency capability

11.	2006	Plans. Operating rules that allow plans, diversion type, carrier losses, annual limits and on/off dates
12.	2007-2008	Irrigation Practice File is allowed to contain 4 water supply irrigation method combinations (Surface Water Flood, Surface Water Sprinkler, Ground Water Flood and Ground Water Sprinkler). Expanded the ability to divert to and from plans.
13	2012	Expanded the ability to divert to and from plans. Extensive testing of plans by application to the Lower South Platte River in Colorado.
14	2014	Revised the program to compile and store under GitHub in order to allow multiple authors to enhance the program and save edits as different branches that can be reviewed and/or adopted for production.
15	2015	Testing and comparison to historic results following the transfer to GitHub. Added a Changed Water Right operating rule (type 26) that allows a water right to be diverted by priority from the river and temporarily stored for later use.

2.0 Introduction

The State of Colorado's Stream Simulation Model (StateMod) is a monthly or daily water allocation and accounting model capable of making comparative analyses for the assessment of various historical and future water management policies in a river basin. It is designed to be applied to any river basin through appropriate input data preparation.

This document was prepared to explain the features and functions of StateMod and presumes the reader has a basic understanding of river operations. It is current for **StateMod Version 15**. The documentation is intended for use by engineers, water resource planners or anyone involved in water management decision making. It is structured such that Sections 1 - 3 will stand alone to provide a general description of the model and its features. Sections 4 – 10 provide the detail required to develop data sets and implement the model in a river basin.

StateMod's operation, like the stream itself, is governed by its hydrology, water rights, and the associated structures and operating rules. It recognizes five (5) types of water rights: direct flow rights, instream flow rights, reservoir storage rights, well rights, and operational rights. Each of the water rights is given an administration number (rank) and location in the stream system. The model then sorts the water rights by rank and simulates their operation by priority using the Prior Appropriation Doctrine (first in time, first in right). The water right categories are self explanatory with the possible exception of the operational rights, which generally pertain to reservoir operating policies, exchanges, carrier ditch systems, and terms and conditions associated with a water rights operation.

The key components of StateMod are as follows:

- **Daily or Monthly Time Step**. Simulates in a monthly or daily time step. For a daily simulation, input data requirements may be simplified by allowing the user to: 1. Provide daily data, 2. Estimate daily data by requesting the model divide a monthly value by the number of days in a month, 3. Estimate daily data by requesting the model use a monthly average, or 4. Estimate daily data by requesting the model use monthly data and another gages daily distribution. Daily baseflow data may be developed directly or estimated from monthly baseflow estimates.

- **Network System**. Simulates tributaries and main stem river systems through the use of a tree structured network system.

- **Prior Appropriation Doctrine**. Simulates direct flow, instream flow, reservoir storage, well and operational rights under the Prior Appropriation doctrine (i.e. First in time, first in right) as a function of water availability, priority, decreed amount, demand, structure capacity and location.

- **Operational Rules**. Simulates a wide variety of operating agreements and exchanges between one or more structures.

- **Return Flows**. For a given structure, simulates one or more return flow patterns returning to one or more stream nodes to represent the impact of surface and ground water returns on stream operations.

- **Instream Flows**. Simulates Instream Flows as a reach or point.

- **Wells**. Simulates wells as the sole source to a water user or as a supplemental supply.

- **Plans**. Simulates terms and conditions associated with a water transfer, reusable water supplies or out-of-priority well pumping.

- **Base or Natural Flows**. Estimates a base or natural streamflow from gaged or estimated streamflow, diversion and reservoir data.

- **Modified Direct Solution Algorithm**. Uses an efficient, Modified Direct Solution Algorithm (Bennett, Ray R., December 2000), which allows variable efficiency, soil moisture accounting and immediate (current time step) return flows to be evaluated without having to iterate.

- **Variable Efficiency**. Allows the user to simulate water use by specifying an average or variable efficiency.

- **Soil Moisture Accounting**. Simulates soil moisture inflow, use and storage.

- **Transmountain Diversions**. Simulates transmountain imports and diversions from a basin.

- **Call Reporting**. Estimates the calling structure and calling right.

- **Graphical User Interface (GUI).** Includes a comprehensive GUI that allows input data to be viewed, edited, and graphed; output data to be viewed and graphed; map based depiction of basin, hydrology, structure locations, etc. See the CDSS website for more information on this tool.

- **Data Centered Approach.** The entire system operates as a data centered component with a direct link the CDSS database (HydroBase). By providing a list of structures to HydroBase input files can be created and formatted for model input to ensure results are reproducible and easily refreshed for a new study period or database updates**.**

- **Error Checking**. Performs extensive input data error checking throughout the program.

The following definitions are provided in order to define commonly used terms throughout model documentation:

- **Baseflow –** Represents basin streamflows absent man's influence including diversions, return flows, reservoir operations and pumping. If 100% of man's influence is removed, baseflows are often called virgin flows or natural flows.

- **Physical Flow** and **Available Flow** – Physical flow represents the amount of water in the stream that occurs at, or above, the node. The physical flow legally available for diversion at a node is termed the available flow. Available flow is the portion of the physical flow that is not required to meet downstream senior water rights. The Modified Direct Solution Algorithm identifies the minimum available flow at all downstream nodes in order to determine the available flow at node that can be diverted.

- **Model Calibration** – Calibration is the process of simulating the river basin under historical conditions, and judiciously adjusting parameter estimates to achieve agreement between observed and simulated values of streamflow gages, reservoir levels, and diversions.

- **Diversion Structure** – Represents structures located on the river, such as diversion headgates, pumps and carrier ditches where water is diverted from the river to meet a diversion demand.

- **Reservoir Structure** – Represents storage structures located on or off channel that divert water from the river using reservoir storage rights.

- **Demand Structure** – Represent structures located on the river or off channel that have a demand, which can be met by a different structure such as a carrier, reservoir, or wells.

- **Instream Flow Structure** or **Instream Flow Point** – Represents a reach on the river (e.g. from tributary headwaters to confluence with main stem river) or a river location (e.g. wastewater treatment plan outfall) where instream flow demands exist.

- **Plan Structure** – Represents a structure used to account for 1. Augmentation Plans, 2. Terms and Conditions associated with a water transfer, and 3. Reusable water supplies.

- **Unit Response Function** – Represent when return flows or depletions will impact the river over time. For example a power plant diversion may have an immediate unit response function while an irrigation diversion or well pumping may have a lagged unit response function.

- **Efficiencies** – Define the amount of diverted water that is consumed versus the amount supplied. When the water supply is at the source (headgate or well head) it is called System Efficiency. System efficiency is commonly split into conveyance efficiency (representing diversions less ditch loss) and application efficiency (representing water use less application loss).

- **Consumptive Water Requirement (CIR)** – The amount of water required for consumption by an irrigation, municipal or instream use. The CIR excludes any conveyance or application efficiencies. For an irrigation demand it is often called an Irrigation Water Requirement (IWR), which is the potential evapotranspiration less effective precipitation

StateMod consists of four (4) major components: the Base Flow module, the Simulation module, the Report module, and the Data Check module.

1. The **Base Flow**, or **Natural Flow**, module produces a set of streamflows that would have occurred in the basin without a user-specified level of man's development. For example, if a

user supplied data that allows 100% of man's influence to be removed, the base flow developed would represent natural stream flows. On the other hand if a user supplies data that allows only 80% of mans influence to be removed, the baseflow developed would represent something in-between (e.g. 80%) natural and developed. The latter in-between approach is often used as a cost effective measure to simplify baseflow development by including relatively large projects and excluding smaller, less significant developments. Note that any developments not included in the baseflow calculation are not ignored, instead their impact on the system is included in the in-between baseflow estimate.

2. The **Simulation** module operates the river system and accounts for inflows, river gains, diversions, instream flows, well pumping, and reservoir operations.

3. The **Report** module processes the results of the Simulation module into user specified reports and graphs data sets.

4. The **Data Check** module reads the input files and performs various data checks.

Following is a general sequence for operating StateMod:

1. Develop a stream node network based on the location of key gages, river confluences, reservoirs, diversions, wells, and instream flows.

2. Construct the necessary monthly input files using the formats described in Section 4.0.

3. Check the input files by executing StateMod's Data Check Module.

4. Develop base stream flows by executing StateMod's Base Flow Module.

5. Simulate the stream system's operation by executing StateMod's Simulation Module.

6. Evaluate results and generate graphs and tables by executing StateMod's Report Module.

7. If desired, add daily simulation capability.

The remainder of this document is organized as follows:

Section	Title	Description
3.0	Model Description	Describes the theoretical basis of river operations, water allocation and reservoir operations
4.0	Input Description	Describes the input format for each data set
5.0	Output Description	Describes the contents of the various outputs files
6.0	Model Operation	Describes the model's operation from both the screen or command line arguments
7.0	Standard Modeling Procedures	Describes technical details of selected portions of the programs operation and provides information on standard modeling procedures
8.0	Supporting Utilities	Describes supporting utilities available to assist in developing a StateMod data set
9.0	Discontinued but Supported Files	Describes discontinued but supported data file formats

3.0 Model Description

The State of Colorado's Stream Simulation Model (StateMod) is capable of simulating stream diversions, instream demands, well pumping, reservoir operations and river flows on a monthly or daily basis for any stream system using user specified data. To facilitate this simulation, the river basin is divided into a series of river nodes which generally represent gauging stations, river confluences, diversion structures and reservoirs. Accounting is performed on a water right basis while reporting is performed by structure and each river node. The following sections are available in this chapter:

- 3.1 Stream Flow Allocation
- 3.2 System Operation
- 3.3 Model Application
- 3.4 Daily Operations
- 3.5 Variable Efficiency
- 3.6 Demands
- 3.7 Soil Moisture Accounting
- 3.8 Wells
- 3.9 Plans

3.1 Stream Flow Allocation

StateMod allocates water to a diversion, instream flow, or reservoir based upon physically available river flow, legally available flow (priority), decreed right, delivery capacity, and demand. Demand is an input to StateMod, but is typically estimated outside the model to reflect historical or future demands associated with agricultural, municipal, and industrial water needs. As a well may pump water from ground water storage, StateMod allocates water to a well using the same constraints described previously except it is not limited to physical availability of flow in the river. If current or future depletions caused by wells exceed the available flow, the water supply is identified as coming from ground water storage.

The water allocation scheme used in the current version of StateMod is the Modified Direct Solution Algorithm (MDSA) (Bennett, Ray R., December 2000). The MDSA is an enhancement to the Direct Solution Algorithm (DSA) that recognizes the impact of a diversion's return flows even when they occur in the same month or day that they were diverted. The enhancement associated with the MDSA allows water use efficiencies to vary up to a user specified maximum and account for soil moisture contents. The MDSA eliminates the need to iterate between time steps unless reservoir operations or return flows that do not accrue to a downstream node make new water available to the system.

Following is an abbreviated description of the stream allocation scheme, graphics depicting a simplified version of this approach follow:

1. Water availability is determined at each river node to include both native inflows and return flows accruing from a prior time step.

2. The most senior direct, instream, storage, well or operational water right is identified.

3. Diversions are estimated to be the minimum of the decreed water right, structure capacity, demand, and available flow in the river. For a direct flow or reservoir right, the available flow in the river is the minimum of the diverting or downstream node plus any of the diverting right's return flow to that node at the current time step. For an instream right, the available flow in the river is the flow at each river node within the instream reach. For a well, pumping is not constrained by the available flow in the river since pumping may deplete ground water storage.

4. Downstream flows are adjusted to reflect the senior diversion and its return flows.

5. Return flows for future time periods are determined and stored.

6. Well depletions for future time periods are determined and stored.

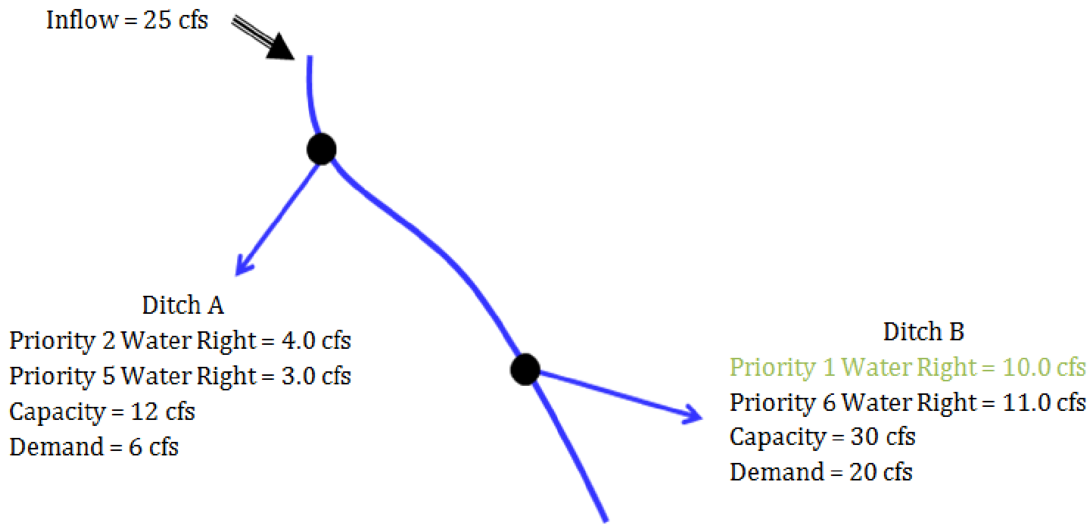
7. The process is repeated by priority for each successive direct, instream, storage, well and operational water right.

8. If new water is introduced to the system from a reservoir's operation or return flows accrue to a non-downstream node, the model reoperates the current time step and the process is repeated beginning with the most senior direct, instream, storage or operational right.

9. The process is repeated for each month or day of the study period.

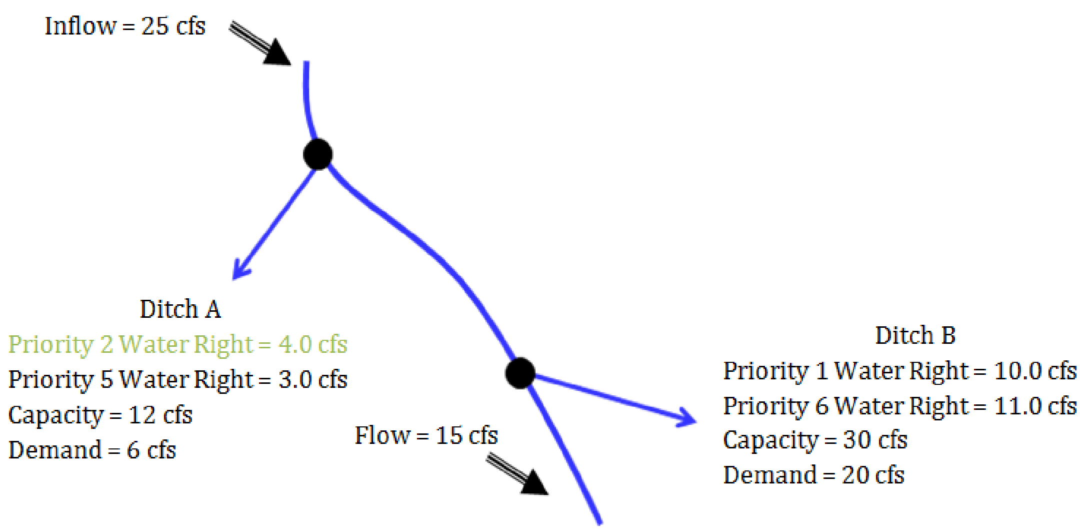
StateMod allocates water by priority, therefore if the administration numbers of two water rights are the same, their relative priority is set by StateMod based on the order it is read within a file and between data files as follows: instream flows, reservoirs, diversions, operating rights, and wells. It is recommended that the user review the list of water rights as read by StateMod in the water rights summary (*.xwr) file and overwrite administration numbers as appropriate to trigger based on actual operations. The user can generate a water rights summary (*.xwr) file by running the Report Option 4 – Water Rights List.

StateMod Simulation Step 1



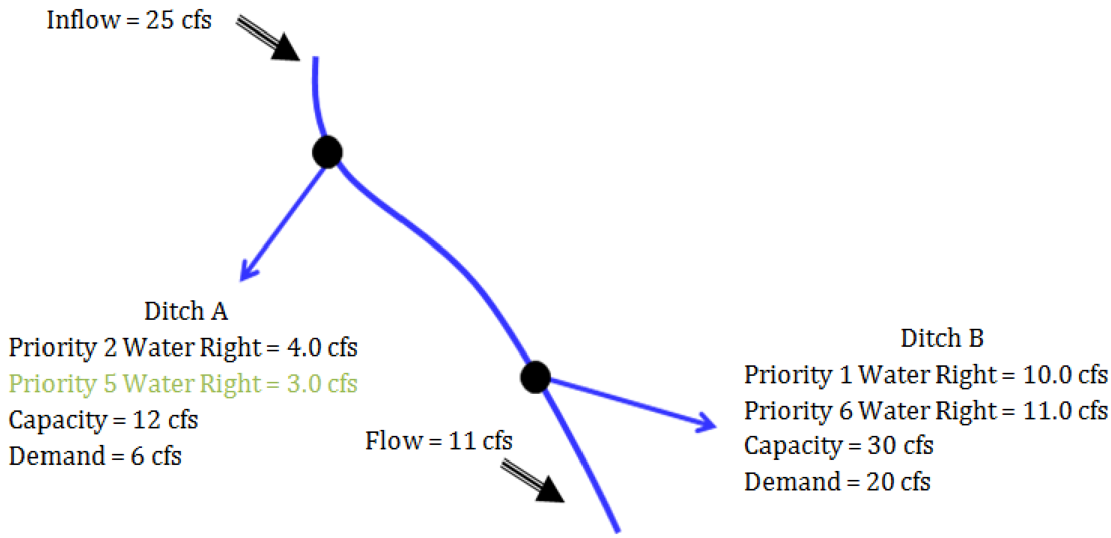
1) Priority 1: Diversion = min (demand, water right, capacity, available flow) = min(20, 10, 30, 25) = 10 cfs
2) Demand decreased to 20 – 10 = 10 cfs
3) Diversion structure capacity decreased to 30 – 10 = 20 cfs
4) Available flow decreased to 25 – 10 = 15 cfs

StateMod Simulation Step 2



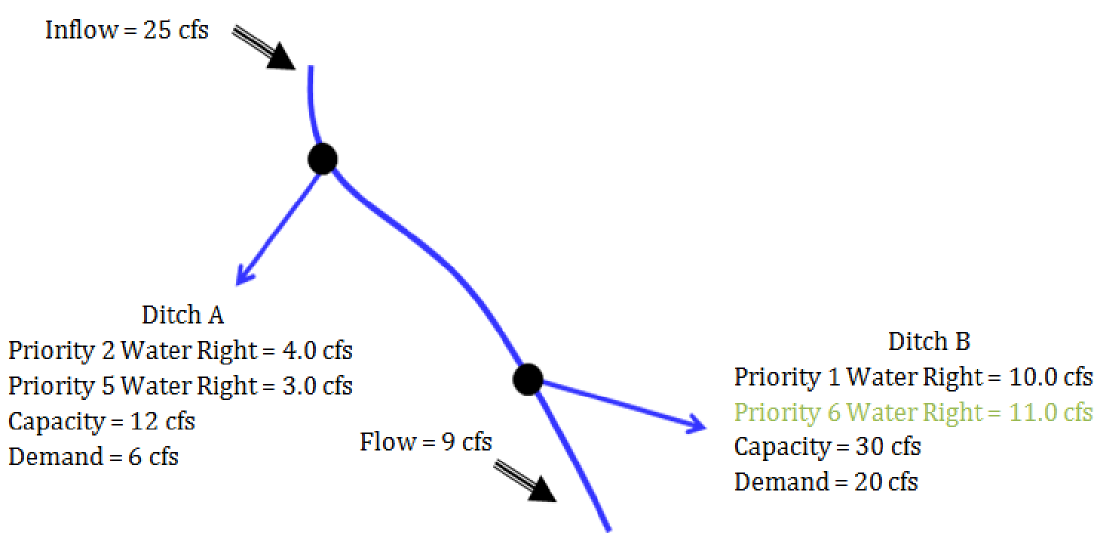
5) Priority 2: Diversion = min (demand, water right, capacity, available flow) = min(6, 4, 12, 15) = 4 cfs
6) Demand decreased to 6 – 4 = 2 cfs
7) Diversion structure capacity decreased to 12 – 4 = 8 cfs
8) Available flow decreased to 15 – 4 = 11 cfs

StateMod Simulation Step 3



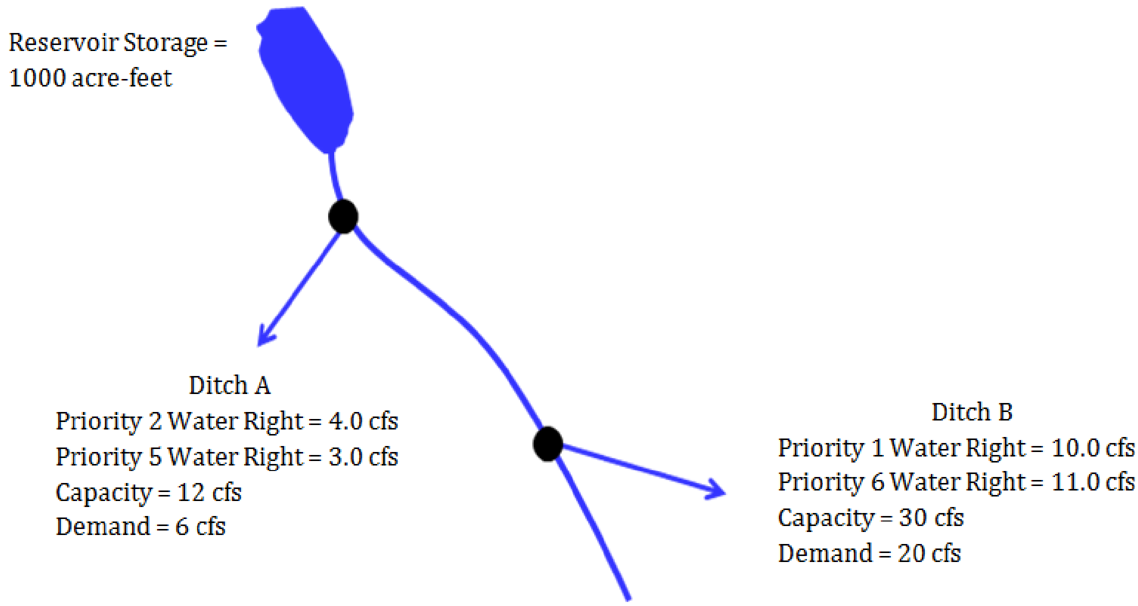
9) Priority 5: Diversion = min (demand, water right, capacity, available flow) = min(2, 3, 8, 11) = 2 cfs
10) Demand decreased to 2 – 2 = 0 cfs Demand is Satisfied
11) Available flow decreased to 11 – 2 = 9 cfs

StateMod Simulation Step 4



12) Priority 6: Diversion = min (demand, water right, capacity, available flow) = min(10, 11, 20, 9) = 9 cfs
13) Diversion structure capacity decreased to 20 – 9 = 11 cfs
14) Demand decreased to 10 – 9 = 1 cfs Demand is Not Satisfied
15) Available flow decreased to 9 – 9 = 0 cfs

StateMod Simulation Step 5



16) Priority 6.1: Reservoir Release = min (demand, capacity, reservoir storage) = min(1, 11, 1000) = 1 cfs
17) Diversion structure capacity decreased to 11 - 1 = 10 cfs
18) Demand decreased to 1 – 1 = 0 cfs Demand is Satisfied

3.2 System Operations

System operations describe how direct, instream, well and storage rights interact with a water right owner's preferences. Reservoirs store water based on physically available river flow, legally available flow (priority), decreed right, storage capacity, demand, and operating rules. A balance is computed which accounts for the inflows and outflows from a reservoir including natural inflow, pumped inflow, controlled releases, spills, net evaporation and seepage. Downstream river flows associated with a reservoir storage or release are adjusted using the same water allocation procedure outlined in the previous section.

Water is released from a reservoir to satisfy an owner's demand, exchange agreement, augmentation requirement, hydropower goals, or target storage values. Reservoirs may have one or more ownership accounts and may be located on the main channel or off-channel. Standard operating policies associated with most river basins have been implemented in StateMod, as described in Section 4 and Section 7.

System operations, diversion return flows to non-downstream river nodes, and well pumping return flows have the potential to add additional water to a river which might be available to a senior water right. For example, when a reservoir releases water to meet a target storage level, additional water may become available to a senior downstream right. Similarly, if a ditch returns water to a neighboring non-downstream tributary, those return flows may be used by a senior ditch on that tributary. Finally when the return flow associated with well pumping exceeds its depletion to the river, additional water may become available to a senior downstream right. When such a system operation, non-downstream return flow or net accretion occurs, the model automatically re-evaluates (re-operates) all water rights in priority in order that senior rights may benefit from the additional water supply. The following are noted:

- When "new water" becomes available because of a system operation, non-downstream return flow or net accretion, the model automatically re-operates all water rights in priority in order that senior rights may benefit from the additional water supply.
- The user can control the number of iterations by adjusting the control (*.ctl) file reoperation variable (ireopx). This variable allows the user to turn off the reoperation capability or specify a volume before reoperation occurs. Both of these activities can impact results but may be an efficient method of operation if the user is interested in testing a new structure or feature and performance is an issue.
- If the user wants to force a reoperation at a specific administration date, a type 12 operating rule can be specified.

3.3 Model Application

This section describes the procedure for applying the river and system operations previously described. Model input files used to drive the model are described in Section 4.

StateMod is structured to perform one of 4 interrelated activities:

- **Base Flows (Natural Flows)**
- **Simulate**
- **Report**
- **Data Check**

The **Base Flow Module** creates a set of "base streamflows" or “natural flows” which have the impact of historical diversions, return flows, well pumping, and reservoir storage, release, evaporation and seepage removed. The generation of a "base streamflow" sequence is necessary for a basin planning model in order to analyze a "What If" scenario which includes a proposed water right or operating strategy that may impact historic river operations. This module may be executed by the user to develop a "natural streamflow" sequence if all impacts of man are removed or a "base streamflow" sequence if only selected impacts of man are removed. When the user selects to generate a "base streamflow" rather than a "natural streamflow" sequence, they are implicitly assuming the historic diversion and reservoir operation impacts which are left in the gage will not change significantly under a What If scenario. By including this component within the model, data preparation requirements are reduced significantly and future simulated return flow patterns are, where appropriate, consistent with the base or natural streamflow generation. Note, the base flow module may be executed with missing streamflow data (specified by -999) to allow man's impact to be removed prior to filling missing data gaps using a technique such as regression.

The **Simulate Module** operates the river based on user specified water rights and operating criteria. It begins by reading data that is constant over time such as the river network, reservoir structures, diversion structures, instream flow structures, well structures and water rights. Time varying data such as streamflow, demands, and climate data are read. Then for every simulation time step, direct, instream, storage, well and operational rights are simulated from the most senior to junior priority. At the end of each month, results are printed for each river node to a direct access binary file. If a simulation only option is chosen, then the program is complete and detailed reports may be obtained through the Report module. If a simulation plus report option is chosen, then at the end of the simulation period, the binary file is read to produce detailed monthly or daily results in a tabular form for each diversion, instream flow, well structure, reservoir, and gage as follows:

Monthly Model Output

- File *.xdd containing detailed monthly diversion and instream flow results
- File *.xre containing detailed monthly reservoir results
- File *.xwe containing detailed monthly well structure results
- File *.xir containing detailed monthly instream flow reach results
- File *.xop containing detailed monthly operational right results
- File *.xss containing detailed monthly structure results
- File *.xpl containing detailed monthly plan structure results
- File *.xca containing call information at the end of a time step
- File *.xrp containing replacement reservoir data

Daily Model Output

- File *.xdy containing detailed daily diversion and instream flow results
- File *.xry containing detailed daily reservoir results
- File *.xwy containing detailed daily well structure results

Note the detailed diversion and instream file (*.xdd) includes information for each river node. Therefore, data associated with the river at every structure, stream gage, confluence, etc. is included. The other standard reports include additional information for a particular structure type or operational activity. For example, the reservoir summary report includes data for each reservoir account while the instream flow report includes data for each node within an instream flow reach.

The **Report Module** reads the direct access, binary file generated by the simulate module to produce user specified reports and files which may be imported to a number of common spreadsheet packages such as Excel for graphing. Following are the standard reports available:

Monthly Model Reports

- Diversion Summary (*.xdd)
- Reservoir Summary (*.xre)
- Operational Right Summary (*.xop)
- Instream Flow Summary (*.xir)
- Well Summary (*.xwe)
- Plan Summary (*.xpl)
- Binary Data File (*.xbn)
- Water Balance (*.xwb)
- Water Rights List (*.xwr)
- Graph Data for Diversions and Gages (*.xdg)
- Graph for Well Structures (*.xwg)
- Graph Data for Reservoirs (*.xrg)
- Supply (total diversion), shortage and consumptive use summaries (*.xsu, *.xsh, *.xcu)

Daily Mode Reports

- Diversion Summary (*.xdy)
- Reservoir Summary (*.xry)
- Well Summary (*.xwy)

The **Data Check Module** echoes the streamflow and diversion data, prints a comprehensive list of all water rights sorted by priority, tabulates input data for simplified reporting, and performs selected data checks of the input files including:

- Stream network is properly connected
- Return flows return to a stream node
- Return flow delay tables total 100% (including loss)
- Distribution of return flows to river nodes or losses equals 100%
- Wells have both a return flow and depletion table
- Water rights are assigned to a structure or operation
- Structures have a water right
- Demands are assigned to a structure
- Structures have a demand or operation
- Reservoir area/capacity tables increase
- Operational rights are properly specified
- Time varying data files (streamflow, demands, precipitation, etc.) have data for the selected study period and year type [Calendar Year (January through December), Water Year (October through September), or Irrigation Year (November through October)].

3.4 Daily Operations

StateMod can operate on a monthly or daily time step. See Section 7 for additional discussion on how to add daily capability to a monthly model. For simplicity StateMod estimates every February has 28 days, therefore any daily data provided for February 29 in a leap year is ignored. The daily capability can be implemented directly or by building upon a monthly model. Constructing a monthly model first is recommended for the following reasons:

- The most difficult part of developing a basin model is understanding the system. By first developing a monthly model, the system operation can be investigated without burdening the user with the volume of information ultimately required for a daily model.
- A daily model is typically developed to be able to simulate large and small flow events that occur within a monthly time step. Therefore, although daily streamflow data will be required, the user may want to estimate some of the other terms required for a daily analysis, such as diversion demands or reservoir targets, using a simplified approach. The ability to supply a simple distribution method to estimate daily data includes the following options:
    1. Divide a monthly estimate by the number of days in a month or
    2. Set daily data to a monthly average or
    3. Use another gages daily distribution or
    4. Use a pattern developed by connecting the midpoints of monthly data (common for demand data) or
    5. Use a pattern developed by connecting the endpoints of monthly data (common for reservoir data).

- Daily baseflows may be developed directly as daily data or estimated from monthly baseflow estimates.
- For the case where a structure has both daily and monthly data which do not equal, the distribution method described above specifies which controls. This approach provides maximum flexibility to assign daily data.
- The routing of daily streamflows is accounted for by the gain and loss term that results from the base (natural) stream flows estimated by or provided to the model.
- Routing of reservoir releases are estimated to occur instantaneously in StateMod. The routing of reservoir releases is not included because 1. StateMod is a primarily a planning model, 2. The additional detail required to properly implement reservoir releases with a travel time component is not justified since the system would have to include some kind of forecasting to know a reservoir release is required before a reservoir demand occurs and 3. The volume of water potentially delivered early by ignoring a reservoir's travel time is offset by the potential over release that occurs after the demand is satisfied.

3.5 Variable Efficiency

StateMod allows water use efficiency to vary from 0 to a user specified maximum value. See Section 7 for additional discussion on how to implement variable efficiency in a model. The following are noted:

- Variable efficiency uses the Modified Direct Solution Algorithm (Bennett, Ray R., December 2000).
- Variable efficiency requires consumptive water requirement data be provided for every diversion and well only structure by year. If not provided, it is estimated from the average efficiency data provided in the diversion and well station (*.dds and *.wes) files and demand data.
- Variable efficiency for wells may include a value for both flood and sprinkler applications if the acres served by sprinklers are provided.
- Variable efficiency operations may include soil moisture accounting although it is not required.
- Variable efficiency capability applies to all direct diversion, well pumping and carrier to diversion structure operations.
- Variable efficiency capability does not apply to reservoir releases. These operating rules continue to use the average efficiency data provided in the diversion station file (*.dds) to determine the structure's demand from the reservoir.

3.6 Demands

StateMod provides several methods to simulate structure demands. The selection of a demand approach is relatively simple for a system with surface water only. However for a system with both surface and ground water selecting an appropriate demand approach can be critical because diversions, wells and reservoir data often have different water use efficiencies. The following are noted:

- Demand data may be provided at the supply point (includes inefficient water use) or as a consumptive requirement (includes no inefficient water use). When demands are provided as a consumptive requirement, the model adjusts the demand on-the-fly to include the inefficiencies associated with the water supply source (surface diversion or well) being simulated.
- Demand data can be provided for diversions and wells separately or as a single value that may be served from surface or ground water supplies. The ability to separate or combine demands based on source allows the flexibility to perform both historic and calculated calibration.
- Demands that can be served by both surface and ground water may be simulated using a Maximum Demand Approach. This approach allows a structure to divert surface water up to their decreed amount and limits ground water pumping to the consumptive requirement. This approach allows a user to divert surface water that may result in a relatively low water use efficiency but use ground water, as needed, at a relatively high efficiency.

3.7 Soil Moisture Accounting

The State Model has the ability to include soil moisture as a water supply. See Section 7 for additional discussion on how to implement soil moisture accounting. The soil moisture capacity is calculated as follows:

SM = D * A * C

SM = Soil Moisture

D = Soil Depth - average soil depth provided for all structures in the control (*.ctl) file

A = Area - data provided by structure in the annual time series (*.ipy) file

C = Soil Moisture Capacity - data provided by structure in the soil parameter (*.par) file or in the consumptive use structure (*.str) file

- The Soil Moisture option allows water to be stored in the soil zone up to its capacity and the diverting structures (direct diversion or well) efficiency.
- StateMod initializes the soil moisture reservoir contents to be 50% of the soil moisture capacity.
- If the irrigated area of a structure is reduced from one year to the next and the resulting soil moisture capacity is exceeded any water in excess of the capacity is estimated to be a loss attributed to that structure.
- The Soil Moisture option requires the variable efficiency option (see Section 3.5) be used.
- In a simulation mode, the Soil Moisture option uses an operating rule to specify an administration date that controls when water is available to be taken out of the soil zone to satisfy a consumptive (not total) demand. In order to represent water use when historic diversions are provided as a demand this operating rule allows water to be taken out of the soil zone when a structure's consumptive irrigation water requirement exists even if the user has specified the structures demand to be zero.
- In the baseflow mode, the Soil Moisture option takes water out of the soil zone to satisfy a consumptive (not total) demand after surface water and well water use occurs. In order to represent water use in baseflow mode, water can be taken out of the soil zone when a structure's consumptive irrigation water requirement exists even if the user has specified the structures diversion and pumping to be zero.

3.8 Wells

The StateMod model allows ground water pumping via wells to be modeled. See Section 7 for more information on how to model well operations. The following are noted:

- Wells are generally operated within StateMod either as an aggregate of wells and their associated water rights tied to a well structure or as supplemental well water rights tied to a surface water diversion structure.
- If a well structure is not tied to a surface water diversion structure then well demands are provided in the well demand file.
- If a well structure is tied to a surface water diversion structure, then demands may be provided and treated in several ways as specified by the control variable *icondem.*
- Wells may increase the water supply available at the river at a given time step if well return flows exceed the stream depletion. StateMod checks for such a condition and reoperates to allow senior ditches to benefit from the additional water supply.
- Wells may require two or more delay patterns to represent the delay associated with return flows and depletions. The data for both types of delays are specified in the delay table input file. Note when the sum of return flows to the river is less than 100%, the balance is treated as a loss. Similarly when the sum of depletions to the river is less than 100%, the balance is treated as salvage.
- Wells may cause river flows to go negative when their estimated depletion to the river exceeds the streamflow. StateMod treats such an occurrence as an indication that pumping impacts have depleted ground water storage rather than the stream flow. Under such a case, StateMod allows the pumping to occur and accounts for the source of water as originating from ground water storage. This water is presented in the diversion summary output under the column titled "From/To GW Stor" for each river node and for the whole basin in the water budget report (*.xwb). Note the quantity of water supplied by ground water storage in a simulation time period is taken out of the stream the next time period before any water allocation occurs. The control file variable *iwell* allows the repayment of this water to be limited to a maximum amount to represent stream / ground water systems that are disconnected. Also, since data for this term is generally not observed, baseflow calculations may be influenced by this lack of data.
- Well information for supplemental wells is presented in four columns of the diversion summary (*.dds) file. The column titled "From Well" describes the total amount of water pumped and made available to a diversion. The column titled "Well Depletion" represents the impact of a previous months pumping on the river. The column titled "To/From GW Stor" was described above. The column titled "River by Well" represents the impact of the current months pumping on the river. The "Well Depletion" and "River by Well" data are separated because the impact of a previous months pumping on the river influences the water supply available to all users before any diversions occur while the impact of the current months pumping impacts water rights that are junior to the well only. In general, the columns titled "Well Depletion" and "River by Well" include the impact of all well pumping on the river at any given point in the river.

3.9 Plans

StateMod uses plan structures to model complex operations, such a reusable supplies, recharge supply and augmentation demands, terms and conditions, changed water rights, out-of-priority plans, and imports. The specific operation desired by the user is defined by the type of plan structure used, the associated plan input files, and the array of operating rules required to operate the plan structure. See Section 7 for additional discussion on how to model plan structures and operations.

Eleven plan types are currently available; note that Plan Types 5 and 6 are intentionally omitted as they are no longer functional in StateMod:

- **Type 1 - T&C Plan** is used to store a future obligation associated with the transfer of water from one structure to another. For example, a water right transfer might require historical return flows be maintained as part of the transfer. When a T&C plan is specified, StateMod calculates the obligation for the time step it occurs and all associated future time steps. Future returns and/or depletions are estimated using the same delay information specified for the source structure or in the operating rule that includes the T&C plan.
- **Type 2 - Well Augmentation Plan** is used to store a future obligation to return water to the river (augment) when a well depletes the river out of priority. When a Well Augmentation Plan is specified, StateMod calculates the current and future obligation for the time step it occurs and all associated future time steps. Future returns and/or depletions are estimated using the same delay information specified for the source well structure.
- **Type 3 - Reservoir Reuse Plan** is used to store a reusable water supply associated with a reservoir. As the reuse plan represents water stored in the reservoir, any unused water can be carried over in the plan to the next time step.
- **Type 4 - Non-Reservoir (Diversion) Reuse Plan** is used to store a reusable water supply associated with a diversion. As the reuse plan is associated with a diversion, any unused water must be spilled since it cannot be carried over to the next month.
- **Type 7 - Transmountain Import Plan** is used to account for imported water which, in many cases, may be used to extinction. The return flows generated from deliveries from a Type 7 plan are typically stored in Type 3 or Type 4 Reuse Plans. See the "How to Model Imports" section for more information on this plan type and import operations.
- **Type 8 - Recharge Plan** is used to store a water supply that originated from reservoir, recharge area, or canal seepage. The water supply from this plan is typically used to meet a well augmentation demand generated in a Type 2 plan. The return to the river is controlled by a unit response table therefore it accrues to the river as a supply even if it is not assigned to a demand.
- **Type 9 - Out of Priority Plan** is used to store a future obligation associated with water that is diverted out of priority. These plans are typically used to represent out-of-priority diversions to storage pursuant to the upstream storage statute (e.g. Blue River decree diversions by Denver and Colorado Springs).
- **Type 10 - Special Well Augmentation Plan** is used to store the depletion associated with a well that is not required to be augmented. Examples include pumping in a designated basin or

pumping by a well which has been decreed to be non-tributary (i.e. “coffin wells”). A special augmentation plan is typically used to demonstrate that every well in the model is assigned to an augmentation plan even if some wells are not required to augment their depletions.

- **Type 11 - Accounting Plan** is used to “temporarily” divert water in priority which may subsequently be used at a later point in the priority system or by a number of other structures. Note this plan type was historically used for changed water rights, however due to the complexity of those operations, Plan Type 13 was developed exclusively for those operations. The Type 11 plan is still used in special operations such as the South Platte Compact.
- **Type 12 - Release Limit Plan** is used to limit the cumulative supply from multiple sources to monthly and annual values. This plan is typically included in a series of other operating rules to limit the total amount of diversions or reservoir releases to a user-specified monthly or annual amount.
- **Type 13 – Changed Water Rights Plan** is a specific type of accounting plan that is used to handle changed water right operations, allowing water to be “temporarily diverted” in priority, split to other Type 13 plans if the changed right has more than one owner, then released at a later priority to meet demands.

The following are noted:

- Section 4 describes the physical data associated with a plan which includes its ID, name and location in the stream network.
- Water accounted for in various reuse plans be used as a source for many other operating rules.
- If a plan is not specified as a part of an operating rule or well water right, StateMod warns the user but assumes there are no terms and conditions to be imposed.
- Total demand and supply associate with a plan are reported as part of the standard stream node output (*.xdd) under the plan ID and appropriate location in the network.
- Detailed reporting of a plan is provided in a standard plan output file (*.xpl).
- Reservoir reuse plans are used to account for reusable water associated with an account in a reservoir. Reservoir reuse plans can be located anywhere in the network but are typically located adjacent to the associated reservoir. Reusable water supplies can be accounted for by assigning a reservoir reuse plan as part of an operating rule.
- Non-reservoir reuse plans are located on the stream network where the water is physically located.
- Terms and conditions (T&C) plans are located on the stream network at the most upstream location(s) where the terms and conditions of a water transfer are to be implemented (e.g. if a term and condition of a transfer requires a diversion leave historic return flows at the transfer location, then the plan should be located just downstream of the transfer location). Return flow obligations associated with a term and condition are a function of how much water gets transferred. Therefore when a terms and conditions (T&C) plan is specified, StateMod calculates the obligation on-the-fly for the month it occurs and all associated future months. Future return flow and/or depletion percentages and patterns may be specified to equal the same values as the source structure or the plan itself. The terms and conditions are defined within the operating rule.

- Well augmentation plans should be located on the stream network at the most upstream location(s) where the lagged pumping depletions affect the river. The lagged river depletions associated with operating a well water right out-of-priority represents the demands for a well augmentation plan. The timing pattern of depletions from pumping are included in the unit response table (monthly - *urm; daily - *.urd). Lagged river depletions associated with well pumping are a function of how much pumped water is simulated. When a well augmentation plan is specified, StateMod calculates the lagged river depletion on-the-fly the month it occurs and all associated future months. Operating rules can be used to satisfy this demand when a well is in priority or from other water supplies, including accretions from recharge diversions (Recharge Plan).
- Accretions associated with recharge water rights diverted from the river to recharge sites can be represented in Recharge Plans. Recharge plans are located on the stream network at the location(s) where the lagged river accretions associated with recharge diversions have been separately estimated to occur. The timing pattern of accretions from recharge diversions is included in the unit response table (monthly - *urm; daily - *.urd). Lagged river accretions associated with recharge diversions are a function of how much recharge diversion is simulated. When a recharge plan is specified, StateMod calculates the lagged river depletion on-the-fly the month it occurs and all associated future months. Operating rules can be used to supply the calculated accretions to meet other demands (e.g. well augmentation plan demands).
- Out-of-Priority plans are used to represent out-of-priority diversions to storage pursuant to the upstream storage statute (e.g. Blue River decree diversions by Denver and Colorado Springs). Accounting for replacement requirements associated with upstream storage statute operations are specified within the operating rule. Operating rules can be used to satisfy this demand when from other water supplies.
- Release limit plans are currently implemented for representing monthly and annual limits to reservoir releases (e.g. Green Mountain Reservoir HUP pool releases to Senate Document 80 beneficiaries).
- Special Well Augmentation Plans are used to represent lagged well depletions to the river system for wells that are considered not tributary to the river system (i.e. Coffin wells and designated basin wells). The timing pattern of depletions from pumping are included in the unit response table (monthly - *urm; daily - *.urd). Lagged depletions associated with well pumping are a function of how much pumped water is simulated. When a special well augmentation plan is specified, StateMod calculates the lagged depletion on-the-fly the month it occurs and all associated future months.

Colorado's Decision Support Systems

4.0 Input Description

This section describes the input files required to operate the StateMod Model. Some data file formats have been superseded over time while continuing to maintain the old format. For a description of the old format see Section 9.0 Discontinued by Supported File Formats.

The following subsections are available in this section:

- 4.0 Remarks
- 4.1 Response File (*.rsp)
- 4.2 Control File (*.ctl)
- 4.3 River Network File (*.rin)
- 4.4 River Station File (*.ris)
  - 4.4.1 River Gage File (*.rig)
- 4.5 Direct Diversion Station File (*.dds)
- 4.6 Direct Diversion Right File (*.ddr)
- 4.7 Instream Flow Station File (*.ifs)
- 4.8 Instream Flow Right File (*.ifr)
- 4.9 Well Station File (*.wes)
- 4.10 Well Right File (*.wer)
- 4.11 Reservoir Station File (*.res)
- 4.12 Reservoir Right File (*.rer)
- 4.13 Operational File (*.opr)
  - 4.13.1 Reservoir to Instream Flow
  - 4.13.2 Reservoir to a Direct Flow or Reservoir or Carrier
  - 4.13.3 Reservoir to a Carrier
  - 4.13.4 Reservoir Exchange to a Direct Flow
  - 4.13.5 Reservoir Exchange to Storage
  - 4.13.6 Paper Exchange Between Reservoir Accounts (Bookover)

4.0 Remarks

Regardless of how the model is applied: Base Flow, Simulate, Report, or Data Check of a monthly simulation requires no more than the first 29 files (less may be provided if wells are simulated). Additional files are needed to implement more complex operations, including files 31 - 33 for variable efficiency and soil moisture accounting; files 36 – 46 for a daily simulation; and files 47 – 53 for specific, relatively unique applications that include a downstream call, plans, and the Rio Grande Compact.

Throughout this documentation a standard file naming convention has been used (e.g. Response file (*.rsp), Control file (*.ctl), etc. where * refers to a basin or scenario). This naming convention is recommended for scenario management but it is not required. Note that model output files take on the name of the response (*rsp) file; the user is encouraged to manage different model runs using the response file name.

When the base streamflow file is generated outside the StateMod baseflow module or represents a file that has been saved for historical purposes, it is typically named *.rim. However when the StateMod baseflow results are used for the simulation, the baseflow file it is typically named *.xbm to ensure data passes from the baseflow module to the simulate module.

In general, the top of each data set contains a variable number of comment cards identified by a ”#" in column 1; for files created using a DMI (TSTool or StateDMI) these comments reflect the command file used to create the file. Generally, only the control (*.ctl) file and operational right (*.opr) files allow comments identified by a '#' below the header and within the data itself. It is recommended that a

‘#’ sign be used specifically in the operating rule file to provide additional comments (as this file is not created using a DMI) and to turn off all lines associated with operating rules not used in a given scenario. Monthly time series data contain values for each month of the study period. Annual time series contain twelve values to be repeated for each year of the study period.

All structure names and ID’s are limited to 24 and 12 characters respectively. To allow free formatted input files there should be no blank characters in the name or ID or they should be in single or double quotes (e.g. instead of My Name use ‘My_Name’ or “My Name”).

Identifiers used throughout the model are limited to 12 characters. However if the standard numbering convention shown below is followed the ID should be limited to 9 characters since 3 of the 12 may be used to identify up to 99 unique water rights (e.g. 123456789.01). In general, any character may be used as an ID in StateMod although two reports; one related to the operational right file and one related to consumptive use by water district identifier look for specific characters in specific fields to simplify reporting. The Check option generates a report for operating rules which uses the operational right ID to the left of the decimal point to group operational rights from the same source together. Similarly, the consumptive use report (*xcu) from the Report option presents the diversions by water district by combining all structures that have the first two digits of their ID the same. The following convention is recommended to ensure the reports operate appropriately and that data for different river basins will have unique identifiers:

Item	Source	Example
Diversion ID	State WD + 5-digit ID	5700501
Reservoir ID	State WD + 5-digit ID	5703001
Instream Flow ID	State WD + 5-digit ID	5702501
Instream Flow terminus ID	State WD + 5-digit ID	5702501_Dwn
Water Right	Associated Structure ID plus .01, .02, etc.	5700501.01
Operational Right ID	Source Structure * 10 + .01, .02, etc.	5703010.01
Streamflow Gage ID	USGS ID	09010400
Intermediate River Node	Upstream USGS ID + .01	09010400.01
Precipitation ID	NOAA/NCDC ID	USC00050848
Evaporation ID	NOAA/NCDC ID	USC00050848
Administration Number	State Engineer's Administration Number	16192.10378
Delay (Return Flow) Table ID	1, 2, 3, etc.	

```
Aggregated diversions  User WD_XXB###, where 43_ADW001
        WD is the water district
        XX is the aggregated type
                AD = diversion         AR = reservoir
                AM = municipal         AS = stock pond
```

```
B = basin (W=White, S=San Juan, etc.)
### = counter
```

4.1 Response File (*.rsp)

The response file contains the names of all other data files required to run the model. This file is read by subroutine StateM. Note, that Version 10.30 and greater allows a user to enter response file data using one of two formats; random and sequential. StateMod reads the first file type and based on the occurrence of the character '=' in the first file name it determines if the file is random (contains a '=') or sequential (does not contain a '=').

The random file approach allows file names to be entered in any order as described below under Random Response Format. Any file type that is not required for a simulation is simply not included. Also any file name may be commented out by including a '#' character in column 1. Its format is described in the table below (Random Response Format). For a description of the sequential, old, format see the section titled 9.0 Discontinued but Supported File Formats.

Note that model output files take on the name of the response (*rsp) file; the user is encouraged to manage different model runs using descriptive response file naming conventions.

```
File Descriptor                       File Type              Standard Suffix
Control =                             Control File                  *.ctl
River_Network =                       River Network File            *.rin
River_Gage =                          River Gage File               *.rig

Reservoir_Station =                   Reservoir Station             *.res
Diversion_Station =                   Diversion Station             *.dds
StreamGage_Station =                  Stream Gage Station           *.ris
Instreamflow_Station =                Instream Flow Station         *.ifs
Well_Station =                        Well Station                  *.wes

Instreamflow_Right =                  Instream Flow Right           *.ifr
Reservoir_Right =                     Reservoir Right               *.rer
Diversion_Right =                     Diversion Right               *.ddr
Operational_Right =                   Operational Right             *.opr
Well_Right =                          Well Right                    *.wer

Precipitation_Monthly =               Precipitation Monthly         *.prc
Precipitation_Annual =                Precipitation Annual          *.pra
Evaporation_Monthly =                 Evaporation Monthly           *.evm
Evaporation_Annual =                  Evaporation Annual            *.eva
Stream_Base Monthly =                 Baseflow Monthly              *.rim/*.xbm

Diversion_Demand_Monthly =            Diversion Demand Monthly      *.ddm
Diversion_Demand_AverageMonthly =     Diversion Demand Annual       *.dda
Diversion_DemandOverride_Monthly =    Diversion Override Monthly    *.ddo
Instreamflow_Demand_Monthly =         Inst. Flow Demand Monthly     *.ifm
Instreamflow_Demand_AverageMonthly =  Inst. Flow Demand Ave. Monthly *.ifa
Well_Demand_Monthly =                 Well Demand Monthly           *.wem
```

```
DelayTable_Monthly =                    Delay Table Monthly            *.dly
Reservoir_Target_Monthly =              Reservoir Target Monthly       *.tar
Reservoir_Return =                      Reservoir Seepage Return Data  *.rrf

IrrigationPractice_Yearly =             Irrigation Practice Yearly     *.ipy
ConsumptiveWaterRequirement_Monthly =   Irrigation Water Req. Monthly  *.iwr/*.ddc
StateCU_Structure =                     StateCU Structure (AWC) file   *.str

Reservoir_Historic_Monthly =            Reservoir Historic Monthly     *.eom
StreamEstimate_Coefficients =           Stream Estimate Coefficients   *.rib
StreamGage_Historic_Monthly =           Stream Gage Historic Monthly   *.rih
Diversion_Historic_Monthly=             Diversion Historic Monthly     *.ddh
Well_Historic_Monthly =                 Well Historic Monthly          *.weh

OutputRequest =                         Output Request                 *.out

Stream_Base_Daily =                     Stream Base Daily              *.rid
Diversion_Demand_Daily =                Direct Flow Demand Daily       *.ddd
Instreamflow_Demand_Daily =             Instream Flow Demand Daily     *.ifd
Well_Demand_Daily =                     Well Demand Daily              *.wed
Reservoir_Target_Daily =                Reservoir Target Daily         *.tad
DelayTable_Daily =                      Delay Table Daily              *.dld
ConsumptiveWaterRequirement_Daily =     Irrigation Water Req. Daily    *.iwd
StreamGage_Historic_Daily =             StreamGage Historic Daily      *.riy
Diversion_Historic_Daily =              Diversion Historic Daily       *.ddy
Well_Historic_Daily =                   Well Historic Daily            *.wey
Reservoir_Historic_Daily =              Reservoir Historic Daily       *.eoy

Downstream_Call =                       Downstream Call                *.cal
RioGrande_Spill_Monthly =               Rio Grande Spill file          *.rgs
San_Juan_Recovery =                     San Juan Recovery Data         *.sjr

GeographicInformation =                 Geographic Information (1)     *.gis
Network =                               Network File (1)               *.net

Plan_Data =                             Plan Data                      *.pln
Plan_Wells =                            Plan Well Augmentation Data    *.plw
Plan_Return =                           Plan Return Data               *.prf

Reach_Data =                            Reach Report Data              *.rch
```

(1) The Geographic Information (*.gis) and Network (*.net) files are not used by StateMod. However, if included, they allow the StateMod GUI to use them for presentation.

4.2 Control File (*.ctl)

The control file contains information which controls the model simulation. To allow old StateMod data sets to operate without editing, the data after the year type (row 18-1) is assumed to be zero if not provided. Comments, indicated by a # in column 1, may be provided at any location in this file. This file is read by subroutine DATINP.

Row-data	Variable	Description
Title Data		
1 thru 2		Format (a80)
1-1	headin(i,1)	Title printed on output
2-1	headin(i,2)	Title printed on output
Study Period Data		
3 through 32		Format (i8 or f8.0)
3-1	iystr	Starting year of the simulation
4-1	iyend	Ending year of the simulation
General Control Switches		
5-1	iresop	Switch for output units; 1=cfs for all, 2=acft for all, 3=kaf for all, 4=cfs for daily and acft for monthly 5=cms for all
6-1	moneva	Switch for Evaporation and precipitation data; 0 = monthly; 1=average
7-1	iopflo	Switch for Streamflow; 1=total, 2=gains
8-1	numpre	Number of precipitation stations
9-1	numeva	Number of evaporation stations
10-1	interv	+n =Number of entries in each delay (return flow) pattern -1 =Variable number of entries per delay (return flow) pattern. return data is provided as a percent (e.g. 5.00) -100 =Variable number of entries per delay (return flow) pattern. return data is provided as a decimal (e.g. 0.05).
Factor Data		
11-1	factor	Factor to convert from CFS to AF/DAY (1.9835)
12-1	rfacto	Divisor for streamflow data units; Enter 0 for data provided in CFS, Enter 1.9835 for data provided in AF/Mo
13-1	dfacto	Divisor for diversion data units; Enter 0 for data provided in CFS, Enter 1.9835 data provided in AF/Mo
14-1	ffacto	Divisor for in-stream flow data units; Enter 0 for data provided in CFS, Enter 1.9835 for data provided in AF/Mo
15-1	cfacto	Factor to convert reservoir content data to AF
16-1	efacto	Factor to convert evaporation data to feet/mo
17-1	pfacto	Factor to convert precip. data to feet/mo
18-1	cyr1	Year type Format (a5) (Right justified,

all capital letters)
CYR = Calendar Year (Jan - Dec)
WYR = Water Year (Oct - Sep)
IYR = Irrigation Year (Nov - Oct)

Advanced Control Switches

19-1 icondem Switch for demand data type
See Section 7 for a discussion of the Demand options.
If simulating wells (iwell > 0 see below)
- 1 Historical Demand Approach
  demands for structures with both SW and GW rights are provided in a separate file (e.g. *.ddm & *.wem) and are not added (i.e. SW shortages cannot be supplied by GW & visa versa)
- 2 Historic Sum Demand Approach
  demands for structures with both SW & GW rights are provided separately (i.e. the *.ddm and *.wem files are added. Demands can be supplied by SW or GW)
- 3 Structure Demand Approach
  demands for structures with both SW and GW rights are provided in one file, the direct diversion demand file (e.g. *.ddm).Demands for well only lands are provided in the well demand file (*.wem) Demands can be supplied by SW or GW).
- 4 Supply Demand Approach
  Same as 3 but the surface water may be diverted up to their demand even if a CIR does not exist. See Section 7 for a detailed discussion.
- 5 Decreed Demand Approach
  Same as 4 but the Decreed Demand Approach is used. See Section 7 for additional discussion.

20-1 ichk Switch for detailed output
- 0 No detailed results
- 1 Print river network
- 4 Print detailed water right, operation and re-op data
- 5 Print detailed demand data
- 6 Print detailed daily data
- 7 Print detailed return flow data
- 8 Print detailed daily baseflow data to *.log file and daily baseflow results to the *.xtp file
- 9 Print detailed reoperation data

```
                                    10 Echo operational right file read
                                    11 Print reservoir evaporation details
                                    14 Detailed water right data
                                    20 Override daily ID for testing
                                    21 Print top of binary file for *.xbn report
                                    24 Print detailed results of opr. rule 23
                                          downstream call
                                    25 Limit daily baseflow output to the river
                                          ID specified in variable ccall (24-1)
                                    30 Do not print daily binary results
                                    90 Print detailed water use data from return
                                    91 Print detailed demand data from Bomsec and
                                          well water right data from Welrig
                                    92 Print detailed soil moisture data
                                    94 Print ichk=4 plus call information
                                          -n Print allocation data at river node n
                                    100+n Echo operational right file read and
                                          provide detailed output for an
                                          operational right type n for the
                                          operational right ID provided for
                                          variable ccall (24-1). Note
                                          ichk=131 provides details on an
                                          operational right type 31
                                    201 Provide detailed output for an instream
                                          right ID provided for ccall (24-1)
                                    202 Provide detailed output for a reservoir
                                          right ID provided for ccall (24-1)
                                    203 Provide detailed output for a diversion
                                          right ID provided for ccall (24-1)
                                    206 Provide detailed output for a well right
                                          ID provided for ccall (24-1)
21-1           ireopx         Switch for reoperation control
                              See Section 3 for a discussion of the
                                    Reoperation control
                                    0 Reoperate for reservoir releases and
                                          returns to non downstream returns
                                          (default)
                                    1 Do not reoperate
                                    -n Reoperate when the sum of reservoir
                                          releases or downstream return flows
                                          exceed n in acft.
22-1           ireach         Switch for instream flow reach approach
                              See Section 7 for a discussion of the
                                    Instream flow options.
                                    0 No instream reach approach (Phase II)
                                    1 Instream reach approach (Phase III)
                                    2 Same as 0 plus monthly instream
                                          demands may be provided in the monthly
                                          may be provided in the monthly
                                          instream demand file (*.ifm)
                                    3 Same as 1 plus monthly instream
                                          demands may be provided in the
                                          monthly instream demand file
```

		(*.ifm)
23-1	icall	Switch for detailed call data See Section 7 for a discussion of the Detailed call data 0 No detailed call data 1 Yes detailed call data
24-1	ccall	Detailed call water right ID (e.g. Section 4.6 field 1-1 variable (cidvri) See Section 5 for a discussion of the Detailed call data Note this variable is not used if the control variable icall = 0
25-1	iday	Switch for daily calculations See Section 7 for a discussion of the Daily capability 0 Monthly analysis 1 Daily analysis 2 Daily analysis where the daily demand is a monthly total that is decreased by the amount diverted each day (i.e. "daily-decrementing" approach).
26-1	iwell	Switch for well operations See Section 7 for a discussion of the well options. 0 No well analysis -1 No well analysis but the file names are included in the response file (*.rsp) 1 Well analysis with no max recharge 2 Well analysis with a constant maximum Stream recharge assigned as variable gwmaxrc in the control file (*.ctl) 3 Well analysis with a variable maximum Stream recharge assigned as variable Gwmaxrc in the river network file (*.rin)
27-1	gwmaxrc(1)	Maximum recharge limit (cfs) See Section 7 for a description of the well options and this variable +n Constant maximum recharge limit (cfs). Only used when variable iwell of the control file (*.ctl) is set to 2.
28-1	isjrip	Switch for an annual San Juan Recovery Program (SJRIP) Sediment file is no longer used
29-1	itsfile	Switch for an annual irrigation practice file See Section 7 for a discussion of Variable efficiency and use of the annual CU time series data 0 No time series file provided -1 Time series file provided in the response (*.rsp)file but not used 1 Use Annual GW area limit only

		2 Use Annual Well Capacity only 10 Use all data provided in *.ipy file. This includes annual GW area, well capacity, area served by ground water, area served by sprinklers, max Flood efficiency, max sprinkler efficiency, and total area
30-1	ieffmax	Switch for annul consumptive water requirement (*.iwr or *.ddc) file See Section 7 for a discussion of Variable efficiency and use of the annual CU time series data 0 No IWR file provided -1 IWR (*.iwr) file provided in the response (*.rsp)file but not used 1 IWR file provided and variable efficiency used. (requires itsfile from above be > 0) 2 IWR file provided and printed to output but variable efficiency is not used except to limit reservoir releases to days when an IWR exists when iday = 2
31-1	isprink	Switch for sprinkler data (area and efficiency) use See Section 7 for a description of the sprinkler options 0 No sprinkler data used 1 For baseflow or simulation mode Use sprinkler area, sprinkler efficiency and gwmode data provided in time series file (*.ipy)
32-1	soild	Switch for soil moisture accounting See Section 7 for a Description of the Soil Moisture capability 0 No Soil Moisture (*.str) file provided -1 Soil Moisture (*.str) file provided in the response (*.rsp) file but not used +n Soil Moisture (*.str) used where +n is a typical soil zone depth (ft) (e.g. 2.5 - 3.0 ft). Note StateMod sets the initial soil moisture storage to 50% of the soil capacity
33-1	isig	Switch for significant figures behind decimal point in output files 0 No significant figures 1 One significant figure 2 Two significant figures

4.3 River Network File (*.rin)

The river network file is used to describe the river basin of interest. The network (*.net) diagram is typically created in StateDMI, then commands are used to convert the diagram to the river network “flat file” formate. Note, the last downstream node should be blank. This file is read by subroutine DATINP.

```
Row-data        Variable        Description

1                               Format (a12, a24, a12, 1x, a12, 1x, f8.0)
1-1             cstaid(1)       River node ID
1-2             stanam(i,1)     Station name
1-3             cstadn(1)       Downstream node
                                Note leave blank for the end of the network
                                      or for a tributary with a futile call
1-4             comment(1)      Comment reserved for structure at
                                      this location
1-5             gwmaxr(1)       Variable maximum recharge limit (cfs).
                                   Only used when variable iwell of the
                                   control file (*.ctl) is set to 3.

                                Repeat for the number of river nodes
```

4.4 River Station File (*.ris)

The river station file is used to describe the name and location of nodes where baseflows are known. Baseflows typically consist of streamflow gages (which have a historical time series in the historical stream flow file (*.rih)) and other nodes which have a base flow estimated using information in the base flow data file (*.rib). The number and order of entries corresponds to the Stream flow file. This file is read by subroutine DATINP.

```
Row-data        Variable        Description

Station Data
1                               Format (a12, a24, a12, 1x, a12)
1-1             crunid(1)       Stream station ID
1-2             runnam(i,1)     Station name
1-3             cgoto(1)        River node with a stream gage
1-4             crunidy(1)      Daily Stream station ID (for daily model only)
                                See Section 7 for a detailed discussion

                                Enter Stream station ID (crunid) if daily data
                                Will be provided for this station
                                      Monthly data controls
                                      Enter another stream station ID to use the
                                      daily distribution of another but weight
                                      values by the monthly total in *.rim file
                                Enter 0 to use the average daily value from
                                      the monthly total in the *.rim file
                                      Monthly data controls
```

```
                              Enter 3 to use the daily value provided in
                                    the daily river (*.rid) file
                                    Daily data controls
                              Enter 4 to use a daily pattern developed by
                                    connecting the midpoints of monthly data
                                    Monthly data controls

                              Repeat for the number of stream gages
```

4.4.1 River Gage File (*.rig)

The river gage file is used to describe the name and location of nodes where gaged streamflows are located. Gaged streamflows have a historical time series in the historical stream flow file (*.rih). This file is part of a future enhancement that clearly separates data in the river station file (*.ris) into gaged and non gaged flow locations. Currently this file is used by the daily baseflow module only. This file is read by subroutine VIRIN.

```
Row-data       Variable       Description
_____________________________________________________________________

Station Data
1                             Format (a12, a24, a12, 1x, a12)
1-1            crunid(1)      Stream Gage station ID
1-2            runnam(i,1)    Station name
1-3            cgoto(1)       River node with a stream gage
1-4            crunidy(1)     Daily Stream station ID (for daily model only)
                              See Section 7 for a detailed discussion

                              Enter Stream station ID (crunid) if daily data
                                    Will be provided for this station
                                    Monthly data controls
                              Enter another stream station ID to use the
                                    daily distribution of another but weight
                                    values by the monthly total in *.rim file
                                    Monthly data controls
                              Enter 0 to use the average daily value from
                                    the monthly total in the *.rim file
                                    Monthly data controls
                              Enter 3 to use the daily value provided in
                                    the daily river (*.rid) file
                                    Daily data controls
                              Enter 4 to use a daily pattern developed by
                                    connecting the midpoints of monthly data
                                    Monthly data controls
                              Enter Stream station ID (crunid) if daily data
                                    will be provided for this station
                                    Monthly data controls
                              Enter another stream station ID to use the
                                    daily distribution of another but weight
                                    values by the monthly total in *.rim file
                                    Monthly data controls
                              Enter 0 to use the average daily value from
                                    the monthly total in the *.rim file
```

Monthly data controls
Enter 3 to use the daily value provided in
the daily river (*.rid) file
Daily data controls
Enter 4 use a daily pattern developed by
Connecting the midpoints of monthly data
Monthly data controls

Repeat for the number of stream gages

4.5 Direct Diversion Station File (*.dds)

The direct diversion station file contains information to describe the physical properties of each direct diversion in the system. This file is read by subroutine DATINP. Note that the average efficiency data provided with this file (*divefc*) is not used when the maximum efficiency approach is operated (see control file variable *ieffmax*) unless the structure type (*irturn*, below) is a carrier.

Row-data	Variable	Description
Station Data		
1		Format (a12, a24, a12, i8, f8.2, 2i8, 1x, a12)
1-1	cdivid(1)	Diversionstation ID
1-2	divnam(i,1)	Diversion name
1-3	cgoto	River node where diversion is located
1-4	idivsw(1)	Switch; 0=off, 1=on
1-5	divcap(1)	Diversion capacity (CFS)
1-6	dumx	Not currently used
1-7	ireptyp(1)	If a general replacement reservoir option (type 10) is used. 0 Do not provide general replacement reservoir benefits 1 Provide 100% replacement -1 Provide depletion replacement
1-8	cdividy(1)	Daily Diversion ID (not used for monthly model) See Section 7 for a detailed discussion Enter station ID (cdivid) if daily data will be provided for this station Monthly data generally controls Enter another station ID to use the daily distribution of another but weight values by the monthly total in *.ddm file Monthly data generally controls Enter 0 to use the average daily value from the monthly data in the *.ddm file Monthly data controls Enter 3 to use the daily value from the daily demand (*.ddd) file Daily data controls Enter 4 use a daily pattern developed by connecting the midpoints of monthly data Monthly data controls

Diversion Switches

2		Format(12x, a24, 12x, 2i8, f8.2, f8.0, i8)
2-1	usernam(1)	User name
2-2	idvcom(1)	Data type switch 1 monthly total demand provided (Section 4.17), 2 annual total demand provided (Section 4.18), 3 monthly irrigation water requirement provided (Section 4.17) 4 annual irrigation water requirement provided (Section 4.17) 5 estimate to be zero
2-3	nrtn(1)	Number of return flow locations or table references
2-4	divefc(1)	System efficiency switch. Enter 0-100 % for a constant value each month. Enter a negative value to provide 12 values, one for each month. Note this data is not used when the maximum efficiency approach is used (see control file variable ieffmax) unless The structure type (irturn, below) is a carrier
2-5	area(1)	Recent Irrigated Acreage (ac)
2-6	irturn(1)	Use type; 0 = Storage 1 = Irrigation 2 = Municipal 3 = Carrier 4 = Transmountain 5 = Other
2-7	demsrc(1)	Demand source code (used for documentation purposes and non-StateMod applications to determine if a structure supplies an irrigation demand.) 1 = Irrigated acreage from GIS database 2 = Irrigated acreage from structure file (tia) 3 = Irrigated acreage from GIS database, the primary component of lands served by multiple structures 4 = Same as 3 but data is from the structure file (tia) 5 = Secondary component of lands served by multiple structures 6 = Municipal, industrial or transmountain structure (no acreage data expected) 7 = Carrier structure (no acreage data expected) 8 = Acreage data provided by the user -999 = Acreage data unknown

Monthly Efficiency Data		
3		Free Format (Include if divefc above is < 0)
3-1	diveff(1,12)	Efficiency % by month for the year type selected (water year, irrigation year, calendar year)
Return Flow Data		
4		Format (36x, a12, f8.2, i8)
4-1	crtnid(1)	River node receiving return flow
4-2	pcttot(1)	Percent of return flow to this river node
4-3	irtndl(1)	Delay (return flow) table for this return flow
		Repeat for number of returns (nrtn)
		Repeat for number of diversions

4.6 Direct Diversion Rights File (*.ddr)

The direct diversion rights file contains data associated with a diversion right. This file is read by subroutine RIGINP.

Row-data	Variable	Description
Right Data		
1		Format (a12, a24,a12,4x, f12.0,f8.2,i8)
1-1	cidvri(1)	Diversion right ID
1-2	named(1)	Diversion right name
1-3	cgoto	Direct diversion structure ID associated with this right
1-4	irtem(1)	Administration number
1-5	dcrdiv(1)	Decreed amount(CFS)
1-6	idvrsw(1)	Switch 0=off 1=on +n Begin in year n -n Stop after year n
		Repeat for the number of diversion rights

4.7 Instream Flow Station File (*.ifs)

The instream flow station file contains information to describe the physical properties of each instream flow in the system. This file is read by subroutine DATINP.

Row-data	Variable	Description
Station Data		
1		Format (a12, a24, a12, 1x, a12,1x,a12,i8)
1-1	cifrid(1)	Instream flow station ID
1-2	xfrnam1(i,1)	Instream flow station name

1-3	cgoto(1)	Upstream river node where the instream flow point or reach is located
1-4	ifrrsw(1)	Switch; 0=off, 1=on
1-5	crtnid	Downstream river node where the instream flow point or reach is located. For an instream point enter cgoto(1) or leave blank
1-6	cifrridy(1)	Daily Instream station ID (for daily model only)
		See Section 7 for a detailed discussion
		Enter Instream station ID (crunid) if daily data will be provided for this station Monthly data controls
		Enter another instream station ID to use the daily distribution of another but weight values by the monthly total in *.rim file
		Enter 0 to use the average daily value from the monthly data in the *.ifm file Monthly data controls
		Enter 3 to use the daily value from the daily demand (*.ifd) file Daily data controls
		Enter 4 use a daily pattern developed by connecting the midpoints of monthly data Monthly data controls
1-7	iifcom(1)	Data type switch 1 monthly total demand provided (Section 4.17) 2 annual total demand provided (Section 4.18)
		Repeat for the number of instream flow stations

4.8 Instream Flow Right File (*.ifr)

The instream flow right file contains data associated with an instream flow's water rights. Note that StateMod allows two more more instream flow rights for one reach. This file is read by subroutine RIGINP

Row-data	Variable	Description
Right Data		
1		Format (a12, a24,a12, 4x, f12.0, f8.2, i8)
1-1	cifrri	Instream Flow right ID
1-2	namei(1)	Instream Flow right name
1-3	cgoto	Instream structure ID associated with this right
1-3	irtem(1)	Administration number
1-4	dcrifr(1)	Decreed amount(CFS)
1-5	iifrsw(1)	Switch 0=off 1=on +n Begin in year n -n Stop after year n

```
                              Repeat for the number of instream flow rights
```

4.9 Well Station File (*.wes)

The well station file contains information to describe the physical properties of each well structure in the system. This file is read by subroutine DATINP.

```
Row-data       Variable       Description
Station Data
1                             Format (a12, a24, a12, i8, f8.2, 1x, a12, 1x, f12.5)
1-1            cdividw(1)     Well Station ID
1-2            divnamw(1)     Well Station name
1-3            idvstaw(1)     River node where the well is located
1-4            idivsww(1)     Switch; 0=off, 1=on
1-5            divcapw(1)     Well capacity (cfs)
1-6            cdividyw(1)    Daily Well Station ID (not used for monthly
                                    model) See Section 7 for a detailed discussion

                              Enter station ID (cdividw) if daily data
                                    will be provided for this station
                                    Monthly data controls
                              Enter another station ID to use the daily
                                    distribution of another but weight values
                                    by the monthly total in *.wem
                                    Monthly data controls
                              Enter 0 to use the average daily value from
                                    the monthly data in the *.wem file
                                    Monthly data controls
                              Enter 3 to use the daily value from
                                    the daily well demand (*.wed) file
                                    Daily data controls
                              Enter 4 use a daily pattern developed by
                                    connecting the midpoints of monthly data
                                    Monthly data controls
1-7            primary(1)     Switch;
                              0=off Water right priorities determine when water
                                    is diverted.  This option is commonly
                                    called SW primary
                                    because SW is typically senior
                              +n=on Well water rights will be adjusted by n.
                                    This option is called GW primary because it
                                    allows priority of GW rights
                                    to be made senior to SW rights when an
                                    appropriate value
                                    of n is provided (e.g. 15000).Note
                                    StateMod operates
                                    appropriately if n makes a ground water
                                    right negative

Well Switches
2                             Format(36x, a12, 3i8, f8.2, f8.0, i8, f8.0)
```

2-1	idvcow2(1)	Diversion this well structure is associated with. Enter NA if this well is not associated with a diversion structure
2-2	idvcomw(1)	Data type switch 1 monthly total demand provided (Section 4.22) 2 Not active. Reserved for annual total demand 3 monthly irrigation water requirement provided(Section 4.21) 4 Not active. Reserved for annual irrigation water requirement 5 estimate to be zero 6 this well station is tied to a direct diversion station and expects demand data provided as a total in file *.ddm (e.g. no well demand data is expected)
2-3	nrtnw(1)	Number of return flow locations or table references
2-4	nrtnw2(1)	Number of depletion locations or table References
2-5	divefcw(1)	System efficiency Enter 0-100% for a constant value each month. Enter a negative value to provide 12 values, one for each month
2-6	areaw(1)	Irrigated acreage (ac) for future n = Irrigated acreage for this structure -1 = Irrigated acreage provided in the direct diversion station file (*.dds).Use when a structure has both SW and GW supplies
2-7	irturnw(1)	Use type; 1 = irrigation 2 = municipal 3 = commercial 4 = transmountain 5 = other (e.g. augmentation or recharge wells)
2-8	demsrcw(1)	Demand source code (used for documentation purposes and non StateMod applications to determine if a structure supplies an irrigation demand) 1 = Irrigated acreage from GIS database 2 = Irrigated acreage from structure file (tia) 3 = Irrigated acreage from GIS database, the primary component of lands served by multiple structures 4 = Same as 3 but data is from the structure file (tia) 5 = Secondary component of lands served by multiple structures

Row-data	Variable	Description
		6 = Municipal, industrial or transmountain structure (no acreage data expected)
		7 = Carrier structure (no acreage data expected)
		8 = Acreage data provided by the user
		-999 = Acreage data unknown
Monthly Efficiency Data		
3		Free Format (Include if divefc above is < 0)
3-1	diveffw(1,12)	Efficiency % by month for the year type selected (water year, irrigation year, calendar year)
Return Flow Data		
4		Format (36x, a12, f8.2, i8)
4-1	crtnidw(1)	River node receiving return flow
4-2	pcttotw(1)	Percent of return flow to this river node
4-3	irtndlw(1)	Delay (return flow) table for this return flow
		Repeat for number of return locations (nrtnw)
Depletion Data		
5		Format (36x, a12, f8.2, i8)
5-1	crtnidw2(1)	River node receiving depletion
5-2	pcttotw2(1)	Percent of depletion to this river node
5-3	irtndlw2(1)	Delay (depletion) table for this return flow
		Repeat for number of depletion locations(nrtnw2)
		Repeat for number of wells

4.10 Well Right File (*.wer)

The well right file contains data associated with a well structures. This file is read by subroutine RIGINP.

Row-data	Variable	Description
Right Data		
1		Format (a12, a24,a12, 4x, f12.0, f8.2, i8)
1-1	cidvri(1)	Well right ID
1-2	cnamed(1)	Well right name
1-3	cgoto	Well structure ID associated with this right
1-3	irtem(1)	Administration number
1-4	dcrdivw(1)	Decreed amount(CFS)
1-5	idvrsww(1)	Switch 0=off 1=on

```
              +n Begin in year n
              -n Stop after year n

        Repeat for the number of well rights
```

4.11 Reservoir Station File (*.res)

The reservoir station file contains information to describe the physical properties of each reservoir in the system. Reservoirs may be operated such that they will not (iressw = 1 or 2) or will (iressw = 3) divert above their target. When a reservoir stores above its target and subsequently releases that water as part of an operating rule, the net result is a paper fill which is charged against the reservoir right's one fill limitation and additional water becomes available downstream of the reservoir. This file is read by subroutine GETRES.

```
Row-data       Variable       Description
________________________________________________________________________

Station Data
1                             Format (a12, a24, a12, i8,f8.0, 1x, a12)
1-1     cresid(1)             Reservoirstation ID
1-2     resnam(i,1)           Reservoir name
1-3     cgoto                 River node where reservoir is located
1-4     iressw(1)             Switch for reservoir;
                              0 off,
                              1 on, Do not adjust for dead storage
                                    Do not store above reservoir targets
                              2 on, Do not store above reservoir targets
                                    Adjust maximum ownership and initial
                                    storage of the last account by the
                                    dead storage volume
                              3 on, Do not adjust for dead storage
                                    Do not store above reservoir target
                                    Charge ability to store above a
                                    reservoir target to the decree
                                    (e.g. paper fill)
1-5     rdate(1)              Date for one fill rule administration
                              +n month for reoperation at the beginning
                              of the month (e.g. 1 = January 1,
                              2 = February 1, etc.)
                              -1 to do not administer the one fill rule.
1-6     cresidy(1)            Daily reservoir ID (not used for monthly model)
                              See Section 7 for a detailed discussion

                              Enter station ID (cresid) if daily data
                              will be provided for this station
                              Monthly data controls
                              Enter another station ID to use the daily
                                    distribution of another but weight values
                                    by the monthly total in the reservoir
                                    target (*.tar) file or reservoir end-
                                    of-month (*.eom) file
```

Monthly data controls
Enter 0 to use the average daily value from
the monthly data in the reservoir
target (*.tar) file or reservoir end-
of-month (*.eom) file
Monthly data controls
Enter 3 to use the daily value from
the daily reservoir target (*.tad) file
or reservoir end-of-day (*.eod) file
Daily data controls
Enter 4 use a daily pattern developed by
Connecting the midpoints of monthly data
Monthly data controls
Enter 5 to use a daily pattern developed by
connecting the end points of monthly data

Physical Data

Row 2		Format (24x, 4f8.0, 4i8)
2-1	volmin(1)	Minimum reservoir content (AF)
2-2	volmax(1)	Maximum reservoir content (AF)
2-3	flomax(1)	Maximum flow downstream of the reservoir (e.g. current stream flow plus the reservoir release (CFS)
2-4	deadst(1)	Dead storage in reservoir (AF)
2-5	nowner(1)	Number of owners
2-6	nevapo(1)	Number of evaporation stations for this reservoir
2-7	nprecp(1)	Number of precipitation stations for this reservoir
2-8	nrange(1)	Number of area capacity values

Owner Data

Row 3		Format (12x, a12, 3f8.0, i8)
3-1	ownnam(1)	Owner name
3-2	ownmax(1)	Maximum storage of owner 1
3-3	curown(1)	Initial storage of owner 1
3-4	pcteva(1)	Switch for evaporation distribution 0 Prorate reservoir evaporation between all accounts proportionally based on their current storage volume n Apply n (%) to this account -1 No evaporation to this account
3-5	n2own(1)	Ownership date used for one fill calculations 1 Ownership is tied to a first fill right(s), 2 Ownership is tied to a second fill right(s)

Repeat for the number of owners (nowner)

Evaporation Data

Row 4		Format (24x,f8.2)
4-1	cevar(1)	Evaporation station ID for this reservoir
4-2	weigev(1)	Percent of this station to use

Repeat for the number of evap stations

```
                              (nevapo)

Precipitation Data
Row 5                         Format (24x,,f8.2)
5-1     cprer(1)              Precipitation station ID
5-2     weigpr(1)             Percent of this station to use

                              Repeat for the number of precipitation stations
(nprecp)

Area Capacity Data
Row 6                         Format (24x,3f8.0)
6-1     conten(i,1)           Content in area capacity table for point 1 (AF)
6-2     surarea(i,1)          Area associated with the content for point 1 (ac)
6-3     seepage(irg,1)        Seepage associated with the content for
                                    point 1 (AF per month)

                              Repeat above for nrange(1) values

                              Repeat rows 1-8 for the number of reservoirs
```

4.12 Reservoir Right File (*.rer)

The reservoir rights file contains data associated with a reservoir's water rights. This file is read by subroutine RIGINP.

```
Row-data       Variable       Description
_____________________________________________________________________

Right Data
                              Format (a12,a24,a12,4x,f12.0,f8.0,4i8,a12)
1-1     cirsid(1)             Reservoir right ID
1-2     namer(1)              Reservoir right name
1-3     cgoto                 Reservoir station ID associated with this right
1-3     rtem(1)               Administration number
1-4     dcrres(1)             Decreed amount (AF)
1-5     irsrsw(1)             Switch
                                    0=off
                                    1=on
                                    +n Begin in year n
                                    -n Stop after year n
1-7     iresco(2,1)           Switch for account distribution
                                    +n Account to be served by this right
                                    0 Fill all accounts based on their
                                          ratio of their ownership ration
                                    -n Fill the first n accounts based on
                                          the ratio of their ownership
1-8     ityrsr(1)             Reservoir right type;
                                    1 Standard
                                    -1 Out Of Priority water right
1-9     n2fill(1)             Reservoir right type
                                    1 First fill,
```

```
                                       2 Second fill
1-10    copid(1)                 Associated Out-of-priority operational right
                                       (include only for Out Of Priority water rights
                                       (ityrsr = -1)

                                 Repeat for the number of reservoir rights
```

4.13 Operational Right File (*.opr)

The operational file describes unique or complex operations within the basin. Operating rules simulate these operations using the source, destination, priority, rule type and other parameters included in each rule. Use of the terms “operational rights” and “operating rules” are used interchangeably herein. This file is read by subroutine OPRINP. As the data and information associated with this file varies based on the type of operational right selected, the input descriptions is repeated for each operating rule.

Comments, indicated by a # in column 1 may be provided at any location in this file. It is recommended that a ‘#’ sign be used specifically in the operating rule file to provide additional comments (as this file is not created using a DMI) and to turn off all lines associated with operating rules not used in a given scenario. In addition to any comments, it is recommended the following string be provided near the top of the file before any data #FileFormatVersion 2 to indicate the format used in the file. If the format version indicator is not provided StateMod will try to read the file and try to determine the appropriate file type. Beginning with version 12.0 an operating rule file format was adopted that includes six additional variables associated with water reuse, diversion type, etc. For a description of the old (*.par file) format, which StateMod still supports, see Section 9.0 Discontinued by Supported File Formats.

The following are noted:

- StateMod operating rules represent water being diverted or transferred from a Source to a Destination with a particular Delivery Method. Identification of these elements is necessary to select the appropriate operating rule for each situation.

- Sources can be the River (for direct flow and storage rights – see Sections 4.6 and 4.12), Ground Water (for well rights – see Section 4.10), a Reservoir (see Section 4.11) or a Plan structure (see Section 3.9).

- Destinations can be diversion structures, reservoirs, instream flows, or plan structures

- StateMod operating rules deliver water to meet demands via the river or through a carrier. Water delivered by the river is self explanatory. For example, a reservoir release to the river that is later diverted or exchanged from the river by ditch. StateMod considers the delivery method to be a carrier when water is delivered from one structure by another structure without being released to the river. For example, the delivery from an off-channel reservoir to an irrigation demand directly located below the reservoir. All carriers such as canals, ditches, laterals, pipelines, tunnels, etc are treated as diversion structures.

Delivery Method Relative to the Source

Delivery Method	**Description**
River	Release to the river then divert directly or by exchange
Carrier	Release to a carrier. Water is transported to a user by a canal, it is not released to the stream system.
Bookover	Transfer from one reservoir account to another account or another reservoir (water is not physically moved)
Alternate_Point	Divert at a different location than the water right
Out_Of_Priority	Out of Priority

- Destinations can be diversion structures, reservoirs, instream flows, or plan structures

- A total of 11 generic operating rule types were originally sufficient for development of all of the western slope planning models. Development of the Rio Grande planning model required eight new rule types. One more rule type was added to support revisions to the San Juan model. Two more rule types were added when representation of the Blue River decree operations was added to the Colorado model. Recently, in preparation for the South Platte planning model, 27 new rule types have been added to the StateMod executable, bringing the total to 50 operating rule types.

- The original 11 operating rule types typically addressed a single Source, multiple Destination types, and a single Delivery Method. Pursuant to the continuing development of the model there is some redundancy with the original operating rule types and a subsequent one that provides the same functionality but has more flexibility. For example, the Carrier without Loss rule (type 11) can be replaced with the Carrier with Loss rule (type 45) by simply setting the carrier loss to zero.

- There are two ways to set the beginning and ending years of operation for an operating rule. Originally the annual on/off switch (*ioprsw(1)*) defined either the starting or ending year of operation for a rule, but this functionality was enhanced by the development of the the start/end date (*IoBeg*, *IoEnd*) fields. It is recommended the start/end dates be used to define the period of operation for the rules.

Descriptions of each operating rule and their associated input variables, are included in Sections 4.13.1 to 4.13.50. Examples of each operating rule are provided in Section 4.13.51.

Figures 1 through 4 are flow charts developed to assist a user to select the appropriate operating rule. Figures 1-3 provide information when the source of water is a Reservoir, Direct Flow Right or a Plan Structure, respectively. Figure 4 provides information for special rules that have been developed for unique circumstances (e.g. Rio Grande compact, South Platte River compact, Augmentation Wells, etc.). These figures can be used by selecting the appropriate figure based on the source of water, and selecting the appropriate subset (Delivery Method, Ownership, Plan Type, Special Rule) that meets a user's needs.

Following are five (5) examples of how to use these figures to select the appropriate operating rule:

Example 1 - Release water from a reservoir (Source) to a direct diversion (Destination) by river exchange (Delivery Method)

- On Figure 1 (Source – Reservoir), follow the arrow titled “Delivery via the River by Exchange”. Continue down that arrow to the arrow titled Destination “Diversion”, resulting in use of type 4 operating rule (see Section 4.13.4).

Example 2 - Diversion of an entire (100%) direct flow right (Source) to an off-channel reservoir (Destination) through a carrier structure (Delivery Method) with or without loss.

- On Figure 2 (Source - Direct Flow Right) , follow the arrow titled “Total (100 percent) Amount of Right” to Destination “Carrier to a Diversion or Reservoir”, resulting in use of type 11 operating rule (see Section 4.13.11). If carrier losses associated with diversions to storage are to be representedthe Destination “Carrier to Reservoir with Loss” would result in use of a Type 45 operating rule (see Section 4.13.45).

Example 3 - Release reusable water stored in a Plan (Source) and Reservoir to meet Terms & Conditions on a neighboring tributary (Destination) via a river exchange (Delivery Method)

- On Figure 3 (Source – Plan Structure) follow the arrow titled “From Reservoir Reuse Plan” to Destination “Terms & Conditions Plan Delivery by Exchange”, resulting in use of type 49 operating rule (explained further below in Section 4.13.49).

Example 4 - Represent the South Platte Compact

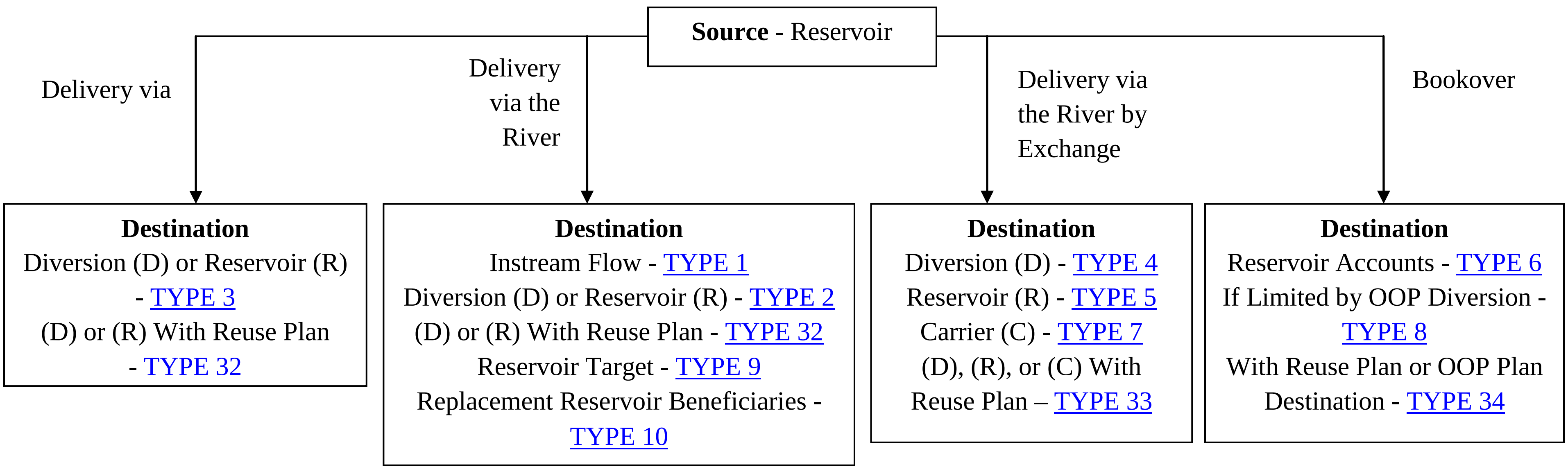
- On Figure 4 (Special Operating Rules) select the box titled “Interstate Compacts” to Destination “South Platte Compact”, resulting in use of type 40 and type 50 operating rules (see Section 4.13.40 and 4.13.50);

Example 5 - Operate an Augmentation Well

- On Figure 4 (Special Operating Rules) select the box titled “Source – Ground Water”to Augmentation Well, resulting in use of type 37 operating rule (explained further below in Section 4.13.49).

STATEMOD OPERATING RULES DECISION TREE

Figure 1: Operating Rule Types, Source = Reservoir



STATEMOD OPERATING RULES DECISION TREE

Figure 2: Operating Rule Types, Source = Direct Flow Right

Source – Direct Flow Right

Total (100%) Amount of Right →

Destination

Carrier (C) to Diversion or Reservoir - TYPE 11
(C) With Loss - TYPE 45
(C) Constrained by Source Ditch Demand - TYPE 14
Diversion or Reservoir by Exchange from Source Structure With Reuse - TYPE 31
Alternate Point of Diversion - TYPE 39

Diversion of Direct Flow Right
- Direct Delivery - TYPE 24
- Delivery by Exchange - TYPE 25

Pro-Rata Percentage of Diversion Amount or Depletion Amount of Right →

Destination

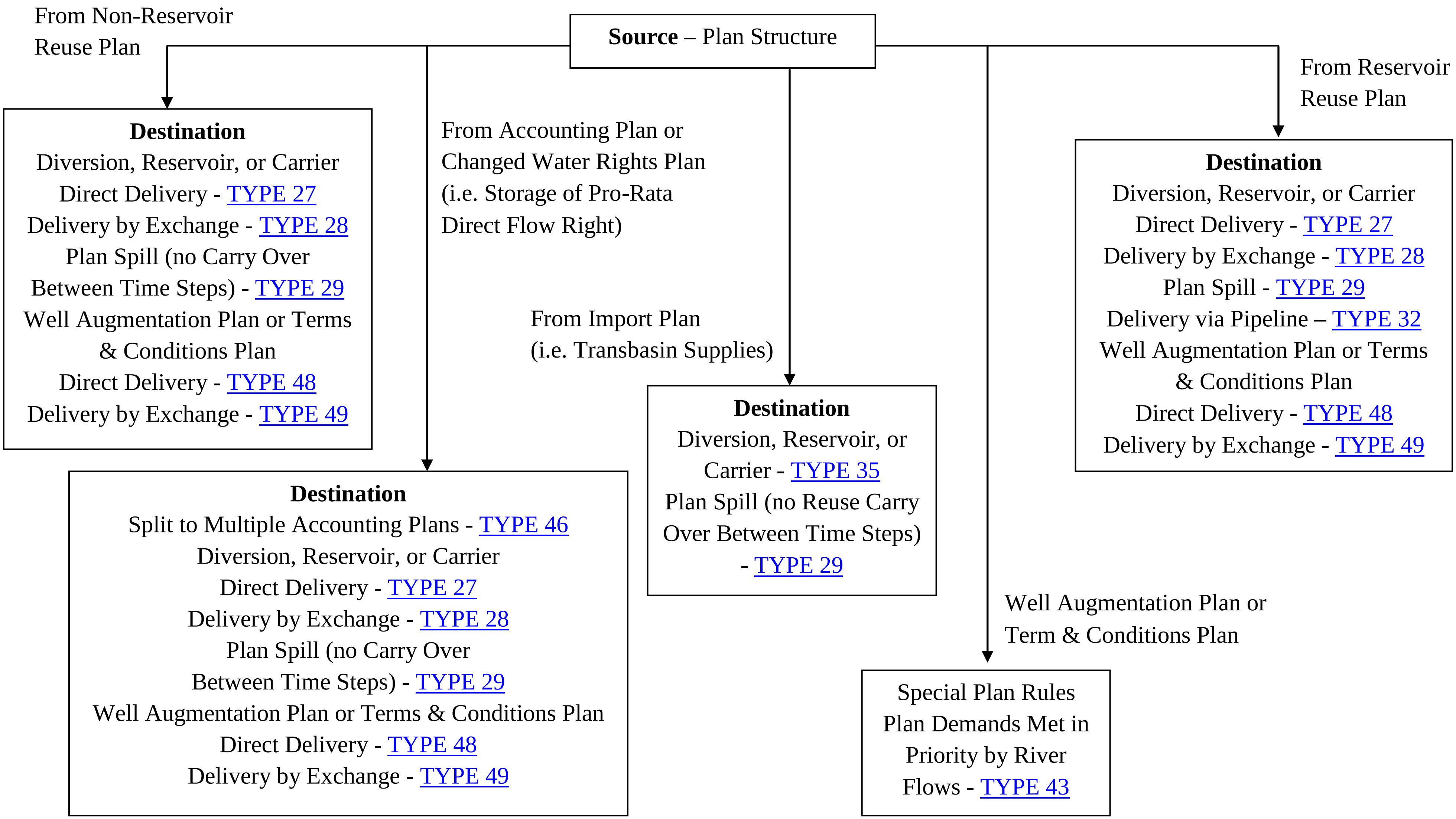
Instream Flow (Interruptible Supply) - TYPE 15

Diversion of Changed Water Right into Changed Water Right Plan - TYPE 26

Reservoir With No Other Use of Direct Flow Right (Diversion Only, Not Depletion) - TYPE 16

STATEMOD OPERATING RULES DECISION TREE

Figure 3: Operating Rule Types, Source = Plan Structure



STATEMOD OPERATING RULES DECISION TREE

Figure 4: Special Operating Rule Types

Interstate Compacts
La Plata Compact (Index Flow) - TYPE 13
Rio Grande Compact Deliveries - TYPE 17
Conejos River Compact Deliveries - TYPE 18
South Platte Compact - TYPE 40 and TYPE 50

Soil Moisture
Soil Moisture Use Senior to Surface and/or Ground Water Right – TYPE 22

Other
Reoperation (Increase Speed of Simulation) - TYPE 12
Downstream Call Function (Used for Modeling a Portion of a River System) - TYPE 23

Storage Operations
OOP Diversion (Upstream Storage Statute) - TYPE 38 operated with OOP Bookover – TYPE 8

Storage with Special Limits (e.g., Green Mountain 1955 Exchange Limited by Dillon and Colorado Springs OOP Diversion and Storage Plan) – TYPE 41
Administrative Plan Limit (HUP Releases, Colorado Springs Operations) – TYPE 47
Plan Reset – TYPE 42

Source – Ground Water
Augmentation Well - TYPE 37
Recharge Well – TYPE 44

Item	Destination or Diverting Structure	Source or Replacement Structure	Operational Activity
4.13.1	Instream Flow	Reservoir	Reservoir to Instream Flow Delivery by the River
4.13.2	Direct Flow or Reservoir	Reservoir	Reservoir to a Direct Flow or reservoir or carrier Delivery by the river or carrier
4.13.3	Direct Flow or Reservoir	Reservoir	Reservoir to a Carrier Delivery by a carrier
4.13.4	Direct Flow	Reservoir	Reservoir Exchange to a Direct Flow Delivery by the river
4.13.5	Reservoir	Reservoir	Reservoir Exchange to Storage Delivery by the river
4.13.6	Reservoir	Reservoir	Bookover transfer between reservoir accounts
4.13.7	Diversion or Reservoir	Reservoir	Reservoir to a Carrier by Exchange Delivery by the river
4.13.8	Reservoir or Plan	Reservoir or Plan	Out-of-Priority Bookover Bookover of an Out-of-Priority diversion
4.13.9	NA	Reservoir	Release for target contents Delivery by the river
4.13.10	Direct Flow	Reservoir	General Reservoir Replacement By direct release or exchange Delivery by the river
4.13.11	Direct Flow or Reservoir	Water Right	Carrier Right to a ditch or reservoir Delivery by a carrier
4.13.12	NA	NA	Reoperation Reoperate water rights
4.13.13	Instream Flow	Stream Gage	Index flow constraint on an instream flow diversion Note La Plata Compact uses this Operating Rule
4.13.14	Direct Flow or Reservoir	Direct Flow	Carrier Right with Constrained Demand Carrier constrained by the demand At both the destination and source Delivery by the river

4.13.15	Instream Flow	Water Right	Interruptible supply Based on a natural flow estimate Transfer a direct diversion water Right to an instream flow
4.13.16	Direct Flow	Water Right	Direct Flow Storage Allow the unused portion of a direct flow decree to be stored in a reservoir
4.13.17	Direct Flow	Index Station	Rio Grande Compact - Rio Grande portion
4.13.18	Direct Flow	Index Station	Rio Grande Compact – Conejos River portion
4.13.19	Direct Flow	River	Split Channel Operations
4.13.20	NA	Reservoir	San Juan Reservoir RIP Operation
4.13.21	Well	NA	Wells with Sprinkler Use
4.13.22	Direct Flow and Well	NA	Soil Moisture Use
4.13.23	Downstream Call	River	Downstream Call Operate a downstream call
4.13.24	Direct Flow or Reservoir or Plan	Water Right	Direct Flow Exchange Supply a direct flow or reservoir or plan by exchange of a water right From river or carrier
4.13.25	Direct Flow or Reservoir or Plan	Water Right	Direct Flow Bypass Supply a direct flow or reservoir or Plan by a bypass of a water right From river or carrier
4.13.26	Changed Water Right Plan	Water Right	Transfer a direct flow water water right to an administrative plan
4.13.27	Diversion or Reservoir	Reservoir or Reuse Plan	Reservoir or ReUse Plan to a Diversion or Reservoir Direct with or without destination reuse Supply a diversion or Reservoir from a Reservoir or Reuse Plan directly from the river or a carrier

4.13.28	Diversion or Reservoir	Reservoir or ReUse Plan	Reservoir or ReUse Plan to a Diversion or Reservoir by exchange with or without destination reuse Supply a diversion or reservoir from a reservoir or plan by exchange by Exchange from the river or a carrier
4.13.29	NA	Plan	Plan Spill Release water from a plan delivery by the river Source water location is destination when Changed Water Rights Plan is source
4.13.30	Reservoir	Operating Rule	Reservoir Rediversion Redivert water released by another operating rule for a T&C plan
4.13.31	Direct Flow or Reservoir	Water Right	Carrier Right with Reuse
4.13.32	Direct Flow or Reservoir or Carrier	Reservoir & Reservoir Reuse Plan	Plan Reservoir and Plan to a direct flow or reservoir or carrier direct with or without destination reuse Delivery by the river or carrier
4.13.33	Direct Flow or Reservoir or Carrier	Reservoir & Reservoir Reuse Plan	Plan to a Direct Flow or reservoir or carrier by exchange with or without destination reuse Delivery by the river or carrier
4.13.34	Reservoir	Reservoir (bookover)	Bookover with Reuse with Reuse
4.13.35	Import Diversion	Acct.Plan	Import to an Accounting Plan Delivery by the river
4.13.36	Direct Flow	Water Right	Seasonal (daily) Water Right (e.g. Meadow Rights)
4.13.37	Plan	Well Water Right	Augmentation Well Pump an augmentation well to satisfy a T&C or Well Augmentation plan requirement
4.13.38	Direct Flow or Reservoir or	Water Right	Out-of-Priority Diversion Divert out-of-priority to

	Carrier		a reservoir or a diversion with Respect to a senior reservoir right. Addresses the upstream storage statute.
4.13.39	Well or Diversion	Water Right	Alternate Point Pump or divert using an alternate Point of diversion
4.13.40	Diversion or Instream Flow	River	South Platte Compact Release Works in conjunction with a type 50 operating rule to 1) release Water to a user that is water short and located upstream of the Washington county line (e.g not in Water District 64) or 2) to the South Platte compact itself.
4.13.41	Reservoir	Water Right	Storage with Special Limits Limit reservoir storage by the amount diverted by one or more Out-of-Priority Plans
4.13.42	NA	Plan	Plan Reset
4.13.43	Well Augmentation Plan	River	In-Priority Supply Determine if well depletions from pumping in a prior time step or terms and conditions accounted for in a Plan structure are in priority
4.13.44	Recharge Reservoir	Well Water Right	Recharge Well Pump a recharge well to a Recharge Reservoir
4.13.45	Direct Flow or Reservoir	Water Right	Carrier Right with Loss to a ditch or reservoir Delivery by a carrier
4.13.46	Admin Plan	Admin Plan	Multiple Ownership
4.13.47	NA	Rel. Limit Plan	Monthly/Annual Plan Limits
4.13.48	Direct Flow or Reservoir or Carrier	Reservoir or Plan	Reservoir or Plan to Plan Direct
4.13.49	Plan or Reservoir Reuse	Plan	Reservoir or Plan to Plan Exchange

```
4.13.50  Plan           River       South Platte Compact Storage
                                    Works in conjunction with a type
                                    40 operating rule to allow
                                    water to be diverted in priority to
                                    a plan that represents the South
                                    Platte compact
```

4.13.1 Reservoir Release to an Instream Flow (ityopr=1)

The type 1 operating rule provides a method to release water to an instream flow via the river.

```
Row-data        Variable        Description
_______________________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)       Operational right ID
1-2            nameo(1)        Operational right name
1-3            rtem(1)         Administration number
1-4            dumx            Monthly Switch
                                  0 No monthly on/off values
                                  12 Number of monthly on/off
                                  Switches provided
1-5            ioprsw(1)       Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n Begin in year n
                                  -n Stop after year n

Destination Data
1-6            ciopde          Destination instream structure
1-7            iopdes(2,1)          Destination instream account (typically 1)

Supply Data
1-8            ciopso(1)       Supply reservoir ID
1-9            iopsou(2,1)     Supply reservoir account
1-10           ciopso(2)       0
1-11           iopsou(4,1)     0

Type Data
1-12           ityopr(1)       1

Associated Plan Data
1-13           creuse          NA

Diversion Type
1-14           cdivtyp         NA

Conveyance Loss (%)
1-15           OprLoss         0

Miscellaneous Limits
1-16           OprLimit        0
```

```
Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

4.13.2 Reservoir Release to a Diversion or Reservoir or Carrier (ityopr=2)

The type 2 operating rule provides a method to release water to a reservoir, direct flow structure or a carrier via the river. In addition, it can be used to constrain a diversion to the capacity of up to 10 intervening structures or carriers. Note a diversion is implicitly constrained by the capacity of the destination structure (variable ciopde, row-data 1-6).

```
Row-data     Variable         Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x, 2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operation right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Intervening Structure
                              Switch
                              +n Number of intervening structures
                                 (max = 10)
                              -n Include -12 monthly on/off
                                 values minus n intervening
                                 structures.
                              Note, when a negative value is,
                              provided, it should be -13 or less
                              for 12 monthly values and 1
                              intervening structure)
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n


Destination Data
1-6            ciopde         Destination diversion ID or reservoir ID
1-7            iopdes(2,1)    Destination structure account
                                    For a diversion destination, enter 1
```

```
                                    For a reservoir destination, enter
                                    +n Account served by this right
                                    -n Fill first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8            ciopso(1)      Supply reservoir ID
1-9            iopsou(2,1)    Supply reservoir account
1-10           ciopso(2)      0
1-11           iopsou(4,1)    0 = provide 100% replacement
                              -1 = provide depletion replacement
Type Data
1-12           ityopr(1)      2

Associated Plan Data
1-13           creuse            NA

Diversion Type
1-14           divtyp            NA

Conveyance Loss (%)
1-15           OprLoss           0

Miscellaneous Limits
1-16           OprLimit          0

Start Date
1-17           IoBeg             First year of operation

End Date
1-18           IoEnd             Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                    +n Day first used that month
                                    -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data
Include only if the variable (dumx) = 1-10 or < -12 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                                 For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.3 Reservoir Release to a Diversion or Reservoir by a carrier (ityopr=3)

The type 3 operating rule provides a method to release water to a reservoir or direct flow structure by a conduit (e.g. a pipeline or canal that flows directly from a reservoir to a user) rather than the river. In addition, it can be used to constrain a diversion to the capacity of up to 10 intervening structures or carriers. Note a diversion is implicitly constrained by the capacity of the destination structure (variable ciopde, row-data 1-6).

```
Row-data         Variable        Description
_____________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Structure Switch
                                 +n Number of intervening structures
                                 (max = 10)
                                 -n Include 12 monthly on/off values
                                    minus n intervening structures
                                    Note, when a negative value is,
                                    provided, it should be -13 or less)
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Destination diversion ID or destination
                                 reservoir ID
1-7            iopdes(2,1)    Destination structure account
                              For a diversion destination, enter 1
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8            ciopso(1)      Supply reservoir ID
1-9            iopsou(2,1)    Supply reservoir account
1-10           ciopso(2)      0
1-11           iopsou(4,1)    0 = provide 100% replacement
                              -1 = provide depletion replacement

Type Data
1-12           ityopr(1)      3

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        Diversion

Conveyance Loss (%)
1-15           OprLoss        0
```

```
Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data
Include only if the variable (dumx) = 1-10 or < -12 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.4 Reservoir Release to a Diversion by Exchange with the River (ityopr=4)

The type 4 operating rule provides a method to allow a direct flow diversion to occur via a reservoir exchange. In general, an exchange is required whenever a reservoir cannot serve a direct flow diversion or reservoir directly. When the destination variable ciopde (row-data = 1-6) is a structure ID, the exchange is not constrained by the structures water right. When the destination variable ciopde (row-data = 1-6) is a water right, the exchange is limited to its decreed amount less any diversions that have been charged to that right. For a direct diversion the limit is constrained to diversions that have occurred in the current time step. For a reservoir, the limit is constrained by storage that has occurred over the administrative season. The type 4 operating rule implicitly limits the exchange amount to ensure no senior, intervening water rights are impacted. Intervening rights are those water rights that occur between the diversion and a point downstream where the releasing reservoir's water is available.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Switch
                                 0 No monthly on/off values
                                 12 Number of monthly on/off switches provided
```

```
1-5             ioprsw(1)      Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n Begin in year n
                                  -n Stop after year n

Destination Data
1-6             ciopde         Destination structure ID or water right
1-7             iopdes(2,1)    Destination structure account, enter 1 for a
                               diversion

Supply Data
1-8             ciopso(1)      Supply reservoir ID
1-9             iopsou(2,1)    Supply reservoir account
1-10            ciopso(2)      0
1-11            iopsou(4,1)    0 = provide 100% replacement
                               -1 = provide depletion replacement

Type Data
1-12            ityopr(1)      4

Associated Plan Data
1-13            creuse         NA

Diversion Type
1-14            cdivtyp        NA

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0

Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.5 Reservoir Storage by Exchange (ityopr=5)

The type 5 operating rule allows a reservoir to store water by an exchange with another reservoir. When the destination reservoir variable ciopde (row-data = 1-6) is a reservoir ID, the exchange is not constrained by the reservoir’s water rights. When the variable ciopde (row-data = 1-6) is a water right, the exchange is limited to the water right specified less any diversions that have been charged to that right during the administrative season.

```
Row-data        Variable        Description

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly Switch
                                   0 No monthly on/off values
                                   12 Number of monthly on/off switches provided
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n Begin in year n
                                   -n Stop after year n

Destination Data
1-6             ciopde          Destination reservoir ID or water right
1-7             iopdes(2,1)     Destination structure account
                                For a reservoir destination, enter
                                   +n Account to be served by this right
                                   -n Fill the first n accounts based on
                                      the ratio of their ownership

Supply Data
1-8             ciopso(1)       Supply reservoir ID
1-9             iopsou(2,1)     Supply reservoir account
1-10            ciopso(2)       0
1-11            iopsou(4,1)     0

1-12            ityopr(1)       5

Associated Plan Data
1-13            creuse          NA

Diversion Type
1-14            cdivtyp         NA

Conveyance Loss (%)
1-15            OprLoss         0

Miscellaneous Limits
1-16            OprLimit        0

Start Date
1-17            IoBeg           First year of operation First year of operation

End Date
1-18            IoEnd           Last year of operation Last year of operation
```

```
Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the
                                 first month specified in the control file
```

4.13.6 Reservoir to Reservoir Transfer (Bookover) (ityopr=6)

The type 6 operating rule allows a reservoir to reservoir bookover to occur. It is commonly used to transfer water from one reservoir storage account to another in a particular month. In addition, the amount booked over may be constrained by a diversion demand or the amount diverted by another operating rule.

The following are noted:

- If variable iopsou(2,1) is set to a diversion structure, variable iopsou(4) is set to 99 and variable oprlimit is set to 0, the book over can be limited by the demand specified in the direct diversion demand file (*.ddm).

- If variable iopsou(2,1) is set to a operating rule, variable iopsou(4) is set to 0, and variable oprlimit is set to 0, the book over can be limited by the amount divered by another operating rule.

- If variable iopsou(2,1) is set to a operating rule, iopsou(4) is set to 0 and oprlimit is set to 1, the bookover can be limited to not occur after the operating rule iopsou(2,1) operates. This capability was added for several reservoirs located in the San Juan Basin where water needs to get booked from several accounts in a reservoir to an account in that same reservoir then booked back from that account in order to reallocate total reservoir storage to each individual account at the beginning of the reservoir's administration year.

A Bookover is reported in the reservoir report (*.xre) as follows:

- When a Type 6 Bookover operating rule is used to book water from one reservoir account to another without making a release to the river, the reservoir report (*.xwb) for the total reservoir (account 0) and the account where the water was booked shows the water under the column 7, "From Carrier by Other". In addition, the reservoir report (*.xwb) for the individual account along with the operating rule reporting (*.xop) reflect the actual amount diverted.

- When a Type 6 Bookover operating rule is used to book water from one account to another and then back at the same reservoir, the reservoir report (*.xwb) for the total reservoir (account 0) shows the water moving twice (once out and once back in) under the column 7, "From Carrier by Other". However, the reservoir report (*.xwb) for the individual accounts along with the operating rule reporting (*.xop) reflect the actual amount diverted.

- See Section 7 for additional discussion on modeling reservoir operations, including bookovers.

Row-data	Variable	Description
Control Data		
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12, 1x,a12,1x, 2f8.0, 2i8)		
1-1	cidvri(1)	Operational right ID
1-2	nameo(1)	Operational right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly and Structure Switch 0 No monthly on/off values 12 Number of monthly on/off switches provided
1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n Begin in year n n Stop after year n
Destination Data		
1-6	ciopde	Destination reservoir ID
1-7	iopdes(2,1)	Destination structure account For a reservoir destination, enter +n Account served by this right -n Fill the first n accounts based On the ratio of their ownership
Supply Data		
1-8	ciopso(1)	Supply reservoir ID
1-9	iopsou(2,1)	Supply reservoir account
1-10	ciopso(2)	If not required enter 0 If limited by the amount diverted under an operating rule, enter the operating rule ID If limited by a diversion demand amount enter the diversion structure ID
1-11	iopsou(4,1)	0 if ciopso(2) is 0 or an operating rule ID 99 if ciopso(2) is a diversion structure ID
Type Data		
1-12	ityopr(1)	6
Associated Plan Data		
1-13	creuse	NA
Diversion Type		
1-14	cdivtyp	NA
Conveyance Loss (%)		
1-15	OprLoss	0

```
Miscellaneous Limits
1-16            OprLimit       0 if ciopso(2) is 0
                               1 if ciopso(2) is a operating rule and
                                  The user wants this (cidvri(1))
                                  operating rule to not operate after
                                  the the operating rule specified
                                  by ciopso(2) operates.  (See above
                                  for additional discussion of this
                                  capability.

Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.7 Diversion by a Carrier by Exchange (ityopr=7)

The type 7 operating rule provides a method to allow a diversion by a carrier via a reservoir exchange. In general, an exchange is required whenever a reservoir cannot serve a demand directly. This operating rule implicitly limits the exchange amount to ensure no senior, intervening water rights are impacted. Intervening rights are those water rights that occur between the storing reservoir and a point downstream where the releasing reservoir's water is available.

```
Row-data        Variable       Description
______________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri(1)      Operational right ID
1-2             nameo(1)       Operational right name
1-3             rtem(1)        Administration number
1-4             dumx           Monthly Switch
                                  0 No monthly on/off values
                                  12 Number of monthly on/off switches provided
1-5             ioprsw(1)      Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n Begin in year n
                                  -n Stop after year n
Destination Data
1-6             ciopde         Destination - Operational Right ID of the Carrier
1-7             iopdes(2,1)    Destination account
```

```
                              For a diversion destination, enter 1
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8            ciopso(1)      Supply reservoir ID
1-9            iopsou(2,1)    Supply reservoir account
1-10           ciopso(2)      0
1-11           iopsou(4,1)
                              See Section 7 for a discussion of the
                              Reservoir demand options.
                                 0 = reservoir demand is not adjusted
                                 +n = Reservoir demand is limited to not
                                    exceed CIR/n; where n (%) is the efficiency
                                    of reservoir water use. Note n (%) is
                                    limited to not exceed the max system
                                    efficiency. Also a +n requires the variable
                                    efficiency option (ieffmax) from control
                                    file be on.

Type Data
1-12           ityopr(1)      7

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation
End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file


Intervening Structure Data
```

```
Include only if the variable (dumx) = 1-10 or < -12 1-10 or < -12
Format (36x, 10a12)
3-1           intern(1,1)    For +dumx, Enter dumx intervening
                                structure ID's
                             For -dumx, Enter abs(dumx)-12
                                intervening structure ID's
```

4.13.8 Out-Of-Priority Reservoir Bookover (ityopr=8)

The type 8 operating rule works in concert with an out-of-priority diversion (type 38) to book water

1. From an out-of-priority reservoir account to another reservoir account or

2. From an out-of-priority (OOP) plan to reduce its obligation.

This rule was significantly enhanced in order to address 1. Out out-of-priority diversions in addition to out-of-priority storage and 2. Out-of-priority storage and diversions occurring at more than one reservoir and diversion with regard to the same subordinated reservoir.

When the destination is a reservoir the out-of-priority diversion is typically kept in a separate account of the junior reservoir (e.g. an OOP account). Also an out-of-priority plan is used to track the amount taken. If the volume of water stored in the OOP plan exceeds the remaining capacity of the subordinated reservoir right, the Type 8 rule books water from the out-of-priority account to another general purpose account within the junior reservoir and the OOP plan obligation is reduced. To perform this activity the operating rule "associated" with the OOP diversion or storage being booked over must be known to the type 8 operating rule. If the subordinated reservoir right does not fill then a type 27 operating rule is typically used to transfer the water from the out-of-priority reservoir to the subordinated reservoir and adjust the obligation stored in the OOP Plan.

When the destination is an OOP Plan the out-of-priority diversion is stored under the OOP Plan. Once the volume of water stored in the OOP plan exceeds the remaining capacity of the subordinated reservoir right, the obligation stored in the OOP plan is reduced. To perform this activity the operating rule "associated" with the OOP diversion or storage being booked over must be known to the type 8 operating rule. If the subordinated reservoir right does not fill then a type 27 operating rule is typically used to transfer the water from a reservoir to the subordinated reservoir and adjust the obligation stored in the OOP Plan.

The following are noted:

- The variable ciopso(2) (row-data 1-10) is used to identify the senior decree that is being subordinated.
- The variable intern(n,1) (rule n, value 1) is used to identify the junior decree that will be credited withdiverting water out of priority when booked over.
- The variables intern(n,2) (rule n, value 2) through intern(n,10) (rule n, value 10) are used to identify up to 9 operating rules associated with this OOP plan.
- If the destination is a reservoir all OOP diversions are charged against the junior reservoir's water right when they are booked over to an account where they can be released.

- If the subordinated water right is not filled, the water stored out of priority is released to the subordinated reservoir at the end of the administration year assigned to each reservoir (see variable rdate in a reservoir station file (*.res)).
- The type 8 operating rule has generic applications but was originally developed to handle the Blue River decree that allows OOP storage of water in Dillon Reservoir (an upstream junior reservoir), OOP storage of water in Blue Lake (an upstream reservoir), OOP diversion to Roberts Tunnel (an upstream junior diversion), and an OOP diversion to the Con Hoosier system before Green Mountain Reservoir (a downstream senior) is filled. See Section 7 for additional description of the Blue River Decree implementation to the Colorado River Basin.

```
Row-data          Variable          Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                  1x,a12,1x, 2f8.0, 2i8)
1-1               cidvri(1)         Operational right ID
1-2               nameo(1)          Operational right name
1-3               rtem(1)           Administration number
1-4               dumx              Monthly switch
                                    Enter 2 if no on/off switches are provided
                                       e.g. one for an associated Water Right and
                                       one for an associated operating Rule
                                    Enter -14 if on/off switches are provided
                                       e.g. twelve on/off switches,
                                       one for an associated Water Right and
                                       one for an associated operating Rule
1-5               ioprsw(1)         Annual On/Off Switch
                                       0=off
                                       1=on
                                       +n Begin in year n
                                       -n Stop after year n

Destination Data
1-6               ciopde            Destination reservoir ID or Plan ID
1-7               iopdes(2,1)       Destination structure account
                                    For a reservoir destination, enter
                                       +n Account to be served by this right
                                       -n Fill the first n accounts based on
                                          the ratio of their ownership

Supply Data
1-8               ciopso(1)         If the destination is a reservoir enter
                                       the supply reservoir ID (same as the
                                       destination ID)
                                    If the destination is a Plan enter NA
1-9               iopsou(2,1)       If the destination is a reservoir enter
                                       the supply reservoir account
                                    If the destination is a Plan enter NA
1-10              ciopso(2)         Supply (subordinated) water right ID
1-11              iopsou(4,1)       0
```

```
Type Data
1-12           ityopr(1)      8

Associated Plan Data
1-13           creuse         Out-of-Priority Plan ID

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Destination Water Right or Associated Reservoirs
Include only if the variable (dumx) = +n or < -12
3                             Format (36x, 10a12)
3-1            intern(1,1)    The destination water right ID
                                 (the one storing Out-of-Priority)
3-2            intern(1,2)    The OOP operational right associated
                                 with this bookover
                              Note must be provided in the *.opr
                                 file before the bookover right
```

4.13.9 Reservoir Target (ityopr=9)

The type 9 operating rule allows reservoir releases to be made from a reservoir to satisfy a target reservoir content specified in the *.tar file. This operating rule is commonly applied to simulate flood control operations where forecast data is are unavailable. In addition, it may be used to simulate hydropower operations when a hydropower demand cannot be specified by other means.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
```

1-2	nameo(1)	Operational right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly Switch 0 No monthly on/off values 12 Number of monthly on/off switches provided
1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n Begin in year n -n Stop after year n
Destination Data		
1-6	ciopde	NA
1-7	iopdes(2,1)	0
Source Data		
1-8	ciopso(1)	Reservoir ID
1-9	iopsou(2,1)	Reservoir account; Enter 0 to meet target levels by releasing from each account by the proportionate amount currently in each
1-10	ciopso(2)	0
1-11	iopsou(4,1)	0
Type Data		
1-12	ityopr(1)	9
Associated Plan Data		
1-13	creuse	NA
Diversion Type		
1-14	cdivtyp	NA
Conveyance Loss (%)		
1-15	OprLoss	0
Miscellaneous Limits		
1-16	OprLimit	0
Start Date		
1-17	IoBeg	First year of operation
End Date		
1-18	IoEnd	Last year of operation
Monthly Data		
Include only if the variable (dumx) = 12		
2		Free Format
2-1	Imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

4.13.10 General Replacement Reservoir to a Diversion by a Direct Release or Exchange (ityopr=10)

The type 10 operating rule provides a method to supply reservoir water to a large number of structures without supplying individual operating rules for each. The following are noted:

- The operating rule checks whether reservoir replacement water will be supplied to a diversion by a direct reservoir release or exchange.
- The operating rule serves all water rights which are senior to its Administration number which have variable "ireptyp" of the Direct Diversion Station File (*.dds) set to 1 or -1.
- The variable “ireptyp” specified by structure in the diversion station (*.dds) file specifies if replacement releases are to be made for the full diversion (ireptyp=1) or depletion (ireptyp=-1) or not at all (ireptyp=0).
- When more than one replacement reservoir is specified, they are sorted by Administration number and operate by priority, most senior first.
- The replacement reservoir operating rule applies to direct flow structures only, therefore carrier systems must be tied to a replacement reservoir directly. The following are is noted:
- The replacement reservoir operating rule has generic applications but was originally developed to handle the replacement reservoir obligations of Green Mountain Reservoir in the Colorado River Basin.
- When a replacement reservoir operating rule is included in a simulation and the release from a replacement reservoir is non-zero, additional information associated with the replacement reservoir operation is provided in the replacement reservoir summary (*.xrp).

```
Row-data        Variable        Description
_______________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operation right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly Switch
                                   0 No monthly on/off values
                                   12 Number of monthly on/off switches
                                provided
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on

Destination Data
1-6             ciopde          0
1-7             iopdes(2,1)     0

Source Data
1-8             ciopso(1)       Supply reservoir ID
1-9             iopsou(2,1)     Supply reservoir account
1-10            ciopso(2)       NA
```

```
1-11           iopsou(4,1)    0 (not used)

Type Data
1-12           ityopr(1)      10

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0 Do not adjust Monthly or Annual
                                 Operational limits
                              1 Operating Rule ID specified in row 3
                                 for which monthly and Annual limits
                                 will be INCREASED by the amount released
                              2 Operating Rule ID specified in row 3
                                 for which monthly and Annual limits
                                 will LIMIT the amount released

Start Date
1-17           IoBeg          First year the operating rule is on

End Date
1-18           IoEnd          Last year the operating rule is on

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Monthly and Annual Limitation Data
Include only if the switch (OprLimit > 0)
Format (36x, 10a12)
3-1            cx             If OprLimit=1, Operating Rule ID
                                 for which monthly and Annual limits
                                 will be INCREASED by the Amount released.
                              If OprLimit=2, Operating Rule ID
                                 for which monthly and Annual limits
                                 will LIMIT the Amount released
```

4.13.11 Carrier Right to a Ditch or Reservoir (ityopr=11)

The type 11 operating rule provides a method to divert water to a reservoir or direct flow structure using another structure's water rights. In addition, it can be used to constrain a diversion to the capacity of up to 10 intervening structures.The following are noted:

- A diversion is implicitly constrained by the capacity of the destination structure (variable ciopde).
- The source water right may operate as a standard direct flow right and/or as a carrier. When the variable iopsou(2,1) = 1 the right is used as a carrier only. When the variable iopsou(2,1) = 0 the right is used as both a direct flow right and a carrier right.
- If the source is a diversion right, the administration number used for the operating rule is the priority of the diversion right, not the priority assigned to the operating rule.
- If several operating rules use the same water right, diversions are not allowed to exceed the decreed capacity.
- If the destination is a diversion, the demand is the destination structure's demand. Any return flows use the return flow pattern and locations assigned to the destination structure in the diversion station file (*.dds).
- If the destination is a reservoir, the operating rule demand is the destination reservoir's capacity.
- If the destination is a reservoir and the source is a diversion right, the operating rule diversion IS NOT CHARGED against the reservoir's decree.
- If the destination is a reservoir and the source is a reservoir right, the operating rule diversion IS CHARGED against the reservoir's decree.
- If carrier losses are to be included use a type 45 operating rule.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number. Note if
                                   ciopso(1) is a diversion right,
                                   its administration number is
                                   used and rtem is ignored
1-4             dumx            Monthly and Structure Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   -n Include -12 for monthly on/off
                                      values minus n intervening
                                      structures
                                      Note, when a negative value is,
                                      provided, it should be -13
                                      or less).
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
```

+n=Begin in year n
-n=Stop after year n

Destination Data

1-6	ciopde	Destination diversion or reservoir ID
1-7	iopdes(2,1)	Destination structure account, 1 for a diversion destination +n for a reservoir destination, +n Account served by this right -n Fill the first n accounts using the ratio of their ownership

Source Data

1-8	ciopso(1)	Water right ID under which the diversion occurs Note may be a diversion right or a reservoir right
1-9	iopsou(2,1)	0 The source water right (ciopso(1)) is left on (i.e. it can be used as a both a direct flow right and this operating rule). 1 The source water right (ciopso2(1) is turned off (i.e. it can only be used by this operating rule)
1-10	ciopso(2)	NA the water right is administered at the location specified in the appropriate water right file +n the water right is administered at location n (e.g. a reservoir right is administered at a the location of a carrier)
1-11	iopsou(4,1)	0 Not used

Type Data

1-12	ityopr(1)	11

Plan Data

1-13	creuse	NA If the carrier loss is not associated with a recharge source +n Enter Recharge Plan ID If the carrier loss is a recharge source. Note the Plan type must be recharge (type 8)

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0 No carrier limitation

```
                              +n Carrier limit (cfs) Note this
                                 value is an additional constraint
                                 that is imposed on a carrier
                                 since the capacity of the diverting
                                 structure and all carriers is an
                                 implicit constraint. This value is
                                 typically used to represent the
                                 maximum diversion rate allowed to
                                 fill a reservoir

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds
                                 to the first month specified in
                                 the control file

Intervening Structure Data
Include only if the variable (dumx) = 1-10 or < -12 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx) - 12
                                 intervening structure ID's
```

4.13.12 Reoperation (ityopr=12)

The type 12 operating rule provides a method to speed up model execution while incurring some level of inaccuracy. It is typically used in coordination with the control file variable ireopx. When the control file variable ireopx is set to 0, all activities that supply new water to the system (reservoir releases, return flows to non downstream tributaries, etc.) automatically cause the model to reoperate with no inaccuracy and this operating rule is not required. When the control file variable ireopx is set to 1, this operating rule initiates reoperation at the Administration number specified. Reoperation, as used herein, restarts the water right allocation procedure from senior to junior in order to allow senior ditches to benefit from any new water that might have been introduced to the system.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri         Operational right ID
```

```
1-2             nameo(1)       Operation right name
1-3             rtem(1)        Administration number
1-4             dumx           0
1-5             ioprsw(1)      Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n=Begin in year n
                                  -n=Stop after year n
1-6             ciopde         0

Destination Data
1-7             iopdes(2,1)    0
1-8             ciopso(1)      0

Supply Data
1-9             iopsou(2,1)    0
1-10            ciopso(2)      0
1-11            iopsou(4,1)    0

Type Data
1-12            ityopr(1)      12

Associated Plan Data
1-13            creuse         NA
Diversion Type
1-14            cdivtyp        NA

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0

Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.13 La Plata Compact (Index Flow) (ityopr=13)

The type 13 operating rule allows an instream flow to operate based on its location on the river and the stream flow at a remote location. This rule has generic applications but was originally developed to handle the La Plata River compact in the San Juan River Basin. This compact, in general, limits Colorado's commitment to deliver water to New Mexico based on the flow at an upstream, index gage. Additional discussion of the La Plata Compact implementation is provided in Section 7.

```
Row-data         Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)       Operational right ID
1-2            nameo(1)        Operational right name
1-3            rtem(1)         Administration number
1-4            dumx            Monthly Switch
                                  0 No monthly on/off values
                                  12 Number of monthly on/off switches provided
1-5            ioprsw(1)       Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n=Begin in year n
                                  -n=Stop after year n
Destination Data
1-6            ciopde          Destination Instream Flow
1-7            iopdes(2,1)     Destination Account, enter 1
Supply Data
1-8            ciopso(1)       River ID of the Index flow station
1-9            iopsou(2,1)     Percent of the Index flow station available
1-10           ciopso(2)       Instream Flow water right
1-11           iopsou(4,1)     1 The source water right (ciopso(2) is turned off)
                                  i.e. it can only be used by this operating rule)

Type Data
1-12           ityopr(1)       13

Associated Plan Data
1-13           creuse          NA

Diversion Type
1-14           cdivtyp         NA

Conveyance Loss (%)
1-15           OprLoss         0

Miscellaneous Limits
1-16           OprLimit        0

Start Date
1-17           IoBeg           First year of operation

End Date
1-18           IoEnd           Last year of operation

Monthly Data
```

```
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.14 Carrier Right with Constrained Demand (ityopr=14)

The type 14 operating rule provides a method to divert water to a reservoir or direct flow structure using another structure's water rights. It is similar to the type 11 operating rule except the amount diverted is constrained by the demand of the structure associated with the source water right. Because it is an extension of the Type 11 operating rule, the amount diverted by a Type 14 rule is constrained by the source water right, carrier capacity, and the demand of the source structure. The following are noted:

- When the variable iopsou(4,1) is equal to 0, the diverting structure's demand is limited to the monthly value read from the direct flow demand (*.ddm) file. When the variable iopsou(4,1) is greater than 1, the diverting structure's demand for the year is limited to the annual value read as variable iopsou(4,1).
- The source water right may operate as a standard direct flow right and/or as a carrier. When the variable iopsou(2,1) = 1 is the right is used as a carrier only. When the variable iopsou(2,1) = 0 the right is used as both a direct flow right and a carrier right.

```
Row-data        Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri         Operational right ID
1-2             nameo(1)       Operational right name
1-3             rtem(1)        Administration number.Note if ciopso(1) is
                                  a diversion right, its administration
                                  number is used and rtem is ignored.
1-4             dumx           Monthly and Structure Switch
                                  +n Number of intervening structures
                                     (max = 10)
                                  -n Include -12 monthly on/off values
                                     minus n intervening structures
                                     Note, when a negative value is,
                                     provided, it should be -13 or less)
1-5             ioprsw(1)      Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n=Begin in year n
                                  -n=Stop after year n

Destination Data
1-6             ciopde         Destination diversion ID or reservoirID
1-7             iopdes(2,1)    Destination structure account
                               For a diversion destination, enter 1
```

```
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Source Data
1-8            ciopso(1)      Water right ID under which the diversion occurs
                                 (must be a diversion right)
1-9            iopsou(2,1)    0 The source water right (ciopso(1)) is left on
                                 (i.e. it can be used as a both a direct flow
                                 right and this operating rule)
                              1 The source water right (ciopso2(1) is turned off
                                 (i.e. it can only be used by this operating rule)

1-10           ciopso(2)      NA (not used)
1-11           iopsou(4,1)    1 Monthly diversion limit is provided in the
                                 direct diversion demand file (*.ddm) for
                                 ciopso(2)
                              +n Annual diversion limit (acft). Note any data
                                 provided in the direct diversion demand file
                                 (*.ddm) is ignored.

Type Data
1-12           ityopr(1)      14

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

```
Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.15 Interruptible Supply Direct (ityopr=15)

The type 15 operating rule allows a direct flow diversion's water right (ciopso(2)) to defer its ability to divert in order to supply water to an instream flow located downstream. The rule may or may not operate in a given year based on the flow (iopsou(2)) at a specified location (ciopso(1)) in the network in the month indicated when variable imonsw(i) is equal to 2. The following comments are provided to assist in using and interpreting this operating rule:

- Once a water right has chosen to interrupt their supply and provide water to the instream flow, it cannot reoperate until it is turned off.
- The amount available for diversion is the minimum available to the source water right when it is in priority (i.e. diversion to instream flow = min (instream flow demand, direct diversion water right, direct diversion demand, available flow to direct diversion).
- Variable iopsou(4,1) allows the user to specify if the amount transferred is the total amount diverted or the amount that would have been consumed.
- The monthly on/off switches (imonsw(i)) allows the operating rule to continue from one simulation year through the next (e.g. begin in August of one year and continue through October of the next year). However, this ability requires the operating rule not operate until the first on switch (imonsw(i) = 2) is encountered.
- The Administration number assigned to the source water right overrides the variable rtem(1) provided with the operating rule.
- Because this operating rule has the ability to turn on and off based on a discharge, this operating rule is either on or off (i.e. the user is not allowed to initiate its operation during the study period by specifying a year for variable ioprsw(1).

```
Row-data       Variable       Description
_____________________________________________________________________

Source Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri         Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number. Note since ciopso(1) is
                                 a water right, its administration
                                 number is used and rtem(1)is ignored.
1-4            dumx           Monthly Switch
                                 0=No monthly on/off values
                                 12=Number of monthly on/off switches
                                 provided
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
```

```
                                 1=on
                                 +n=Begin in year n
                                 -n=Stop after year n

Destination Data
1-6            ciopde         Destination instream flow ID
1-7            iopdes(2,1)    1 Destination structure account

Source Data
1-8            ciopso(1)      Stream ID used to determine if the interruptible
                                 supply operating rule will be used
1-9            iopsou(2,1)    Natural streamflow (acft) below which the
                                 interruptible supply operating rule
                                 will be used
1-10           ciopso(2)      Direct flow diversion water right to be used
                                 as the interruptible supply
1-11           iopsou(4,1)    0 = allow 100% of the decree to be diverted
                              -1 = allow depletion (CU) to be diverted

Type Data
1-12           ityopr(1)      15

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
```

```
                                      structure ID's
                                   For -dumx, Enter abs(dumx)-12
                                      intervening structure ID's
```

4.13.16 Direct Flow Storage Direct (ityopr=16)

The type 16 operating rule allows a direct flow diversion's water right (ciopso(1)) to store in account (iopdes(2,1) of reservoir (ciopde). The amount stored may be limited by a maximum exchange percent (iopsou(4,1)); which is the same as 100 - a bypass percent. The following comments are provided to assist in using and interpreting this operating rule:

- A water right may operate as a standard direct flow right and/or as a direct flow storage right. When the variable iopsou(2,1) = 0 is the right is used as a direct flow storage right only. When the variable iopsou(2,1) = 1 is the right is used as both a direct flow right and a direct flow storage right.
- The source water right must be associated with 1 user (i.e. multiple users at the same diversion are not supported).
- Because a direct flow storage right may be used to serve both a direct flow storage user and as a direct flow storage right, the Administration number assigned to the operating rule is used in the analysis (i.e. it is not overridden by the source water rights administration number).
- Variable iopsou(4,1) allows the user to specify the maximum percent of the remaining decree that may be stored. This maximum percent is equivalent to 100 - a bypass percent.
- Direct flow storage is limited to the irrigation season by evaluating the demand associated with the structure tied to the source water right in the direct flow demand file (*.ddm). In addition, the user may control seasonal demands using the monthly on/off switch (imonsw(i)).
- The amount available for diversion is the minimum physical water available, remaining decree (e.g. some of the decree may have been used for direct diversion purposes), the exchange potential between the direct flow right and the reservoir, the maximum direct flow storage percent, the remaining reservoir volume, the reservoir target, the remaining reservoir account volume.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri         Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Structure Switch
                                 +1 Destination Structure ID
                                    (use to provide demand data
                                    when the destination is tied
                                    to a carrier)
                                 -n Include -12 monthly on/off values
                                    minus n destination structure IDs
                                    (use to provide demand data
                                    when the destination is tied
                                    to a carrier)
```

1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n=Begin in year n -n=Stop after year n

Destination Data

1-6	ciopde	Destination reservoir ID
1-7	iopdes(2,1)	Destination reservoir account

Source Data

1-8	ciopso(1)	Direct Flow water right ID
1-9	iopsou(2,1)	0 The source water right (ciopso(1)) is left on (e.g. it can be used as a both a direct flow right and this operating rule) 1 The source water right (ciopso2(1) is turned off (e.g. it can only be used by this operating rule)
1-10	ciopso(2)	0 (not used)
1-11	iopsou(4,1)	Maximum direct flow storage percent

Type Data

1-12	ityopr(1)	16

Associated Plan Data

1-13	creuse	NA

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

Demand Data
Include only if the variable (dumx) = +n or < -12

```
Format (36x, 10a12)
3-1             Intern(1,1)    Enter the destination structure ID
                                  (use to provide demand datawhen the destination
                                  is tied to a carrier)
```

4.13.17 Rio Grande Compact - Rio Grande River Direct (ityopr=17)

The type 17 operating rule was developed specifically for the Rio Grande River's portion of the Rio Grande Compact. Unlike most other operating rules, it requires two rows of data. The first row of data expects:

- The destination to be an Instream flow (i.e. an Instream flow right just below the Rio Grande at Labatos gage).
- Source 1 to be the stream gage that represents the index flow (i.e. Rio Grande at Del Norte)
- Source 2 to be the stream gage used to adjust to the discharge at the Instream flow location (i.e. the combined discharge of the Conejos River near La Sauses).

The second row of data expects:

- Qdebt is the year when annual obligation calculations begin to include adjustments for the cumulative surplus / shortage (i.e. 1985)
- Qdebtx is the initial surplus / shortage (acft) for Rio Grande (e.g. 944,000 * 60%).
- Source 3 is not used.
- The Source 4 coefficient represents the annual yield (acft/yr) of the Closed Basin Project to the Rio Grande River.
- The Source 5 coefficient represents the annual discharge of the Norton Drain South to the Rio Grande River.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right nam
1-3             rtem(1)         Administration number
1-4             dumx            Enter -8 if no monthly switches included.
                                Enter -20 if monthly switches are included.
                                Note the above allows 2 - 3 rows of data
                                   to be provided for this operational rule
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                    +n=Begin in year n
                                   -n=Stop after year n

Destination Data
1-6             ciopde          Destination instream flow ID
1-7             iopdes(2,1)     Coefficient (1.0)

Source Data
1-8             ciopso(1)       Source 1 (Index Gage)ID (Rio Grande at
```

		Del Norte)
1-9	iopsou(2,1)	Source 1 coefficient (1.0)
1-10	ciopso(3)	Source 2 (Index Gage) ID (Combined Conejos River nr La Sauses)
1-11	iopsou(4,1)	Source 3 coefficient (-1.0)

Type Data

1-12	ityopr(1)	17

Associated Plan Data

1-13	creuse	NA

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Additional Compact Data

2 Format (12x, 24x, 12x, 4x, 12x,f8.0, f8.0, 3(1x, a12, i8))

2-1	qdebt	Year when annual obligation calculation includes an adjustment for the cumulative surplus shortage
2-2	qdebtx	Initial surplus/shortage (acft) for the Rio Grande in the year this operating rule begins
2-3	ciopso(5)	Source 3 (not used on Rio Grande)
2-4	iopsou(6,1)	Source 3 Coefficient (1.0)
2-5	ciopso(7)	Source 4 not used (enter Closed Basin)
2-6	iopsou(8,1)	Source 4 Closed Basin annual yield to Rio Grande (e.g. 19,200 acft/yr)
2-7	ciopso(9)	Source 5 not used (NortonDrnS)
2-8	iopsou(10,1)	Source 5 Norton Drain South annual yield to Rio Grande(e.g. -4000 acft/yr)

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

4.13.18 Rio Grande Compact - Conejos River Direct (ityopr=18)

The type 18 operating rule was developed specifically for the Conejos River's portion of the Rio Grande Compact. Unlike most other operating rules, it requires two rows of data. The first row of data expects:

- The destination to be an Instream flow (i.e. an Instream flow just below the combine Conejos River near La Sauses).
- Source 1 is the stream gage that represents the first index flow (i.e. Conejos River near Magote).
- Source 2 is the stream gage that represent the second index flow (i.e. Los Pinos River near Ortiz).

The second row of data expects:

- Qdebt is the year when annual obligation calculations begin to include adjustments for the cumulative surplus / shortage (i.e. 1985).
- Qdebtx is the initial surplus / shortage (acft) for the Conejos River (e.g. 944,000 * 40%).
- Source 3 is the stream gage that represents the third index flow (San Antonio River at Ortiz).
- The Source 4 coefficient is used to represent the annual yield (acft/yr) of the Closed Basin Project to the Conejos River.
- The Source 5 coefficient is used to represent the annual discharge of the Norton Drain South to the Conejos River.

Note the format of a standard operational right input file has been adjusted to include a third source and account (coefficient).

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri          Operational right ID
1-2            nameo(1)        Operational right name
1-3            rtem(1)         Administration number
1-4            dumx            Enter -8 if no monthly switches included
                               Enter -20 if monthly switches are included
                               Note the above allows 2 or 3 rows of data
                                  to be recognized for this operational
                                  rule
1-5            ioprsw(1)       Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n=Begin in year n
                                  -n=Stop after year n

Destination Data
1-6            ciopde          Destination instream flow ID
1-7            iopdes(2,1)     Coefficient (1.0)
```

Source Data

1-8	ciopso(1)	Source 1 (Index Gage)ID (Conejos River near Magote)
1-9	iopsou(2,1)	Source 1 coefficient (1.0)
1-10	ciopso(2)	Source 2 (Index Gage) ID (Los Pinos River near Ortiz)
1-11	iopsou(4,1)	Source 2 coefficient (1.0)

Type Data

1-12	ityopr(1)	18

Associated Plan Data

1-13	creuse	NA

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Additional Compact Data

2	Format (12x, 24x, 12x, 4x, 12x,f8.0,f8.0, 3(1x, a12, i8))	
2-1	qdebt	Year when annual obligation calculations include an adjustment for the cumulative surplus shortage
2-2	qdebtx	Initial surplus/shortage (acft) for the Conejos in the year this operating rule begins
2-3	ciopso(5)	Source 3 (Index Gage) ID (San Antonio River at Ortiz)
2-4	iopsou(6,1)	Source 3 Coefficient (1.0)
2-5	ciopso(7)	Source 4 not used (enter ClosedBasin for documentation purposes)
2-6	iopsou(8,1)	Source 4 Closed Basin annual yield to Conejos (e.g. 12,800 acft/yr)
2-7	ciopso(9)	Source 5 not used (enter NortonDrnS for documentation purposes)
2-8	iopsou(10,1)	Source 5 Norton Drain South annual yield to Conejos(e.g. 4000 acft/yr)

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

```
2-1             imonsw(1)       Monthly switch 0=off, 1=on
                                   +n Day first used that month
                                   -n Day last used that month
                                Note the first entry corresponds to the first
                                   month specified in the control file
```

4.13.19 Split Channel Operations (ityopr=19)

The type 19 operating rule for split channel operations is currently under development.

4.13.20 San Juan Reservoir RIP Reservoir Operation (ityopr=20)

The type 20 operating rule for the SJRIP is no longer used.

4.13.21 Wells with Sprinkler Use (ityopr=21)

The type 21 operating rule allows the administration date for wells with sprinklers to be different than that specified by the well water rights (*.wer) file. This operating rule is commonly applied to simulate maximum water supply mode which preferentially meets a structures demand by wells with sprinklers first, surface water second and wells with flood irrigation last. Note this operating rule expects, and checks, that the control file (*.ctl) variables *itsfile*, *ieffmax* and *isprnk* are set appropriately. As described in Section 4.2, the control variable *itsfile* provides sprinkler area, sprinkler efficiency and *gwmode* data; the control variable *ieffmax* provides flood efficiency data; and the variable *isprnk* specifies sprinklers will be used. Note the irrigation practice time series file (*.ipy) variable *gwmode* must equal 1 (maximum supply) in order for this operating rule to apply.

```
Row-data        Variable        Description
_______________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            0
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n Begin in year n
                                   -n Stop after year n

Destination Data
1-6             ciopde          NA
1-7             iopdes(2,1)     0

Source Data
1-8             ciopso(1)       NA
1-9             iopsou(2,1)     0
1-10            ciopso(2)       NA
1-11            iopsou(4,1)     0
```

```
Type Data
1-12            ityopr(1)      21

Associated Plan Data
1-13            creuse         NA

Diversion Type
1-14            cdivtyp        NA

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0
Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.22 Soil Moisture Use (ityopr=22)

The type 22 operating rule allows the administration date for soil moisture use to be specified for all ditches and wells with one operational right. This operating rule is commonly applied when soil moisture accounting is included in the analysis (control variable *soild* = 1). Note this operating rule expects, and checks, that the control file (*.ctl) variables *itsfile, ieffmax* and *soild* are set appropriately. As described in Section 4.2, the control variable *soild* allows water deliveries in excess of a diversion's consumptive demand to be stored in the soil moisture zone. This operating rule allows the administration date to be specified that controls when water stored in the soil moisture zone is used (e.g. after surface rights, after well right, etc.). Note the soil moisture accounting requires the variable efficiency option be on by setting the annual time series file control variable (itsfile) equal to 10.

```
Row-data        Variable       Description
___________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri(1)      Operational right ID
1-2             nameo(1)       Operational right name
1-3             rtem(1)        Administration number
1-4             dumx           0
1-5             ioprsw(1)      Annual On/Off Switch
```

```
                                   0=off
                                   1=on
                                   +n Begin in year n
                                   -n Stop after year n

Destination Data
1-6            ciopde         NA
1-7            iopdes(2,1)    0

Source Data
1-8            ciopso(1)      NA
1-9            iopsou(2,1)    0
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0

Type Data
1-12           ityopr(1)      22

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

4.13.23 Downstream Call Direct (ityopr=23)

The type 23 operating rule allows a downstream call to be provided which limits any upstream diversions, reservoir storage, etc. that are junior to the calls administration number. The following comments are provided to assist in the use and interpretation this operating rule:

- The downstream call must be tied to an instream flow station.

- Call data are specified as a time series in a file named "Downstream_Call (*.cal)" (see Section 4.1 Response Data). Note for a monthly model the call on day 1 is used to estimate the call for that month.
- The amount of water controlled by a downstream call is the minimum of its instream flow water right, its demand, and the available flow in the river when it is called. If the user wants to control the entire flow below a downstream call structure a large decreed amount and demand should be specified.
- For a free river the downstream call's administration number should be entered as the most junior water right in the basin (e.g. 999999).
- The downstream calls administration number specified in the operation right file should be the most junior in the basin. This ensures it is not called as an operating rule prior to a consumptive (diversion, well, reservoir) water right.
- If the quantity of water associated with a downstream call is known then it is recommended the user model it as a standard instream flow (see Section 4.7).

```
Row-data         Variable         Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri           Operational right ID
1-2            nameo(1)         Operational right name
1-3            rtem(1)          Administration number (enter the most
                                   junior in the basin (e.g. 999999))
1-4            dumx             Monthly Switch
                                   0 No monthly on/off values
                                   12 Number of monthly on/off
                                      Switches provided
1-5            ioprsw(1)        Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n=Begin in year n
                                   -n=Stop after year n

Destination Data
1-6            ciopde           Instream flow station
1-7            iopdes(2,1)      1 (not used)

Source Data
1-8            ciopso(1)        NA (not used)
1-9            iopsou(2,1)      1 (not used)
1-10           ciopso(2)        0 (not used)
1-11           iopsou(4,1)      0 (not used)

Type Data
1-12           ityopr(1)        23

Associated Plan Data
1-13           creuse           NA
```

```
Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0


Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

4.13.24 Direct Flow Exchange Direct (ityopr=24)

The type 24 operating rule allows a direct flow diversion's water right (ciopso(1)) to be exchanged to another direct flow structure, reservoir or plan (ciopde). The exchange can occur from the river or by a carrier. The amount diverted can be limited to the amount available (Diversion) or its CU (Depletion). The following comments are provided to assist in using and interpreting this operating rule:

- This operating rule controls both the source and exchanged (destination) diversion or storage. Any shortages at the source location are shared with the destination based on ownership of each.
- The **percent ownership** can be supplied that limits the exchange of the source water right.
- The **consumptive use** of the supply data can be specified to limit the exchange. The efficiency of water use for the exchanged water is set in the plan (*.pln) file. It may be set to a fixed efficiency for all months, a constant value for each of 12 months or to the efficiency of the source water right structure.
- The **source water right** may be transferred to a diversion, reservoir or plan (ciopde). When the destination is a plan, the user is typically trying to 1. Satisfy a T&C Plan obligation or 2. Temporarily store the water in an Accounting Plan.
    - If a portion or all of the source water right has been changed and the destination is a changed water rights plan, it is recommended the user not use this rule and instead implement Changed Water Rights plan operations (See Section 7 and Section 4.13.26).
- Because a direct flow exchange right may be used to serve both a direct flow right and as a direct flow exchange right, the administration number assigned to the operating rule is used in

the analysis for both the direct flow and the direct flow exchange (i.e. it is not overridden by the source water rights administration number).

- Direct flow exchange may be controlled over a season by using the monthly on/off switch (imonsw(im)). Note the monthly on/off switches only control the exchange operation (i.e. the source water right continues to operate independent of the monthly on/off switch).
- **Monthly and Annual exchange limits** are required as input.
- The **exchange amount** is the minimum physical water available, remaining decree of the exchanging right (e.g. some of the decree may have been used for direct diversion purposes), the exchange potential between the destination and exchange locations, the monthly and annual exchange limits and the destination structure’s capacity.
- **Carrier losses** associated with intervening structures may be provided if variable OprLoss is > 0 or = -1 and the variable dumx = 1-10 or < -12. Note carrier losses are routed back to the system using the return flow parameters associated with the carrier structure.
- **Terms and Conditions** (T&C Plans) may be calculated if the source 2 variable (ciopso2) is set to a T&C plan. The variable iousou(4,1) is used to indicate how and when T&C demands are calculated.
    - If the user is implementing T&C on a changed water right, it is recommended the user implement Changed Water Rights plan operations (See Section 7 and Section 4.13.26) and associate the T&C plan when the water is released from the Changed Water Rights plan.
    - When ciopso2 = Plan ID and iopsou(4,1)=-1 the destination must be an accounting plan and the T&C Obligation is calculated when water is released from that Accounting plan using a type 27 or 28 rule.
    - When ciopso2 = Plan ID and iopsou(4,1)=1 a standard return pattern is used to calculate the T&C Obligation. A **Standard Return Pattern** calculates the T&C Obligation to be:
        - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
    - When ciopso2 = Plan ID and iopsou(4,1)=2 a fixed return pattern is used to calculate the T&C Obligation. A **Fixed Return Pattern** calculates the T&C Obligation to be:
        - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
    - When ciopso2 = Plan ID and iopsou(4,1)=3 a mixed return pattern is used to calculate the T&C Obligation. **Mixed Return Pattern** contains both a Standard and Fixed component and calculates the T&C Obligation to be:

        - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
        - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
    - When ciopso2 = Plan ID and iopsou(4,1)=4 a default return pattern is used to calculate the T&C Obligation. A **Default Return Pattern** has a standard component that uses historic return flow data associated with the source water right to calculate the T&C Obligation.
    - If the variable ciopso2 is set to a T&C Plan ID and iopsou(4,1) is greater than zero then CU Factors are expected to be provided in card 5. Note the CU Factors typically represent negotiated values to, but not necessarily the same as, the efficiency of the Transfer From Structure. Also these factors are only used when iopsou(4,1) = 1 (Standard Return) or 3 (Mixed Return) even though they are required as input.
- Water diverted by a Type 24 operating rule are reported in the **Stream Report (*.xdd)** as follows:
    - At the source, the water exchanged to the destination is reported as Carried, Exchanged or Bypassed.
    - At the destination, the water diverted is reported as From River by Other.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri         Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Intervening Structure Switch
                                 +n Number of intervening structures
                                    (max = 10)
                                 12 Monthly (12) on/off values
                                 -n Include -12 monthly on/off
                                    values minus n intervening
                                    structures
                                    Note, when a negative value is,
                                    provided, it should be -13 or
                                    less for 12 monthly values and
                                    one intervening structure
1-5            ioprsw(1)      Annual On/Off Switch
```

0=off
1=on
+n=Begin in year n
-n=Stop after year n

Destination Data

1-6	ciopde	Destination structure (Diversion ID, Reservoir ID or Accounting Plan ID) Use Type 26 operating rule and Type 13 plan for changed water rights.
1-7	iopdes(2,1)	Destination account For a diversion destination, enter 1 For a plan destination, enter 1 For a reservoir destination, enter the account

Source Data

1-8	ciopso(1)	Source water right ID
1-9	iopsou(2,1)	Percent of source water right to exchange
1-10	ciopso(2)	T&C Plan ID Enter NA if none or If the destination is an Accounting Plan and the terms and conditions associated with this transfer will be calculated when water is released
1-11	iopsou(4,1)	0 if ciopso(2) = NA 1 for a standard return pattern 2 for a fixed annual return pattern 3 for a mixed return pattern 4 for a default (source) return pattern -1 the terms and conditions associated with this transfer will be calculated when water is released

Type Data

1-12	ityopr(1)	24

Associated Plan Data

1-13	creuse	Reuse Plan ID (enter NA if none)

Diversion Type

1-14	cdivtyp	Diversion or Depletion

Conveyance Loss (%)

1-15	OprLoss	0 No Transit loss -1 Provide intervening structure with loss data in row 3.

Miscellaneous Limits

1-16	OprLimit	0 -1 Execute the first iteration only Review results – option not fully tested

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

Intervening Structure Data without loss
Include only if OprLoss = 0 and the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)

3-1	intern(1,1)	For +dumx, Enter dumx intervening structure ID's For -dumx, Enter abs(dumx)-12 intervening structure ID's

Intervening Structure Data with loss
Include only if OprLoss > 0 or = -1 and the variable (dumx) = 1-10 or < -12
See Section 7 for the approach used to model an augmentation station (e.g. a structure that carries a diversion, typically with loss, then returns non-lost water to the river).
Free Format

3b-1	intern(1,1)	Intervening structure ID (e.g. a Diversion ID or Stream ID)
3b-2	OprLossC(l,1)	Carrier Loss for Structure ID %
3b-3	InternT(1,1)	Intervening Structure Type Enter Carrier if it is a diversion structure located on the river Enter Return if it is a return location on the River
		Repeat for +dumx values

Exchange Limits (Monthly and Annual)
Free Format

4-1	OprMax(1,1-12)	Monthly exchange limit (af/mo)
4-13	OprMax(1,13)	Annual exchange limit (af/yr)

T&C CU Factors Data
Include only if ciopso(2)is a T&C Plan and iopsou(4,1) is >0
Note the data is only used when iopsou(4,1) is a standard Return pattern (1) or a mixed return pattern(3).
Free Format

5-1	OprEff(1)	Efficiency in month 1
5-2	OprEff(2)	Efficiency in month 2

```
5-12          OprEff(12)    Efficiency in month 12
```

4.13.25 Direct Flow Bypass Direct (ityopr=25)

The type 25 operating rule allows a direct flow diversion's water right (ciopso(1)) to be bypassed to a direct flow structure, reservoir or plan (ciopde). The diversion can occur from the river or through a carrier. The amount diverted may be limited to the amount available (Diversion) or its CU (Depletion). The following comments are provided to assist in using and interpreting this operating rule:

- A water right may operate as both a standard direct flow right and as a bypass water right.
- The user can supply data that limits the bypass to a percent (ownership) of the water right.
- The user can supply data that limits the bypass to the consumptive use of their portion of the water right. The efficiency of water use is estimated to equal the efficiency of the source water right's structure.
- The **source water right** may be transferred to a diversion, reservoir or plan (ciopde). When the destination is a plan, the user is typically trying to satisfy a T&C Plan obligation generated by another operating rule with the source water right.
- The user can supply a **"Reuse plan"** (creuse) that allows consumptive use credits associated with the direct flow bypass to be stored. A "Reuse Plan" may not be assigned when the destination is a plan because it using the full transfer to offset a T&C requirement.
- Because a direct flow bypass right may be used to serve both a direct flow right and as a direct flow bypass right, the administration number assigned to the operating rule is used in the analysis analysis for both the direct flow and the direct flow bypass (i.e. it is not overridden by the source water rights administration number).
- Direct flow bypass operations may be controlled over a season by using appropriate demand data and/or the monthly on/off switch (imonsw(im)). Note the monthly on/off switches only control the bypass operation (i.e. the source water right continues to operate independent of the monthly on/off switch).
- **Monthly and Annual exchange** limits are required as input.
- The amount available for diversion is the minimum physical water available, remaining decree of the exchanging right (e.g. some of the decree may have been used for direct diversion purposes), the bypass potential between the destination and bypass location, and the destination structure's capacity and the destination structure's demand.
- **Carrier losses** associated with intervening structures may be provided if variable OprLoss is > 0 or = -1 and the variable dumx = 1-10 or < -12. Note carrier losses are routed back to the system using the return flow parameters associated with the carrier structure.
- **Terms and Conditions** (T&C Plans) may be calculated if the source 2 variable (ciopso2) is set to a T&C plan. The variable iousou(4,1) is used to indicate how and when T&C demands are calculated.
    - If the user is implementing T&C on a changed water right, it is recommended the user implement Changed Water Rights plan operations (See Section 7 and Section 4.13.26) and associate the T&C plan when the water is released from the Changed Water Rights plan.

- When ciopso2 = Plan ID and iopsou(4,1)=-1 the destination must be an accounting plan and the T&C Obligation is calculated when water is released from that Accounting plan using a type 27 or 28 rule.
- When ciopso2 = Plan ID and iopsou(4,1)=1 a standard return pattern is used to calculate the T&C Obligation. A **Standard Return Pattern** calculates the T&C Obligation to be:
  - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=2 a fixed return pattern is used to calculate the T&C Obligation. A **Fixed Return Pattern** calculates the T&C Obligation to be:
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=3 a mixed return pattern is used to calculate the T&C Obligation. **Mixed Return Pattern** contains both a Standard and Fixed component and calculates the T&C Obligation to be:
  - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s)is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=4 a default return pattern is used to calculate the T&C Obligation. A **Default Return Pattern** has a standard component that uses historic return flow data associated with the source water right to calculate the T&C Obligation.
- If the variable ciopso2 is set to a T&C Plan ID and iopsou(4,1) is greater than zero then CU Factors are expected to be provided in card 5. Note the CU Factors typically represent negotiated values related to, but not necessarily the same as, the efficiency of the Transfer From Structure. Also these factors are only used when iopsou(4,1) = 1 (Standard Return) or 3 (Mixed Return) even though they are required as input.

- Water bypassed by a Type 25 operating rule is reported in the **Stream Report (*.xdd)** as follows:
  - At the source, the water bypassed to the destination is reported as Carried, Exchanged or Bypassed.
  - At the destination, the water diverted is reported as From River by Other.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
        1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly and Intervening Structure
                                Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   12 Monthly (12) on/off values
                                   -n Include -12 monthly on/off
                                      values minus n intervening
                                      structures
                                      Note, when a negative value is,
                                      provided, it should be -13 or
                                      less for 12 monthly values and
                                      one intervening structure
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n=Begin in year n
                                   -n=Stop after year n

Destination Data
1-6             ciopde          Destination structure (Diversion ID
                                   Reservoir ID or Plan ID)
                                Use Type 26 operating rule and Type 13 plan
                                for changed water rights.
1-7             iopdes(2,1)     Destination structure account
                                For a diversion destination, enter 1
                                For a reservoir destination, enter
                                   +n Account to be served by this right
                                   -n Fill the first n accounts based on
                                      the ratio of their ownership

Source Data
1-8             ciopso(1)       Source water right ID
1-9             iopsou(2,1)     Percent of source water right to be bypassed
1-10            ciopso(2)       T&C Plan ID
                                Enter NA if none or
                                   if the destination is an Accounting
                                   Plan and the terms and conditions
```

```
                              associated with this transfer will
                              be calculated when water is released
1-11           iopsou(4,1)    0 if ciopso(2) = NA
                              1 for a standard return pattern
                              2 for a fixed return pattern
                              3 for a mixed return pattern
                              -1 the terms and conditions associated
                                 with this transfer will be
                                 calculated when water is released

Type Data
1-12           ityopr(1)      25

Associated Plan Data
1-13           creuse         Reuse Plan ID (enter NA if none)

Diversion Type
1-14           cdivtyp        Diversion or Depletion

Conveyance Loss (%)
1-15           OprLoss        0 No Transit loss
                              -1 Provide intervening structure
                              with loss data in row 3.


Miscellaneous Limits
1-16           OprLimit       0


Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if OprLoss = 0 and the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
                                 if < -12 enter abs(dumx)-12
```

```
                                 intervening structure IDs

Intervening Structure Data with loss
Include only if OprLoss > 0 or = -1 and the variable (dumx) = 1-10 or < -12
See Section 7 for the approach used to model an augmentation station (i.e. a
structure that carries a diversion, typically with loss, then returns non-lost
water to the river).
Free Format
3b-1           intern(1,1)    Intervening structure ID
                                 (e.g. a Diversion ID or Stream ID)
3b-2           OprLossC(l,1)  Carrier Loss for Structure ID %
3b-3           InternT(1,1)   Intervening Structure Type
                              Enter Carrier if it is a diversion
                                 structure located on the river
                              Enter Return if it is a return
                                 location on the River

                              Repeat for +dumx values
Exchange Limits (Monthly and Annual)
Note: Must include 13 values
Free Format
4-1            OprMax(1,1-12) Monthlyexchange limit (af/mo)
4-13           OprMax(1,13)   Annual exchange limit (af/yr)

T&C CU Factors
Include only if ciopso(2)is a T&C Plan and iopsou(4,1) is >0.
Free Format
5-1            OprEff(1)      Efficiency in month 1
5-2            OprEff(2)      Efficiency in month 2

5-12           OprEff(12)     Efficiency in month 12
```

4.13.26 Changed Water Right (ityopr=26)

The type 26 operating rule allows a changed water right to be diverted from the river and temporarily stored in an accounting plan. Once the changed water right is stored in an accounting plan it can be released at a junior priority by a direct release using a Type 27 rule or by exchange using a Type 28 operating rule or spilled using a Type 29 rule. It can also be split into more than one owner using a Type 46 operating rule. The amount changed is limited by water supply available to the source water right and the percent of the source water right to be changed. The following comments are provided to assist in using and interpreting this operating rule:

- The **percent ownership** allows the user to specify the amount of the souuce water right to be changed and temporarily stored in a plan.
- The **source** must be a diversion water right.
- The **destination** must be a Changed Water Rights plan (Type 13).
- Because a changed water right may be used to serve both a direct flow right and a changed right, the administration number assigned to the operating rule is used in the analysis for both the direct flow and the changed water right (i.e. it is not overridden by the source water rights administration number).

- **Monthly and Annual exchange limits** are required to control the amount changed by month and year.
- The source water right is controlled by this operating rule. Therefore the **source water right is turned off** when this operating rule is read and the source water right cannot be used to divert water as a standard direct flow water right.
- The **changed amount** is the minimum of the physical water available, decree of the source water right and the monthly and annual exchange limits.
- The changed water right **operates once per iteration** (e.g. it is not allowed to benefit from a junior diversions return flows or a junior reservoirs release).
- **The water that remains at the head gate is limited by the source structures capacity**. When a portion of the water available to a Type 26 operating rule remains at the headgate and is diverted by the source structure, the source structures capacity is reduced by the amount diverted.
- **The changed amount is not limited by the source structure's capacity**. Capacity limitatons are imposed when water is released from the administrative plan using a type 26 or type 27 operating rule. If, the source structure happens to be used as a carrier as part of a release by a type 27 rule or by a type 28 rule, the capacity of the structure is reduced by the amount carried (not the amount released and carried).
- Changed water rights are reported in the **Stream Report (*.xdd)** (1) at structure where the source water right is located, (2) at the destination administrative plan and (3), if the destination plan is subsequently split to multiple administration plans, at each of those administrative plans as follows:
    - Changed water released for use by a direct release (type 27) or by an exchange (Type 28) is reported as Carried, Exchanged or Bypassed.
    - Changed water released as a spill (Type 29) is not reported as Carried, Exchanged or Bypassed.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly and Intervening Structure Switch
                                   0 No monthly on/off control
                                     12 Monthly on/off control provided
                                      (
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n=Begin in year n
                                   -n=Stop after year n

Destination Data
```

```
1-6            ciopde         Destination Plan ID
1-7            iopdes(2,1)    Destination account, enter 1


Source Data
1-8            ciopso(1)      Source water right ID
1-9            iopsou(2,1)    Percent of source water right to
                                   be changed
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0 if ciopso(2) = NA

Type Data
1-12           ityopr(1)      26

Associated Plan Data
1-13           creuse         Reuse Plan ID (enter NA if none)

Diversion Type
1-14           cdivtyp        Diversion

Conveyance Loss (%)
1-15           OprLoss        0 No Transit loss

Miscellaneous Limits
1-16           OprLimit       0 No Operating Limits

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Exchange Limits (Monthly and Annual)
Free Format
4-1            OprMax(1,1-12) Monthly exchange limit (af/mo)
4-13           OprMax(1,13)   Annual exchange limit (af/yr)
```

4.13.27 Reservoir or Reuse Plan or Accounting Plan to a Diversion or Reservoir or Carrier or Plan or Instream Flow with Reuse Direct (ityopr=27)

The type 27 operating rule provides a method to release water from a Reservoir or ReUse Plan (type 4 or 6), or Out-of-Priority (OOP) Plan (type 9), or Accounting Plan (11), or Changed Water Right Plan (type 13) to a diversion or reservoir or instream flow or instream flow reach directly via the river or by a carrier. The following are noted:

- A “**ReUse Plan**” is a plan type that can be used identify the location of a reusable water supply associated with a CU transfer, or transmountain import (see Section 7 for more details about plans).
- An “**Accounting Plan**” is a plan type that is used for accounting only (see Section 7 for more details about plans).
- An “**OOP Plan**” is a plan type that is associated with a diversion or storage taken out-of-priority by a type 38 operating rule.
- A “**Changed Water Right Plan**” is a plan type that can be used to identify the location of water diverted by a Changed Water Right Operating Rule (type 26).
- If the source is a Reuse, Accounting or Changed Water Right Plan, the destination may be reusable (e.g. creuse is a reuse plan (type 3 or 4).
- If the source is an Changed Water Right Plan (plan type 13), the variable Oprlimit must have a value between 5 and 9.
- If the source is a reservoir, the source data may be tied to an Out-of-Priority Plan (e.g. creuse is a OOP plan (type 9)).
- If carrier losses are calculated (OprLoss>0), the return flow pattern and return locations are those assigned to the SOURCE (CARRIER) structure in the diversion station file (*.dds) (e.g. if the source is a water right tied to structure X, then the return flow pattern and locations are those provided for structure X in the diversion station file (*.dds)).
- The variable OprLimit is used to constrain a release to an operating rule that contains monthly and annual limits, the amount diverted by another operating rule or, if the source is a Changed Water Right, the operating rule that diverted the Changed Water Right.
    - If the variable OprLimit set to 1 or 6, StateMod will warn the user a value of 1 or 6 are not currently operational but are reserved for potential future enhancements.
    - If the variable OprLimit is set to 2, 4 or 7, the operating rule ID specified in row 4’s monthly and annual limits **will be decreased and limit** the amount released.
    - If the variable OprLimit is set to 3, 4 or 8, the operating rule ID specified in row 4 or 5 **will limit** a release to the amount diverted byanother operating rule..
    - If the variable OprLimit is set to 4 or 9, the operating rule ID specified in row 4 should be an operating rule with monthly and annual limits (similar to Oprlimit=2), the operating rule ID specified in row 5 should be the operating rule that will limit a release to the amount diverted by that operating rule (similar to OprLimit = 3). If the variable OprLimit is set to 5, 7, 8 or 9, the source should be a Changed Water Right Plan (type 13) and the operating rule ID specified in row 4, 5 or 6 should be the operating rule that diverted the Changed Water Right.
- **Terms and Conditions** (T&C Plans) may be calculated if the source 2 variable (ciopso2) is set to a T&C plan. The variable iousou(4,1) is used to indicate how and when T&C demands are calculated.
    - When ciopso2 = Plan ID and iopsou(4,1)=-1 the destination must be an accounting plan and the T&C Obligation is calculated when water is released from that Accounting plan using a type 27 or 28 rule.

- When ciopso2 = Plan ID and iopsou(4,1)=1 a standard return pattern is used to calculate the T&C Obligation. A **Standard Return Pattern** calculates the T&C Obligation to be:
  - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=2 a fixed return pattern is used to calculate the T&C Obligation. A **Fixed Return Pattern** calculates the T&C Obligation to be:
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=3 a mixed return pattern is used to calculate the T&C Obligation. **Mixed Return Pattern** contains both a Standard and Fixed component and calculates the T&C Obligation to be:
  - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s)is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=4 a default return pattern is used to calculate the T&C Obligation. A **Default Return Pattern** has a standard component that uses historic return flow data associated with the source water right to calculate the T&C Obligation.
- If the variable ciopso2 is set to a T&C Plan ID and iopsou(4,1) is greater than zero then CU Factors are expected to be provided in card 5. Note the CU Factors typically represent negotiated values related to, but not necessarily the same as, the efficiency of the Transfer From Structure. Also these factors are only used when iopsou(4,1) = 1 (Standard Return) or 3 (Mixed Return) even though they are required as input.

- An **Augmentation Structure** (i.e. a structure that carries a diversion, typically with loss, then returns non-lost water to the river for subsequent diversion) can be modeled as follows:
  - Variable dumx should be set so that at least two structures will be provided in row 3b.

- The first carrier should be the Structure ID that diverts water from the stream and has an intervening structure type = Carrier.
- The second carrier should be a station on the river that has an intervening structure type = Return.
- Note that conveyance losses can be specified for a intervening structure type = Carrier but not an intervening structure type = Return. This limitation allows losses to be routed to the system using the return flow properties of the carrier structure.
- If water that returns to the river is subsequently rediverted into another carrier at least three entries should be provided sequentially as follows; 1. An intervening structure with type = Carrier, 2. An intervening structure with type = Return, and 3. An intervening structure with type = Carrier.
- A maximum of 10 intervening structures (intervening types = Carrier or Return) can be provided.

- Releases from a Plan by a Type 27 operating rule are reported in the **Stream Report (*.xdd)** as follows:
  - At the source, the water release to the destination is reported as Carried, Exchanged or Bypassed.
  - At the destination, the water diverted is reported as From River by Other.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly Intervening Structure Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   12 Monthly (12) on/off values
                                   -n Include -12 monthly on/off
                                      values minus n intervening
                                      structures
                                      Note, when a negative value is,
                                      provided, it should be -13 or
                                      less for 12 monthly values and
                                      one intervening structure
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n Begin in year n
                                   -n Stop after year n

Destination Data
1-6             ciopde          Destination structure (diversion
                                   or reservoir or instream flow or
                                   T&C (type 1) or Accounting Plan (type 11)
```

1-7	iopdes(2,1)	Destination structure account For a diversion or plan or instream flow destination enter 1 For a reservoir destination, enter +n Account to be served by this right -n Fill the first n accounts based On the ratio of their ownership
Supply Data		
1-8	ciopso(1)	ReUse Plan or Accounting Plan or Reservoir
1-9	iopsou(2,1)	If ciopso(1) is a plan enter the ownership % If ciopso(1) is a reservoir enter the account #
1-10	ciopso(2)	T&C Plan ID (enter NA if none)
1-11	iopsou(4,1)	0 if ciopso(2) = NA 1 for a standard return pattern 2 for a fixed return pattern 3 for a mixed (standard and fixed) return pattern
Type Data		
1-12	ityopr(1)	27
Associated Plan Data		
1-13	creuse	If the source is a Reuse Plan ID enter Reuse Plan ID or NA if none If the source is a Reservoir enter the associated Reuse Plan or OOP Plan ID
Diversion Type		
1-14	cdivtyp	Diversion or Depletion If the destination is a reservoir set to Diversion
Conveyance Loss (%)		
1-15	OprLoss	0 No Transit loss -1 Provide intervening structure with loss data in row 3.
Miscellaneous Limits		
1-16	OprLimit	0 Do not constrain the release by another operating rule. Note OprLimit must be 5, 7, 8 or 9 if the source is an Changed Water Right Plan (type 13).

		1 Not operational. Preserved for a potential enhancement. 2 Decrease monthly and annual releases limits of the operational rule specified in row 4. 3 Limit the amount released by the amount diverted by the operational rule in row 4 or row 5. 4 Include the functionality of oprlimit = 2 in row 4 and the functionality of oprlimit = 3 in row 5. 5 If the source is a Changed Water Right Plan (type 13), enter the operational right ID (type 26) that diverted the Changed Water Right. 6 Not operational. Preserved for a potential enhancement. 7 A combination of Oprlimit = 2 and 5. 8 A combination of Oprlimit = 3 and 5. 9 A combination of Oprlimit = 4 and 5.

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

Intervening Structure Data with loss
Include only if OprLoss > 0 or = -1 and the variable (dumx) = 1-10 or < -12
Note that intervening structure data without a loss is not operational, use a zero carrier loss to model these operations.
See Section 7 for the approach used to model an augmentation station (e.g. a structure that carries a diversion, typically with loss, then returns non-lost water to the river).
Free Format

3b-1	intern(1,1)	Intervening structure ID (e.g. a Diversion ID or Stream ID)
3b-2	OprLossC(l,1)	Carrier Loss for Structure ID %
3b-3	InternT(1,1)	Intervening Structure Type Enter Carrier if it is a diversion structure located on the river Enter Return if it is a return location on the River Repeat for +dumx values

Associated Operating Rule

```
Include only if the switch (OprLimit) = 2, 3, 4, 5, 7, 8 or 9
Free Format
4-1            cx             If OprLimit=2, 4, 7 or 9 Operating
                                 Rule ID with monthly and annual limits
                              If OprLimit=3 or 8 Operating
                                 Rule ID that will LIMIT the amount released
                              If Oprlimit=5, Operating Rule ID that
                                 Diverted water to a Changed Water
                                 Right Plan (type 13)
Associated Operating Rule
Include only if the switch (OprLimit) = 4, 7, 8 or 9
Free Format
5-1            cx             If OprLimit=4, 8 or 9 Operating Rule
                                 ID that will limit the amount diverted
                              If OprLimit= 7, Operating Rule ID that
                                 Diverted water to a Changed Water
                                 Right Plan (type 13)
Associated Operating Rule
Include only if the switch (OprLimit) = 9
Free Format
6-1            cx             If OprLimit= 9, Operating Rule ID that
                                 Diverted water to a Changed Water
                                 Right Plan (type 13)


T&C CU Factors
Include only if ciopso(2)is a T&C Plan and iopsou(4,1) is >0.
Free Format
7-1            OprEff(1)      Efficiency in month 1
7-2            OprEff(2)      Efficiency in month 2

7-12           OprEff(12)     Efficiency in month 12
```

4.13.28 Reservoir or Reuse or Accounting Plan to a User by Exchange (ityopr=28)

The type 28 operating rule provides a method to release water from a Reservoir, or ReUse Plan (type 4 or 6), or Out-of-Priority (OOP) Plan (type 9), or Accounting Plan (11), or Changed Water Right Plan (type 13) to a diversion, reservoir, instream flow, or carrier by exchange. In addition, it can be used to release water to an instream flow node or reach. The following are noted:

- A "**ReUse Plan**" is a plan type that can be used identify the location of a reusable water supply associated with a CU transfer or transmountain import (see Section 7 for more details about plans).
- An "**Accounting Plan**" is a plan type that is used for accounting only (see Section 7 for more details about plans).
- An "**OOP Plan**" is a plan type that is associated with a diversion or storage taken out-of-priority by a type 38 operating rule.
- A "**Changed Water Right Plan**" is a plan type that can be used to identify the location of water diverted by a Changed Water Right Operating Rule (type 26).
- If the source is a Reuse, Accounting Plan or Changed Water Right, the destination may be reusable (i.e. creuse is a reuse plan (type 3 or 4).

- If the source is an Changed Water Right Plan (plan type 13), the variable Oprlimit must have a value between 5 and 9.
- If the source is a reservoir, the source data may be tied to an out-of-priority Plan (i.e. creuse is an OOP plan (type 9)).
- If carrier losses are calculated (OprLoss>0), the return flow pattern and return locations are those assigned to the SOURCE (CARRIER) structure in the diversion station file (*.dds) (e.g. if the source is a water right tied to structure X, then the return flow pattern and locations are those provided for structure X in the diversion station file (*.dds)).
    - The variable OprLimit is used to constrain a release to to an operating rule that contains monthly and annual limits, the amount diverted by another operating rule or, if the source is a Changed Water Right, the operating rule that diverted the Changed Water Right. If the variable OprLimit set to 1 or 6, StateMod will warn the user a value of 1 or 6 are not currently operational but are reserved for potential future enhancements.
    - If the variable OprLimit is set to 2, 4 or 7, the operating rule ID specified in row 4's monthly and annual limits **will be decreased and limit** the amount released.
    - If the variable OprLimit is set to 3, 4 or 8, the operating rule ID specified in row 4 or 5 **will limit** a release to the amount diverted byanother operating rule.
    - If the variable OprLimit is set to 4 or 9, the operating rule ID specified in row 4 should be an operating rule with monthly and annual limits (similar to Oprlimit=2), the operating rule ID specified in row 5 should be the operating rule that will limit a release to the amount diverted by that operating rule (similar to OprLimit = 3).
    - If the variable OprLimit is set to 5, 7, 8 or 9, the source should be a Changed Water Right Plan (type 13) and operating rule ID specified in row 4, 5 or 6 should be the operating rule that diverted the Changed Water Right.
- **Terms and Conditions** (T&C Plans) may be calculated if the source 2 variable (ciopso2) is set to a T&C plan. The variable iousou(4,1) is used to indicate how and when T&C demands are calculated.
    - If the user is implementing T&C on a changed water right, it is recommended the user implement Changed Water Rights plan operations (See Section 7 and Section 4.13.26) and associate the T&C plan when the water is released from the Changed Water Rights plan.
    - When ciopso2 = Plan ID and iopsou(4,1)=-1 the destination must be an accounting plan and the T&C Obligation is calculated when water is released from that Accounting plan using a type 27 or 28 rule.
    - When ciopso2 = Plan ID and iopsou(4,1)=1 a standard return pattern is used to calculate the T&C Obligation. A **Standard Return Pattern** calculates the T&C Obligation to be:
        - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).

- When ciopso2 = Plan ID and iopsou(4,1)=2 a fixed return pattern is used to calculate the T&C Obligation. A **Fixed Return Pattern** calculates the T&C Obligation to be:
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=3 a mixed return pattern is used to calculate the T&C Obligation. **Mixed Return Pattern** contains both a Standard and Fixed component and calculates the T&C Obligation to be:
  - T&C Obligation (standard) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) * (1.0-CU Factor)), where the CU Factor is provided in row 5. The first value in a standard return flow table corresponds to the month diverted, the second to the month after a diversion, etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s) is provided in the plan Return File (*.prf).
  - T&C Obligation (fixed) = (Data in the return flow file (e.g. *.urm)) * ((Released Water) The first value in a fixed return flow table corresponds to the first month in the simulation (e.g. January for a calendar year simulation), the second month to February (again for a calendar year simulation), etc. Data that associates a Plan ID with any number of Return Flow Location(s), Percent(s), and Return Table ID(s)is provided in the plan Return File (*.prf).
- When ciopso2 = Plan ID and iopsou(4,1)=4 a default return pattern is used to calculate the T&C Obligation. A **Default Return Pattern** has a standard component that uses historic return flow data associated with the source water right to calculate the T&C Obligation.
- If the variable ciopso2 is set to a T&C Plan ID and iopsou(4,1) is greater than zero then CU Factors are expected to be provided in card 5. Note the CU Factors typically represent negotiated values related to, but not necessarily the same as, the efficiency of the Transfer From Structure. Also these factors are only used when iopsou(4,1) = 1 (Standard Return) or 3 (Mixed Return) even though they are required as input.

* Releases from a Plan by a Type 28 operating rule are reported in the **Stream Report (*.xdd)** as follows:
  - At the source, the water release to the destination is reported as Carried, Exchanged or Bypassed.
  - At the destination, the water diverted is reported as From River by Other.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operational right name
```

```
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Intervening Structure Switch
                                 +n Number of intervening structures
                                    (max = 10)
                                 12 Monthly (12) on/off values
                                 -n Include -12 monthly on/off
                                    values minus n intervening
                                    structures
                                    Note, when a negative value is,
                                    provided, it should be -13 or
                                    less for 12 monthly values and
                                    one intervening structure
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde            Destination structure (diversion
                                 or reservoir or instream flow or plan)
1-7            iopdes(2,1)    Destination structure account
                                 For a diversion or plan or instream
                                    flow destination enter 1
                                 For a reservoir destination, enter
                                    +n Account to be served by this right
                                    -n Fill the first n accounts based
                                       on the ratio of their ownership

Supply Data
1-8            ciopso(1)      ReUse Plan or Accounting Plan or Reservoir
1-9            iopsou(2,1)    If ciopso(1) is a plan
                                    enter the ownership %
                                 If ciopso(1) is a reservoir
                                    enter the account #
1-10           ciopso(2)      T&C Plan ID (enter NA if none)
1-11           iopsou(4,1)    0 if ciopso(2) = NA
                                 1 for a standard return pattern
                                 2 for a fixed return pattern
                                 3 for a mixed (standard and fixed)
                                 return pattern

Type Data
1-12           ityopr(1)      28

Associated Plan Data
1-13           creuse            Reuse Plan ID (enter NA if none)
Diversion Type
1-14           cdivtyp           Diversion or Depletion
                                 If the destination is a reservoir
                                    set to Diversion

Conveyance Loss (%)
```

```
1-15            OprLoss           0 No Transit loss
                               -1 Provide intervening structure
                                     with loss data in row 3.

Miscellaneous Limits
1-16            OprLimit       0 Do not constrain the release by
                                     another operating rule.  Note
                                  OprLimit must be 5, 7, 8 or 9
                                  if the source is an Changed Water
                                  Right Plan (type 13).
                                  1 Not operational.
                                     Preserved for potential enhancement.
                                  2 Decrease monthly and annual releases
                                     limits of the operational rule
                                     specified in row 4.
                                  3 Limit the amount released by the
                                     amount diverted by the operational
                                     rule in row 4 or row 5.
                                  4 Include the functionality of
                                     oprlimit =2 in row 4 and oprlimit=3
                                     in row 5.
                                  5 If the source is a Changed Water Right Plan
                                     (type 13), enter the operational right ID that
                                     diverted the Changed Water Right.
                                  6 Not operational.
                                     Preserved for a potential enhancement.
                                  7 A combination of Oprlimit = 2 and 5.
                                  8 A combination of Oprlimit = 3 and 5.
                                  9 A combination of Oprlimit = 4 and 5.
Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file

Intervening Structure Data with loss
Include only if OprLoss > 0 or = -1 and the variable (dumx) = 1-10 or < -12
Note that intervening structure data without a loss is not operational, use a zero
carrier loss to model these operations.
See Section 7 for the approach used to model an augmentation station (e.g. a
structure that carries a diversion, typically with loss, then returns non-lost
water to the river).
Free Format
```

```
3b-1            intern(1,1)    Intervening structure ID
                                  (e.g. a Diversion ID or Stream ID)
3b-2            OprLossC(l,1)  Carrier Loss for Structure ID %
3b-3            InternT(1,1)   Intervening Structure Type
                               Enter Carrier if it is a diversion
                                  structure located on the river
                               Enter Return if it is a return
                                  location on the River

                               Repeat for +dumx values


Associated Operating Rule
Include only if the switch (OprLimit) = 2, 3, 4, 5, 7, 8 or 9
Free Format
4-1             cx             If OprLimit=2, 4, 7 or 9 Operating
                                  Rule ID with monthly and annual limits
                               If OprLimit=3 or 8 Operating
                                  Rule ID that will LIMIT the amount released
                               If Oprlimit=5, Operating Rule ID that
                                  Diverted water to a Changed Water
                                  Right Plan (type 13)

Associated Operating Rule
Include only if the switch (OprLimit) = 4, 7, 8 or 9
Free Format
5-1             cx             If OprLimit=4, 8 or 9 Operating Rule
                                  ID that will limit the amount diverted
                               If OprLimit= 7, Operating Rule ID that
                                  Diverted water to a Changed Water
                                  Right Plan (type 13)
Associated Operating Rule
Include only if the switch (OprLimit) = 9
Free Format
6-1             cx             If OprLimit= 9, Operating Rule ID that
                                  Diverted water to a Changed Water
                                  Right Plan (type 13)

T&C CU Factors
Include only if ciopso(2)is a T&C Plan and iopsou(4,1) > 0.
If iopsou(4,1) = 2 (fixed) or 4 (default) enter -1.0 since this data is not used.
Free Format
7-1             OprFac(1)      CU factor in month 1
7-2             OprFac(2)      CU factor in month 2
...                            ...      ...
7-12            OprFac(12)     CU factor in month 12

                               Repeat for number of return flow locations
```

4.13.29 Reservoir or Plan Spill (ityopr=29)

The type 29 operating rule provides a method to spill water from a Reservoir or Reuse Plan or Accounting Plan or a Changed Water Right Plan to the system. The following are noted:

- When water is spilled from a plan it must be a Reuse Plan, an Accounting Plan or a Changed Water Right Plan.
    - A “ReUse Plan” is a special structure type that can be used identify the location of a reusable water supply associated with a CU transfer or transmountain import (see Section 7 for more details about plans).
    - An “Accounting Plan” is a special structure type that can be used to identify the location of transferred water that might be used for a variety of demands (see Section 7 for more details about plans).
    - A “Changed Water Right Plan” is a special structure that can be used to temporarily store a changed water right at its decreed priority and released at a priority that is junior by a direct release using a type 27 operating rule or by exchange using a type 28 operating rule or spilled using a type 29 operating rule (see Sectoin 7.43 for more details about a Changed Water Right plan).
- If the reuse plan is tied to a reservoir (e.g. it is a plan type 3 or 5) then source 1 (ciopso(1)) should be a reservoir ID and source 2 (ciopso(2)) may or may not be a Plan ID.
- If the reuse plan is not tied to a reservoir then source 1 (ciopso(1)) should be a plan ID and source 2 (ciopso(2)) should be NA.
- If the variable OprLimit is set to 1 the operating rule ID specified in row 4 will have its monthly and annual limits increased by the amount released.
- If the source is an Changed Water Right plan then the destination (ciopde) should be the location of the source water right.
- The type 29 operating rule allows the source to be a reservoir that may or may not be associated with a plan. As opposed to a standard reservoir spill operating rule (type 9) that releases water from a reservoir to meet a target storage, a type 29 reservoir spills the amount currently in storage when the operating rule executes. (e.g. it releases without regard to the target storage).
- The variable ciopde allows the user to specify where a spill will occur. The following are recommended:
    - If a plan is specified, with or without a reservoir, the user has the ability to control if the available flow at the node where the reservoir is located does or does not get adjusted. This capability is often required for a Changed Water Right Plan where the water may be diverted, temporarily stored in a plan that subsequently gets spilt for temporary storage in other plans associated with multiple users and ultimately released. If simulating a changed water right, the spill location, variable ciopde, should be the location of the changed water right.
    - If a plan is not specified, e.g. water is being spilled from a reservoir for an administrative purpose, the spill will occur at the reservoir node and the River Outflow and Available Flow are adjusted using the same approach as a type 9 operating rule. If the source is a reservoir the spill location, variable ciopde, should be NA since the reservoir location is the default spill location.

```
Row-data        Variable        Description

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
```

```
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Switch
                                 0 No monthly on/off values
                                 12 Monthly on/off switches
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n

1-6            ciopde         Spill location.
                                 If the supply (ciopso(1)) is a plan:
                                    NA spill downstream of the plan location
                                    +n river ID where the plan spill occurs
                                 If the supply (ciopso(1)) is a reservoir:
                                    NA the spill will occur at the
                                    Reservoir location
1-7            iopdes(2,1)    0

Supply Data
1-8            ciopso(1)      Supply Reservoir ID or ReUse plan ID
                                 or Administrative plan ID
1-9            iopsou(2,1)    Supply Reservoir account or ReUse
                                 Account (enter 0 if not applicable)
1-10           ciopso(2)      Supply Plan ID associated with a reservoir
                              Enter NA if none
1-11           iopsou(4,1)    0

Type Data
1-12           ityopr(1)      29

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0 Do not adjust Monthly or Annual
                              Operational limits
                                 +n Adjust monthly and Annual limits
                                 of the operational rule
                                 specified in row 3 below
Start Date
1-17           IoBeg          First year of operation

End Date
```

```
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Monthly and Annual Limitation Data
Format (36x, 10a12)
Include only if the switch (OprLimit) = 1
3-1            cx             Operating Rule ID for which monthly and annual
                                 limits will be increased by the amount spilled
```

4.13.30 Reservoir Re Diversion (ityopr=30)

The type 30 operating right allows a reservoir to re-divert water released in the same time step to a T&C plan by another operating rule. This operating rule is similar to a standard reservoir diversion except the amount diverted is limited to the amount released by a prior operating rule (ciopso1).This rule was developed and is commonly used because T&C releases are typically required to benefit other users before the system knows a release was unnecessary. Therefore, when implemented properly, the senior administration number of the T&C release operates and makes water available to other water users. Then the junior reservoir re diversion (type 30) operates to try and re-store this release if water is available (e.g. the release was not required).

```
Row-data       Variable       Description
________________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Intervening Structure Switch
                                 +n Number of intervening structures
                                      (max = 10)
                                 12 Monthly (12) on/off values
                                 -n Include -12 monthly on/off
                                 values minus n intervening
                                 structures
                                 Note, when a negative value is,
                                 provided, it should be -13 or
                                 less for 12 monthly values and 1
                                 intervening structure)
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n
```

```
Destination Data
1-6            ciopde         Destination reservoir
1-7            iopdes(2,1)    Destination account

Supply Data
1-8            ciopso(1)      Operating right ID associated with
                                 the release of water to a T&C plan
1-9            iopsou(2,1)    0
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0

Type Data
1-12           ityopr(1)      30

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)

3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure IDs
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure IDs
```

4.13.31 Carrier Right with Reuse (ityopr=31)

The type 31 operating rule provides a method to divert water to a reservoir or direct flow structure using another structure's water rights. It is similar to the type 11 operating rule except it tracks reusable water associated with the diverted water's return flows. Water may be diverted to a reservoir or direct flow structure using a carrier structure's water rights. In addition, it can be used to constrain a diversion to the capacity of up to 10 intervening structures.

Note a diversion is implicitly constrained by the capacity of the destination structure (variable ciopde 1-6). Also, if several operating rules use the same water right, diversions are not allowed to exceed the decreed capacity. Finally if the destination is a reservoir, the operating rule demand is the destination reservoir's capacity. If the destination is a diversion, the demand is the destination structure's demand.

```
Row-data       Variable       Description
___________________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri         Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number. Note if
                                 ciopso(1) is a diversion right, its
                                 administration number is used and
                                 rtem is ignored
1-4            dumx           Monthly and Structure Switch
                                 +n Number of intervening structures
                                 (max = 10)
                                 -n Include -12 for monthly on/off values
                                 minus n intervening structures.
                                 Note, when a negative value is,
                                 provided, it should be -13 or less)
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n=Stop after year n

Destination Data
1-6            ciopde         Destination diversion ID or reservoir ID
1-7            iopdes(2,1)    Destination structure account
                              For a diversion destination, enter 1
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Source Data
1-8            ciopso(1)      Diversion Water right ID
1-9            iopsou(2,1)    0
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0
```

```
Type Data
1-12          ityopr(1)      31

Associated Plan Data
1-13          creuse         Reuse Plan ID (enter NA if none)

Diversion Type
1-14          cdivtyp        NA

Conveyance Loss (%)
1-15          OprLoss        0

Miscellaneous Limits
1-16          OprLimit       0

Start Date
1-17          IoBeg          First year of operation

End Date
1-18          IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1           imonsw(1)      Monthly switch 0=off, 1=on
                                +n Day first used that month
                                -n Day last used that month
                             Note the first entry corresponds to the first
                                month specified in the control file


Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1           intern(1,1)    For +dumx, Enter dumx intervening
                                structure ID's
                             For -dumx, Enter abs(dumx)-12
                                intervening structure ID's
```

4.13.32 Reservoir with a Reservoir Reuse Plantyp to a User Direct (ityopr=32)

The type 32 operating rule provides a method to release water from a reservoir with a reservoir reuse plan (type 3 or 5) to a reservoir, direct flow, instream flow node or instream flow reach located downstream of the reservoir. If the delivery method is a release from the reservoir directly to a demand or reservoir (i.e. no release to the river) the diversion type (cdivtyp) should be set to Direct. If the delivery method is the river and the delivery is intended to meet the destination’s demand the diversion type (cdivtyp) should be set to Diversion. If the destination is a diversion and the delivery is intended to meet the consumption associated with the destination’s demand, the diversion type (cdivtyp) should be set to Depletion. In addition, carriers can be used to constrain a release to the capacity of up to 10 intervening structures or carriers. Note a diversion is implicitly constrained by the capacity of the destination structure (variable ciopde).

Row-data	Variable	Description
Control Data		
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12, 1x,a12, 1x,2f8.0, 2i8)		
1-1	cidvri(1)	Operational right ID
1-2	nameo(1)	Operation right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly and Intervening Structure Switch +n Number of intervening structures (max = 10) -n Include -12 monthly on/off values minus n intervening structures Note, when a negative value is, provided, it should be -13 or less for 12 monthly values and
1-5	ioprsw(1)	Annual On/Off Switch 0 off 1 on +n Begin in year n -n Stop after year n
Destination Data		
1-6	ciopde	Destination diversion ID or reservoir ID or Instream flow ID
1-7	iopdes(2,1)	Destination structure account For a diversion or instream flow destination, enter 1 For a reservoir destination, enter +n Account to be served by this right -n Fill the first n accounts based on the ratio of their ownership
Supply Data		
1-8	ciopso(1)	Supply reservoir ID
1-9	iopsou(2,1)	Supply reservoir account
1-10	ciopso(2)	Supply Reservoir Reuse Plan ID at Source
1-11	iopsou(4,1)	See Section 7 for a discussion of the Reservoir demand options. 0 = Reservoir demand is not adjusted +n = Reservoir demand is limited to not exceed CIR/n; where n (%) is the efficiency of reservoir water use that is limited to not exceed the max system efficiency

```
                                                Note a +n requires the
                                                variable efficiency option
                                                (ieffmax) from control file be
                                                on

Type Data
1-12           ityopr(1)      32

Associated Plan Data
1-13           creuse         Reuse Plan ID for returns (enter NA if none)

Diversion Type
1-14           cdivtyp        Diversion or Depletion or Direct

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation


Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.33 Reservoir with a Reuse Plan to a User by Exchange (ityopr=33)

The type 33 operating rule provides a method to release water from a Reservoir with a Reservoir Reuse plan (type 3 or 5) to a reservoir, direct flow, instream flow or a carrier located upstream of the reservoir, by exchange when the receiving structures return flows can be reused. The amount released may equal the destinations demand (Diversion) or consumption (Depletion). In addition, it can be used to constrain a diversion to the capacity of up to 10 intervening structures or carriers. Note a diversion is implicitly constrained by the capacity of the destination structure (variable ciopde, row-data 1-6).

```
Row-data        Variable       Description
_______________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operation right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Intervening Structure Switch
                                 +n Number of intervening structures
                                    (max = 10)
                                 -n Include -12 monthly on/off
                                    values minus n intervening
                                    structures
                                    Note, when a negative value is
                                    provided, it should be -13 or
                                    less for 12 monthly values and
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Destination diversion ID or reservoir
                                   ID or Instream Flow node or reach
1-7            iopdes(2,1)    Destination structure account
                              For a diversion destination, enter 1
                                 For a ISF destination, enter 1
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8            ciopso(1)      Supply reservoir ID
1-9            iopsou(2,1)    Supply reservoir account
1-10           ciopso(2)      Supply Reservoir Reuse Plan ID
1-11           iopsou(4,1)
                              See Section 7 for a discussion of the
                              Reservoir demand options.
                                 0 = reservoir demand is not
                                    adjusted
                                 +n = Reservoir demand is limited to not
                                      exceed CIR/n; where n (%) is
                                      the efficiency of reservoir
                                      water use that is limited to
                                      not exceed the max system
                                      efficiency
                                      Note a +n requires the
                                      variable efficiency option
                                      (ieffmax) from control file be
```

```
                                              on

Type Data
1-12           ityopr(1)      33

Associated Plan Data
1-13           creuse         Reuse Plan ID for returns (enter NA if none)

Diversion Type
1-14           cdivtyp        Diversion or Depletion

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.34 Reservoir to Reservoir Transfer (Bookover) with a Plan (ityopr=34)

The type 34 operating rule allows a reservoir to reservoir transfer (bookover) to occur where the destination water may be reusable or increase an OOP plan obligation. It is commonly used to transfer water from one reservoir storage account to another in a particular month. The following are noted:

- The destination reservoir may be the same or different than the source reservoir. If they are different the destination reservoir must be located downstream of the source reservoir.
- If the delivery method is a release from the reservoir directly to a demand or reservoir (i.e. no release to the river) the diversion type (cdivtyp) should be set to Direct. If the delivery method is the river and the delivery is intended to meet the destination’s demand the diversion type (cdivtyp) should be set to Diversion.

- The amount transferred can be limited to the amount of water diverted by another operating rule (specified under variable ciopso(2)).
- The amount transferred can be limited to the demand of a diversion structure (specified in field ciopso(2)).
- The amount transferred can be limited to the volume of water in an Out-of-Priority (OOP) plan (specified in field ciopso(2)).
- The amount transferred can be booked from one reservoir to another by a carrier (pipeline).
- If the variable OprLimit is set to 1 the operating rule ID specified in row 4's monthly and annual limits **will be increased and limit** the amount rleased. Also because the capacity of the source structure of the operating rule ID specified in row 4 has already been adjusted the source structure's capacity will not limit the amount diverted.
- If water is being transferred from an OOP plan in one reservoir to an OOP plan in another reservoir then:
  - Source 1 should be the source reservoir
  - Source 2 should be the OOP plan at the source reservoir
  - The destination should be the reservoir receiving the bookover
  - The plan data should be the OOP plan at the destination reservoir

```
Row-data       Variable       Description
_______________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Structure Switch
                                 0 No monthly on/off values
                                 12 Number of monthly on/off
                                    Switches provided
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Destination reservoir ID
1-7            iopdes(2,1)    Destination structure account
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8            ciopso(1)      Supply reservoir ID
1-9            iopsou(2,1)    Supply reservoir account

1-10           ciopso(2)      Transfer Limit
```

```
                              If not required enter 0
                              If limited by the amount diverted under
                                 an operating rule, enter the operating
                                 Rule ID.
                              If limited by a diversion demand amount
                                 enter the diversion structure ID.
                              If limited by an OOP Plan amount
                                 enter the OOP Plan ID.
1-11           iopsou(4,1)    Enter 0 (Not Used)

Type Data
1-12           ityopr(1)      34

Plan Data
1-13           creuse         Reuse Plan ID or OOP Plan ID

Diversion Type
1-14           cdivtyp        Diversion or Direct


Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0 Do not adjust Monthly or Annual
                                 Operational limits
                              1 Increase monthly and Annual
                                Diversion limits of the operational rule
                                 specified in row 4. Also do recognize the
                                 capacity of the structure associated with the
                                 operational rule in row 4 is already adjusted.

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Associated Operating Rule
Include only if the switch (OprLimit) =2 or 3
Free Format
3-1            cx             If Oprlimit=2, Operating Rule ID
                                 for which monthly and Annual
                                 limits will LIMIT the amount released
```

```
                              If OprLimit=3, Operating Rule ID
                                 for which diversions by that rule
                                 will LIMIT the Amount released

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
4a-1           intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.35 Import to a Plan (ityopr=35)

The type 35 operating rule provides a method to import water from outside the system to an accounting plan. An import structure should be specified with the same ID in both the diversion station file (*.dds) and plan file (*.pln) using Plan Type 7. The destination accounting plan must be located directly downstream of the import diversion/plan, intervening structures in this rule are not recommended. Monthly import values should be specified as negative demands in the diversion demand file (*.ddm).If the imported supplies are reusable, designate the reuse plan when the imported water is released from the accounting plan.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operation right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Switch
                                 12 Include monthly on/off values
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Destination accounting plan
1-7            iopdes(2,1)    Destination structure account
                              For a plan destination, enter 1

Supply Data
1-8            ciopso(1)      Diversion ID where imported water enters the system
                                 Note import ID in diversion file (*.dds)
                                 must match import plan ID in plan file (*.pln)
1-9            iopsou(2,1)    0 (not used)
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0

Type Data
```

```
1-12            ityopr(1)      35

Associated Plan Data
1-13            creuse         NA

Diversion Type
1-14            cdivtyp        NA

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0

Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
```

4.13.36 Seasonal (Daily) Water Right Direct (ityopr=36)

The type 36 operating rule provides a method to limit a direct flow water right to begin on a particular day and end on a particular day during a monthly simulation. In addition it may be used in a daily analysis if a diversion has several water rights, with some controlled by their daily demand and others limited toboth their daily demand data and a specified diversion season. The type 36 operating right has generic applications, however it was originally developed to model Meadow Rights that occur in water districts 1 and 64 of the South Platte River.

```
Row-data        Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri(1)      Operational right ID
1-2             nameo(1)       Operation right name
1-3             rtem(1)        Administration number
1-4             dumx           Monthly and Intervening Structure Switch
                                  +n Number of intervening structures
                                     (max = 10)
                                  -n Include -12 monthly on/off
```

```
                                             structures
                                             Note, when a negative value is,
                                             provided, it should be -13 or
                                             less for 12 monthly values and
                                             one intervening structure
1-5             ioprsw(1)      Annual On/Off Switch
                                  0 off
                                  1 on
                                  +n Begin in year n
                                  -n Stop after year n

Destination Data
1-6             ciopde         Destination diversion ID
1-7             iopdes(2,1)    Destination structure account,
                                  enter 1 for a diversion,

Supply Data
1-8             ciopso(1)      Diversion Water Right ID
1-9             iopsou(2,1)    0 (not used)
1-10            ciopso(2)      NA
1-11            iopsou(4,1)    0

Type Data
1-12            ityopr(1)      36

Associated Plan Data
1-13            creuse         NA

Diversion Type
1-14            cdivtyp        Direct

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0

Start Date
1-17            IoBeg          First year of operation
End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off,
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file


Intervening Structure Data without loss
```

```
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.37 Augmentation Well Direct (ityopr=37)

The type 37 operating rule provides a method to pump an Augmentation well in order to satisfy a T&C or Augmentation Plan demand. The source is a well water right. The destination is a T&C or Well Augmentation Plan. The following comments are provided to assist in using and interpreting this rule:

- An augmentation well right is typically tied to a unique (augmentation) Well structure. This allows unique return and depletion data associated with the augmentation well to be provided in the well station file (*.wes). Note that return flows associated with an augmentation are typically assigned a unit response function that routes water to the stream in the same time step that they occur.
- This rule requires source 2 (ciopso(2)) be an "Augmentation plan ID". This allows the augmentation plan requirements associated with the augmentation well to be stored and ultimately satisfied. This plan ID may or may not be the same as the destination plan ID.
- An augmentation well might serve as both a water supply and an augmentation source. This can occur when the same right is assigned to both a standard (irrigation) well structure and an Augmentation well structure. If the administration number assigned in the operational right file is different than the administration number of the source (augmentation) well the operating rule value is used and a warning is printed to the log file. The amount pumped to each demand is limited by the well's total capacity and water right.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operation right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly On/Off Switch
                                 0 Include no monthly on/off values
                                 12 Include 12 monthly on/off values
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         T&C or Well Augmentation Plan ID
1-7            iopdes(2,1)    0 (not used)

Supply Data
1-8            ciopso(1)      Well Water Right ID
```

```
1-9             iopsou(2,1)    0 (not used)
1-10            ciopso(2)      Plan ID used to track the Augmentation
                                  requirement of the Augmentation Well pumping
1-11            iopsou(4,1)    0

Type Data
1-12            ityopr(1)      37

Associated Plan Data
1-13            creuse         NA

Diversion Type
1-14            cdivtyp        NA

Conveyance Loss (%)
1-15            OprLoss        0

Miscellaneous Limits
1-16            OprLimit       0

Start Date
1-17            IoBeg          First year of operation

End Date
1-18            IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1             imonsw(1)      Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1             intern(1,1)    For +dumx, Enter dumx intervening
                                  structure ID's
                               For -dumx, Enter abs(dumx)-12
                                  intervening structure ID's
```

4.13.38 Out-of-Priority Diversion with Plan Direct (ityopr=38)

The type 38, Out-of-Priority Diversion, operating rule provides a method to divert to a reservoir or a diversion out-of-priority with respect to a reservoir based on the upstream storage statute. Source 1 is the senior reservoir right that is being subordinated. Source 2 is the destination reservoir water right that is diverting out-of-priority. The destination is a reservoir or ditch. A plan ID is used to track the volume of water that must be paid back should the subordinated reservoir right go unsatisfied. The following comments are provided to assist in using and interpreting this rule:

- The user must supply an “Out-of-Priority (OOP) Plan ID” associated with the OOP diversion.

- When multiple structures divert with respect to the same subordinated reservoir right, they may be provided the same OOP Plan ID or different OOP Plan ID's. Separate OOP Plan ID's are recommended if the user is interested in monitoring the demand and supplies associated with each OOP diversion. A combined OOP Plan ID is recommended if the user is not interested in monitoring the demand and supplies associated with each OOP diversion.
- The administration number provided to the operating rule is typically just senior to the senior subordinated reservoir right.

```
Row-data       Variable       Description

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
        1x,a12, 1x,2f8.0, 2i8)
1-1     cidvri(1)             Operational right ID
1-2     nameo(1)              Operation right name
1-3     rtem(1)               Administration number
1-4     dumx                  Monthly Intervening Structure Switch
                                 +n Number of intervening structures (max = 10)
                                 12 Monthly (12) on/off values
                                 -n Include -12 monthly on/off
                                    values minus n intervening
                                    Note, when a negative value is,
                                    provided, it should be -13 or
                                    less for 12 monthly values and
                                    one intervening structure
1-5     ioprsw(1)             Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6     ciopde                Diversion or Reservoir ID
1-7     iopdes(2,1)           Destination structure account
                              For a diversion destination, enter 1
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership

Supply Data
1-8     ciopso(1)             Senior subordinated reservoir right ID
1-9     iopsou(2,1)           0 (not used)
1-10    ciopso(2)             Junior right ID diverting out of priority
1-11    iopsou(4,1)           0 (not used)

Type Data
1-12    ityopr(1)             38

Associated Plan Data
1-13    creuse                Reuse Plan ID (used to store amount diverted
                                 out-of-priority)
```

```
Diversion Type
1-14    cdivtyp                NA

Conveyance Loss (%)
1-15    OprLoss                0

Miscellaneous Limits
1-16    OprLimit               0

Start Date
1-17    IoBeg                  First year of operation

End Date
1-18    IoEnd                  Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1     imonsw(1)              Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
Intervening Structure Data
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1     intern(1,1)            For +dumx, Enter dumx intervening
                                  structure ID's
                               For -dumx, Enter abs(dumx)-12
                                  intervening structure ID's
```

4.13.39 Alternate Point Direct (ityopr=39)

The type 39 operating rule allows a structure to divert at an Alternate Point using a water right that is assigned to another structure (i.e. not assigned to the Alternate Point). The alternate point can be located upstream or downstream of the destination structure. The rule allows water to be diverted at one or both locations up to the decreed amount. Source 1 is the water right that allows the diversion. Source 2 is the location in the network where the Alternate Point will be administered. The destination must be a diversion and is typically (but not required to be) the structure associated with Source 1. The following comments are provided to assist in using and interpreting this rule:

- If the source structure is no longer capable of diverting, its capacity is typically set to zero in the diversion structure file.
- The administration number provided to the operating rule is typically equal to or slightly junior to the decreed water right.
- The source water right may operate as a standard direct flow right and as an alternate point. The total amount diverted at the decreed location and the alternate point are limited to the decreed amount, demand, available supply, etc. When the variable iopsou(2,1) = 0 is the right is used as both a direct flow and alternate point. When the variable iopsou(2,1) = 1 the right is only used as an alternate point.

- When the alternate point is a diversion, results are reported in the Stream Report (*.xdd) as follows:
    - At the destination, the diversion is reported as From Carrier by Other.
    - At the source structure, the diversion is reported as From River by Other and Carried, Exchange or Bypassed. The Total Supply associated with the alternate point diversion is therefore zero (diversion less carried water is zero)

- When the alternate point is a well, results are reported in the Stream Report (*.xdd) as follows:
    - At the destination, the diversion is reported as From Carrier by Other.
    - At thesource structure, the well pumping is reported as From Well and Carried, Exchange or Bypassed. The Total Supply associated with the alternate point diversion is therefore zero (well pumping less carried water is zero).

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
1-1             cidvri(1)       Operational right ID
1-2             nameo(1)        Operation right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly On/Off Switch
                                   0 Include no monthly on/off values
                                   12 Include 12 monthly on/off values
1-5             ioprsw(1)       Annual On/Off Switch
                                   0 off
                                   1 on
                                   +n Begin in year n
                                   -n Stop after year n

Destination Data
1-6             ciopde          Destination ID (must be a diversion)
1-7             iopdes(2,1)     Enter 1

Supply Data
1-8             ciopso(1)       Diversion Water right serving the
                                     alternate point
1-9             iopsou(2,1)     0 The source water right (ciopso(1))
                                   is left on (i.e. it can be used
                                   as a both a direct flow right
                                   and this operating rule)
                                1 The source water right (ciopso2(1)
                                   is turned off (i.e. it can only be
                                   used by this operating rule)
1-10            ciopso(2)       Location wehere the Alternate Point
                                   is being administred (may be any
                                   diversion or well location)
1-11            iopsou(4,1)     0 do not limit the diversion to flow
                                   at the source right location
                                1 do limit the diversion to flow
```

```
                                 at the source right location
Type Data
1-12           ityopr(1)      39

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        Diversion

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.40 South Platte Compact Release (ityopr=40)

For a complete description of how the South Platte compact is implemented in StateMod see section 7. The Type 40 operating rule simulates a release from the South Platte Compact Plan. It should be used to allow any diversion not located in water district 64 (e.g. upstream of the Washington county line) to attempt to divert water stored in the South Platte Compact plan and therefore not be called out by the compact. In addition, it should be used to release water from the compact plan to the compact itself. The following comments are provided:

- To serve any diversion that is water short and not located in water district 64 the **destination should be assigned 64x.**

- When the destination is any diversion not located in water district 64 (e.g 64x) the administration number assigned is not used since this operating rule is called immediately following the priority of any water right that is water short and not located in water district 64.
- To serve the compact itself the destination should be assigned an instream flow that represents the South Platte Compact.
- The administration number assigned to the operating rule used to release water from the South Platte Compact to the compact itself should be the most junior in the basin.
- Results for a type 40, South Platte Compact Storage, are reported in the Stream Report (*.xdd) as follows:
  - When the destination is any structure not located in water district 64, the diversion is reported as From River by Other because it is diverted by an operating rule. The Total Supply equals From River by Other that also equals Water Use To Other. In the Station Balance accounting River Outlfow equals the River Inflow less River Divert and River by Well.
  - When the destination is the South Platte Compact, the diversion is reported as From River by Other because it is diverted by an operating rule. The Total Supply equals From River by Other that also equals Water Use To Other. In the Station In/Out accounting the return flow equals the divesion because it is non-consumptive. In the Station Balance accounting River Outlfow equals the River Inflow less River Divert and River by Well.
- The check file contains a list of every structure served by a type 40 operating rule.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)       Operational right ID
1-2            nameo(1)        Operational right name
1-3            rtem(1)         Administration number
1-4            dumx            Monthly switch 0=off, 1=on
                                  +n Day first used that month
                                  -n Day last used that month
                               Note the first entry corresponds to the first
                                  month specified in the control file
1-5            ioprsw(1)       Annual On/Off Switch
                                  0=off
                                  1=on
                                  +n=Begin in year n
                                  -n=Stop after year n

Destination Data
1-6            ciopde          Enter 64x to indicate the operating
                                    rule serves any water right not
                                    located in water district 64; or
                                  Enter the South Platte compact
                                    instream flow ID to indicate
```

```
                                    the operating rule provides
                                    water to the compact itself.
1-7            iopdes(2,1)     Destination Account, enter 1

Supply Data
1-8            ciopso(1)       Compact plan ID (must be an
                                    Administrative plan, type 11)
1-9            iopsou(2,1)     0
1-10           ciopso(2)       NA
1-11           iopsou(4,1)     0

Type Data
1-12           ityopr(1)       40

Associated Plan Data
1-13           creuse          NA

Diversion Type
1-14           cdivtyp         Diversion

Conveyance Loss (%)
1-15           OprLoss         0

Miscellaneous Limits
1-16           OprLimit        0

Start Date
1-17           IoBeg           First year of operation

End Date
1-18           IoEnd           Last year of operation

Type Data
1-12           ityopr(1)       40

Associated Plan Data
1-13           creuse          NA

Diversion Type
1-14           cdivtyp         NA

Conveyance Loss (%)
1-15           OprLoss         0

Miscellaneous Limits
1-16           OprLimit        0

Start Date
1-17           IoBeg           First year of operation

End Date
1-18           IoEnd           Last year of operation
```

4.13.41 Reservoir Storage with Special Limits Direct (ityopr=41)

The type 41 operating rule allows a reservoir to store reservoir water right up to the volume of water stored in an Out-Of-Priority plan. It was originally developed to simulate the so called "1955 Exchange" on the Blue River that limits storage in Green Mountain to the amount of water diverted out-of-priority by Denver and Colorado Springs with respect to Green Mountain Reservoir. The following are noted:

- Source 1 should be a reservoir water right supplied in the reservoir right file (*.rer). Note when this right is tied to a type 41 operating rule it is turned off and StateMod prints a warning. By turning this right off, StateMod ensures this right no longer diverts as a standard reservoir but instead is controlled by information in the Type 41 operating rule.
- The administration number assigned in the reservoir right file overrides the administration number assigned in the operating rule. Note if the administration numbers are not equal, StateMod warns the user that the data in the reservoir right file controls.
- The destination should be a reservoir.
- The variable intern is used to store up to 10 plans that might limit the reservoir storage.
- The intervening plans should be Out-of-Priority (type 9) Plans.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operation right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly and Limiting Plan Switch
                                 +n Number of Limiting OOP plans
                                    (max = 10)
                                 -n Include -12 monthly on/off
                                    values minus n limiting OOP
                                    plans
                                    Note, when a negative value is,
                                    provided, it should be -13 or
                                    less for 12 monthly values and
                                    one limiting OOP plan)
1-5            ioprsw(1)      Annual On/Off Switch
                                 0 off
                                 1 on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Reservoir ID
1-7            iopdes(2,1)    Destination structure account
                              For a reservoir destination, enter
                                 +n Account to be served by this right
                                 -n Fill the first n accounts based on
                                    the ratio of their ownership
```

```
Supply Data
1-8            ciopso(1)      Reservoir Water right
1-9            iopsou(2,1)    0 (not used)
1-10           ciopso(2)      NA
1-11           iopsou(4,1)    0 (not used)

Type Data
1-12           ityopr(1)      41

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        Diversion

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Limiting OOP Plan Volume Data
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx limiting
                                 OOP Plan ID’s
                              For -dumx, Enter abs(dumx)-12
                                 limiting OOP PlanID's
```

4.13.42 Plan Demand Reset (ityopr=42)

The type 42 operating rule provides a method to reset a plan demand. The following are noted:

- Because a type 42 rule does not provide a water supply it should, in general, only be used be used to mimic historical operations and/or restrict an operational activity to annual operations.
- Source 1 should be one of the following plan types: 1 = Term and Condition, 2 = Well Augmentation, 9 = Out-of-Priority Plan.

Row-data	Variable	Description
Control Data		
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12, 1x,a12, 1x,2f8.0, 2i8)		
1-1	cidvri(1)	Operational right ID
1-2	nameo(1)	Operational right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly Switch 0 No monthly on/off values 12 Monthly on/off switches
1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n Begin in year n -n Stop after year n
Destination Data		
1-6	ciopde	NA
1-7	iopdes(2,1)	0
Supply Data		
1-8	ciopso(1)	ReUse plan ID
1-9	iopsou(2,1)	Enter 0
1-10	ciopso(2)	NA
1-11	iopsou(4,1)	0
Type Data		
1-12	ityopr(1)	42
Associated Plan Data		
1-13	creuse	NA
Diversion Type		
1-14	cdivtyp	NA
Conveyance Loss (%)		
1-15	OprLoss	0
Miscellaneous Limits		
1-16	OprLimit	0
Start Date		
1-17	IoBeg	First year of operation
End Date		
1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

```
2-1             imonsw(1)       Monthly switch 0=off, 1=on
                                   +n Day first used that month
                                   -n Day last used that month
                                Note the first entry corresponds to the first
                                   month specified in the control file
```

4.13.43 In-Priority Supply (ityopr=43)

The type 43 operating rule provides a method to supply a T&C requirement or a Well Augmentation Requirement if the amount owed in the current time step occurs in priority. The following are noted:

- In order to determine if future pumping depletions can be satisfied In-Priority a well must be tied to an augmentation plan (see **Section 4.49**)
- The amount of water pumped and its associated depletion over time is reported as part of a standard plan output (*.xpl). Source 1 of this report is reserved for In_Priority_Supply_Now (depletions that occur in priority in the month pumped). Source ‘n’ will report in-priority depletions (depletions that occur at a time step after the pumping) if an In-Priority Supply(type 43) operating rule is specified.
- Pumping is determined to be In-Priority in the time step it occurs if there is water available in the stream to offset any net depletion at that time. Therefore, it is allocated at the administration number of the well and is not controlled by this operating rule.
- T&C requirement is determined to be In-Priority in the time step it occurs if there is water available in the stream to offset any net depletion at that time. It is allocated at the administration number in this operating rule.
- In-Priority Depletions associated with pumping in a prior time step occur if there is water available in the stream to offset the depletion when they occur at the river. Because future depletions are stored by augmentation plan, not well, this determination is made at the administration number assigned to this In-Priority Supply Operating Rule (type 43).
- It is impractical to determine if future depletions are In-Priority using the administration number of each well because there are often thousands of wells being modeled and future depletions often extend over 20 years. In addition, this estimate is considered appropriate for a planning model because wells are typically junior to most direct flow and storage rights.
- The administration number assigned to an In-Priority Supply Operating Rule (type 43) is typically a decree weighted average priority of the wells associated with the well augmentation plan. The decree weighted average priority is calculated as follows:

  Admin_Ave = (sum(WR(j) * Admin(j)) / (sum WR(j))
  Where:
  Admin_Ave is the weighted average administration number
  WR(j) is the decreed water right for well j
  Admin(j) is the administration number of well j
  sum() is the summation

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12, 1x,2f8.0, 2i8)
```

1-1	cidvri(1)	Operational right ID
1-2	nameo(1)	Operational right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly Switch 0 No monthly on/off values 12 Monthly on/off switches
1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n Begin in year n -n Stop after year n

Destination Data

1-6	ciopde	Well Augmentation Plan or Term and Condition Plan
1-7	iopdes(2,1)	0

Supply Data

1-8	ciopso(1)	NA
1-9	iopsou(2,1)	0
1-10	ciopso(2)	NA
1-11	iopsou(4,1)	0

Type Data

1-12	ityopr(1)	43

Associated Plan Data

1-13	creuse	NA

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

4.13.44 Recharge Well (ityopr=44)

The type 44 operating rule provides a method to pump a Recharge well in order to fill a Recharge Reservoir. The following comments are provided to assist in using and interpreting this rule:

- A recharge well operating rule ties a well right (ciopso(1)) to a recharge reservoir (ciopdes(1)) and account (iopdes(2,1)). Typically the recharge reservoir's seepage provides a lagged water supply for an augmentation plan.
- A recharge well only diverts when it is in priority.
- A recharge well is typically located close to the river and has a relatively quick, if not instantaneous, impact on the river. This quick response is not a requirement, simply how they typically operate. If the recharge well has a lagged depletion that is out of priority its augmentation requirement is included in the plan data (creuse). The depletions associated with this source are specified in the well station file (*.wes).
- A recharge well might serve as both a water supply and a recharge reservoir's source. This can occur when the same well right is assigned to both a standard (irrigation) well structure and a type 44 operating rule. If the administration number assigned in the operational right file is different than the administration number of the source (augmentation) well the operating rule value is used and a warning is printed to the log file. The amount pumped to each demand is limited by the well's total capacity and water right.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)       Operational right ID
1-2            nameo(1)        Operation right name
1-3            rtem(1)         Administration number
1-4            dumx            Monthly On/Off Switch
                                  0 Include no monthly on/off values
                                  12 Include 12 monthly on/off values
1-5            ioprsw(1)       Annual On/Off Switch
                                  0 off
                                  1 on
                                  +n Begin in year n
                                  -n Stop after year n
Destination Data
1-6            ciopde          Recharge Reservoir
1-7            iopdes(2,1)     Recharge Reservoir Account

Supply Data
1-8            ciopso(1)       Well Water Right ID
1-9            iopsou(2,1)     0 (not used)
1-10           ciopso(2)       NA (not used)
1-11           iopsou(4,1)     0

Type Data
1-12           ityopr(1)       44

Plan Data
```

```
1-13           creuse         Augmentation Plan used to track future
                                 depletion obligations, if any

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0

Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file

Intervening Structure Data without loss
Include only if the variable (dumx) = 1-10 or < -12
Format (36x, 10a12)
3-1            intern(1,1)    For +dumx, Enter dumx intervening
                                 structure ID's
                              For -dumx, Enter abs(dumx)-12
                                 intervening structure ID's
```

4.13.45 Carrier with Loss (ityopr=45)

The type 45 operating rule provides a method to divert water to a carrier with loss. The carrier then delivers water to a diversion or reservoir. The source may be a diversion water right or, if delivering to a reservoir, a diversion or reservoir water right. The type 45 rule can include transit losses on up to 10 intervening structures. Also it allows the user to specify a percent of the source right that is owned. This routine is similar to type 11 but includes more extensive treatment of transit losses and water right ownership. The following are noted:

- A diversion is implicitly constrained by the capacity of the destination structure (variable ciopde).
- The source water right may operate as a standard direct flow right and/or as a carrier. When the variable iopsou(2,1) = 0 the right is used as a carrier only. When the variable iopsou(2,1) = 1 the right is used as both a direct flow right and a carrier right.
- If a source right is used by both a direct flow and operating rule total diversions by both the direct flow and operating rule are not allowed to exceed the decreed capacity.

- If the destination is a diversion, the source should be a diversion water right.
- **If the destination is a diversion, the demand should be specified at the location where the destination is located** (i.e. not the carrier location). Therefore any transit losses between the carrier headgate and the destination will be calculated by StateMod and implicitly included in the river headgate demand.
- If the destination is a reservoir, the source should be a diversion water right or a reservoir water right.
- **If the destination is a reservoir, the demand is calculated at the location where the reservoir is located** (i.e. not the carrier location). Therefore any transit losses between a river headgate and the destination will be calculated by StateMod and implicitly included in the river headgate demand.
- If the destination is a reservoir and the source is a diversion right, the operating rule diversion IS NOT CHARGED against the reservoir's decree.
- If the destination is a reservoir and the source is a reservoir right, the operating rule diversion IS CHARGED against the reservoir's decree.
- Transit losses are reported with the carrier structure, not the destination.
- When the destination is an off-channel reservoir and the source is its water right, the administration location (ciopso2) may be used to administer the reservoir right at a diversion location located on the mainstem. This diversion location is implicitly treated as a carrier.
- When the miscellaneous limit (oprlimit) is set to a non zero value indicating a limit is provided the source constraint (ipsou(2,k) should be set to 1 to indicate the source water right is controlled by this operating rule. Without this constraint, water may be diverted under the source right, not this operating rule.
- When the miscellaneous limit (oprlimit) is set to 2 the diversion is limited to both the destination demand (ciopde) and the demand of the reservoir structure listed in row 4. The demand of the reservoir structure listed in row 4 is obtained from the monthly target file (*.tam) or daily reservoir target file (*.tad). Note that when the demand (ciopde) is a reservoir the monthly target (along with the capacity, etc.) is implicitly used to limit the amount diverted to a reservoir. However since a resrvoirs capacity may go up or down during a time step the voulue diverted may exceed the target value. When data is assigned herein the target is also used as a volumetric limit that cannot be exceeded in a given time step. This option is, typically, only used when the destination is a Recharge Reservoir.
- When the miscellaneous limit (oprlimit) is set to 3 the diversion is limited to both the destination demand (ciopde) and the demand of the diversion structure listed in row 4. The demand of the diversion structure listed in row 4 is obtained from the monthly diversion demand file (*.ddm) or daily diversion demand file (*.ddd).
- When the miscellaneous limit (oprlimit) is set to 4 the diversion is limited to both the destination demand (ciopde) and the monthly and annual limits specified by the type 47 operating rule listed in row 4.
- Results for a type 45, Carrier with Loss, are reported in the Stream Report (*.xdd) as follows:
    1. At the destination, the diversion is reported as From Carrier by Other,
    2. At the carrier structure, the diversion is reported as From River by Other, loss is reported as From River Loss, and Carried, Exchange or Bypassed is From River by

Other less From River Loss. The Total Supply associated with the carrier is zero (diversion less loss less carried water equals zero)

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number. Note if
                                   ciopso(1) is a diversion right,
                                   its administration number is
                                   used and rtem is ignored
1-4             dumx            Monthly and Structure Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   -n Include 12 monthly on/off
                                      values minus n intervening
                                      structures
                                      Note, when a negative value is
                                      provided, it should be -13
                                      or less
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n=Begin in year n
                                   -n=Stop after year n
Destination Data
1-6              ciopde         Destination diversion or reservoir ID
1-7              iopdes(2,1)    Destination structure account,
                                   1 for a diversion destination
                                   +n for a reservoir destination
                                   +n Account served by this right
                                   -n Fill the first n accounts using
                                      the ratio of their ownership

Source Data
1-8              ciopso(1)      Water right ID under which the
                                   diversion occurs.
                                   Note may be a diversion right or
                                   a reservoir right
1-9              iopsou(2,1)    0 The source water right (ciopso(1))
                                   is left on (i.e. it can be used
                                   as a both a direct flow right
                                   and this operating rule)
                                1 The source water right (ciopso(1)
                                   is turned off (i.e. it can only be
                                   used by this operating rule)
1-10             ciopso(2)      NA the water right is administered at
                                   the location specified in the
                                   appropriate water right file
```

```
                              +n the water right is administered
                                 at location n (e.g. a reservoir
                                 right is administered at the
                                 carrier or the reservoir)
1-11            iopsou(4,1)   +n Percent of the water right
                                 ciopso(1) to be used as a source.

Type Data
1-12           ityopr(1)      45

Associated Plan Data
1-13           creuse         NA If the carrier loss is not
                                 associated with a recharge source
                              +n Enter Recharge Plan ID if the
                                 carrier loss is a recharge source.
                                 Note the Plan type must be recharge
                                 (type 8).

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0 No Transit loss

Miscellaneous Limits
1-16           OprLimit       0  The source water right is not
                                    Shared with another operating rule.
                               1 Not currently operational.
                               2 In addition to the destination
                                    demand (ciopde) the diversion is
                                    limited to the reservoir demand of
                                    the structure listed in Row 4.
                               3 In addition to the destination
                                    demand (ciopde) the diversion is
                                    limited to the diversion demand of
                                    the structure listed in Row 4.
                               4 In addition to the destination
                                    demand (ciopde) the diversion is
                                    limited to the monthly and annual
                                    limits of the Type 47 operating
                                    rule listed in Row 4

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if monthly & structure switch (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
```

```
                                    -n Day last used that month
                                 Note the first entry corresponds to
                                    the first month specified in the control file

Intervening Structure Data with loss
Include only if the monthly & structure switch (dumx) = 1-10 or < -12
See Section 7 for the approach used to model an augmentation station (e.g. a
structure that carries a diversion, typically with loss, then returns non-lost
water to the river).

Free Format
3b-1           intern(1,1)    Intervening structure ID
                                 (e.g. a Diversion ID or Stream ID)
3b-2           OprLossC(l,1)  Carrier Loss for Structure ID %
3b-3           InternT(1,1)   Intervening Structure Type
                              Enter Carrier if it is a diversion
                                 structure located on the river
                              Enter Return if it is a return
                                 location on the River

                              Repeat for +dumx values

Additional Demand constraint
Include only if the switch (OprLimit) = 2 or 3

Free Format
4-1            cx             If Oprlimit = 2 enter the
                                 diversion ID whos demand
                                 will limit the amount diverted.
                              If Oprlimit = 3 enter the
                                 Recharge reservoir ID whose demand
                                 will limit the amount diverted.
                              If Oprlimit = 4 enter the Type 47
                                 Operational right ID that contains
                                 Monthly and annual diversion limits
```

4.13.46 Multiple Plan Ownership (ityopr=46)

The type 46 operating rule provides a method to distribute water from one accounting plan to multiple accounting plans at the same priority. It is typically used along with a Direct Flow Exchange (type 24) or Direct Flow Bypass (type 25) when the transferred water is used by more than one owner. The following are noted:

- The source is an accounting plan for which the water supply is typically a water transfer associated with a Direct Flow Exchange (type 24) or Direct Flow Bypass (type 25).
- The destination is two or more accounting plans. Each plan represents the percent ownership of the transferred water from the original accounting plan. Each should be located downstream of the source account.
- After the water is distributed via the Type 46 rule, water is typically released from the destination plans using an Admin Plan Direct Release (type 27), or an Admin Plan Exchange (type 28), or an Admin Plan Spill (type 29).
- The percent ownership is specified using variable iopdes(2,k) as a percent.

- The maximum number of owners is set at 10.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly and Structure Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   -n Include -12 for monthly on/off
                                      Values minus n intervening
                                      structures
                                      Note, when a negative value is,
                                      provided, it should be -13
                                      or less)
1-5             ioprsw(1)       Annual On/Off Switch
                                   0=off
                                   1=on
                                   +n=Begin in year n
                                   -n=Stop after year n

Destination Data
1-6             ciopde          Destination plan ID
1-7             iopdes(2,1)     Destination ownership %

Source Data
1-8             ciopso(1)       Accounting Plan ID
1-9             iopsou(2,1)     1
1-10            ciopso(2)       NA
1-11            iopsou(4,1)     NA

Type Data
1-12            ityopr(1)       46

Associated Plan Data
1-13            creuse          NA

Diversion Type
1-14            cdivtyp         Diversion

Conveyance Loss (%)
1-15            OprLoss         NA

Miscellaneous Limits
1-16            OprLimit        +n Number of Destinations

Start Date
1-17            IoBeg           First year of operation
```

```
End Date
1-18            IoEnd           Last year of operation

Repeat the Destination plan ID (ciopde) and Destination ownership %
(iopdes(2,1)) for the number of destinations (OprLimit(k))
Format (81x, a12, i8)

Monthly Data
Free Format
Include only if OprLoss = 0 and the variable (dumx) = 12 or less than -12
2-1             imonsw(1)       Monthly switch 0=off, 1=on
                                   +n Day first used that month
                                   -n Day last used that month
Note the first entry corresponds to the first month specified in the control file
```

4.13.47 Accounting Plan Limit (ityopr=47)

The type 47 operating rule provides a method to impose monthly and annual limits for one or more operating rules. It is typically used when the source of the water supply is a "standard" storage right. For example if water is stored in a reservoir under a "standard" storage right, releases to selected users might be limited to the monthly and annual limits imposed by this rule. This rule has generic application but was developed for the Colorado River Basin where replacement reservoir releases from Green Mountain Reservoir, Williams Fork Reservoir and Wolford Mountain Reservoir are limited to 66,000 af/yr. The Accounting Plan assigned as the source in this rule is typically tied to a Replacement Reservoir Release (type 10) or a Direct Flow Release with a Plan (type 27). The following are noted:

- The operating rule's source is an accounting plan that requires a monthly or annual limit. It can be located anywhere in the network.
- The operating rule's destination is null (i.e. the rule simply imposes monthly or annual limits on any water user tied to this plan).
- The administration number specified for this plan is not used by StateMod (i.e. it is simply a place holder).
- The annual limits are reset at the month that corresponds to the source variable iopsou(2,k). For example 1 = January, 2=February, etc.)
- Monthly and annual data is required for this operating rule.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
                1x,a12,1x, 2f8.0, 2i8)
1-1             cidvri          Operational right ID
1-2             nameo(1)        Operational right name
1-3             rtem(1)         Administration number
1-4             dumx            Monthly and Structure Switch
                                   +n Number of intervening structures
                                      (max = 10)
                                   -n Include -12 for monthly on/off
                                      Values minus n intervening
                                      structures
                                      Note, when a negative value is,
```

provided, it should be -13 or less

1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n=Begin in year n -n=Stop after year n

Destination Data

1-6	ciopde	NA
1-7	iopdes(2,1)	NA

Source Data

1-8	ciopso(1)	Accounting Plan ID
1-9	iopsou(2,1)	Month when the operatingal limits are Reset (e.g. 1= January, 2 = February, etc).
1-10	ciopso(2)	NA
1-11	iopsou(4,1)	NA

Type Data

1-12	ityopr(1)	47

Associated Plan Data

1-13	creuse	NA

Diversion Type

1-14	cdivtyp	Diversion

Conveyance Loss (%)

1-15	OprLoss	NA

Miscellaneous Limits

1-16	OprLimit	0 Do not include Monthly or Annual Operational limits 1 Monthly and Annual **diversion** limits are provided (see row 3)

Start Date

1-17	IoBeg	First year of operation

End Date

1-18	IoEnd	Last year of operation

Monthly Data
Free Format
Include only if OprLoss = 0 and the variable (dumx) = 12 or less than -12

2-1	imonsw(1)	Monthly switch 0=off, 1=on +n Day first used that month -n Day last used that month Note the first entry corresponds to the first month specified in the control file

```
Operating Limits (Monthly and Annual)
Include if OprLimit = 1
3-1           OprMax(1,1-12) Monthly exchange limit (af/mo)
3-13          OprMax(1,13)   Annual exchange limit (af/yr)
```

4.13.48 Plan or Reservoir Reuse to a T&C or Augmentation Plan Direct (ityopr=48)

The type 48 operating rule provides a method to release water from a reservoir, recharge site or Reuse Plan to a T&C or Well Augmentation Plan destination (demand) via a direct release to the river. The following comments are provided:

- A “ReUse Plan” **source** is a special structure type that can be used to provide water supplies that might accrue from a water right transfer or reusable imported water. See Section 7 for more details.
- A “Recharge Plan” **source** is a special structure type that can be used to provide water supplies that might accrue from a reservoir or canal seepage.
- A “Special Augmentation” Plan **source** is a plan type that can be used to recognize a physical water supply is not required because of an administrative decision. Examples are wells located in a designated basin or decreed as non tributary.
- A “T&C” Plan destination (**demand)** is a special structure type that can be used to store Terms and Conditions (demands) that might be imposed on a water use as part of a water transfer.
- An “Augmentation” Plan destination (**demand)** is a plan type that can be used to store water demands imposed on a water use in order to allow a well to pump out of priority.
- A “Special Augmentation” Plan destination (**demand)** is a plan that can be used to store water demands that can be offset by an administrative decision. Examples are wells located in a designated basin or decreed as non tributary.
- If the variable OprLimit is set to 0 no adjustment to monthly or annual diversion limits will be performed. If the variable OprLimit is set to -1 the operating rule ID specified in row 4 will have its monthly and annual diversion limits adjusted by the amount released.
- If the variable ceuse is set to a plan ID, any canal losses will be routed to that plan. Note the plan type must be 8 (recharge).
- Results for a type 48, Reservoir to a Plan Direct, are reported in the Stream Report (*.xdd) as follows:
    - At the destination well plan, the diversion is reported as From River by Storage (exchange) and the Total Supply equals From River by Other. The station balance reports River Divert as zero because the diversion is to a plan which is non-consumptive.
    - At the source reservoir on only carrier and Station Balance data are reported. The River Divert equals the net amount diverted at the reservoir (diversion less release). If the reservoir does not store then the net amount diverted should be negative and equal to the amount released to the destination well plan less any losses.

```
Row-data     Variable         Description
___________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
              1x,a12, 1x,2f8.0, 2i8)
```

1-1	cidvri(1)	Operational right ID
1-2	nameo(1)	Operational right name
1-3	rtem(1)	Administration number
1-4	dumx	Monthly Switch 0 No monthly on/off values 12 Number of monthly on/off Switches provided
1-5	ioprsw(1)	Annual On/Off Switch 0=off 1=on +n Begin in year n -n Stop after year n

Destination Data

1-6	ciopde	Plan ID (must be a T&C Plan (type 1) or a Well Augmentation Plan (type 2) or a Special Augmentation Plan (type 10)
1-7	iopdes(2,1)	0 (Not used)

Supply Data

1-8	ciopso(1)	Reservoir ID or Recharge Plan ID or Reuse Plan ID or Special Augmentation Plan ID. If a plan it must be a Reservoir Recharge Plan (type 8) or CU reuse plan (type 3 or 4) or a Special Augmentation Plan (type 10)
1-9	iopsou(2,1)	If ciopso(1) is a reservoir, enter the reservoir account If ciopso(1) is not a reservoir enter 0
1-10	ciopso(2)	If ciopso(1) is a Recharge Plan enter the associated Reservoir ID, otherwise enter NA
1-11	iopsou(4,1)	0

Type Data

1-12	ityopr(1)	48

Associated Plan Data

1-13	creuse	NA	Canal losses are routed to the river
		Plan ID	Canal losses are routed to Plan ID

Diversion Type

1-14	cdivtyp	NA

Conveyance Loss (%)

1-15	OprLoss	0

Miscellaneous Limits

1-16	OprLimit	0

Start Date

1-17	IoBeg	First year of operation

```
End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

4.13.49 Plan or Reservoir Reuse to a T&C or Augmentation Plan by Exchange (ityopr=49)

The type 49 operating rule provides a method to release water from a reservoir, recharge site or Reuse Plan to a T&C or Well Augmentation Plan destination (demand) via an exchange from the river. The following comments are provided:

- A “ReUse Plan” **source** is a special structure type that can be used to provide water supplies that might accrue from a water right transfer or reusable imported water. See Section 7 for more details.
- A “Recharge Plan” **source** is a special structure type that can be used to provide water supplies that might accrue from a reservoir or canal seepage.
- A “Special Augmentation” Plan **source** is a plan type that can be used to recognize a physical water supply is not required because of an administrative decision. Examples are wells located in a designated basin or decreed as non tributary.
- A “T&C” Plan destination (**demand)** is a special structure type that can be used to store water Terms and Conditions (demands) that might be imposed on a water use as part of a water transfer.
- A “Augmentation” Plan destination (**demand)** is a plan type that can be used to store water demands imposed on a water use in order to allow a well to pump out of priority.
- A “Special Augmentation” Plan destination (**demand)** is a plan that can be used to store water demands that can be offset by an administrative decision. Examples are wells located in a designated basin or decreed as non tributary.
- If the variable OprLimit is set to 0 no adjustment to monthly or annual diversion limits will be performed. If the variable OprLimit is set to -1 the operating rule ID specified in row 4 will have its monthly and annual diversion limits adjusted by the amount released.
- Results for a type 49, Reservoir to a Plan by Exchange, are reported in the Stream Report (*.xdd) as follows:
    - At the destination well plan, the diversion is reported as From River by Other (exchange) and the Total Supply equals From River by Other. The station balance reports River Divert as zero because the diversion is to a plan which is non-consumptive.
    - At the source reservoir only carrier and Station Balance data are reported. The River Divert equals the net amount diverted at the reservoir (diversion less release). If the

reservoir does not store then the net amount diverted should be negative and equal to the amount released to the destination well plan less any losses.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12, 1x,2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly Switch
                                 0 No monthly on/off values
                                 12 Number of monthly on/off
                                    switches provided
1-5            ioprsw(1)      Annual On/Off Switch
                                 0=off
                                 1=on
                                 +n Begin in year n
                                 -n Stop after year n

Destination Data
1-6            ciopde         Plan ID (must be a T&C Plan (type 1)
                                 or Augmentation Plan (type 2) or
                                 Special Augmentation Plan (type 10)
1-7            iopdes(2,1)    0 (Not used)

Supply Data
1-8            ciopso(1)      Reservoir ID or Recharge Plan ID or
                                 Reuse Plan ID or Special
                                 Augmentation Plan ID
                              If a plan it must be
                                 Seepage Plan (type 8) or
                                 CU reuse plan (type 3 or 4)
                                 or a Special Augmentation Plan (type 10)
1-9            iopsou(2,1)    If ciopso(1) is a reservoir, enter the
                                 reservoir account
                              If ciopso(1) is a plan, enter NA
1-10           ciopso(2)      If ciopso(1) is a Recharge Plan enter the
                                 associated Reservoir ID, otherwise enter NA
1-11           iopsou(4,1)    0

Type Data
1-12           ityopr(1)      49

Associated Plan Data
1-13           creuse         NA

Diversion Type
1-14           cdivtyp        NA

Conveyance Loss (%)
1-15           OprLoss        0
```

```
Miscellaneous Limits
1-16           OprLimit       0

Start Date
1-17           IoBeg          First year of operation

End Date
1-18           IoEnd          Last year of operation

Monthly Data
Free Format
Include only if the variable (dumx) = 12 or less than -12
2-1            imonsw(1)      Monthly switch 0=off, 1=on
                                 +n Day first used that month
                                 -n Day last used that month
                              Note the first entry corresponds to the first
                                 month specified in the control file
```

4.13.50 South Platte Compact Storage (ityopr=50)

For a complete description of how the South Platte compact is implemented in StateMod see Section 7. The Type 50 operating rule temporarily stores water available to the South Platte Compact in priority in an administrative plan. It is used in conjunction with a type 40 operating rule to insure the South Platte Compact does not call out any water right located in water district 64 (e.g. upstream of the Washington county line). In addition it is used with a type 40 operating rule to release water to the compact itself after every junior water right not located in water district 64 has had the opportunity to insure it was not called out by the compact. The following comments are provided:

- The type 50 operating rule turns off the source instream flow right so that it is completely controlled by the type 50 operating rule.
- The administration number assigned to the operating rule used to store water in the South Platte Compact plan (type 50) should be 17332.00000, the value associated with the South Platte's decreed priority of June 14, 1897.
- Results for a type 50, South Platte Compact Storage, are reported in the Stream Report (*.xdd) as follows:
    - At the destination compact plan, the diversion is reported as From River by Other because it is diverted by an operating rule. The Total Supply equals From River by Other that equals Water Use To Other. The station In/Out reports the diversion as a return flow because it is non-consumptive. The Station Balance reports River Divert as the amount diverted to the plan.

```
Row-data       Variable       Description
_____________________________________________________________________

Control Data
Format (a12, a24, 12x, 4x, f12.5, f8.0, i8, 3(1x,a12,i8), i8, 1x,a12,
               1x,a12,1x, 2f8.0, 2i8)
1-1            cidvri(1)      Operational right ID
1-2            nameo(1)       Operational right name
1-3            rtem(1)        Administration number
1-4            dumx           Monthly switch 0=off, 1=on
```

```
                              +n Day first used that month
                              -n Day last used that month
                           Note the first entry corresponds to the first
                              month specified in the control file
1-5           ioprsw(1)    Annual On/Off Switch
                              0=off
                              1=on
                              +n=Begin in year n
                              -n=Stop after year n

Destination Data
1-6           ciopde       Enter the plan ID that corresponds
                                To the South Platte compact (must
                                Be an administrative, type 11 plan)
1-7           iopdes(2,1)  Destination Account, enter 1

Supply Data
1-8           ciopso(1)    Instream flow water right associated
                                With the South Platte Compact

1-9           iopsou(2,1)  0
1-10          ciopso(2)    NA
1-11          iopsou(4,1)  0

Type Data
1-12          ityopr(1)    50

Associated Plan Data
1-13          creuse       NA

Diversion Type
1-14          cdivtyp      Diversion

Conveyance Loss (%)
1-15          OprLoss      0

Miscellaneous Limits
1-16          OprLimit     0

Start Date
1-17          IoBeg        First year of operation

End Date
1-18          IoEnd        Last year of operation
```

4.13.51 Operating Rule Examples

```
#
# Operating rule types listed below are described in detail in StateMod documentation,
# Section 4.13.x where 'x' is the rule type listed below.
#
# This .opr file contains example operating rules that can be copied to a blank file to start
# development of operating rules for a different application. These examples have the correct
# format and can be expanded based on information in Section 4.13 of the StateMod documentation
# and the specific applications for which the rules are to be used.
#
# Start new .opr file with header line below that starts with "# ID        Name"
#
#
#
#               OPERATING RULE TYPES
#     ========================================
#        1   Reservoir to an Instream Flow
#        2   Reservoir to a Direct Flow or Reservoir or Carrier
#        3   Reservoir to a Carrier
#        4   Reservoir Exchange to a Direct Flow
#        5   Reservoir Exchange to Storage
#        6   Paper Exchange Between Reservoirs
#        7   Reservoir to a Carrier by Exchange
#        8   Out-of-Priority Book Over
#        9   Release for Target Contents
#        10  General Reservoir Replacement
#        11  Carrier to a Ditch or Reservoir
#        12  Re-operate Water Rights
#        13  Index flow Constraint on an Instream Flow Diversion
#        14  Carrier with Constrained Demand
#        15  Interruptible Supply
#        16  Direct Flow Storage
#        17  Rio Grande Compact - Rio Grande
#        18  Rio Grande Compact - Conejos River
#        19  Split Channel Operations
#        20  San Juan Reservoir RIP Operation
#        21  Wells with Sprinkler Use
#        22  Soil Moisture Use
#        23  Downstream Call
#        24  Direct Flow Exchange of a Pro-Rata Water Right
#        25  Direct Flow Bypass of a Pro-Rata Water Right
#        26  Changed Water Rights Operation
#        27  Reservoir or Reuse Plan to a Diversion or Reservoir Direct with or without Destination Reuse
#        28  Reuse Plan to a Diversion or Reservoir by Exchange with or without Destination Reuse
#        29  Reuse Plan Spill
#        30  Reservoir Re-Diversion
#        31  Carrier to a Ditch or Reservoir with Reusable Return Flows
#        32  Reservoir and Plan to a Direct Flow or reservoir or Carrier Direct with or without Destination Reuse
#        33  Reservoir and Plan to a Direct Flow or Reservoir or Carrier by Exchange with or without Destination Reuse
#        34  Reservoir to Reservoir Transfer with Reuse
#        35  Import to a Diversion, Reservoir or Carrier with or without Reuse
#        36  Seasonal (daily) On and Off Capability (e.g. Meadow Rights)
#        37  Augmentation Well
#        38  Out-of-Priority Diversion (addresses the upstream storage statute)
```

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#        39  Alternate Point Diversion
#        40  South Platte Compact
#        41  Reservoir Storage with Special Limits
#        42  Plan Reset
#        43  In-Priority Well Depletion
#        44  Recharge Well
#        45  Carrier with Transit Loss (allows multiple carriers and associated loses)
#        46  Multiple Ownership Plans (distributes Plan contents to multiple plans)
#        47  Administration Plan Limits
#        48  Plan or Reservoir Reuse to a Plan Direct
#        49  Plan or Reservoir Reuse to a Plan by Exchange
#       50  South Platte Compact Storage
#
#
#         GENERAL GUIDE TO COLUMN ENTRIES
#  ==========================================
#   ID         ID number of operating rule that is used to separate operating rule output in *.xop file
#   Name       Name of operating rule - used for descriptive purposes only
#   Admin#     Administration number used to determine priority of operational water rights relative to other operations and direct diversion, reservoir, instream flow, and well rights (see tabulation in *.xwr file)
#   # Str      Number of carrier structures, monthly on/off switches, or monthly volumetrics (flag telling StateMod program the number of entries on next line)
#   On/Off     1 for ON and 0 for OFF (must use # to turn off rules with more than one line)
#   Dest ID    Destination of operating rule whose demand is to be met by simulating the operating rule
#   Dest Ac    Account at destination to be met by operating rule - typically 1 for a diversion structure and account number for reservoir destination
#   Sou1 ID    ID number of primary source of water under which water right is being diverted in operating rule - typically a water right, reservoir, or Plan structure
#   Sou1 Ac    Account of Sou1 - typically 1 for a diversion structure and account number for reservoir source
#   Sou2 ID    ID of Plan where reusable storage water or reusable ditch credits is accounted
#   Sou2 Ac    Percentage of Plan supplies available for operation
#   Type       Rule type corresponding with definitions in Chapter 4 of StateMod documentation
#   ReusePlan  ID of Plan where reusable return flows or diversions to storage are accounted
#   Div Type   'Diversion' indicates pro-rata diversion of source water right priority or exchange of reusable credits to Dest1
#              'Depletion' indicates pro-rata diversion of source water right priority consumptive use or augmentation of upstream diversions at Dest1
#   OprLoss    Percentage of simulated diversion lost in carrier ditch (only applies to certain rules - see StateMod documentation, Section 4.13)
#   Limit      Capacity limit for carrier structures different from capacity in .dds file (used to represent constricted conveyance capacity for winter deliveries to reservoirs)
#   Comments   Description of rule type
#
# Note - multiple *.opr input file formats may be provided. It is recommended the following string be provided near the top of the file before any data: # FileFormatVersion 2
# If the format version indicator is not provided StateMod will try to read the file and try to determine the appropriate file type.
#
#
#          OPERATING RULE EXAMPLES
#  ==========================================
#
# ID        Name                    NA                    Admin#   # Str  On/Off Dest Id     Dest Ac  Sou1 Id     Sou1 Ac  Sou2 Id     Sou2 Ac     Type ReusePlan    Div Type      OprLoss   Limit Comments
# ---------eb----------------------eb----------exxxxb----------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------exb----------exb----------exb------eb------exb----------
#
# FileFormatVersion 2
#
##########
#  Type 1   Reservoir to an Instream Flow
#          Green Mountain Reservoir (ID 363543 - Account 6) to meet 15-mile reach fish flows (ID 952002)
#          during July through October only (12 monthly switches for USGS Water Year simulation included on second line)
#
3635430.26  Opr Fish to Fish Flow                   99999.93011     12.       0 952002            1 363543            6 0                  0       1 NA           NA                  0       0       0    9999
                                  1 0 0 0 0 0 0 0 0 1 1 1
#
```

```
##########
#  Type 2   Reservoir to a Direct Flow or Reservoir or Carrier
#           Williams Fork Reservoir (ID 513709) release from GMR1 Pool (Account 4) to meet Farmers Irrigation Company (ID 952011) demand
#           carried through Silt Pump Canal (ID 390663 on second line)
#
5137090.30  Opr WFR-Silt Project                    39041.00002      1.       1 950011            1 513709            4 0                 1       2 NA            NA                   0       0       0    9999
                        390663
#
##########
#  Type 3   Reservoir to a Carrier
#           Meadow Creek Reservoir (ID 513686) release from Denver/Englewood Pool (Account 1) directly to Moffat Tunnel (ID 510728) without using the river
#
5136860.02  Opr MCrkRes to 510728                   31259.30134      0.       1 510728            1 513686            1 0                 0       3 NA            NA                   0       0       0    9999
#
##########
#  Type 4   Reservoir Exchange to a Direct Flow
#           Meadow Creek Reservoir (ID 513686) release from Vail Ditch Pool (Account 2) to the upstream Vail Ditch (ID 510941) via the river by exchange
#
5136860.01  Opr MCkRes->VailIrDivSys                31259.30134      0.       1 510941            1 513686            2 0                 0       4 NA            NA                   0       0       0    9999
#
##########
#  Type 5   Reservoir Exchange to Storage
#           Wolford Mountain Reservoir (ID 503668) release from Colorado Springs Replacement Pool (Account 1) to first two accounts (-2 below) in upstream
#           Granby Reservoir (ID 514620) via the river by exchange
#
5036680.17  Opr Wolford - Granby Ex                 31258.00007      0.       1 514620           -2 503668            9 0                 0       5 NA            NA                   0       0       0    9999
#
##########
#  Type 6   Paper Exchange Between Reservoirs
#           Bookover of water from Vega Reservoir (ID 723844) Project Irrigation Pool (Account 1) to Vega Reservior Power Exchange Pool (Account 3), limited
#           by amount of water simulated through operating rule ID 7205830.01 (Cottonwood Branch Pipeline direct diversion water right carried to Molina Power
#           Plant - see Type 11 example below)
#
7238440.19  Opr Vega Bookovr for 583                37486.00001      0.       1 723844            3 723844            1 7205830.01        0       6 NA            NA                   0       0       0    9999
#
##########
#  Type 7   Reservoir to a Carrier by Exchange
#           Rifle Gap Reservoir (ID 393508) release from Silt Pool (Account 1) to Grass Valley Canal (ID 390563) via river by exchange to meet simulated
#           Type 11 carrier diversion in operating rule ID 3905630.01 (Grass Valley Canal direct flow right to Dry Elk Valley Irrigation)
#
3935080.01  Opr RifleGap to G.Valley                37503.36902      0.       1 3905630.01        1 393508            1 0                 0       7 NA            NA                   0       0       0    9999
#
##########
#  Type 8   Out-of-Priority Bookover
#           Bookover water stored in Upper Blue Lakes Out-of-Priority (OOP) account (Reservoir ID 363570, Account 2) to the general purpose account in Upper Blue Lakes (Account 3)
#           The OOP diversions via the Upper Blue Lakes storage right (ID 363570.01 - first entry on third line) subordinated to the Green Mountain Reservoir storage right (ID 363543.01)
#           occur via a Type 38 OOP Diversion rule (ID 3635700.08 - second entry on third line)
#           The type 8 OOP bookover simulates once the 363543.01 storage right is paper filled and occurs during the July through October period (12 switches on second line)
#           The amount of water booked over reduces the OOP Plan (ID 363570OOPPLN) by the same amount
#
3635700.15  OOP_Upper_Blue_Bookover                 99999.00000    -14.       1 363570            3 363570            2 363543.01         0       8 363570OOPPLN NA                    0       0       0    9999
                        0 0 0 0 0 0 1 1 1 1 0 0
                        363570.01    3635700.08
#
```

```
##########
#  Type 9   Release for Target Contents
#           Release water proportionally from all accounts (Account 0) in Williams Fork Reservoir (ID 513709) to meet target contents in *.tar file
#           (Dest ID = 0 and Dest Account = 0 in operating rule)
#
5137090.15  Opr Williams Fork target                 99999.99999      0.       1 0                  0 513709            0 0                   0       9 NA           NA                  0       0       0    9999
#
##########
#  Type 10  General Reservoir Replacement
#           Wolford Mountain Reservoir (ID 503668) releases from Denver R1 Pool (Account 5) over the 1985 to 1996 period to supply reservoir water to a
#           large number of structures without supplying individual operating rules for each. Beneficiaries of reservoir releases from this operating rule
#           have direct flow water right (*.ddr) administration numbers senior to the operating rule's administration number (48965.99994) and variable
#           "ireptyp" in the direct diversion station (*.dds) file set to 1 or -1.
#
5036680.31  Opr Wolf Replace1                        48965.99994      0.       1 0                  1 503668            5 0                   0      10 NA           NA                  0       0    1985    1996
#
##########
#  Type 11  Carrier to a Ditch or Reservoir Using a Direct Flow Right
#           Carry water through Cottonwood Branch Pipeline (ID 720583) using its direct diversion right (ID 720583.01) to Molina Power Plant (ID 720807)
#
7205830.01  Opr Cottonwood-Molina                    37486.00000      0.       1 720807             1 720583.01         1 NA                  0      11 NA           NA                  0       0       0    9999
#
#           Carrier to a Reservoir using a Storage
#           Carry water through North Horse Supply Canal (NHorseSup) to Haines Flat Reservoir (ID HainesRes) using its storage right (ID HainesRes.01)
#           The primary difference with the previou rule is the storage right is not administered at the location of the reservoir right but, instead,
#            is administered on a neighboring tributary at the location of Sou2 ID NHorseSup
#
Haines.01   Opr_Fill_Haines_NHorse                     2008.0000      1.       1 HainesRes          1 HainesRes.01      0 NHorseSup           0      11 NA           NA                  0       0       0    9999
                                    NHorseSup
#
##########
#  Type 12  Re-operate Water Rights
#           Limit tolerance of reoperation in the model based on user specified administration number (50000.0), as necessary, to stop run-time errors
#           (i.e. ireopx > 1000 iteration limit)
#
ReopLimit.01 Opr_Limit_Reoperation                   99999.99999      0.       1 0                  0 0                 0 0                   0      12 NA           NA                  0       0       0    9999
#
##########
#  Type 13  Index Flow Constraint on an Instream Flow Diversion
#           Operate La Plata Compact as most senior water right (admin. no. 0.00001) to deliver to downstream location (instream flow ID 332999) based on percentage (50%)
#           of index gage(La Plata River at Hesperus - ID 09365500) over June to December period (12 monthly switches for Irrigation Year simulation included on line 2)
#
3329990.01  Opr LaPlata Compact                       0000.00001     12.       1 332999             1 09365500         50 332999.01           1      13 NA           NA                  0       0       0    9999
                                    1 1 0 0 0 0 0 1 1 1 1 1
#
##########
#  Type 14  Carrier with Constrained Demand
#           Limit water carried through Willow Creek Feeder (ID 510958) using its senior water right (ID 510958.01) to fill the first two accounts (Destination
#           Account = -2) in Granby Reservoir (ID 514620) by the amount historically diverted by Willow Creek Feeder included in direct diversion demand (*.ddm) file
#
5109580.01  Opr WCrkFeeder to Granby                 31258.00000      0.       1 514620            -2 510958.01         1 0                   1      14 NA           NA                  0       0       0    9999
#
```

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##########
#  Type 15  Interruptible Supply
#           Dedicate Louden Ditch (ID 0400530) junior water right (ID 0400530.03) to instream flow reach (ID BigT_ISF) when downstream gage flows at ID 06741510 drop below
#           3000 acre-feet per month (~50 cfs)
#           One hundred percent of the decree (zero value after water right ID 0400530.03) can be used as an interruptible supply during the May through October period (12 switches on Line 2)
#
ISFDonate   Opr_DirectFlowToISFReach                32224.00000     12.       1 BigT_ISF           1 06741510        3000 0400530.03         0      15 NA           NA                  0       0       0    9999
                        0 0 0 0 1 1 1 1 1 1 0 0
#
##########
#  Type 16  Direct Flow Storage
#           Limit water carried through Willow Creek Feeder (ID 510958) using its senior water right (ID 510958.01) to fill the first two accounts (Destination
#           Account = -2) in Granby Reservoir (ID 514620) by the amount historically diverted by Willow Creek Feeder included in direct diversion demand (*.ddm) file
#           This rule is similar to the Type 14 rule above except that it requires a bypass of 40 percent of the water right, thereby limiting the direct flow storage
#           to 60 percent (variable listed before rule type 16) of the Willow Creek Feeder senior water right
#
5109580.01  Opr WCrkFeeder to Granby                31258.00000      1.       1 514620            -2 510958.01          1 0                   60      16 NA           NA                  0       0       0    9999
#
##########
#
#  Type 17  Rio Grande Compact - Rio Grande
#           Starting in 1969, determine Colorado's Rio Grande Compact delivery requirements to downstream location (ID RGCOM) based on index flows at the Rio Grande
#           at Del Norte gage (ID 08220000) and the Conejos River nr La Sauses (ID 08249000)
#           Include water from source IDs ClosedBasin and NortonSouth
#
RGCOM.01    Opr Compact-RioGrande                      1.00000    -20.    1969 RGCOM            1. 08220000         1. 08249000        -1.      17 NA           Diversion           0       0    1969    9999
                                                                1985.      0.                    1 ClosedBasin    19200 NortonSouth    -4000
                        1 1 1 1 1 1 1 1 1 1 1 1
#
##########
#  Type 18  Rio Grande Compact - Conejos River
#           Starting in 1969, determine Colorado's Rio Grande Compact delivery requirements to downstream location (ID RGCOM) based on index flows at the Conejos River
#           nr Magote gage (ID 08246500) and the San Antonito River at Ortiz (ID 08247500)
#           Include water from source IDs ClosedBasin and NortonSouth
#
COCOM.01    Opr Compact-Conejos                        1.00000    -20.    1969 COCOM            1. 08246500         1. 08247500         1.      18 NA           Diversion           0       0    1969    9999
                                                                1985.      0. 08248000           1 ClosedBasin    16000 NortonSouth     4000
                        1 1 1 1 1 1 1 1 1 1 1 1
#
##########
#  Type 19  Split Channel Operations
#           Currently Under Development
#
##########
#  Type 20  San Juan Reservoir RIP Operation – these operations are no longer used to simulate SJRIP
#
##########
#  Type 21  Wells with Sprinkler Use
#           Operate wells serving sprinkler-irrigated lands first based on input priority (admin. no. 36525.0) senior to ground water rights (*.wer) in order to maximize water supply mode
#
Opr_Spr.01  Opr_Sprinkler                           36525.00000       0.       1 NA                0 NA                0 0                   0      21 NA           NA                  0      -1       0    9999
#
```

```
##########
#  Type 22  Soil Moisture Use
#           Water deliveries in excess of a diversion's consumptive demand can be stored in the soil moisture zone, with this operating rule defining the priority (admin. no. 100000.0)
#           water stored in the soil moisture zone is used (e.g. after surface rights, after well right, etc.).
#
Opr_Soil.01 Opr_Soil_Moisture                    100000.00000       0.       1 NA                 0 NA                 0 0                  0      22 NA           NA                  0      -1       0    9999
#
##########
#  Type 23  Downstream Call
#           Operate downstream call (modeled as instream flow node ID DwnCall). Priorities of daily calls defined in call *.cal) file. Priority of Type 23 operating rule set as most
#           junior water right in basin to ensure the call's instream flow demand does not simulate prior to any other water rights.
#
Opr_Dwncall Opr_Dwncall                          999999.00000      0.       1 DwnCall            1 N/A                1 0                  0      23 NA           NA                  0       0       0    9999
#
##########
#  Type 24  Direct Flow Exchange of a Pro-Rata Water Right
#           Exchange water diverted in priority associated with portion (100%) of Burlington Canal (ID 0200802) water right (ID 0200802.03) to upstream municipal demand (ID Metro_IN),
#           limited by monthly exchange amounts (ac-ft values listed on line 2)
#
OprBurl.01  Opr_Burlington_to_Metro_In              5205.00000      0.       1 Metro_IN           1 0200802.03       100 NA                  0      24 NA           Diversion           0       0       0    9999
        0.      0.      0.   5000.   5000.   5000.   5000.   5000.   5000.   5000.      0.      0. 25000.0
#
##########
#  Type 25  Direct Flow Bypass of a Pro-Rata Water Right
#           Bypass water diverted in priority under Fisher Ditch (ID 0700570) water right (ID 0700507.01) to downstream demand (ID CherokPP)
#           carried through Fisher Ditch with 10% ditch loss (line 2) limited by monthly bypass amounts (ac-ft values listed on line 3)
#
Fish.01     Opr_ChangedFisherToAcctPSCO             4198.00000      1.       1 CherokPP           1 0700570.01      71.3 NA                  0      25 NA           Diversion          -1       0       0    9999
                                0700570     10 Carrier
       0.      0.      0.    308.    615.    796.    923.    796.    548.    376.      0.      0.  4366.0
#
##########
#  Type 26  Changed Water Rights Operation
#           Temporarily store a portion (50%) of Eureka Ditch (ID 4700614) changed water right (ID 4700614.01) in a Changed Water Rights plan (ID 614_PLN, Plan Type 13)
#           limited by monthly and annual amounts (ac-ft values listed on line 2)
#           Remaining portion of water right is available to meet any headgate demand
#
614_PLN.01  Eureka_Full_Plan                       13765.00000      0.       1 614_PLN            1 4700614.01        50 NA                  0      26 NA           Diversion           0       0       0    9999
   0.   0.  0.  0.  4300.  4300.  4300.  4300.  0.  0.  0.  0.  15000.0
#
##########
#  Type 27  Reservoir or Reuse Plan to a Diversion or Reservoir Direct with or without Destination Reuse
#           Release water from Accounting Plan (ID 614_40PLN) to Eureka Ditch Irrigation Demand (ID 614_40_I) through
#           a carrier (Burlington Canal ID 4700614) (line 2) with a Reuse Plan (ID Reuse)
#           Capacity at the source water right location will be accounted for by referencing the original Changed Water Rights operating rule (Opr ID 614_PLN.01, Type 26) (line 3)
#
614_PLN.04  614_40PLN_to_614_40_I                  13765.00004      1.       1 614_40_I           1 614_40PLN        100 NA                  0      27 ReusePln     Diversion          -1       5       0    9999
                                4700614       0       Carrier
                                614_PLN.01
#
```

```
##########
#  Type 28  Reuse Plan to a Diversion or Reservoir by Exchange with or without Destination Reuse
#           Release water from Accounting Plan (ID Compact_Pln) to Irrigation demand (ID CoorsAB_Wtr) via exchange through
#           a carrier (ID 0100501) with a 29 percent conveyance loss
#
CompactEx.1 Compact_to_0100507_I                    18353.10000      1        1 0100507_I          1 Compact_Pln      100 NA                0      28 NA           Diversion          -1        0       0    9999
                                    0100501  29   Carrier
#
##########
#  Type 29  Reuse Plan Spill
#           Spill unused water stored in Changed Water Rights plan (ID 614_PLN) since it cannot be carried over to subsequent time steps
#            Spill to the source water right location  (ID 4700614) when spilling a Changed Water Rights plan
#            Spill at the plan location for other types of plan (ID NA)
#
614_PLN.10  614_PLN_Spill                           13765.00009      0.       1 4700614            0 614_PLN            0 NA                0      29 NA           NA                  0        0       0    9999
#
##########
#  Type 30  Reservoir Rediversion
#           Not currently used -
#           Releases from Type 48/Type 49 rules are limited by the destination plan demands, which precludes excess releases being made
#           that would be rediverted under a Type 30 rule
#
##########
#  Type 31  Carrier to a Ditch or Reservoir with Reusable Return Flows
#           Carry water through Pecks Gulch diversion (ID 0700537 on line 3) using its water right (ID 0700537.02) to Hole In the Ground Reservoir
#           (ID 0704492) using portion (100%) of Barr Lake storage right (ID 0200802.01) over the November to March period (12 monthly
#           switches for Irrigation Year included on line 2) with stored water accounted for in Reservoir Reuse Plan (ID CC_HIG_Sto)
#
Pecks.03    Opr_Pecks_to_HIG                        43829.19751    -13.       0 0704492            1 0700537.02         0 N/A               0      31 CC_HIG_Sto   NA                  0        0       0    9999
                                    1 1 1 1 1 1 0 0 0 0 0 0
                                    0700537
#
##########
#  Type 32  Reservoir and Plan to a Direct Flow or Reservoir or Carrier Direct with or without Destination Reuse
#           Release water from reservoir (ID 0704492) and associated Reservoir Reuse Plan (ID CC_HIG_Sto) to Central City demand (ID CC_WTP)
#           directly with reusable return flows stored in Non Reservoir Reuse Plan (ID CCReusePlan)
#
HIG.01      Opr_HIG_to_CC_WTP                       52731.00001      0.       0 CC_WTP             1 0704492            1 CC_HIG_Sto        0      32 CCReusePlan  NA                  0        0       0    9999
#
##########
#  Type 33  Reservoir and Plan to a Direct Flow or Reservoir or Carrier by Exchange with or without Destination Reuse
#           Release water from reservoir (ID 0203699) and associated Reservoir Reuse Plan (ID WGLksPln) to Thornton demand (ID THIN_DMD)
#           by exchange with reusable return flows stored in Non Reservoir Reuse Plan (ID MetroTh)
#
WGL.04      Opr_WGL_Reusable_To_THIN_DMD            55835.00004      0.       1 THIN_DMD           1 0203699            1 WGLksPln          0      33 MetroTh      Diversion           0        0       0    9999
#
##########
#  Type 34  Reservoir to Reservoir Transfer with Reuse
#           Bookover water stored in Upper Blue Lakes (ID 363570, Account 1) and associated Out-of-Priority Plan (364512OOPPLN) to first five accounts (Account 5)
#           in Dillon Reservoir (ID 364512) on August 1 each year (-1 switch on second line) limited by Colorado Springs Utilities release limit plan operating rule (ID CSULimit.01)
#
3635700.06  Opr_UBlue_to_Dillon_Book                    1.00002     12.       1 364512             5 363570             2 363570OOPPLN      0      34 364512OOPPLN Diversion           0        2       0    9999
                                    0 0 0 0 0 0 0 0 0 0 -1 0
                                    CSULimit.01
#
```

```
##########
#  Type 35  Import to a Plan
#           Import diversion structure (ID TestImp) stored in accounting plan (ID TestPln)
#           Import diversion structure ID must be the same as the Import plan ID (Plan Type 7)
#
TestImp.01  TestImporttoPlan                             1.00000      0.       1 TestPln           1 TestImp           1 NA                  0      35 NA           NA                 0.0     0.0       0    9999
#
##########
#  Type 36  Seasonal (daily) On and Off Capability (e.g. Meadow Rights)
#           Operate a direct flow meadow right (ID 0100517.01) for Deuel and Snyder Canal (ID 0100517) through May 15 only
#           (12 monthly switches for Calendar Year simulation included on line 2)
#
Opr_Mead.01 Opr_Meadow_D&S_01                          100.00000      12.      1 0100517           1 0100517.01        0 0                   0      36 NA           NA                   0      -1       0    9999
                                    1 1 1 1 -15 0 0 0 0 0 0 0
#
##########
#  Type 37  Augmentation Well
#           Operate augmentation well water right (ID 6405901) to meet an augmentation plan demand (ID 6402517)
#           with lagged depletions from augmentation well pumping accounted for in an augmentation plan (ID 6402517)
#
64025170.09 SEDGWICK Aug Well                        99996.00000       0       1 6402517           1 6405901           0 6402517             0      37 NA           Diversion        0.00    0.00       0    9999
#
##########
#  Type 38  Out-of-Priority Diversion (addresses the upstream storage statute) with operating rule priority senior to diversion structure's water right
#           Operate Con-Hoosier Tunnel (ID 954683) diversions against Green Mountain Reservoir storage right (ID 363543.01)
#           (admin. no. 31257.99995) to that storage right priority over the April to July period (12 monthly swithces for
#           USGS Water Year included on line 2) and account for those diversions in an out-of-priority plan structure (ID 54683OOPPLN)
#
9546830.03  Opr_OOP_Cont_Hoosier                     31257.99995     12.       1 954683            1 363543.01         0 364683.01           0      38 954683OOPPLN Diversion            0       0       0    9999
                                    0 0 0 0 0 0 1 1 1 1 0 0
#
##########
#  Type 39  Alternate Point Diversion - currently under development
#           Operate water right (ID Dem_2_Wr#1) to meet demand (ID Dem_2) at alternate point of diversion (ID Alt_Div)
#
Or_AltPoint Opr_AlternatePoint                           1.00000      0.       1 Dem_2             1 Dem_2_Wr#1        1 Alt_Div             0      39 NA           Diversion            0       0       0    9999
#
##########
#  Type 40  South Platte Compact
#           Operate Compact at Stateline (represented by instream flow ID 6499999) to meet South Platte Compact requirement
#           (120 cfs with 6/14/1897 priority date (admin. no. 17332.0), represented as instream flow water right
#           over the April 1 to October 15 season (represented as instream flow demand (*.ifr) for ID 649999)
#           Compact_64x attempts to meet upstream demands (upstream of WD 64) from the Compact Plan (ID Compact_Pln) via exchange
#           Compact_Isf releases remaining water in the Compact Plan (ID Compact_Pln) to meet the Compact Demand (ID 6499999)
#           Works in conjunction with Type 50 rule, see below
#
Compact_64x Opr_Compact_Out_64x                      17332.00000      0.       1 64x               1 Compact_Pln       0 NA                  0      40 NA           Diversion          0.0     0.0       0    9999
Compact_Isf Opr_Compact_Out_Isf                      99999.99999      0.       1 6499999           1 Compact_Pln       0 NA                  0      40 NA           Diversion          0.0     0.0       0    9999
#
```

```
##########
#  Type 41  Reservoir Storage with Special Limits
#           Implement 1955 exchange as part of Blue River Decree by limiting Green Mountain Reservoir (ID 363543) storage diversions (ID 363543.01)
#           to the first 5 accounts in the reservoir (Destination Account = -5) up to the volume of water stored out-of-priority by Con-Hoosier Tunnel,
#           Upper Blue Lakes, Roberts Tunnel, and Dillon Reservoir, as accounted for in the respective out-of-priority Plans
#           (954683OOPPLN, 363570OOPPLN, 364684OOPPLN, 364512OOPPLN) over the April to July period (12 monthly swithces for USGS Water Year included on line 2)
#
3635430.29  Opr_1955_B_R_Decree_Exch                 38628.00000    -16.       1 363543            -5 363543.04          0 NA                  0      41 NA           Diversion           0       0       0    9999
                                    0 0 0 0 0 0 1 1 1 1 0 0
                                    954683OOPPLN 363570OOPPLN 364684OOPPLN 364512OOPPLN
#
##########
#  Type 42  Plan Reset
#           Zero out accounting plan for Con-Hoosier Tunnel (ID 954683OOPPLN) on March 31 (12 monthly switces for USGS Water Year included on line 2)
#
954683PLN.1 Opr_Reset_C-Hoosier_Plan                 99999.99999     12.       1 NA                 0 954683OOPPLN       0 NA                  0      42 NA           NA                  0       0       0    9999
                                    0 0 0 0 0 31 0 0 0 0 0 0
#
##########
#  Type 43  In-Priority Well (or T&C) Depletion
#           Meet augmentation requirements accounted for in Augmentation Plan (ID 0102513) with river flows based on input priority (admin. no. 58925.00001)
#
01025130.01 ROTHE In-Priority Lagged                 58925.00001       0       1 0102513            1 NA                 0 NA                  0      43 NA           Diversion        0.00    0.00       0    9999
#
##########
#  Type 44  Recharge Well
#           Operate recharge well water right (ID 6406709) to recharge area (ID 6402517_R).
#           Recharge pond seepage accounted for based on seepage characteristics in reservoir structure (*.res) file and  reservoir delay table (*.rrf) file
#
64025170.08 SEDGWICK Recharge Well                   55971.00000       0       1 6402517_R          1 6406709            0 NA                  0      44 NA           Diversion        0.00    0.00       0    9999
#
##########
#  Type 45  Carrier with Transit Loss (allows multiple carriers and associated loses)
#           Carry water through Empire Canal (Carrier ID 0100501) to Empire Reservoir (ID 0103816) using portion (100%) of Empire Reservoir storage right (ID 0103816.01)
#           with losses through carrier (29%)
#
01038160.01 Opr_Empire_Store                         20226.00000       1.      1 0103816            1 0103816.01         0 0100501           100      45 NA           Diversion         0.0     0.0       0    9999
                                    0100501 29 Carrier
#
##########
#  Type 46  Multiple Ownership Plans (distributes Plan contents to multiple plans)
#           Split portion of water diverted into Changed Water Rights Plan (ID 614_PLN - see Type 26 above) to number (2)
#           of Changed Water Rights Plans (614_60PLN, 614_40PLN) owned by users of the total portion of
#           water diverted from the river based on their specific percentages (60%, 40%, respectively) of the total portion diverted
#
614_PLN.02  Split_Eureka_Full_Plan_60_40             13765.00002      0.       1 614_60PLN         60 614_PLN            1 NA                  0      46 NA           Diversion           0       2       0    9999
                                                                                 614_40PLN         40
#
```

```
##########
#  Type 47 Administration Plan Limits
#          Limit releases associated with plan structure (ID HUPLimitPLN) to monthly and annual amounts listed on Line 2
#          The operating rule that defines the limits of the release limit plan (ID HUPLimit.01) is typically used in General Reservoir Replacement (type 10) or Plan release
#          to demand (type 27/28) operating rules as a limit on the operation of these other operating rules
#
HUPLimit.01 Annual_HUP_Pool_Release_Limit                1.00000      0.       1 NA                1 HUPLimitPLN        4 0                  0      47 NA           Diversion           0       1       0    9999
  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.  66000.
#
##########
#  Type 48 Plan or Reservoir Reuse to a Plan Direct
#          Meet term and conditions return flow obligations (ID Burl_RFs) with release of Non Reservoir Reuse Plan supplies (ID MetroTh) directly via the river
#
Metro.09    OprMetroThBurl_RFs                       55835.00014      0.       1 Burl_RFs          0 MetroTh            0 NA                 0      48 NA           NA                  0       0       0    9999
#
#
##########
#  Type 49 Plan or Reservoir Reuse to a Plan by Exchange
#          Meet well augmentation plan requirements (ID 0102513) with releases from Recharge Plan supplies (ID 0102528_PlC) via the river by exchange
#
01025130.06 ROTHE Recharge                           58925.00003       0       1 0102513           1 0102528_PlC        0 NA                 0      49 NA           Diversion        0.00    0.00       0    9999
#
##########
#  Type 50 South Platte Compact Storage
#          Temporarily store the Compact Instream Flow right (ID 6499999.01) in the Compact accounting plan (ID Compact_Pln) under the instream flow priority (17332.00000)
#          This rule works in conjunction with Type 40, see above
#
Compact_In  Opr_Compact_In                           17332.00000      0.       1 Compact_Pln       1 6499999.01         0 NA                 0      50 NA           Diversion         0.0     0.0       0    9999
#
```

4.14 Precipitation File - Monthly (*.prc) or Annual (*.pra)

The evaporation file contains total monthly (12 values per simulation year) or annual (12 average values for every year) evaporation data. The type of data provided is controlled by the variable ***moneva*** from the control file. This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   ('FT' or 'IN')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.2)
2-1             ipyr            Year
2-2             cpreid          Precipitation station ID
2-3             preprt(1-12,1) Precipitation (in) for months 1-12

Repeat for the number of stations numpre

Repeat for each year of the simulation
```

4.15 Evaporation File - Monthly (*.evm) or Annual (*.eva)

The evaporation file contains total monthly (12 values per simulation year) or annual (12 average values for every year) evaporation data. The type of data provided is controlled by the variable ***moneva*** from the control file. This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data
                                Enter 1 for January, 10 for October, etc.
1-2             iby             Beginning year of data
                                For monthly data, enter the year (e.g. 1975)
                                For annual data, enter 0
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   ('FT' or 'IN')
```

```
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.2)
2-1             ieyr            Year
2-2             cevaid          Evaporation station ID
3-3             evaprt(1-12,1) Evaporation for months 1-12

Repeat for the number ofstations numeva

Repeat for each year of the simulation
```

4.16 Stream Flow File - Monthly (*.rim or *.xbm)

The streamflow file may contain total baseflows or gains for each month of the simulation period. The control variable ***iopflo*** identifies which is expected; total baseflow (1) or gains (2). When this file is generated outside Statemod or is generated by Statemod and saved for historic purposes, it is commonly named *.rim. When this file is generated by the Statemod baseflow module it is typically named *.xbm. The user is recommended to rename a StateMod generated baseflow file named *.xbm to *.rim to ensure the preservation of a historic baseflow file and a continuous flow of results from the baseflow module to the simulation module. This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   (' ACFT' or 'CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.0)
2-1             iryr            Year
2-2             cistat          Streamflow station ID
2-3             runoff(1-12,1) Streamflow or gain (AF) for months 1-12

Repeat for the number of stations numrun

Repeat for each year of the simulation
```

4.17 Direct Flow Demand File - Monthly (*.ddm)

The monthly direct flow demand file contains demands for direct diversions for each month of the simulation period. Monthly data is required when the diversion station variable ***idvcom*** is set to 1 (monthly total demand) or 3 (monthly irrigation water requirement). Data should be entered in the order of the structure file (*.dds). See Section 7 for a discussion of various approaches available for specifying demand data; demands may be specified as a total at the headgate or as a consumptive irrigation water requirement at the farm. This file is read by subroutine MDAINP.

```
Row-data       Variable       Description
_______________________________________________________________________

Control Data
1                             Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1            ibm            Beginning month of data (e.g. 1=Jan)
1-2            iby            Beginning year of data (e.g. 1975)
1-3            iem            Ending month of data
1-4            iey            Ending year of data
1-5            cunit          Units of data
                                 (' ACFT' or 'CFS')
1-6            cyr            Year type
                                 'CYR'= calendar year (1-12)
                                 'WYR'= water year (10-9)
                                 'IYR'= irrigation year (11-12)
Time Series Data
2                             Format (i4, 1x, a12, 12f8.0)
2-1            idyr           Year
2-2            cistat         Demand station ID
2-3            diverm(1-12,1) Demands (AF) for months 1-12

Repeat for the number of stations numdiv

Repeat for each year of the simulation
```

4.18 Direct Flow Demand File - Annual (*.dda)

The annual direct flow demand file contains twelve constant demands which are repeated for each year of the study period. Annual data is required when the diversion station variable ***idvcom*** is set to 2 (annual total demand) or 4 (annual irrigation water requirement). Data should be entered in the order of the structure file (*.dds). This file is read by subroutine MDAINP.

```
Row-data       Variable       Description
_______________________________________________________________________

Control Data
1                             Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1            ibm            Beginning month of data (e.g. 1=Jan)
1-2            iby            Beginning year of data (e.g. 1975)
1-3            iem            Ending month of data
1-4            iey            Ending year of data
1-5            cunit          Units of data
```

		(' ACFT' or 'CFS')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-12)

Time Series Data

2		Format (5x, a12, 12f8.0)
2-1	cistat	Demand station ID
2-2	diverm(1-12)	Demands (AF) for months 1-12

Repeat for the number of stations

4.19 Direct Flow Demand Overwrite File - Monthly (*.ddo)

The direct flow demand overwrite file contains monthly demands for each year of the study period for selected structures. This file allows a what if scenario to be evaluated quickly without revising the direct flow demand file. This file is read by subroutine MDAINP.

Row-data	Variable	Description
Format (i4, 1x, a12, 12f8.0)		
1-1	idyr	Year
1-2	cistat	Demand station ID
1-3	diverm(1-12)	Demands (AF) for months 1-12

Repeat for the number of stations to be overridden

Repeat for each year of the simulation

4.20 Instream Flow Demand - Monthly (*.ifm)

The monthly instream flow demand file contains instream flow demands for each month of the simulation period. Data should be entered in the order of the structure file (*.ifs). To allow StateMod to be backward compatible with old data sets, this file is required only when monthly data is required (e.g. when the instream flow station (*.ifs) file variable ***iifcom*** is set to 1).
Note negative monthly demands are estimated to be a forecast which is currently only used by the Rio Grande compact simulations (see operation rule types 17 and 18). Also for use by the Rio Grande compact the variable ***rspilx*** may be used to specify the month when a spill occurred and the prorated portion of the spill attributed to Colorado. Data should be entered by year with stations in any order. This file is read by subroutine MDAINP.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data

1-4	iey	Ending year of data
1-5	cunit	Units of data
		(' ACFT' or ' CFS')
1-6	cyr	Year type
		' CYR'= calendar year (1-12)
		' WYR'= water year (10-9)
		' IYR'= irrigation year (11-12)

Time Series Data

2		Format (i4, 1x, a12, 12f8.0, 10x, f8.2)
2-1	idyr	Year
2-2	cistat	Demand station ID
2-3	diverm(1-12,1)	Demands (AF) for months 1-12
		A negative number is treated as a forecast

Repeat for the number of instream flow stations

Repeat for each year of the simulation

Note rspilx is only used by the Rio Grande operating rules (types 17 and 18).

4.21 Instream Flow Demand - Annual (*.ifa)

The instream flow demand file contains 12 monthly instream flow demands for use each year of the simulation. Data should be entered in the order of the structure file (*.ifs). This file is read by subroutine MDAINP.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 0 for annual data)
1-3	iem	Ending month of data
1-4	iey	Ending year of data
1-5	cunit	Units of data
		(' ACFT' or 'CFS')
1-6	cyr	Year type
		'CYR'= calendar year (1-12)
		'WYR'= water year (10-9)
		'IYR'= irrigation year (11-12)
Time Series Data		
2		Format (5x, a12, 12f8.0)
2-1	cistat	Instream Flow station ID
2-2	flowr(1-12,1)	Instream flow requirement for months 1-12

Repeat for the number of stations numifr

Repeat for each year of the simulation

4.22 Well Demand File - Monthly (*.wem)

The monthly well demand file contains demands for well structures for each month of the simulation period. Data may be entered in any order (i.e. its order is independent of the structure file). Monthly data is required when the diversion station variable ***idvcom*** is set to 1 (monthly total demand) or 3 (monthly irrigation water requirement). Note when a well structure is tied to a diversion the total demand is provided in the direct diversion station file and no monthly well demand data is required. This approach should have the control file (.ctl) variable ***icondem*** set to 6. See Section 7 for a discussion of various approaches available for specifying demand data; demands may be specified as a total at the headgate or as a consumptive irrigation water requirement at the farm. This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   (' ACFT' or 'CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.0)
2-1             idyr            Year
2-2             cistatw         Demand station ID
2-3             divermw(1-12,1)   Demands (AF) for months 1-12

Repeat for the number of stations numdivw

Repeat for each year of the simulation
```

4.23 Delay (Return Flow) Table - Monthly (*.urm)

The monthly unit response table file contains coefficients to lag return flows. If the variable ***interv*** of the control file is a positive value, then interv values are expected for every pattern. If variable ***interv*** of the control file is a -1, then the number of values are specified for each pattern. Note a daily model (control file variable ***iday=1***) requires a variable number of return values be provided (variable ***interv*** must be negative). This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
```

1		Format (free)
1-1	idly	Delay table ID
1-2	ndly(1)	Number of entries in delay table idly Include only if variable interv of the control file is equal to -1
Delay Data		
1-3	dlyrat(j,1)	Delay factor for time period j Include as a percent if variable **Interv** of the control file is positive or equal to -1 Include as a decimal if variable **Interv** of the control file is equal to -100 Include ndly or interv delay entries Repeat for the number of delay tables used in the diversion station file

4.24 Reservoir Target File - Monthly (*.tar or *.tam)

The reservoir target file contains monthly targets for a reservoir's minimum and maximum contents. Data should be entered in the order of the structure (*.res) file. Positive maximum contents are end of month targets. Negative values are forecasted inflows. When forecasted inflows are provided the monthly target is estimated as follows:

Target (im) = Current Storage (im) - (Current Storage (im) - Forecast (im) - End Target) / (Months Remaining +1);

Where:

Target (im) is the reservoir target.
Current Storage (im) is the total reservoir storage in month im.
Forecast (im) is the total inflow for the remaining forecast period. Note for a linear forecast this term is often set to -1.
End Target is the target at the end of the forecast period.
Months remaining is the total of all months remaining to be forecasted in a year.

For example, if the forecast data for April, May, June, July is 1,000 af, -1, -1, and 700 af and the Current Storage in April = 1000, then the Target in May is: 1000 - (1000 - 1 -700)/3 = 900.

This file is read by subroutine MDAINP.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data

Row-data	Variable	Description
1-4	iey	Ending year of data
1-5	cunit	Units of data (' ACFT' or 'CFS')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-12)
Time Series Data		
2		Format (i4, 1x, a12, 12f8.0, 10x, f8.2)
2-1	iyr	Year
2-2	cistat	Reservoir station ID
2-3	conmin(1-12,1)	Minimum reservoir targets (AF) for months 1-12
Time Series Data		
3-1	iyr	Year
3-2	xista2	Reservoir station ID
3-3	targetx(1-12,1)	Positive values equal the maximum reservoir targets (AF) by month. Negative values equal the forecasted inflow for future months

Repeat for the number of stations numres

Repeat for each year of the simulation

4.25 Historic Reservoir Content File - Monthly (*.eom)

The historic reservoir content file (*.eom) contains end of month reservoir content data for each year of the study period. Data should be entered in the order of the structure (*.res) file. This data is only used by the Base Flow module to simulate reservoir storage and evaporation impacts on gaged stream flows. It is used by the report module to compare simulated results to gaged observations. This file is read by subroutine VIRGEN.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data
1-4	iey	Ending year of data
1-5	cunit	Units of data (' ACFT' or 'CFS')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-12)
Time Series Data		
2		Format (i4, 1x, a12, 12f8.0)

```
2-1             iryr           Year
2-2             cistat         Reservoir station ID
2-3             resvol(1-12,1) End of Month reservoir contents

Repeat for the number of stations numres

Repeat for each year of the simulation
```

4.26 Base Flow Data (*.rib)

Base flow data is used by the baseflow module to estimate base flows at river nodes that do not have hisoric records using the following formula:

```
FlowX= (FlowB(1)*coefB(1) + FlowB(2)*coefB(2)+ ....) +
pf * (FlowG(1)*coefG(1) + FlowG(2)*coefG(2)+ ....)

Where:
FlowX=  Flow at intermediate node to be estimated

FlowB=  Base flow station(s)
FlowG=  Gain flow station(s)

pf=     Proration factor for gain term
coefB=  Base flow coefficient
coefG=  Gain flow coefficient
```

The first term ((FlowB(1)*coefB(1) + FlowB(2)*coefB(2)+ ....) typically represents upstream gaged flows. The second term (pf * (FlowG(1)*coefG(1) + FlowG(2)*coefG(2)+ ....) typically represents the gain between gages. This file is read by subroutine VIRGEN.

```
Row-data        Variable        Description

Base Station Data
1                               Format (a12, 8x, i8, 10(f8.3, 1x, a12)
1-1             FlowN           Intermediate river node ID
1-2             mbase           Number of base stations to follow
1-3             coefB(1)        Base flow coefficient
1-4             FlowB(1)        Base station ID

Repeat for the number of gaged flows (mbase)

Proration Data
2                               Format (12x, f8.2, i8, 10(f8.3, 1x, a12)
2-1             pf              Proration factor for gain term
2-2             nbase           Number of gain stations to follow
2-3             coefG(1)        Base flow coefficient
2-4             FlowG(1)        Base station ID

Repeat for the number of gain stations flows (nbase)

Repeat for the number of intermediate nodes where base flows are to be estimated
```

4.27 Historic Streamflow File - Monthly (*.rih)

The monthly historic streamflow file is used by the baseflow module to estimate Base flows at gaged and ungaged locations. The monthly historic streamflow file is also used by the report module to compare simulated results to gaged observations. Note, the base flow module may be executed with missing streamflow data (specified by -999) to allow mans impact to be removed prior to filling missing data gaps using a technique such as regression. This file is read by subroutine VIRGEN.

```
Row-data        Variable        Description
___________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   (' ACFT' or 'CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.0)
2-1             iryr            Year
2-2             cistat          Demand station ID
2-3             runoff(1-12,1)  Gaged streamflow for months 1-12
                                Enter -999 to indicate missing data

Repeat for the number of gages provided in the river station file (Section 4.4)

Repeat for each year of the simulation
```

4.28 Historic Diversion File - Monthly (*.ddh)

The monthly historic diversion file is used by the baseflow module to estimate Base flows at gaged and ungaged locations. It is used by the report module to compare simulated results to gaged observations. This file is read by subroutine VIRGEN.

```
Row-data        Variable        Description
___________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   (' ACFT' or 'CFS')
```

```
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.0)
2-1             idyr            Year
2-2             cistat          Demand station ID
2-3             diverm(1-12,1) Recorded diversions for months 1-12

Repeat for the number of demand structures provided in the structure file

Repeat for each year of the simulation
```

4.29 Historic Well Pumping File - Monthly (*.weh)

The monthly historic well pumping file is used by the baseflow module to estimate Base flows at gaged and ungaged locations. It is used by the report module to compare simulated results to gaged observations. This file is read by subroutine VIRGEN.

```
Row-data        Variable        Description
________________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                   (' ACFT' or 'CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, 1x, a12, 12f8.0)
2-1             idyr            Year
2-2             cistatw         Well station ID
2-3             divermw(1-12,1)   Well pumping for months 1-12

Repeat for the number of wells provided in the structure file

Repeat for each year of the simulation
```

4.30 San Juan RIP Sedimentation - Annual (*.sjr)

The annual San Juan Recovery Implementation Plan sedimentation plan file is not longer used.

4.31 Irrigation Parameter Yearly Data File - Annual (*.ipy)

The annual CU time series file contains information required to perform calculations using a variable efficiency approach. It is only used when the control file (*.ctl) variable itsfile >= 1. It is formatted exactly the same as the annual time series file used by the consumptive use model (StateCU). The current standard is to provide four water supply irrigation method combinations (Surface Supply Flood Irrigation, Surface Supply Sprinkler Irrigation, Ground Supply Flood Irrigation and Ground Supply Sprinkler Irrigation). For a description of the old (*.ipy file) format, which StateMod still supports, see Section 9.0 Discontinued but Supported File Formats.

Because multiple input file formats may be provided it is recommended the following string be provided near the top of the file before any data: # FileFormatVersion 2. If the format version indicator is not provided StateMod will try to read the file and try to determine the appropriate file type

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                              Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm            Beginning month of data (e.g. 1=Jan)
1-2             iby            Beginning year of data (e.g. 1975)
1-3             iem            Ending month of data
1-4             iey            Ending year of data
1-5             cunit          Units of data ('NA')
1-6             cyr            Year type
                                    'CYR'= calendar year (1-12)
                                    'WYR'= water year (10-9)
                                    'IYR'= irrigation year (11-10)

Time Series Data
2                              Format (i4,1x,a12,3f6.0,2f8.0,f12.0,f3.0,f8.0)
2-1             idly           Year
2-2             ID             Structure ID
2-3             ceff           Conveyance efficiency (decimal)
2-4             feff           Maximum flood efficiency (decimal)
2-5             seff           Maximum sprinkler efficiency (decimal)
2-6             AcreSF         Acres with a Surface Water Supply and Flood Irrigation
2-7             AreaSS         Acres with a Surface Water Supply and Sprinkler
Irrigation
2-6             AcreGF         Acres with a Ground Water Supply and Flood Irrigation
2-7             AreaG          Acres with a Ground Water Supply and Flood Irrigation
2-8             mprate         Maximum pumping rate (af/mo)
2-9             gwmode         Ground water use mode
                                    1 = maximum supply mode
                                    2 = mutual ditch supply mode
2-10            areax          Total Irrigated acreage for year idly (ac)
```

4.32 Consumptive Water Requirement File - Monthly (*.ddc)

The monthly consumptive water requirement (*.ddc) file contains the consumptive requirement for direct diversion and well only structures for each month of the simulation period. For an irrigation structure the consumptive water requirement is commonly called the Irrigation Water Requirement (IWR). Regardless if the structure is used for irrigation or municipal or industrial use the consumptive water requirement is the amount of water that would be consumed by that structure (e.g. no losses or inefficiencies are included). It is only used when the control file (*.ctl) variable efficiency variable (*ieffmax)* = 1. Data should be provided for every diversion and well only structure. If data is inadvertently provided for a Well structures that is also served by both Surface water the data provided under the Diversion ID is used. When data is not provided (e.g. for a municipal or non consumptive demand) the CU requirement is set to the structures demand / average efficiency provided in the diversion station (*.dds) file or well station (*.wes) file, respectively. Data can be entered in any order. This file is read by subroutine MDAINP.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data
1-4	iey	Ending year of data
1-5	cunit	Units of data ('CFS')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-10)
Time Series Data		
2		Format (i4, 1x, a12, 12f8.0)
2-1	idyr	Year
2-2	cistat	Demand station ID
2-3	diverm(1-12,1)	CU requirement(AF) for months 1-12

Repeat for the number of diversion and Well only stations

Repeat for each year of the simulation

4.33 Soil Moisture (StateCU_Structure) File (*.str)

The soil moisture file is the same as the current StateCU structure file. Note that StateMod versions 10.30 and greater use this in order to be consistent with recent StateCU enhancements. For a description of the old (*.str file) format, which StateMod still supports, see Section 9.0 Discontinued but Supported File Formats.

The StateCU structure file (*.str) contains consumptive use parameters by structure that do not change with time. Only the soil moisture data (*.awc) is used by StateMod in order to perform soil moisture accounting. Other consumptive use information contained in the file (e.g. latitude, location, associated climate stations, etc.) are currently not used.

The soil moisture reservoir available to each structure is the parameter *awc* multiplied by the structures area, multiplied by average depth for every structure in the system specified in the control file (*.ctl) by variable *soild* (feet). It is formatted exactly the same as the soil parameter file used by the consumptive use model (StateCU), therefore it often contains data before or beyond the variable *awc*that is not used by StateMod. Data can be entered in any order. This file is read by subroutine MDAINP during the first year and month of the simulation only.

Because multiple input file formats may be provided it is recommended the following string be provided near the top of the file before any data: # FileFormatVersion 2. If the format version indicator is not provided StateMod will try to read the file and determine the appropriate file type.

```
Row-data          Variable          Description

Control Data
1                                   Format (i4, 1x, a12, 12f8.0)
1-1               cistat            Station ID
1-2               dum               Latitude
1-3               dum               Elevation
1-4               dum               Region1 (e.g. County)
1-5               dum               Region2 (e.g. Hydrologic unit)
1-6               dum               Structure Name
1-6               ncli              # of climate stations
1-7               awc               Available water content (fraction)

Format(a12,f6.2,f9.2)
2-1               dum               Climate ID
2-2               dum               Temperature station weight
2-3               dum               Precipitation station weight

Repeat for the number of stations ncli
```

4.34 GIS File (*.gis)

The *.gis file contains reference to files which contain GIS data related to structures and maps used by the Graphic User Interface.

```
Type              Variable          Description

Control Data
Format (data type: file name (1))
streamflow:     filena  streamflow gage file name
diversion:      filena  diversion location file name
reservoirs:     filena  reservoir location file
precipitation:  filena  precipitation station location file name
```

```
basin:          filena  basin file name
rivers:         filena  hydrology file name
```

4.35 Output Request (*.out)

The output request file contains data which will limit the extent of selected output file requests. Note, the first two rows of data (variables ftype and parameter) are only used by the special printout request (*.xsp). Rows 3 through n contain reference data for the structure(s) to be printed and are used by the standard printout reports (*.xdd, *.xre, *.xir, *.xwe and *.xop). To eliminate the need to type an output request file, one is automatically generated by the check option (-check) for every type of structure in the system. Note the default name for that file is *.xou. It is commonly renamed to *.out and referenced as such in the response file to avoid it being overwritten whenever a new check run is made. Also the structures to be printed by that file default to print nodes where inflow occurs (FLO) and not print other types of nodes (DIV, RES, ISF, WEL, OTH).

Row-data	Variable	Description
Control Data		
1		Format (a72)
1-1	ftype	Output type switch
		Diversion
		Instream Flow
		StreamGage
		Reservoir
		Well
Parameter Data		
2		Format (a72)
2-1	Parameter	For ftype = Diversion, Instream Flow or Streamgage
		Total_Demand
		CU_Demand
		From_River_By_Priority
		From_River_By_Storage
		From_River_By_Exchange
		From_Well
		From_Carrier_By_Priority
		From_Carrier_By_Storage
		Carried_Water
		From_Soil
		Total_Supply
		Total_Short
		CU_Short
		Consumptive_Use
		To_Soil
		Total_Return
		Upstream_Inflow
		Reach_Gain
		Return_Flow
		Well_Depletion
		To_From_GW_Storage

River_Inflow
River_Divert
River_By_Well
River_Outflow
Available_Flow

For ftype = Reservoir
Initial_Storage
River_Priority
River_Storage
River_Exchange
Carrier_Priority
Carrier_Storage
Total_Supply
Storage_Use
Storage_Exchange
Carrier_Use
Total_Release
Evap
Seep_Spill
Sim_EOM
Target_Limit
Fill_Limit
River_Inflow
Total_Release
Total_Supply
River_By_Well
River_Outflow

For ftype = Well
Demand
FromWell
Short
ConsumptiveWaterUse
Return
Loss
FromRiver
FromGWStor
FromSalvage

3		Format (a12,1x,a24,1x,a3,1x,i5)
3-1	idreq	Requested ID Enter ALL, All, all or 0 to get all Enter -999 to indicate last ID requested)
3-2	rec24	Requested structure name
3-3	idtypx	Requested structure type
3-4	ix	Print switch 0 do not print 1 print

Repeat for each structure

4.36 Streamflow File - Daily (*.rid)

The daily streamflow file contains baseflows or a daily pattern for each day of the simulation period. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the daily river station variable ***crunidy*** is set to 3 the river station variable ***crunid*** is used to indicate daily data controls and any monthly data provided in the monthly streamflow file (*.rim or *.xbm) is ignored. When the river station variable ***crunidy*** is set to any ID including its own StateMod uses daily data as a pattern to estimate daily data from monthly data as follows:

$$Qd = Dp * Qm / Dm$$

Where:

Qd = daily estimated flow
Dp = daily flow (pattern)
Qm = monthly flow from the monthly flow file (*.rim)
Dm = monthly sum of daily flow (pattern)

This file is only required if the model is operated in a daily mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data         Variable         Description
________________________________________________________________________

1                                 Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1              ibm              Beginning month of data (e.g. 1=Jan)
1-2              iby              Beginning year of data (e.g. 1975)
1-3              iem              Ending month of data
1-4              iey              Ending year of data
1-5              cunit            Units of data ('CFS')
1-6              cyr              Year type
                                     'CYR'= calendar year (1-12)
                                     'WYR'= water year (10-9)
                                     'IYR'= irrigation year (11-12)

Time Series Data
2                                 Format (i4, i4, 1x, a12, 31f8.0, f8.0)
2-1              idyr             Year
2-2              cistat           Daily station ID
2-3              virindx(1-31)    Streamflow (cfs) or pattern (unitless) for days 1-
31, etc.

Repeat for the number of stream gage stations

Repeat for each year of the simulation
```

4.37 Direct Flow Demand File - Daily (*.ddd)

The daily direct flow demand file contains direct diversion demands or a daily pattern for each day of the simulation period. Data should be entered in the order of the structure file (*.dds). To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the diversion station variable ***cdividy*** is set to 3 the diversion station variable ***cdivid*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.ddm) is ignored. When the diversion station variable ***cdividy*** is set to any ID including its own (**cdivid**) StateMod uses daily data as a pattern to estimate daily data from monthly data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable       Description
_______________________________________________________________________

Control Data
1                              Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm            Beginning month of data (e.g. 1=Jan)
1-2             iby            Beginning year of data (e.g. 1975)
1-3             iem            Ending month of data
1-4             iey            Ending year of data
1-5             cunit          Units of data ('CFS')
1-6             cyr            Year type
                                  'CYR'= calendar year (1-12)
                                  'WYR'= water year (10-9)
                                  'IYR'= irrigation year (11-12)

Time Series Data
2                              Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy             Year
2-2             im             Month
2-2             cdividx        Daily station ID
2-3             diverdx(1-31)  Demand (cfs) or pattern (unitless) for days 1-31,
etc.

Repeat for the number of stations numdiv

Repeat for each year of the simulation
```

4.38 Instream Flow Demand File - Daily (*.ifd)

The daily instream flow demand file contains instream flow demands or a daily pattern for each day of the simulation period. Data should be entered in the order of the structure file (*.ifs). To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the instream flow station variable ***cifridy*** is set to 3 the instream flow station variable ***cifrid*** is used to indicate daily data controls and any monthly data provided in the annual instream flow demand file (*.ifa) is ignored. When the diversion station variable ***cifridy*** is set to any ID including its own (***cifrid)*** StateMod uses daily data as a pattern to estimate daily data from monthly data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data
                                (' ACFT' or 'CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy              Year
2-2             im              Month
2-2             cifridx         Daily station ID
2-3             flowrx(1-31)    Demand (cfs) or pattern (unitless) for days
                                   1-31, etc.

Repeat for the number of instream flows stations

Repeat for each year of the simulation
```

4.39 Well Demand File - Daily (*.wed)

The daily well demand file contains well demands or a daily pattern for each day of the simulation period. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the well station variable ***cdividwy*** is set to 3 the well station variable ***cdividw*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.wem) is ignored. When the diversion station variable ***cdividwy*** is set to any ID including its own (***cdividw)*** StateMod uses daily data as a pattern to estimate daily data from monthly data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily mode with wells on (control file variable *iwell*=1). Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
```

```
1-2            iby            Beginning year of data (e.g. 1975)
1-3            iem            Ending month of data
1-4            iey            Ending year of data
1-5            cunit          Units of data ('CFS')
1-6            cyr            Year type
                                 'CYR'= calendar year (1-12)
                                 'WYR'= water year (10-9)
                                 'IYR'= irrigation year (11-12)

Time Series Data
2                             Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1            iy             Year
2-2            im             Month
2-2            cdividxw       Daily station ID
2-3            diverdxw(1-31) Demand (cfs) or pattern (unitless) for days 1-31,
etc.

Repeat for the number of wells

Repeat for each year of the simulation
```

4.40 Reservoir Target Content File - Daily (*.tad)

The daily reservoir target file contains reservoir targets or a daily pattern for each day of the simulation period. Data should be entered in the order of the structure (*.res) file. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the reservoir station variable ***cresidy*** is set to 3 the reservoir station variable ***cresid*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.tar) is ignored. When the reservoir station variable ***cresidy*** is set to any ID including its own (***cresid)*** StateMod uses daily data as a pattern to estimate daily data from monthly data using the same approach described under daily streamflow data (Section 4.36).

This file only required if the model is operated in a daily mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data       Variable       Description
____________________________________________________________________

Control Data
1                             Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1            ibm            Beginning month of data (e.g. 1=Jan)
1-2            iby            Beginning year of data (e.g. 1975)
1-3            iem            Ending month of data
1-4            iey            Ending year of data
1-5            cunit          Units of data (' ACFT')
1-6            cyr            Year type
                                 'CYR'= calendar year (1-12)
                                 'WYR'= water year (10-9)
                                 'IYR'= irrigation year (11-12)

Time Series Data
```

```
2                              Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy             Year
2-2             im             Month
2-2             cresidx        Daily station ID
2-3             targex2(1-31)  Maximum reservoir target (acft) or pattern for days
1-31

Repeat for the number of stations numres

Repeat for each year of the simulation
```

4.41 Irrigation Water Requirement File - Daily (*.ddx)

The daily consumptive water requirement (*.ddx) file contains the CU requirement for direct diversion and well only structures for each day of the simulation period. It is only used when the control file (*.ctl) variable efficiency control (*ieffmax)* = 1. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the diversion station variable ***cdividy*** is set to the diversion station variable ***cdivid*** daily data controls and any monthly data provided in the monthly consumptive water requirement file (*.ddc) is ignored. When the river station variable ***cdividy*** is set to any ID other than its own direct flow station variable ***cdivid.*** StateMod uses daily data as a pattern to estimate daily data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily mode with variable efficiency (control file itsfile=1 or 10). Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable       Description
_____________________________________________________________________

Control Data
1                              Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm            Beginning month of data (e.g. 1=Jan)
1-2             iby            Beginning year of data (e.g. 1975)
1-3             iem            Ending month of data
1-4             iey            Ending year of data
1-5             cunit          Units of data
                                  (' ACFT' or 'CFS')
1-6             cyr            Year type
                                  'CYR'= calendar year (1-12)
                                  'WYR'= water year (10-9)
                                  'IYR'= irrigation year (11-12)

Time Series Data
2                              Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy             Year
2-2             im             Month
2-2             cresidx        Daily station ID
2-3             targex2(1-31)  Consumptive Water Requirement(cfs) or pattern for
days 1-31
```

```
Repeat for the number of stations numdiv

Repeat for each year of the simulation
```

4.42 Delay Table File - Daily (*.dld)

The daily delay table file contains coefficients to lag return flows. If the variable ***interv*** of the control file is a positive value, then interv values are expected for every pattern and data is expects to be provided as a percent. If the variable ***interv*** of the control file is a -1, then the number of values are specified for each pattern and data is expected to be provided as a percent. If the variable ***interv*** of the control file is a -100, then the number of values are specified for each pattern and data is expected to be provided as a decimal. This file is read by subroutine MDAINP.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (a8, i4, (12f8.2))
1-1             idly            Delay table ID
1-2             ndly(1)         Number of entries in delay table idly
                                   Include only if variable interv of
                                      the control file is equal to -1
                                      or -100
1-3             dlyratd(j,1)    Delay factor for time period j
                                   Include as a percent if variable interv of
                                      the control file is positive or equal to -1
                                   Include as a decimal if variable interv
                                      of the control file is equal to
                                      –100

Include ndly or interv delay entries

Repeat for the number of delay tables used in the diversion station file
```

4.43 Historic Streamflow File - Daily (*.riy)

The daily historic streamflow file contains streamflows or a daily pattern for each day of the simulation period. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the river station variable ***crunidy*** is set to 3 the river station variable ***crunid*** is used to indicate daily data controls and any monthly data provided in the monthly historic streamflow file (*.rih) is ignored. When the river station variable ***crunidy*** is set to any ID including its own (***crunid)*** StateMod uses daily data as a pattern to estimate daily data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily baseflow mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable        Description
_____________________________________________________________________
```

```
Control Data
1                              Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm            Beginning month of data (e.g. 1=Jan)
1-2             iby            Beginning year of data (e.g. 1975)
1-3             iem            Ending month of data
1-4             iey            Ending year of data
1-5             cunit          Units of data ('CFS')
1-6             cyr            Year type
                                  'CYR'= calendar year (1-12)
                                  'WYR'= water year (10-9)
                                  'IYR'= irrigation year (11-12)

Time Series Data
2                              Format (i4, i4, 1x, a12, 31f8.0, f8.0)
2-1             idyr           Year
2-2             cistat         Daily station ID
2-3             virindx(1-31)  Historic Streamflow (cfs) or pattern
                                  (unitless) for days 1-31, etc.

Repeat for the number of stream gage stations

Repeat for each year of the simulation
```

4.44 Historic Diversion File - Daily (*.ddy)

The daily historic diversion file contains diversions or a daily pattern for each day of the simulation period. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the diversion station variable ***cdividy*** is set to 3 the diversion station variable ***cdivid*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.ddm) is ignored. When the diversion station variable ***cdividy*** is set to any ID including its own (***cdivid)*** StateMod uses daily data as a pattern to estimate daily data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily baseflow mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable       Description
________________________________________________________________________

Control Data
1                              Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm            Beginning month of data (e.g. 1=Jan)
1-2             iby            Beginning year of data (e.g. 1975)
1-3             iem            Ending month of data
1-4             iey            Ending year of data
1-5             cunit          Units of data ('CFS')
1-6             cyr            Year type
                                  'CYR'= calendar year (1-12)
                                  'WYR'= water year (10-9)
                                  'IYR'= irrigation year (11-12)
```

```
Time Series Data
2                               Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy              Year
2-2             im              Month
2-2             cdividx         Daily station ID
2-3             diverdx(1-31)   Historic diversion (cfs) or pattern
                                   (unitless) for days 1-31, etc.

Repeat for the number of stations numdiv

Repeat for each year of the simulation
```

4.45 Historic Well Pumping File - Daily (*.wey)

The daily historic well pumping file contains well pumping or a daily pattern for each day of the simulation period. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the well station variable ***cdividyw*** is set to 3 the diversion station variable ***cdividw*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.wem) is ignored. When the diversion station variable ***cdividwy*** is set to any ID including its own (***cdividw)*** StateMod uses daily data as a pattern to estimate daily data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily baseflow mode with wells. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data ('CFS')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy              Year
2-2             im              Month
2-2             cdividxw        Daily station ID
2-3             diverdxw(1-31)  Daily Pumping (cfs) or pattern
                                   (unitless) for days 1-31, etc.

Repeat for the number of wells
```

Repeat for each year of the simulation

4.46 Historical Reservoir Content File - Daily (*.eoy)

The daily historic reservoir content file contains reservoir contents at the end of the day or a daily pattern for each day of the simulation period. Data should be entered in the order of the structure (*.res) file. To simplify the preparation of daily data, StateMod allows the user to provide daily data or a pattern to be used with monthly data. When the reservoir station variable ***cresidy*** is set to 3 the reservoir station variable ***cresid*** is used to indicate daily data controls and any monthly data provided in the monthly direct flow demand file (*.tar) is ignored. When the reservoir station variable ***cresidy*** is set to any ID including its own (***cresid)*** StateMod uses the daily data as a pattern to estimate daily data using the same approach described under daily streamflow data (Section 4.36).

This file is only required if the model is operated in a daily baseflow mode. Data can be entered with stations entered in any order. This file is read by subroutine DAYDATA.

```
Row-data        Variable        Description
_____________________________________________________________________

Control Data
1                               Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1             ibm             Beginning month of data (e.g. 1=Jan)
1-2             iby             Beginning year of data (e.g. 1975)
1-3             iem             Ending month of data
1-4             iey             Ending year of data
1-5             cunit           Units of data ('AF')
1-6             cyr             Year type
                                   'CYR'= calendar year (1-12)
                                   'WYR'= water year (10-9)
                                   'IYR'= irrigation year (11-12)

Time Series Data
2                               Format (i4, i4, 1x, a12, 31f8.2, f8.0)
2-1             iy              Year
2-2             im              Month
2-2             cresidx         Daily station ID
2-3             targex2(1-31)   Daily reservoir target (acft) or pattern for days 1-
31

Repeat for the number of stations numres

Repeat for each year of the simulation
```

4.47 Downstream Call File (*.cal)

The downstream call file is used in conjunction with a downstream call operating rule type 23. See Section 4.13.23 for a description of this operating rule. This file is typically only used for a daily application. Therefore, when StateMod is executed in a monthly mode the call specified on day 1 is used to represent the monthly call. Note that this file is currently formatted to match an example file provided by the user that requested its implementation. Therefore some data contained in that file (e.g. calling structure, priority date) is not used by StateMod. For a monthly analysis this file is read by subroutine MDAINP. For a daily analysis this file is read by subroutine DAYEST.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data
1-4	iey	Ending year of data
1-5	cunit	Units of data ('NA')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-12)
Call Data		
1		Free Format
2-1	icy1	Year
2-2	icm1	Month
2-3	icd1	Day
2-4	dcall1	Administration number of calling right

Repeat for the number of days in simulation

4.48 Rio Grande Spill (*.rgs)

The Rio Grande Spill file contains a file that indicates when Elephant Butte Reservoir historically spilled. Note this file is used only when the Rio Grande Compact is simulated (operating rules 17 and 18) to determine when any debt accrued by Colorado is erased. This file is read by subroutine MDAINP.

Row-data	Variable	Description
Control Data		
1		Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1	ibm	Beginning month of data (e.g. 1=Jan)
1-2	iby	Beginning year of data (e.g. 1975)
1-3	iem	Ending month of data
1-4	iey	Ending year of data
1-5	cunit	Units of data ('NA')
1-6	cyr	Year type 'CYR'= calendar year (1-12) 'WYR'= water year (10-9) 'IYR'= irrigation year (11-12)

For Rio Grande Compact Operating Rules only.

2-1	rspilx(1-12)	0= No Elephant Butte Spill

```
                                      +n= Elephant Butte Spill Data
                                         The integer portion is the month
                                            of spill (e.g. month 6 = 6)
                                         The decimal portion is the
                                            % of Spill that was Colorado’s
                                         Note when a spill occurs:
                                            If Colorado is in debt it is erased
                                            If Colorado is in surplus
                                            their surplus is reduced by %

Repeat for the number of years in the simulation
```

4.49 Plan Data File (*.pln)

The plan station file contains information related to operating a term and condition, well augmentation and reuse plan. It provides data related to the plan including its ID, name, location on the river system, etc. If return flow data is specified for a plan it is provided in the Plan Return File (*.prf). Section 7 provides additional discussion of a plan and their use.

Note that plan efficiency and plan return data can be provided for any plan type, however this information is only used by StateMod for T&C plans (Type 1), Well Augmentation plans (Type 2), and Reuse plans (Types 3 and 4).

- The variable ipeff(1) allows the user to provide either a constant or 12 efficiency values to be used for individual months. If a constant value is provided, it is equal to the value provided with the source structure in the diversion station file (*.dds).

- The variable iprf(1) allows the user to provide either a constant or 12 return flow values to be used for individual months. If a constant value is provided, it is equal to the value provided with the source structure in the diversion station file (*.dds).

Note this file uses a free format read (which is slowly being added to other parts of StateMod). Therefore Plan ID’s and Plan names should be provided with no spaces or in double quotes (e.g. instead of My Name enter “My Name” or My_Name). This file is read by subroutine GETPLN.

```
Row-data       Variable       Description
_____________________________________________________________________

Station Data
1                             Free Format
1-1            Pid(1)         Plan ID (include _ instead of blanks)
1-2            Pname(1)       Plan name (include _ instead of blanks)
1-3            iPsta(1)       River node where the plan is located
1-4            Pon(1)         On (1) or Off (0) switch
1-5            iPlnTyp(1)     Plan type
                                 1 = Terms and Conditions (T&C)
                                 2 = Well Augmentation
                                 3 = Reuse to a Reservoir
                                 4 = Reuse to a Diversion
```

```
                              7 = Import Plan
                              8 = Recharge (reservoir or canal seepage
                              9 = Out-of-Priority Diversion or Storage
                              10 = Special Well Augmentation (e.g.
                                    Designated Basin, Coffin Wells, etc.)
                              11 = Accounting Plan
                              12 = Release Limit Plan
                              13 = Changed Water Right Plan
1-6            Peff(1)        Plan efficiency
                              Enter 0 if not used
                              Enter 1 to read 12 plan efficiency values (%)
                              Enter 999 to use the source structure’s
                                 efficiency data
1-7            iPrf(1)        Plan Return Type
                              Enter 0 if no plan return flows will
                                 be calculated
                              Enter 1 for a T&C Plan with return data
                                 in the plan return flow file (*.prf)
                              Enter 8 for a Recharge Plan with return
                                 data in the plan return flow file (*.prf)
                              Enter 999 to use the source structure’s
                                 return flow data
1-8            iPfail(1)      Plan Failure Switch
                              Used only for a T&C Plan (iPlnTyp = 1)
                              Enter 0 to not turn plan off if it fails
                              Enter 1 to turn a plan off if it fails
1-9            Psto1(1)       Initial plan storage value (acft)
                              Used only for Plan Types = 3, 9, & 12
1-10           Psource(1)     If the plan type is 8 (recharge) enter
                                 ‘Reservoir’ if the source is reservoir
                                 Seepage and enter ‘Diversion’ if the
                                 Source is canal loss.
                              If the plan type is not 8 (not recharge)
                                 enter NA or any other comment
1-11           iPAcc(1)       Source Account of the structure where plan water
                                 becomes available (Note this information is
                                 currently used only when the plan type is
                                 recharge (type 8) from a reservoir

Plan Efficiency Data
Include only if the plan efficiency variable (Peff) = 1
Free Format
2-1            Peff(1,j), j=1,12 Plan efficiency for month 1-12
                              Note the first entry corresponds to the first
                              month specified in the control file
```

4.50 Well Augmentation Plan Data File (*.plw)

The well augmentation plan file contains information that allows a well to operate out of priority because it is tied to an augmentation plan. It provides data that ties a plan ID to a well water right ID and the structure served by that well. This file is read by subroutine GetPlnW. The following is noted:

- StateMod allows one well to be tied to more than one augmentation plan. When this occurs the well's water right should be distributed to each augmentation plan. Typically the distribution to each augmentation plan is based on the acres served by each. This distribution limits total pumping by a well to the decreed rate.
- Because a well may be tied to more than one structure the Well Augmentation Plan file (.plw) is tied to both a well right and the structure served by that right. This limits that augmentation requirement for that well to the structure it serves.

Note this file uses a free format read (which is slowly being added to other parts of StateMod). Therefore Plan ID's and Plan names should be provided with no spaces or in double quotes (e.g. instead of My Name enter "My Name" or My_Name).

```
Row-data        Variable        Description

Free Format
1-1             cistatP         Plan ID
1-2             cistatW         Well Right ID
1-3             cistatS         Well Structure associated with this Well Right
```

4.51Plan Return Flow File (*.prf)

The Plan return file contains return flow data that is used to route canal seepage back to the stream over time (generally used with recharge plans) and plan efficiency information (generally used with T&C plans). For recharge plans, if no plan return flow data is provided, any plan seepage is considered a loss. Similarly if the percent return does not equal 100% then the balance (100%-value specified) is considered a loss. For T&C plans, the total amount of water that returns to the stream is calculated as a function of the amount diverted, the efficiency (or inefficiency) of the diverson (eff), and the return flow pattern. The plan return file (*.prf) contains two pieces of data associated with calculating return flows from a plan; where the return flow enters the stream system (crtnid) and when those returns enter the system over time (irtndlPP). The plan station file provides the efficiency value to be used. As described in section 4.49, StateMod allows the user to provide either a constant efficiency value to use over all time or 12 efficiency values to be used for individual months. This file is read by subroutine GETRES.

```
Row-data        Variable        Description

Control Data
1                               Free Format
1-1             cistat          Plan ID
1-2             crtnid          River node receiving return flow
1-3             pcttotPP(1)     Percent of return flow to this river node
1-4             irtndlPP(1)     Delay (return flow) table for this return flow

Repeat for number of return flow locations

Repeat for number of plans with return flow data
```

4.52 Reservoir Return Flow File (*.rrf)

The Reservoir return file contains return flow data that is used to route reservoir seepage back to the stream over time. If no reservoir return flow data is provided any reservoir seepage is considered a loss. Similarly if the percent return does not equal 100% then the balance (100%-value specified) is considered a loss. This file is read by subroutine GETRES.

Row-data	Variable	Description
Control Data		
1		Free Format
1-1	cistat	Reservoir ID
1-2	crtnid	River node receiving return flow
1-3	pcttotRP(1)	Percent of return flow to this river node
1-4	irtndlRP(1)	Delay (return flow) table for this return flow

Repeat for number of return flow locations

Repeat for number of reservoirs with return flow data

4.53 Reach Data File (*.rch)

The Reach Data file is used to summarize diversion comparison, well comparison, and Consumptive Use reports by reach when the Report option (-report) is specified. To eliminate the need to build a Reach Data file, a preliminary one (*.xrh) is generated by the check option (-check) for every diversion and well in the system. This preliminary Reach Data file contains two main components: Reach Data and Node Data. The following are noted:

- Reach data is used to define how one stream reach is connected to another.
- Node data is used to assigned a stream (river) node to a stream reach.
- The default name for the preliminary file created by the check option is *.xrh. This preliminary file is commonly revised in an editor to reassign the Reach Data connectivity. In addition sub reaches may be defined to represent structures not bounded by a stream gage. After editing the Reach Data file is typically renamed to *.rch to avoid it being overwritten every time a new check run is made.
- If a river gage (*.rig) file is provided it is used by the Check option to define stream reaches. If one is not provided the Check optin uses data in the historic stream file (*.rih) to identify stream reaches. As described, this preliminary definition of steram reaches may be redefined by the user in an editor.
- The file format is free. Therefore names like My Name should be entered as a single string with a hyphen (e.g. My_Name) or enclosed in double quotes (e.g. “My Name”).

Row-data	Variable	Description
1	ctype	Free Format

1-1	ctype	Reach_Data
2-1	RchIdR	Reach ID
2-2	RchNameR	Reach Name
2-3	RchTo	Reach ID reach goes to
2-4	Rrec24	Reach Name reach goes to
2-5	StaID	Stream ID reach goes to

Repeat row 2 for number of Stream Reaches.

Row-data	Variable	Description
1	ctype	Free Format
1-1	ctype	Node_Data
2-1	StaID	River Station ID
2-2	RchNameX	Reach Name
2-3	iRchX	Associated Reach #
2-4	RchIDX	Reach ID

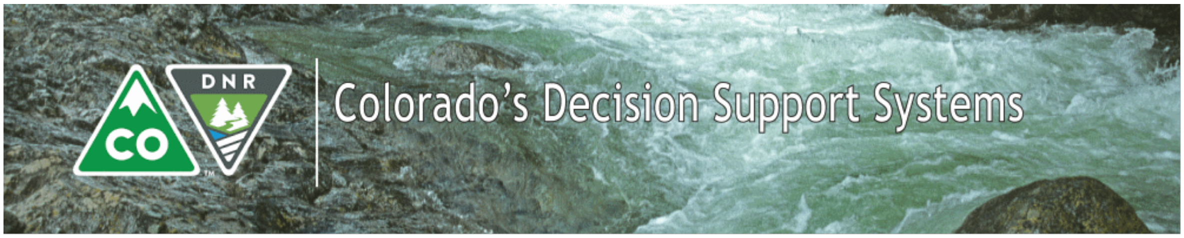
Repeat row 2 for the number of Stream Nodes.

4.54 Plan to Reservoir Recharge Data File (*.plr)

The plan to reservoir recharge file contains information that links a recharge site to an augmentation plan. It provides data that ties a plan ID to a reservoir right, reservoir structure and reservoir owner. StateMod allows one augmentation plan to be tied to more than one recharge sites. This file is read by subroutine GetPlnR.

Note this file uses a free format read (which is slowly being added to other parts of StateMod). Therefore Plan ID's and Plan names should be provided with no spaces or in double quotes (e.g. instead of My Name enter "My Name" or My_Name).

Row-data	Variable	Description
Free Format		
1-1	cistatP	Plan ID
1-2	cistatR	Reservoir Right ID
1-3	cistatS	Reservoir Structure associated with this Right
1-4	cistatO	Reservoir Owner associated with this plan



5.0 Output Description

This chapter describes the report options available in StateMod. The following sections are available in this chapter:

5.0 Remarks

There are numerous output files available from the three modules available in StateMod as described below. For scenario management, the files are given the simulation name plus a standard three character suffix as described below. Section 6.0 Model Operation describes the output command and how to obtain each output file. Note that the output command NA indicates the file is generated by a module automatically. Also, unless otherwise noted, all output files are monthly.

#	Module	Output Command	Output File	Contents
1	Base Flow	NA	*.xbi	Base Flow Information at Stream Gage locations
2	Base Flow	NA	*.xbg	Gaged Base Flow Estimates
3	Base Flow		*.xbm	Estimated Gaged and Ungaged Base Flow
4	Base Flow		*.log	Log file
1	Simulate	NA	*.xdd	Direct and Instream Diversion Data Summary
2	Simulate		*.xre	Reservoir Data Summary (total and by account)
3	Simulate		*.xop	Operation Right Summary
4	Simulate		*.xir	Instream Reach Summary
5	Simulate		*.xca	Call Data Summary
6	Simulate	(1)	*.xpl	Plan Data Summary
7	Simulate	(2)	*.xrp	Replacement Reservoir Summary

8	Simulate	(3)	*.xwe	Well Summary
9	Simulate		*.xss	Structure Summary
10	Simulate		*.log	Log file
11	Simulate-Daily	N/A	*.xdy	Direct and Instream Diversion Data Summary
12	Simulate-Daily		*.xry	Reservoir Data Summary (total and by account)
13	Simulate-Daily		*.xwy	Well Summary (if wells are used)
1	Report	-xst	*.xdd	Direct and Instream Diversion Data Summary
2	Report		*.xre	Reservoir Data Summary (total and by account)
3	Report		*.xop	Operation Right Summary
4	Report		*.xir	Instream Reach Summary
5	Report		*.xwe	Well Summary
6	Report	-xnm	*.xnm	Detailed Node Accounting For All Structures By Year
7	Report		*.xna	Detailed Node Accounting Average
8	Report	-xpl	*.xpl	Detailed Plan Accounting Average
9	Report	-xwb	*.xwb	Water Balance
			*.xgw	Ground Water Balance
10	Report	-xwr	*.xwr	Water Right List Sorted by Basin rank
11	Report	-xdg	*.xdg	Direct Diversion, Instream & Gage Graph file
12	Report	-xrg	*.xrg	Reservoir Graph file
13	Report	-xwg	*.xwg	Well Graph file
14	Report	-xdc	*.xdc	Diversion Comparison file
15	Report	-xrc	*.xrc	Reservoir Comparison file
16	Report	-xwc	*.xwc	Well Comparison file
17	Report	-xsc	*.xsc	Stream Flow Gage Comparison file
18	Report	-xcu	*.xcu	CU Summary
			*.xsu	Water Supply Summary
			*.xsh	Shortage Summary
			*.xwd	CU by Water District (first 2 digits of each ID)
19	Report	-xrx	*.xrx	River Data Summary
20	Report	-xsp	*.xsp	Selected Parameter printout
21	Report	-xbn	*.xbn	ASCII Listing of Binary Direct and Instream Flow Diversion File
22	Report	-xbr	*.xbr	Binary file Listing of Reservoirs
23	Report	-xdy	*.xdy	Daily Direct and Instream Diversion Data
24	Report	-xry	*.xry	Daily Reservoir Data (total and by account)
25	Report	-xwy	*.xwy	Daily Well Data

26 Report	-xwp	*.xwp	Well to Plan Summary
25 Report	N/A	*.log	Log file
1 Data Check	N/A	*.xcb	Base Flow by River ID
2 Data Check	N/A	*.xcd	Direct Demand by River ID
3 Data Check	N/A	*.xci	Instream Demand by River ID
4 Data Check	N/A	*.xcw	Well Demand by River ID
5 Data Check	N/A	*.xwr	Same as *.xwr from the Report option
6 Data Check	N/A	*.xtb	Tabular summary of Input Formatted for Use in a Standard Report
7 Data Check	N/A	*.xou	List of ID's Formatted for Making ID Specific Data Requests
8 Data Check	N/A	*.log	Log file

(1) Plan output is included only when plan data is provided.
(2) Replacement reservoir data is included only when a replacement reservoir operating rule is provided.
(3) Well output is included only when well data is provided and the control switch (iwell) is non zero.

5.1 Base Flow Module Output Files

There are four standard output files from the Base Flow Module; the Base Flow Information File (*.xbi), the Gaged Base Flow Estimate File (*.xbg), the Gaged and Ungaged Base Flow Estimate File (*.xbm), and the Log File (*.log).

5.1.1 Base Flow Information File

The Base Flow Information file (*.xbi) contains information associated with the base flow estimates but in a spreadsheet format for checking. It contains the following data:

#	**Column**	**Description**
0	Year	Simulation Year
0	Mon	The first month specified in the control file
0	Days	The number of days in the month
0	River ID	River station ID
1	Gaged Flow	The streamflow provided in the stream flow file (Section 4.14)
2	Import (-)	The total imports (indicated as negative diversion)
3	Divert (+)	The total of diversions upstream of the river ID Provided in the diversion files (Section 4.15, 4.16, and 4.17)which result in a positive adjustment to the gauged flow
4	Return (-)	The total of current and lagged return flows from upstream diversions and well pumping
5	Well Dep (+)	The total of current and lagged stream depletions from wells (not adjusted for returns)
6	Delta Sto (+)	The total of upstream reservoir storage changes from data in the End of Month content file

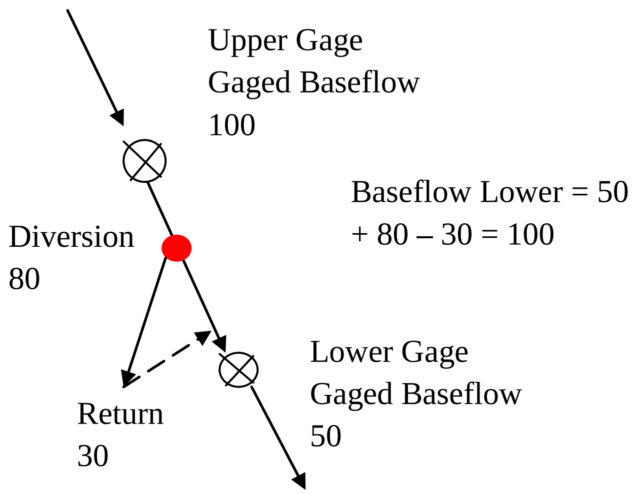
```
                             (Section 4.21) which result in a positive
                             adjustment to the gaged flow
 7       Net Evp (+)       The total of upstream net evaporation occurring at
                             upstream reservoirs which result in a positive
                             adjustment to the gaged flow
 8       Total Base Flow   The estimated base flow
         w/o(-) Base Flow The estimated base flow with negative values set
                             to zero
```

5.1.2 Gaged Base Flow Estimate File

The Gaged Base Flow Estimate file (*.xbg) contains base flow estimates at each gage location provided in the Stream Station input file (Section 4.4). Note, this file is typically used to allow man's impact to be removed from gaged data prior to filling gaps using a technique such as regression. It contains the following data:

```
         Column            Description
         Year              Simulation year
         ID                River station ID
         Oct               Base flow in Oct (the first month specified in the
                             control file (Section 4.2))
         Nov - Dec         Same as above for each month of the year
         Total             Total annual flow for the year

         Repeat            For each River ID and year
```

For example,



5.1.3 Other Base Flow Files

The Base Flow Estimate for Model Input file (*.xbm) contains gaged and ungaged data in the same format as the gaged base flow estimate file (*.xbg). This file is commonly used as an input file to the Simulate Module.

The Log File (*.log) contains a log of the base flow module's operation. The log file contains important information for the user; it is recommended the user review the log file and understand and/or address if necessary any warnings after each model execution. Additionally, if the model fails to execute, the log file provides information as to why the model will not execute to completion.

5.2 Simulate Module Output Files

There are seven (7) standard output files from the Simulate Module. In addition if a plan is modeled then a plan output file is provided. Similarly if a replacement reservoir (type 10) operating rule is specified, then a replacement reservoir file is produced. Following is a description of the data provided in each

1. Diversion (Stream) Summary File
2. Reservoir Summary File
3. Well Summary File
4. Structure Summary File
5. Operations Summary File
6. Log File
7. Check File
8. Replacement Reservoir File
9. Plan File

5.2.1 Stream Summary File

The Stream Summary File (*.xdd) describes all stream flow data at all river nodes. For nodes with stream gages, only the columns containing hydrology data described below (Upstream Inflow, Reach Gain, Return Flow, River Inflow, River Outflow) have non zero values. Nodes with reservoirs are similar to stream gage nodes but include the column River Divert, which may be positive if the reservoir diverts or negative if the reservoir releases. Instream reach data is printed for the upstream node and represents the minimum diverted within the reach. For detailed instream flow reach analysis, the file *.xir, provides detailed data for each node within the instream flow reach.

This summary file reflects information on "Available Flow". Available Flow, as used by StateMod, is the minimum of the stream flow at that point on the river and all downstream locations. It is often quite different than the physical flow at that point on the river. Within StateMod, Available Flow is tracked and adjusted as each water right is operated by priority. However, Available Flow printed to the diversion summary report (*.xdd) is the final value after all water rights have been operated. Therefore, Available Flow is the quantity of water that might be available to a future user at that location who would be the most junior in the system.

In addition, Available Flow is often an indicator on why a structure may be shorted. In general, if the reported Available Flow is greater than zero, then a structure may be shorted only if it is limited by capacity or decree. The Available Flow may not be an indicator of why a structure is shorted if the structure is controlled by an operating rule or if the user has imposed limits on when the model will be allowed to re-operate (see the variable ireopx in the control (*.ctl) file). The control file (*.ctl) variables *icall* and *ccall*, discussed in more detail below, allow a user to evaluate the transient nature of the Available Flow value for an individual water right as it is operated in priority.

The header of the Stream Summary File (*.xdd) describes the structure ID, account and name. In addition, it describes the administration number, on/off switch, owner, and decreed amount for each water right located at this river node. It then contains a time series for the following:

#	Column	Description
General		
0	Str ID	Structure ID
0	Riv ID	River node ID
0	Year	Year of the simulation
0	Mo	Month of the simulation
Demand		
1	Total Demand	Structure Demand provided in the demand files Note if demand data is provided as a consumptive Value total demand is adjusted using a surface Water efficiency
2	CU Demand	Consumptive Demand. Note if a consumptive demand File (*.ddc) is provided this value is printed. If a consumptive demand file is not provided this value is calculated from demand and efficiency data
From River by		
3	Priority	Water Supply from the river by a priority diversion (standard and Operation type 11 diverting structure)
4	Storage	Water Supply from the river by a storage release
5	Other	Water Supply from the river via an exchange, water right transfer or plan
6	Loss	Water Supply lost to the system at the river
From Well		
7	From Well	Water Supply from wells to the structure at this river node.
From Carrier by		
8	Priority	Water Supply from a carrier by a priority diversion (Operation type 3 or 11 destination structure)
9	Other	Water Supply from a carrier by a storage release or exchange (Operation type 2 or 6 destination structure if not diverting)
10	Loss	Water Supply from a carrier lost in transit
Other		
11	Carried Exchange Bypass	Water Supply diverted for carrier purposes. The source will be presented as a From River by Priority, From Carrier by Priority, or From River by Other.
12	From Soil	Water supplied from the soil zone
13	Total Supply	The sum of all water supplies (does not include Carried Water)
Shortage		
14	Total Short	The difference between Total demand and total

supply

15	CU Short	The difference between the CU demand and CU

Water Use

16	CU	Consumptive use of the water supply
17	To Soil	Water diverted to the soil zone.
18	To Other	For a diversion this column describes the total return flow (e.g. the amount that will return over all return time periods) For a reservoir this column describes the water diverted to storage. For an administrative or CU reuse plan this column describes water diverted to the plan
19	Loss	Water diverted that is not consumed, to soil or returned. Typically is non zero when the sum of return locations or delays do not equal 100%.

Station In/Out

20	Upstream Inflow	Inflow from an upstream node to this reach
21	Reach Gain	Inflow from gains to this node as described in stream inflow file (Section 4.14)
22	Return Flow	Inflow from returns to this node. Note this term includes returns from both surface and well supplies in the current time step.
23	Well Depletion	Depletion caused by pumping in prior time steps. Note this term impacts the river inflow (water supply)this month.
24	To_From GWStor	Inflow or outflow to ground water storage. Note this term is positive when ground water storage is required to offset pumping depletions in the current month that cause the river to go negative. This term is negative when stream flow is required to offset water originating from ground water storage in prior months.

Station Balance

25	River Inflow	The sum of inflows to this node
26	River Divert	The sum of water supplies diverted at this node (does not include From Carrier by Storage or From Carrier by Priority)
27	River by Well	The depletion caused by a well in this month. Note this term is similar to a diversion in the current month.
28	River Outflow	Outflow from this node
29	Avail Flow	Available flow at this river node. This is the amount of water available to a potential user that is the most junior in the basin.
30	Control Location	Location on the river that limits the diversion
31	Control Right	Water Right that limits the diversion (calling right)

5.2.2 Reservoir Summary File

The Reservoir Summary File (*.xre) describes diversion, release, storage and stream flow data at river nodes that contain a reservoir. The header describes the reservoir ID, account and name. In addition, it describes the administration number, on/off switch, owner, and decreed amount for each water right located at this river node. It then contains a time series for the following:

```
  #     Column            Description
General

  0     River ID          River node ID
  0     Account           Reservoir account (0 is the total)
  0     Year              Year of the simulation
  0     Mo                Month of the simulation

  1     Initial Storage   Storage at the beginning of month

Water Supply From River by
  2     Priority          Water Supply from the river by a priority diversion
                            standard and Operation type 11 diverting
                            structure)
  3     Storage           Water Supply from the river by a storage release
  4     Other             Water Supply from the river by an exchange, water
                            Right transfer or plan.


Water Supply From Carrier by
  5     Priority          Water Supply from a carrier by a priority diversion
  6     Other             Water Supply from a carrier via a storage release or

  7     Total Supply      The sum of all water supplies

Water Use from Storage to

  8     River for Use     Releases for downstream use (Operation type 1 and 2)
  9     River for Exc.    Releases for exchange (Operation type 4)
 10     Carrier for Use   Releases to a carrier canal (Operation type  3)
 11     Total Release     Total of all releases

Other
 12     Evap              Net evaporation
 13     Seep and Spill    Seepage and spills
 14     EOM Content       End of Month Content
 15     Target-0          For the total reservoir (account 0) Target Storage
        Stor-n Limit      for accounts (account n) their storage limit
 16     BOM Decree Limit  The remaining limit to the one fill rule at the
                            beginning of the month

Station Balance
 17     River Inflow      The sum of inflows to this node
 18     Total Release     Total release
 19     Total Supply      Total reservoir supplies
 20     River by Well     The depletion caused by a well in this month.
```

#	Column	Description
		Note this term is similar to a diversion in the current month.
21	River Outflow	Outflow from this node

5.2.3 Well Summary File

The Well Summary File (*.xwe) describes the structure data (demand, surface supply, ground supply and shortage), use of water (CU, return and loss) and source of water (river, ground water storage and salvage) for every structure that has a well. The header describes the well ID, account and name. In addition, it describes the administration number, on/off switch, owner, and decreed amount for each ground water right located at this structure. It then contains a time series for the following:

#	**Column**	**Description**
General		
0	Structure ID	Well Structure ID
0	River ID	River node ID
0	Year	Year of the simulation
0	Mo	Month of the simulation
Demand		
1	Total Demand	Structure Demand provided in the demand files Note if demand data is provided as a consumptive Value total demand is adjusted using a surface Water efficiency
2	CU Demand	Consumptive Demand. Note if a consumptive demand File (*.ddc) is provided this value is printed. If a consumptive demand file is not provided this value is calculated from demand and efficiency data.
Water Supply		
3	From Well	Water Supply from wells to this structure (e.g. pumping)
4	From SW	Water Supply from other sources (diversions, reservoirs or other Well structures) that are tied to this well structure. Note if this well structure is not tied to a diversion, this column will be zero.
5	From Soil	Water supplied from the soil zone.
6	Total Supply	The sum of all water supplies (does not include carried water
Short		
7	Total Short	The difference between Total demand and total supply.
8	CU Short	The difference between the CU demand and CU
Water Use		
9	CU	Consumptive use of the water supply
10	To Soil	Water diverted to the soil zone.
11	Total Return	Total return flow (note the amount that will return

```
                                over all return time periods)
12      Loss              Water diverted that is not consumed, to soil or
                            Returned. Typically is non zero when the sum
                            Of return locations or delays do not equal 100%.
13      Total Use         Total water use (CU + To Soil + To Return + Loss)

Water Source

14      From River        Well water supplied by the River in this month.
15      From GWStor       Well water supplied by Ground Water in this month
                            (e.g. lagged depletions).
16      From Salvage      Well water supplied by ET Salvage.
17      From Soil         Well water supplied by the soil zone.
18      Total Source      Total water source (From River + From GWStor
                            + From Salvage + From Soil) node
```

5.2.4 Structure Summary File

The Structure Summary File (*.xss) is a standard output when the variable efficiency option is used (control variable *ieffmax*=1). The report describes structure data related to area, demand, maximum efficiency surface water use, ground water use, soil storage, consumptive use and returns. It was developed to provide data similar to that provided by StateCU, the State's consumptive use model.

The header describes the structure (diversion or well ID), account and name. In addition, it describes the administration number, on/off switch, owner, and decreed amount for each water right located at this structure. It then contains a time series for the following:

```
 #      Column            Description
General
 0      Structure ID      Structure ID (diversion or well)
 0      Year              Year of the simulation
 0      Mo                Month of the simulation

Area
 1   Sw Fld               Acres served by surface water and flood irrigation
 2   SW Spr               Acres served by surface water and sprinklers
 3   GW Fld               Acres served by ground water and flood irrigation
 4   GW Spr               Acres served by gronnd water and sprinklers
 5   Total                Total Acres

Demand
 6   Total Demand        Structure Demand provided in the demand files
                           Note if demand data is provided as a consumptive
                           value total demand is adjusted using a surface
                           water efficiency
 7   CU Demand           Consumptive Demand. Note if a consumptive demand
                           file (*.ddc) is provided this value is printed.
                           If a consumptive demand file is not provided this
                           value is calculated from demand and efficiency data

Max Efficiency
 8   FldEff              Maximum flood efficiency
```

```
 9   SprEff              Maximum sprinkler efficiency

Surface Water
10   Divert              Water diverted
11   ConEff              Percent Conveyance Efficiency
12   ConLoss             Conveyance loss
13   To CU               Water consumed
14   To Soil             Water diverted to soil
15   Return              Water that will return
16   Loss                Water that is lost to system
17   ActEff              Percent Actual efficiency (To CU + To Soil)/Divert)* 100

Ground Water
18   Pump                Water pumped
19   Capacity            Well capacity
20   To CU               Water consumed
21   To Soil             Water diverted to soil
22   Return              Water that will return
23   Loss                Water that is lost to system
24   ActEff              Percent Actual efficiency (Pump + To Soil)/Divert
                           * 100

Soil Moisture
25   Soil Storage        Volume of water in soil moisture storage

Consumptive Use
26   SW&GW               Consumptive use of surface and ground water
27   Soil                Consumptive use of soil moisture
28   Total               Total CU (sum of SW&GW and Soil)

Return
29   Total Return        Total of all return flows
30   IWR Short           Unmet Irrigation water requirement
```

5.2.5 Operation Summary File

The Operation Summary File (*.xop) provides a matrix of diversion or release activities associated with each operating right.

5.2.6 Log File

The Log File (*.log) contains a log of the simulation operations. The log file contains important information for the user; it is recommended the user review the log file and understand and/or address if necessary any warnings after each model execution. Additionally, if the model fails to execute, the log file provides information as to why the model will not execute to completion.

5.2.7 Check File

The Check File (*.chk) contains a description of key data and detailed warnings (if any). The check file should always be reviewed following a simulation.

5.2.8 Replacement Reservoir File

The Replacement Reservoir File (*.xrp) is a standard output when a Replacement Reservoir (type 10) operating rule is specified. It was developed to provide detailed replacement reservoir operation information. It is particularly useful when more than one replacement reservoir is operational. Note that a release may not equal a diversion if the release is limited to the structures consumptive use. This "Depletion" Vs "Diversion" option is implemented by structure using variable *ireptyp* in the diversion station (*.dds) file.

#	Column	Description
General		
0	Structure ID	Structure ID (diversion or well)
1	Year	Year of the simulation
2	Mo	Month of the simulation
3	Iter	Iteration
4	Call	Counter to Replace Subroutine per time step
5	Opr ID	Operational Right ID
6	Type	Type of Release (Direct or Exchange)
7	Source ID	Replacement Reservoir
8	Source Name	Replacement Reservoir Name
9	Destin. ID	Destination Diversion ID
10	Destin. Name	Destination Diversion Name
11	Release	Reservoir release
12	Tot-Rel	Total Reservoir Release
13	Divert	Water diverted
14	Tot-Div	Total diversion
15	DepAdj	Depletion Adjustment
16	Rel%	Release %
17	Divo	Total diverted by this operating right this time step
18	ishort	Shortage indicator 0=none, 1=yes

5.2.9 Plan Summary File

The Plan Summary File (*.xpl) is a standard output when a Plan structure type is used. The report describes structure data related to a plan including its type, ID and Source. In addition it describes any operating rules that may use the plan (Use) or provide water to the plan (Src) and whether or not the operating rule tied to that plan is turned on. Note if a plan source is not turned on, an operating rule that uses that plan as a source has its status reported as "off" and a warning is provided in the log file. The data printed to a plan depends on the type of plan specified; plan types are listed below.

Type 1- Terms and Conditions (T&C)
Type 2 - Well Augmentation
Type 3 - Reuse to a Reservoir
Type 4 - Reuse to a Diversion
Type 7 - Import Plan
Type 8 - Recharge (reservoir or canal seepage
Type 9 - Out-of-Priority Diversion or Storage
Type 10 - Special Well Augmentation
Type 11 - Accounting Plan
Type 12 - Release Limit Plan
Type 13 - Changed Water Right Plan

5.2.9.1 Term and Condition Plan (type 1)

```
 #      Column              Description
General
 0      Plan ID             Plan ID
 0      River ID            Plan location on the River network
 0      Year                Year of the simulation
 0      Mo                  Month of the simulation

 1      From Exc_Byp        Total amount exchanged/bypass by opr rules
                             with associated T&C Plan
 2      Plan Demand         T&C Plan demand at this time step
 3      Src 1               Water source 1
 ..     ..                  ..
 ..     ..                  ..
22      Src 20              Water source 20
23      Short               Plan shortage
24      Total               Total of all sources
```

5.2.9.2 Well Augmentation Plan (type 2 and 10)

```
 #      Column              Description
General
 0      Plan ID             Plan ID
 0      River ID            Plan location on the River network
 0      Year                Year of the simulation
 0      Mo                  Month of the simulation

 1      From Well           Augmentation Well Pumping
 2      Plan Demand         Augmentation Plan Demand at this time step
                              Plan Demand is well depletion less return flow
                               from this plans pumping
                              Plan Demand will be zero for Special Aug Plans
 3      Src 1               Water source 1
 ..     ..                  ..
 ..     ..                  ..
22      Src 20              Water source 20
23      Short               Plan shortage
24      Total               Total of all sources
```

5.2.9.3 Reservoir Reuse Plan (type 3)

```
 #      Column              Description
General
 0      Plan ID             Plan ID
 0      River ID            Plan location on the River network
 0      Year                Year of the simulation
 0      Mo                  Month of the simulation

 1      Initial Storage     Initial Reuse Plan storage
 2      Supply Total        Reuse Plan Total Supply this time step
 3      Use 1               Reuse 1
 ..     ..                  ..
```

#	Column	Description
..	..	..
22	Use 20	Reuse 20
23	Total	Total of all uses
24	Ending Storage	Ending Reuse Plan storage

5.2.9.4 Non Reservoir Reuse Plan (type 4)

#	Column	Description
General		
0	Plan ID	Plan ID
0	River ID	Plan location on the River network
0	Year	Year of the simulation
0	Mo	Month of the simulation
1	Supply Total	Reuse Plan Total Supply this time step
2	Use 1	Reuse 1
..	..	..
..	..	..
21	Use 20	Reuse 20
22	Total	Total of all uses

5.2.9.5 Out-of-Priority Plan (type 9)

#	Column	Description
General		
0	Plan ID	Plan ID
0	River ID	Plan location on the River network
0	Year	Year of the simulation
0	Mo	Month of the simulation
1	Initial Demand	OOP Plan demand at beginning of time step
2	Demand Total	OOP Plan demand at this time step
3	Src 1	Water source 1
..	..	..
..	..	..
22	Src 20	Water source 20
23	Total	Total of all sources
24	Ending Demand	OOP Plan demand at end of time step

5.2.9.6 Accounting Plan (type 11)

#	Column	Description
General		
0	Plan ID	Plan ID
0	River ID	Plan location on the River network
0	Year	Year of the simulation
0	Mo	Month of the simulation
1	Supply Total	Simulated diversion accounted for in Plan
2	Use 1	Use 1
..	..	..
..	..	..
21	Use 20	Use 20

22	Total	Total of all uses

5.2.9.7 Release Limit Plan (type 12)

#	Column	Description
General		
0	Plan ID	Plan ID
0	River ID	Plan location on the River network
0	Year	Year of the simulation
0	Mo	Month of the simulation
1	Release Limit	Monthly release limit at beginning of time step
2	Use 1	Water source 1
..	..	..
..	..	..
21	Use 20	Water source 20
22	Total	Total of all sources

5.2.9.8 Changed Water Right Plan (type 13)

#	Column	Description
General		
0	Plan ID	Plan ID
0	River ID	Plan location on the River network
0	Year	Year of the simulation
0	Mo	Month of the simulation
1	Supply Total	Simulated diversion accounted for in Plan
2	Use 1	Use 1
..	..	..
..	..	..
21	Use 20	Use 20
22	Total	Total of all uses

5.2.10 Other Simulation Files

The Instream Reach Summary File (*.xir) provides a matrix of total supply for each node associated with an instream flow reach.

The Daily Direct Diversion File (*.xdy) provides the same data as the monthly diversion and instream flow file (*.xdd) but on a daily time step.

The Daily Reservoir Station file (*.xry) provides the same data as the monthly reservoir station file (*.xre) but on a daily time step.

The Daily Well Station file (*.xwy) provides the same data as the monthly well station file (*.xwe) but on a daily time step.

The Plan Summary file (*.xpl) provides a summary of plan data and operational rules associated with a a plan, as discussed for each plan type above.

5.3 Report Module Output Files

There are twenty four (24) output files available from the Report Module as summarized in the table above and described below.

5.3.1 Basin Water Balance

The Basin Water Balance Report (-xwb) provides a description of the inflows, outflows and storage changes. It contains a time series for the following:

```
 #       Column            Description
General
 0        Year             Year
 0        Mo               Month

Inflows
 1       Stream Inflow     Total inflow to the river from model boundaries
                           and natural gains
 2       Return            Total return flow to the river
 3       From/To GWStor    Total inflow or outflow from ground water storage
 4       From SoilM        Total from soil moisture
 5       From Plan         Total from a non-reservoir reuse plan (type 4) or
                             An accounting plan (type 11) from one of the
                             following 3 operating rules:
                             1 A Multiple Plan Ownership rule (type 46),
                             2 A Reuse Plan to a T&C or Augmentation Plan
                               Direct rule (type 48), or
                             2 A Reuse Plan to a T&C or Augmentation Plan by
Exchange rule (type 49)
 6       Total Inflow      Total of inflows (Stream Inflow + Return +
                           From/To GW Storage + From SoilM)

Outflows
 7       Divert            Total Diversion (From River by Priority + From River
                           by Storage + From River by Exchange + From Carrier
                           by Storage for operational type 3- Instream
                           Diversions, Diversion to Storage From River by
                           Carrier)
 8       From River Well   Total well pumping from the River in this month
 9       Well Depletion    Total well depletion from the river from pumping in
                           previous months
10       Res. Evap         Total reservoir evaporation
11       Stream Outflow    Total outflow from the river
12       Reservoir Change  Total reservoir storage change (End of Month Content
                           - Beginning of Month Content)
13       To SoilM          Total to soil moisture
14       SoilM Change      Soil moisture change (End of Month Content -
                           Beginning of Month Content)
15      Total Outflow      Total of  outflows (Divert + From River by Well +
                           Well Depletion + Res. Evap + Stream Outflow +
                           Reservoir Change + To SoilM + SoilM Change
```

Balance		
16	Delta	Difference between inflows and outflows
Other		
17	CU	Total Consumptive Use
18	Loss	Portion of diversions and pumping that are not consumed or do not return to the stream. Calculated to be (Diversion + Pumping) * (100 - sum of returns to river)
19	Pumping	Total well pumping
20	Salvage	Portion of well pumping offset by ET salvage. Calculated to be Well pumping * (100 - sum of depletions to river)

5.3.2 Water Right Report

The Water Right Report (-xwr) provides a sorted list of water rights. It contains the following:

#	Column	Description
1	Rank	Water right rank
2	Type	Water right type code (see footnote)
3	Admin #	Administration number
4	On/Off	On/Off switch (0=off, 1=on)
5	STR ID #1	Primary structure associated with this right
6	Str ID #2	Secondary structure associated with this right (used only when wells are tied to both a well and diversion structure)
7	Amount	Decreed amount (-1 for an operational right)
8	Right Name	Water right name
9	Structure Name	Associated structure name (blank for an operational right)

5.3.3 Additional Output Reports

The Standard Report (-xst) produces four files; the Demand Summary File (*.xdd), the Reservoir Summary File (*.xre), the Instream Reach Summary File (*.xir), the Well Summary File (*.xwe) and the Operation Right Summary File (*.xop). These are the same files produced by the simulate option and are described above.

The Node Accounting Report (-xna) produces two files: the Detailed Node Accounting (*.xnm) file and Summary Node Accounting (*.xna) file. Both provide the same results as the standard report but are sorted by the stream order provided in the river network file (*.rin). The detailed node accounting file provided data for every month of the study period while the summary provides an annual average.

The Diversion Graph Report (-xdg) provides the same data presented in the diversion and stream gage summary report but it is formatted for easy graphing by a spreadsheet or other plotting package (e.g. XMGR for the workstation).

The Reservoir Graph Report (-xrg) provides the same data presented in the reservoir summary report but it is formatted for easy graphing by a spreadsheet or other plotting package (e.g. XMGR for the workstation).

The Well Graph Report (-xwg) provides the same data presented in the well summary report but it is formatted for easy graphing by a spreadsheet or other plotting package (e.g. XMGR for the workstation).

The Diversion Comparison Report (-xdc) compares the total diversion estimated by the model to the gaged record if available in the historic diversion file (*.ddh). Its output file is named *.xdc. If the user specifies –Report as a secondary parameter when executing this option (e.g. –report –xdc – Report) a Diversion Comparison Summary Report (.xdc) is generated for each Reach specified in the Reach Data (*.rch) file.

The Reservoir Comparison Report (-xrc) compares the end of month contents estimated by the model to the gaged record if available in the historic end of month content file (*.eom).

The Well Comparison Report (-xwc) compares the total well pumping estimated by the model to the gaged record if available in the historic well pumping file (*.weh). Its output file is named *.xwc. If the user specifies –Report as a secondary parameter when executing this option (e.g. –report –xwc – Report) a Well Comparison Summary Report (.xwc) is generated for each Reach specified in the Reach Data (*.rch) file.

The Stream Comparison Report (-xsc) compares the total diversion estimated by the model to the gaged record if available in the historic streamflow file (*.xsc). Its output file is named *.xsc. If the user specifies –Report as a secondary parameter when executing this option (e.g. –report –xsc – Report) a Stream Comparison Summary Report (*.xsc) is generated for each Reach specified in the Reach Data (*.rch) file.

The Consumptive Use Water Supply Report (-xcu) provides four output files; *.xcu, *.xsu, *.xsh and *.xwd. The CU summary (*.xcu) presents the total diversion by each structure in a special format required by the CRDSS consumptive use model. The supply summary (*.xsu) presents the total supply to each structure. The shortage summary (*.xsh) presents the shortage associated with each structure. The water district summary (*.xwd) presents the total diversion for each Reach specified in the Reach Data (*.rch) file.

The River Data Summary Report (-xrx) provides a summary of data provided by river node.
The Selected Parameter Report (-xsp) provides a printout of a selected parameter (e.g. Total_Diversion) available to the standard diversion (*.xdd), reservoir (*.xre) and well (*.xwe) output files. It reads the Output Request file (*.out) to determine the type of output (e.g. Diversion, InstreamFlow, StreamGage, Reservoir or Well), parameter (e.g. Total_Diversion) and ID to print. It creates two output files with the same data in a different format; the output formatted into a matrix is named *.xsp while the output formatted into a column is named *.xs2. Note to get a list of parameters for each data type, enter a dummy variable under parameter type (e.g. x) and review the log file.

The Daily Selected Parameter Report (-xds) provides a printout of a selected parameter (e.g. Total_Diversion) available to the standard daily diversion (*.xdy), reservoir (*.xry) and well (*.xwy) output files. It reads the Output Request file (*.out) to determine the type of output (e.g. diversion), parameter (e.g. Total_Diversion) and ID to print. It creates two output files with the same data in a different format; the output formatted into a matrix is named *.xds while the output formatted into a column is named *.xd2. Note to get a list of parameters for each data type (diversion, stream, instream flow, reservoir or well) enter a dummy variable under parameter type (e.g. x) and review the log file. The Well to Plan Summary (-xwp) provides a summary of every well structure and the augmentation plans, if any, associated with a well structure.

The Log File (*.log) contains a log of the report module's operation. The log file contains important information for the user; it is recommended the user review the log file and understand and/or address if necessary any warnings after each model execution.

The control file contains a variable named ichk that is used to obtain detailed results. Section 4.2 provides a description of these detailed report options.

5.4 Data Check Output Files

There are eight (8) standard output files from the Data Check Module

1. Base Flow File (*.xcb)
2. Direct Demand File (*.xcd)
3. Instream Demand File (*.xci)
4. Well Demand File (*.xcw)
5. Water Right List file (.xwr)
6. Output Request File (*.xou)
7. Reach File (*.xrh)
8. Log File (*.log).

The first four files describe the base flow, direct flow demand, instream flow demand and well demand at each river node, respectively. The water right list file is the same as that produced by the Report Module. The Output Request file provides a list of structures which may be used as an input file for data requests by structure. The Reach file provides a list of structure which may be used as an input file for data requests by reach.

The Log File (*.log) contains a log of the data check module's operation. The log file contains important information for the user; it is recommended the user review the log file and understand and/or address if necessary any warnings after each model execution. Additionally, if the model fails to execute, the log file provides information as to why the model will not execute to completion.

5.5 Binary Output Files

StateMod prints a variable number of direct access binary output files, depending on the types of structures and time step (monthly or daily) being simulated. This section describes the contents of the three major structure types (direct diversion, reservoir and wells) for both monthly and daily time steps. Note that the binary files can be accessed using TSTool; see the TSTool documentation available on the CDSS website (cdss.state.co.us) for more information.

5.5.1 Monthly Binary Direct Diversion File

StateMod prints a monthly direct access binary diversion binary file (*.b43) that describes water use at each river node. The record length is 160 bytes. A typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*numsta + is + numtop

Read(43,rec=irecs) (dat(i), i=1,ndiv)

Where:

Irecs	= the binary record to read
iy	= the year of interest
iystr0	= the starting year
im	= the month of interest
numsta	= the total number of stream nodes
is	= the stream node of interest
numtop	= the total number of header cards (numsta+numdiv+numifr+numres+numrun+numdivw+5+3*maxparm+2)
dat(i)	= the data read
ndiv	= the number of diversion data elements (maxparm)

Row-data	**Variable**	**Description**
1-1	CodeName	Program Name
1-2	ver	Program version
1-3	Vdate	Program version date

Row-data	**Variable**	**Description**
2-1	iystr0	Beginning year of simulation
2-2	iyend0	Ending year of simulation

Row-data	**Variable**	**Description**
3-1	numsta	number of river nodes
3-2	numdiv	number of diversions
3-3	numifr	number of instream flows
3-4	numres	number of reservoirs
3-5	numown	number of reservoir owners (active and inactive)
3-6	nrsact	number of active reservoirs
3-7	numrun	number of base flows
3-8	numdivw	number of well structures (D&W and Well

		only)
3-9	numdxw	number of well only structures
3-10	maxparm	number of parameters for a diversion, reservoir and well
3-11	ndivO	number of data elements in the *.b43 output file
3-12	nres0	number of data elements in the *.b44 output file
3-13	nwelO	number of data elements in the *.b45 **output file**

Row-data	**Variable**	**Description**
4-1	xmonam(1-14)	Month corresponding to the year type e.g. xmonam(1) = Jan for a calendar yr. xmonam(1) = 10 for a water year, etc.

Row-data	**Variable**	**Description**
5-1	mthday(1-12)	Days per month (e.g. if xmonam(6) = June mthday(6)=30 if xmonam(6) = March mthday(6) = 31

Row-data	**Variable**	**Description**
6-1	j	Counter
6-2	cstaid(j)	Station ID
6-3	stanam(I,j), I=1,6)	Station Name

Repeat for j=1, numsta (number of river nodes)

Row-data	**Variable**	**Description**
7-1	j	Counter
7-2	cdivid(j)	Diversion ID
7-3	divnam(I,j), I=1,6)	Diversion Name
7-4	idvsta(i)	River Node

Repeat for j=1, numdiv (number of diversions)

Row-data	**Variable**	**Description**
8-1	j	Counter
8-2	cifrid(j)	Instream flow ID
8-3	xfrnam(I,j), I=1,6)	Instream flow Name
8-4	ifrsta(i)	River Node

Repeat for j=1, numifr (number of instream flows)

Row-data	**Variable**	**Description**
9-1	j	Counter
9-2	cresid(j)	Reservoir ID
9-3	resnam(I,j), I=1,6)	Reservoir Name
9-4	irssta(i)	River Node
9-5	iressw(i)	On (1) / Off(0) Code
9-6	nowner(i)	# of owners

Repeat for j=1, numres+1 (number of reservoirs)

Row-data	Variable	Description
10-1	j	Counter
10-2	crunid(j)	Base Flow ID
10-3	runnam(I,j), I=1,6)	Base Flow Name
10-4	irusta(i)	River Node

Repeat for j=1, numrun (number of base flows)

Row-data	Variable	Description
11-1	j	Counter
11-2	cdividw(j)	Well ID
11-3	divnamw(I,j), I=1,6)	Well Name
11-4	idvstw(i)	River Node

Repeat for j=1, numdivw (number of wells)

Row-data	Variable	Description
12-1	j	Counter
12-2	paramD(j)	Diversion Parameter

Repeat for j=1, maxparm (number of parameters)

Row-data	Variable	Description
13-1	j	Counter
13-2	paramR(j)	Reservoir Parameter

Repeat for j=1, maxparm (number of parameters)

Row-data	Variable	Description
14-1	j	Counter
14-2	paramW(j)	Well Parameter

Repeat for j=1, maxparm (number of parameters)

Row-data	Variable	Description
15-1	unit(1-nx)	Units for each data type in a file Where nx is ndivO for *.b43, ndivR for *.b44, and ndivW for *.b42

Row-data	Variable	Description
16-1	dat(1)	Total Demand (Total_Demand)
16-2	dat(2)	CU Demand (CU_Demand)
16-3	dat(3)	Priority Diversion (From_River_By_Priority)
16-4	dat(4)	Storage Diversion (From_River_By_Storage)
16-5	dat(5)	Exchange Diversion (From_River_By_Exchange)
16-6	dat(6)	River Loss (From_River_Loss)
16-7	dat(7)	From Well (From_River_By_Well)
16-8	dat(8)	Carrier by Priority (From_Carrier_By_Priority)
16-9	dat(9)	Carrier by Exchange (From_Carrier_By_Storage)
16-10	dat(10)	Carried Water (Carried_Water)

16-11	dat(11)	Carried Loss (Carried_Loss)
16-12	dat(12)	From Soil (From_Soil)
16-13	dat(13)	Total Supply (Total_Supply)
16-14	dat(14)	Total Short (Total_Short)
16-15	dat(15)	CU Short (CU_Short)
16-16	dat(16)	CU (Consumptive_Use)
16-17	dat(17)	To Soil (To_Soil)
16-18	dat(18)	Total Return (Total_Return)
16-19	dat(19)	Loss (Loss)
16-20	dat(20)	Upstream Inflow (Upstream_Inflow)
16-21	dat(21)	Reach Gain (Reach_Gain)
16-22	dat(22)	Return Flow (Return_Flow)
16-23	dat(23)	Well Depletion (Well_Depletion)
16-24	dat(24)	To_From GWStor (To_From_GW_Storage)
16-25	dat(25)	River Inflow (River_Inflow)
16-26	dat(26)	River Divert (River_Divert)
16-27	dat(27)	River by Well (River_By_Well)
16-28	dat(28)	River Outflow (River_Outflow)
16-29	dat(29)	Available Flow (Available_Flow)
16-30	dat(30)	Diversion by an instream Flow (Divert_For_Instream_Flow)
16-31	dat(31)	Diversion to Power (Divert_For_Power)
16-32	dat(32)	Diversion from Carrier by Storage (Diversion_From_Carrier)

Field 16-33 is a placeholder that currently contains the same data as field 16-19 (loss)

16-34	dat(34)	Released from plan. (This includes 1. Water diverted into then released from a plan and 2. Water released from a plan to a carrier that returns water to the river)
16-35	dat(35)	Structure type see table below

Structure Type Codes

Code (na)	Structure Type
< 0	Baseflow node[1]
< 10,001	Baseflow node only[1]
0	Well Only
1-5,000	Diversion
5,001 - 7,500	Instream Flow
7,501 - 10,000	Reservoir

[1]Note a code of 1 indicates a diversion, a code of -1 indicates a diversion with at baseflow, a code of –10001 indicates a baseflow node only.

16-36	dat(36)	Number of structures at this node
16-37	dat(37)	Calling river node (-1 means NA)
16-38	dat(38)	Calling right amount (-1 means NA)

Repeat for every river node numsta
Repeat for every month of simulation

5.5.2 Monthly Binary Reservoir File

StateMod prints a direct access binary reservoir file (*.b44) that describes water supply and use for each reservoir and account. As with other reservoir outputs, there are binary outputs for the reservoir as a whole (Account 0) and for the individual reservoir accounts (Account 1, 2, 3, etc). The record length is 160 bytes. Note a typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*nrsactx + ir1 + numtop

Read(44,rec=irecs) (dat(i), i=1,nres)

Where:

Irecs	= the binary record to read
iy	= the year of interest
iystr0	= the starting year
im	= the month of interest
nrsactx	= the total number of active reservoirs (nract) and total number of active nd inactive accounts (numown) (i.e. nrsactx = nrsact + numown)
ir1	= the reservoir account of interest (the first account is always the reservoir total)
numtop	= the total number of header cards (See 7.21.1)
dat(i)	= the data read
nres	= the number of reservoir data elements (29)

Fields 1-15 are exactly the same as the Binary Direct Diversion file.

Row-data	Variable	Description
16-1	dat(1)	Initial Storage (Initial_Storage)
16-2	dat(2)	Priority Diversion (River_Priority)
16-3	dat(3)	Storage Diversion (River_Storage)
16-4	dat(4)	Exchange Diversion (River_Exchange)
16-5	dat(5)	River Loss (River_Loss)
16-6	dat(6)	Carrier by Priority (Carrier_Priority)
16-7	dat(7)	Carrier by Sto_Exc (Carrier_Storage)
16-8	dat(8)	Carrier Loss (Carrier_Loss)
16-9	dat(9)	Total Supply (Total_Supply)
16-10	dat(10)	Storage Use (Storage_Use)
16-11	dat(11)	Storage Exchange (Storage_Exchange)
16-12	dat(12)	Carrier Use (Carrier_Use)
16-13	dat(13)	Total Reservoir Release (Total_Release)
16-14	dat(14)	Reservoir Evaporation (Evap)
16-15	dat(15)	Seepage and Spill (Seep_Spill)
16-16	dat(15)	Simulated EOM Contents (Sim_EOM)
16-17	dat(17)	EOM Target Limit (Target_Limit)
16-18	dat(18)	One Fill Limit (Fill_Limit)
16-19	dat(19)	River Inflow (River_Inflow)
16-20	dat(20)	Total Reservoir Release (Total_Release)
16-21	dat(21)	Total Reservoir Supply (Total_Supply)
16-22	dat(22)	River by Well (River_By_Well)
16-23	dat(23)	River Outflow (River_Outflow)
16-24	dat(24)	Reservoir Carry (Reservoir_Carry)

16-25	dat(25)	Reservoir Loss (Reservoir_Loss)
16-26	dat(26)	Reservoir Seepage (Reservoir_Seep)
16-27	dat(27)	Reservoir account number Note 0 = total(ridr)
16-28	dat(28)	Number of accounts for this reservoir (acc)
16-29	dat(29)	Reservoir (rnr)

Repeat for every reservoir account
Repeat for every reservoir
Repeat for every month of simulation

5.5.3 Monthly Binary Well File

StateMod prints a direct access binary well file (*.b42) that describes water supply and use for each well structure. The record length is 92 bytes. Note a typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*numdivw + nw + numtop

Read(42,rec=irecs) (dat(i), I=1,ndivw)

Where:

Irecs	= the binary record to read
iy	= the year of interest
iystr0	= the starting year
im	= the month of interest
numdivw	= the total number of wells
nw	= the well of interest
numtop	= the total number of header cards
dat(i)	= the data read
ndivw	= the number of well data elements (18)

Fields 1-14 are exactly the same as the Binary Direct Diversion file.

Row-data	**Variable**	**Description**
15-1	dat(1)	Total Demand (Total_Demand)
15-2	dat(2)	Consumptive Use Demand (CU_Demand)
15-3	dat(3)	From Well (From_Well)
15-4	dat(4)	From Surface Water (From_SW)
15-5	dat(5)	From Soil Moisture (From_Soil)
15-6	dat(6)	Total Supply (Total_Supply)
15-7	dat(7)	Total Shortage (Total_Short)
15-8	dat(8)	Consumptive Use Short (CU_Short)
15-9	dat(9)	Total Consumptive Use (Total_CU)
15-10	dat(10)	To Soil Moisture (To_Soil)
15-11	dat(11)	Total Return (Total_Return)
15-12	dat(12)	Loss (Loss)
15-13	dat(13)	Total Use (Total_Use)
15-14	dat(14)	From River (From_River)
15-15	dat(15)	To or From Ground Water Storage

```
                                        (To_From_GW_Storage)
15-16          dat(16)                  From Salvage (From_Salvage)
15-17          dat(17)                  From Soil Moisture (From_Soil)
15-18          dat(18)                  Total Supply (Total_Supply)

Repeat for every well
Repeat for every month of simulation
```

5.5.4 Daily Binary Direct Diversion File

StateMod prints a daily direct access binary diversion binary file (*.b49) that describes water use at each river node and day. The record length is 160 bytes. Note a typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*numsta*31 + is + numtop

Read(49,rec=irecs) (dat(i), i=1,ndiv)

Where:
All terms are the same as defined for the Monthly Direct Diversion File

5.5.5 Daily Binary Reservoir File

StateMod prints a daily direct access binary reservoir file (*.b50) that describes water use at each reservoir and account by day. The record length is 160 bytes. Note a typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*nrsactx + ir1 + numtop

Read(50,rec=irecs) (dat(i), i=1,nres)

Where:
All terms are the same as defined for the Monthly Direct Diversion File

5.5.6 Daily Binary Well File

StateMod prints a daily well file (*.b65) that describes water use for each well structure. The record length is 92 bytes. Note a typical read statement is as follows:

Irecs = ((iy-iystr0)*12 + (im-1))*numdivw*31 + nw + numtop

Read(65,rec=irecs) (dat(i), I=1,ndivw)

Where:
All terms are the same as defined for the Monthly Direct Diversion File

5.6 Additional Reporting Options

StateMod also has the capability of providing more detailed information in specific output files. The following sections describe this additional functionality and how to implement the request for specific output information.

5.6.1 Reach Reporting

Selected State Model reports have the capability to summarize results by stream reach including the diversion comparison (*.xdc), the stream comparison (*.xsc), the reservoir comparison (*.xrc), and the well comparison (*.xwc). In addition a water budget by reach is automatically generated whenever a water budget (*.xwb) is generated. To facilitate reach processing the following are noted:

- As defined herein, a stream reach is simply an aggregation of structures located within a geographic region of the network.
- As described in section 4.53 the preliminary Reach Data file contains two components; Reach Data and Node Data. Reach data is used to define how one stream reach is connected to another. Node data is used to assign a stream (river) node to a stream reach.
- To eliminate the need to build a Reach Data file, a preliminary one (*.xrh) is generated by the check option (-check) for every structure in the system when a river gage (*.rig) file is provided (see Section 4.4.1). If a river gage (*.rig) file is not provided the Check option assigns one to define preliminary stream reaches. If one is not provided no reach data is generated.
- The default name for the preliminary file created by the check option is *.xrh. This preliminary file is commonly revised in an editor to reassign the Reach Data connectivity. In addition sub reaches may be defined to represent structures not bounded by a stream gage. After editing, the Reach Data file is typically renamed to *.rch to avoid it being overwritten every time a new check run is made.

5.6.2 Detailed Call Data

The State Model has the ability to print detailed call data for a diversion, reservoir or instream flow by setting the control file (*.ctl) call variable (***icall)*** = 1 and the call right variable (***ccall***) to the water right of interest. The following are noted:

- Detailed call output is limited to a diversion, reservoir or instream flow right (i.e. operating rules and wells are not currently supported).
- Results are printed to the *.log file for each iteration. Note that the call can change during a time step if new water (e.g. reservoir releases and non-downstream return flow) become available. Therefore results are printed for every iteration of every time step and the volume of output can be quite large.
- Although the output is limited to when a decree is operating, the volume of water reported as diverted in the detailed output is for the entire structure, not just the right.

5.6.3 Call (Control) Reporting

StateMod allocates water based on available supply, demand, water rights and capacity using the prior appropriation doctrine (first in time, first in right). Therefore it never has the need to “call out” a structure because a structure only diverts if it is in priority, supply is available and it has capacity. However StateMod does report a control location and control right that, in many but not all cases, occurs where a structure has historically set a call on the river. This information can be a useful for calibration. The approach used by StateMod to identify a controlling (call) location and right is as follows:

- If a structure is shorted because of available supply, then the “control location” where a downstream water supply limit occurs is identified. If there is a structure (diversion, instream flow, and reservoir) at the “control location”, the “control structure” is identified.

- If a “control structure” does not exist at the “control location” because of natural stream losses, etc. StateMod reports the control structure as “NA”.

- If a “control structure” has been identified the “control right” is calculated based on the amount diverted at the “control structure” and the prior appropriation requirement that its senior decrees diverts water before its junior decrees. For example, if the control structure is diverting 100 cfs and it has two rights; one senior for 60 cfs and one junior for 200 cfs then the junior is the controlling right (because the senior is fully satisfied).

- If a “control structure” does not exist, StateMod records the control right as –1 (for not applicable).

- More than one “control structure” and “control right” can occur in a given time step.

- As defined herein, the “control structure” may not necessarily be water short, it is simply the structure that limits an upstream structure from diverting its full water right.

- If a structure benefits from new (non-native) water resulting from a reservoir release or non-downstream return flows then StateMod recalculates the “control location” and “control right” accordingly.

- If the water supply limit (“control location”) occurs at the diverting structure itself, it is by definition not a “control location”. In such a case StateMod reports the “control location” as “Hgate_Limit” (head gate limit) and the call right as –1.

- If there is no “control location” but a structure is shorted, StateMod reports the call structure as “Cap/Wr_Limit” (capacity or water right limit) and the “control right” as –1.

- Control (call) reporting is currently operational for direct, instream and reservoir rights. Future enhancements may address a call associated with an operational rule.

- The “control location” and “control right” are reported for every structure and time step in the structure summary file (*.xdd). In addition, unique controls (independent of who they are impacting) are reported to the call (control) output file (*.xca).

- If the standard StateMod naming convention is followed and the identifier used at a stream node is the same identifier used for a structure then the “control location” reported in the diversion summary file (*.xdd) is the same as the “control structure”. If the standard naming convention is not followed then the call structure can be identified as the structure located at the control location.

6.0 Model Operation

The State Model is structured to perform one of four (4) interrelated activities:

Base Flows

Simulate

Report

Data Check

For a description of each option, see Section 3.3 of this documentation. The model can be executed using either the StateMod Graphical User Interface available from the CDSS website or via a command line argument. If a command line argument is used, enter the model name and option as follows:

```
        statemod [file] [options]

where:
  file = base file name of the simulation

  Options (1) =
        -v or -version              Print the program version
        -u or -update               Print recent updates
        -base or -baseflow          Perform baseflow option
        -basex or -baseflowx        Perform baseflow option for ungaged areas only.
                         Note: This option assumes gaged flows are natural flows.
        -sim or -simulate           Perform simulate option
                                      with standard reports
        -simx or -simulatex         Perform simulate option
                                      without standard reports

        -rep or -report [options2] Perform report option
        -chk or -check              Perform data check option
```

(1) If omitted, the PC version of the model defaults to requesting the desired option from the screen, while the Unix version prints an error message.

Except for the -report option, each of the above requests are straight forward and require only one command line argument. The -report option allows for one or two additional parameters in order to request the desired report and, as appropriate, desired station without requiring data from the screen by the user. Note, except for the standard output request (-std), the argument name is the same as the output file requested. Following are examples of the report option with second and third parameters supplies:

Argument (1)	Result
-report -xnm	Detailed node accounting for all years and Detailed node accounting average
-report -xwb	Water Balance
-report -xwr	Water Right List sorted by basin rank
-report -xdg [-station id]	Direct Diversion, Instream Diversion and Gage graph file
-report -xrg [-station id]	Reservoir graph file
-report -xwg [-station id]	Well graph file
-report -xdc	Diversion comparison file
-report -xrc	Reservoir comparison file
-report -xwc	Well comparison file
-report -xsc	Stream flow gage comparison file
-report -xcu	Diversions by ditch formatted for the CU model
-report -xst	Standard diversion (*.xdd) and reservoir (*.xre) output
-report -xsp	Special parameter report (2).

(1) If omitted, the PC version of the model defaults to request the desired option from the screen, while the Unix version prints an error message.

(2) For the special parameter report the output type (e.g. diversion, reservoir, well, stream gage or All) and parameter (e.g. River Outflow) must be specified in the output request file.

7.0 Standard Modeling Procedures

This chapter provides technical notes on selected operations, guidance for frequently asked questions regarding the operation of StateMod, and standard and accepted StateMod modeling procedures for implementing the various operations. It is recommended the user follow these approaches, however if the approaches are adapted for more specific operations, it is the user's responsibility to test and verify the results. The following sections are available within this chapter:

7.1 Running the Model

StateMod can be executed through either the StateMod GUI or through command line arguments. See the StateMod GUI User's Manual for more information on how to execute the model through the GUI. In a command line, it is recommended that the user first call for the StateMod executable along with the specific response file (*.rsp), then select the option using the prompted menu. Figure 5 shows the command line argument calling for StateMod Version 15.00.01 (statemod15_0001) and the Lower South Platte Model scenario (SP2013L). The resulting options can then be selected to create natural flows (baseflows), simulate the model, report results, or perform a data check on the model input files. Table 1 summarizes the functionality of each option; a more detailed summary of each option is provided in Section 3.3. Although it is recommended to execute options using the menu, options shown in Table 1 can be included after the response file in the command line argument and executed using a single command.

Modeling Tips:

- Section 2.0 describes the general sequence for developing and operating StateMod, providing guidance on which option should be run.
- It is recommended the user perform a data check on modeling scenarios prior to simulation, in order to check for missing data or incorrect file formats. See the *.log file for a summary of warnings/issues for each file.

Figure 5: Model Execution Command Line Example

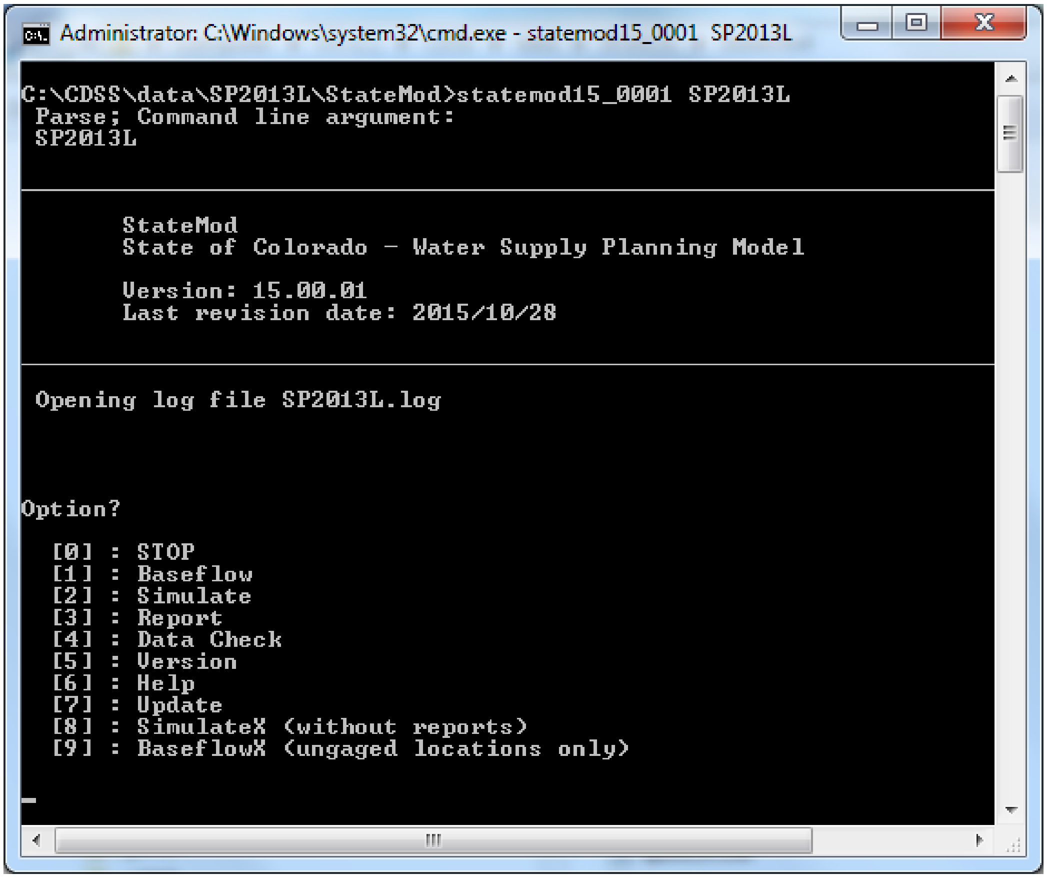
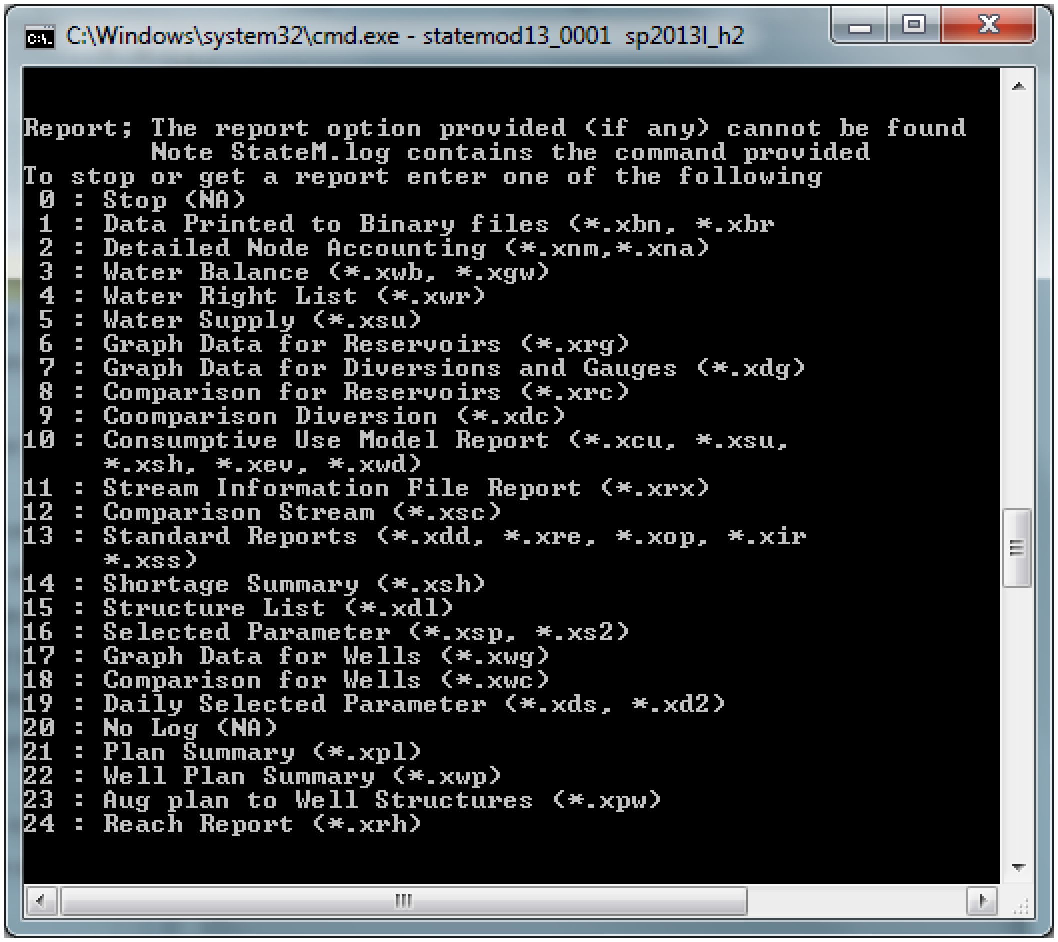


Table 1: StateMod Menu Options

Menu Option	Command Line Designation	Description
0. STOP	N/A	Exit out of current scenario
1. Baseflow	-base or -baseflow	Perform baseflow option and generates baseflows at all locations if data is available.
2. Simulate	-sim or -simulate	Perform simulate option with standard reports
3. Report	-rep or -report	Perform report option
4. Data Check	-chk or -check	Perform data check option
5. Version	-v or -version	Print the program version
6. Help	N/A	Option not currently functional
7. Update	-u or -update	Print recent StateMod updates
8. SimulateX	-simx or -simulatex	Perform simulate option without standard reports
9. BaseflowX	-basex or -baseflowx	Perform baseflow option for ungaged areas only (option typically used after baseflows at gaged locations have been generated and need to be distributed to ungaged areas)

If the Report option (3) is selected, the user will be prompted with a menu of available reports to select from, as shown in Figure 6. Descriptions of the information in each output report can be found in Section 5.0. If the *-rep* option is used, additional parameters are required in order to request the desired report and desired station as appropriate, by including a report output command. For example, the user can included *-xdc* following *–rep* in the command line argument to create the Diversion Comparison output file. A complete list of available report output commands can be found in Section 5.0.

Figure 6: StateMod Report Options



7.1.1 Abnormal Model Termination

It is the user's responsibility to correctly represent the modeled basin and operations in the overall scenario, and understand information supplied in each input file. StateMod will perform minimal error checking of user-supplied data, focusing primarily on consistency between model structures between files, select missing or errant data, and file formats. Incorrect or inconsistent input data will result in an error when executing StateMod and cause the model to terminate prior to completing the execution. The errors are documented in a log file; it is the responsibility of the user to read error messages and react accordingly.

If the model terminates prior to completing the simulation, open the log file (*.log) in a text editor and review the information. The log file will contain various notes on which files were expected to be read and which files were actually read from the response file (*.rsp). The error is the last piece of information in the log file, and the error is generally associated with the last file that was read. Use Section 4.0 to review the format and required data in the specific input file and correct.

7.2 Creating Natural Flows at Gages and Ungaged Locations

As discussed in Section 2.0, natural flows (or baseflows) represent basin streamflows absent man's influence including diversions, return flows, reservoir operations and pumping. If 100% of man's influence is removed, baseflows are often called virgin flows or natural flows. It is recommended that users first develop natural flows at gaged locations, and then distribute those natural flows to ungaged areas. Natural flows at gaged and ungaged locations are then used as the natural flow input to simulation scenarios, such as Historical Calibration or Baseline scenarios.

StateMod estimates natural flows using the Baseflow option and the following equation:

Natural Flow at Gaged Locations =

+ Gaged Flow

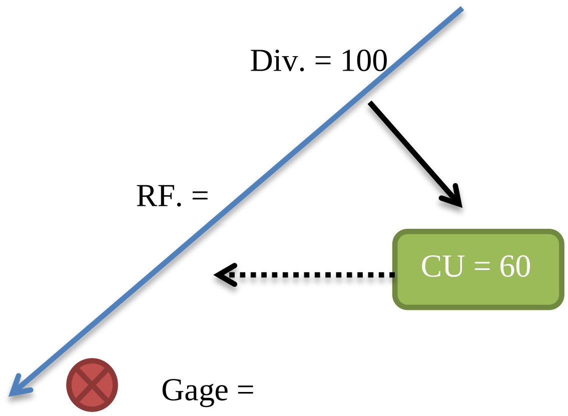
+ Upstream Diversions

– Upstream Return Flows

+/- Upstream Change in Storage

+ Upstream Evaporation

– Imports



Natural Flow = 200 + 100 – 40 = 260

The following steps are recommended to develop a scenario to estimate Baseflow:

1. Create a model scenario that includes a minimum of the following files , as designated in the response file (*.rsp):
    - Control (*.ctl)
    - River_Network (*.rin)
    - StreamGage_Station (*.ris)
    - StreamGage_Historic_Monthly (*.rih)
    - Diversion_Station (*.dds)
    - Diversion_Right (*.ddr)
    - Diversion_Historic_Monthly (*.ddh)
    - DelayTable_Monthly (*.dly)
    - Reservoir_Station (*.res)
    - Reservoir_Right (*.rer)
    - Evaporation_Annual (*.eva)
    - Reservoir_Target_Monthly (* tar)
    - Reservoir_Historic_Monthly (*.eom)

    If crop consumptive use is known and variable efficiency will be considered, also include the following files:
    - IrrigationPractice_Yearly (*.ipy)
    - ConsumptiveWaterRequirement_Monthly (*.iwr)
    - StateCU_Structure (*.str)

    If well structures and pumping will be considered, also include the following files:
    - Well_Station (*.wes)

- Well_Right (*.wer)
- Well_Historic_Monthly (*.weh)

> **Modeling Tip:**
> - There are several complete StateMod datasets available on the CDSS website. It is recommended the user download an existing dataset to use as a template and to assist with trouble shooting.

2. Run the Baseflow option with the scenario to create natural flows at the gaged locations. Note that diversion records, gage data, or reservoir contents can contain missing records (designated as -999 in the files). StateMod will not calculate a natural flow estimate for a month that contains any missing data, leaving the month as missing in the output file. The output from this Baseflow scenario is summarized in the Baseflow Information report (*.xbi) and in the Baseflow at Stream Gages file (*.xbg).
    a. The river connectivity in the network diagram impacts the development of natural flows. It is recommended that confluence nodes should be used to represent tributaries; it is not recommended that a diversion structure or other structure type be used to reflect multiple tributaries.
3. If incomplete records were used to create the baseflow at gaged locations (i.e. -999 in the *.xbg), an external filling technique is required. CDSS models have historically used the Mixed Station Model to automate the filling of missing data through monthly and annual regression relationships; however other tools and techniques can be used. Select a tool/technique and fill the missing data to develop a complete baseflow at gaged locations file (*.xbf).
4. If complete records are used, the Baseflow option will generate natural flows at both gaged and ungaged locations; see discussion below for the additional file (streamflow coefficient/baseflow file (*.rib) required for distribution of natural flows to ungaged locations.

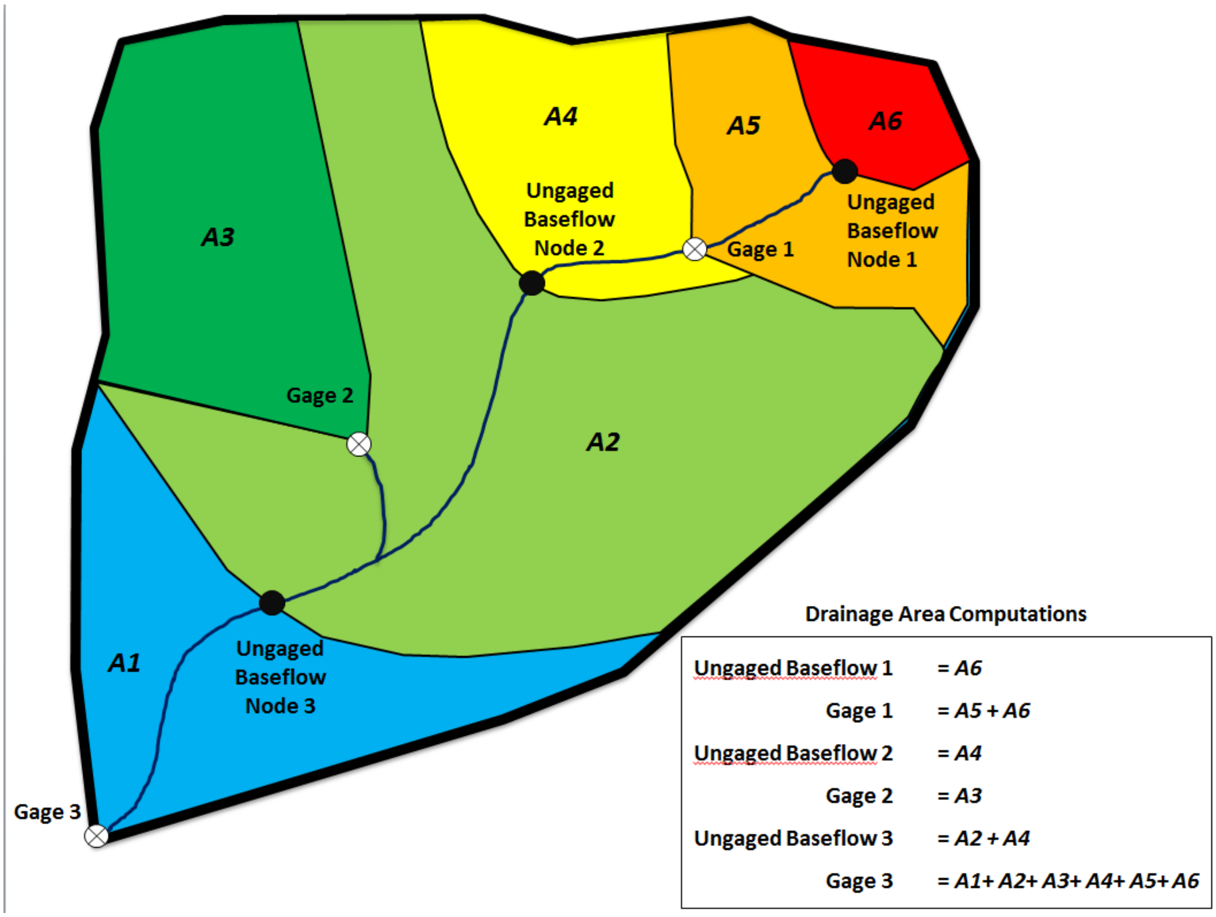
Once complete natural flows are developed at gaged locations, it is necessary to distribute those gains to ungaged locations. Baseflows at ungaged tributaries are zero unless specified by the user and gains are estimated to occur at a gaged locations. Therefore, in order to have a water supply in tributary headwaters or to simulate the river's gain or loss between gaged points, ungaged baseflows must be estimated. StateMod generates baseflows at ungaged locations based on the following formula:

```
FlowX   = (FlowB(1)*coefB(1) + FlowB(2)*coefB(2)+ ....) +
             pf * (FlowG(1)*coefG(1) + FlowG(2)*coefG(2)+ ....)

Where;
FlowX   =      Flow at intermediate node to be estimated

FlowB   =      Base flow station(s)
FlowG   =      Gain flow station(s)

pf      =      Proration factor for gain term
coefB   =      Base flow coefficient
coefG   =      Gain flow coefficient
```

The first term (FlowB(1)*coefB(1)...) represents upstream gaged flow while the second term (pf * (FlowG(1)*coefG(1) ...) represents a distribution of the gain which occurs between gaged flow. The terms FlowB and FlowG are commonly at gaged streamflow stations. The proration factor (pf) is used to distribute the gain between reaches and is commonly estimated to be a ratio of the drainage area multiplied by average annual precipitation compared to that in the gaining reach. The coefficients coefB and coefG are provided throughout the formula for special cases, but are typically 1.0 or -1.0.

The general baseflow formula described above is typically implemented with discretion by a modeler to represent the "gain approach" or the "neighboring gage approach". In the "gain approach", StateMod pro-rates baseflow gain above or between gages to ungaged locations using the product of drainage area and average annual precipitation. Figure 7 illustrates a hypothetical basin and the areas associated with each of three gages and an ungaged location.

Figure 7: Hypothetical Basin Illustration



The area associated with gages is the total upstream area. The area associated with ungaged nodes only includes the incremental area from the ungaged location to the next upstream gage or gages. For example, Gage 3 area includes the entire basin. Ungaged Baseflow Node 3 area only includes the upstream area up to Gage 2 and Gage 1. Precipitation for gaged and ungaged areas should represent the average annual precipitation (inches) for the entire upstream drainage area.

In Figure 7, there are three ungaged baseflow nodes; the StateMod “gain approach” computes the total baseflow at each ungaged node based on the following:

The baseflow gain distributed to Ungaged Baseflow Node 1 is the baseflow gain above Gage 1 pro-rated on the A*P terms.

$$Gain_{ungaged,1} = \left(\frac{(A*P)_{ungaged,1}}{(A*P)_{gage,1}}\right)\left(BF_{gage,1}\right)$$

Total baseflow at Ungaged Node 1 is equal to the $Gain_{ungaged,1}$ term.

The baseflow gain distributed to Ungaged Baseflow Node 2 is the baseflow gain between Gage 1, 2, and 3 pro-rated on the A*P terms.

$$Gain_{ungaged,2} = \left(\frac{(A*P)_{ungaged,2}}{(A*P)_{gage,3} - (A*P)_{gage,2} - (A*P)_{gage,1}}\right)\left(BF_{gage,3} - BF_{gage,2} - BF_{gage,1}\right)$$

Total baseflow at Ungaged Node 2 is equal to the $Gain_{ungaged,2}$ term plus the baseflow at Gage 1.

$$BF_{ungaged,2} = Gain_{ungaged,2} + BF_{gage,1}$$

Ungaged Baseflow Node 3 calculations are very similar. The baseflow gain distributed to Ungaged Baseflow Node 3 is the baseflow gain between Gage 1, 2, and 3 pro-rated on the A*P term.

$$Gain_{ungaged,3} = \left(\frac{(A*P)_{ungaged,3}}{(A*P)_{gage,3} - (A*P)_{gage,2} - (A*P)_{gage,1}}\right)\left(BF_{gage,3} - BF_{gage,2} - BF_{gage,1}\right)$$

Total baseflow at Ungaged Node 3 is equal to the $Gain_{ungaged,3}$ term plus baseflow at Gage 1 and Gage 2.

$$BF_{ungaged,3} = Gain_{ungaged,3} + BF_{gage,1} + BF_{gage,2}$$

A second option for estimating headwater baseflows can be used if the default “gain approach” method created results that do not seem credible. This method, referred to as the “neighboring gage approach”, creates a baseflow time series by multiplying the baseflows at a specified gage by the ratio $(A*P)_{headwater}/(A*P)_{gage}$. This approach is effective when the runoff at an ungaged location does not follow the same pattern as the gains along the main stem. For example, a small ungaged tributary that peaks much earlier or later than the main stem should use the neighboring gage approach with a streamgage in a similar watershed. The user is responsible for ensuring that the overall reach water balance is maintained when using the neighboring gage approach.

Modeling Tips:

- Use the “gain approach” at an ungaged location that is dominated by upstream gaged flows or when the ungaged location has a relatively large drainage area when compared to the downstream gaged data’s drainage area.
- Use the “neighboring gage approach” when the ungaged location’s drainage area is relatively small when compared to the downstream gaged location’s drainage area. Note,

when the neighboring gage approach is taken, the modeler is, in effect, adding a "new" gage. Therefore, when this approach is implemented, care must be exercised to ensure the gain coefficients (coefG) and proration factor (pf) accurately account for this 'new' gage and its associated drainage area.

The following steps are recommended to develop a scenario to distribute baseflow to ungaged locations:

1. Copy and rename the baseflow model scenario response (*.rsp) file to reflect a new model scenario. It is recommended a suffix of "x" be added to the model name to designate the use of the BaseflowX option.
2. Input the area/precipitation factors in the Network (*.net) file in order to create the streamflow coefficient/baseflow file (*.rib) using the standard CDSS approach using StateDMI. Additionally, reflect any neighboring gage assignments in the streamflow coefficient/baseflow file.
3. Add the following files to the new response file (*x.rsp):
    - StreamEstimate_Coefficients (*.rib)
    - Stream_Base_Monthly (*.xbf – reflects the filled baseflows at gaged locations)
4. Set the StreamGage_Historic_Monthly file to the (*.xbf) for output comparison purposes.
5. Run the BaseflowX option with the scenario to distribute natural flows at ungaged locations. The output from this BaseflowX scenario is provided in the Baseflow at Gaged and Ungaged Locations file (*.xbm). This baseflow file (*.xbm) serves as the natural flows (Stream_Base_Monthly) for subsequent simulation scenarios.

7.2.1 Natural Flows with Recharge

When recharge water is part of historical river operations and is to be included in the natural flow calculations, the same natural flow formula is used with the following data:

- Historical diversions (*.ddh) include water from all sources (priority, exchange, etc.) and for all uses (irrigation, municipal, storage, recharge, etc.). This data is commonly called Total Diversion from Headgate.
- StateMod's Natural Flow module knows the amount of total diversion taken to reservoir storage using a reservoir end-of-month file (*.eom) file. This file that contains reservoir storage data for every reservoir in the system.
- The portion of the total diversions that is taken to recharge is input into the model in the Diversion_To_Recharge (*.dre) file. This file contains total diversions to recharge for every diversion structure that carries water to recharge.
- StateMod's Natural Flow module adjusts total diversions to account for the portion that is carried to recharge. In order to calculate return flows associated with recharge, a Reservoir_To_Recharge (*.rre) file is provided containing recharge data for every recharge reservoir. This data, along with the reservoir seepage characteristics specified in the reservoir station (*.res) file and return flow properties specified in the reservoir return file (*.rre), are used to calculate accretions from a recharge site.

- The above calculations can be confirmed by reviewing the Natural Flow Base Flow output(*.xbi). The following are noted:
    - The column titled Divert is the sum of all upstream diversions included in the historical diversion file (*.ddh). Therefore it includes water from all sources (priority, exchange, etc.) and for all uses (irrigation, municipal, recharge, etc.).
    - The column titled Return includes return flows from consumptive uses as well as recharge.
    - The column titled Divert to Rech echoes the data provided in the Diversion_To_Recharge (*.dre) file.
    - The column titled Reservoir to Rech echoes the data provided in the Reservoir_To_Recharge (*.rre) file.
    - When the historical diversion data are adjusted by the amount diverted to recharge, the calculation is not allowed to go negative.
    - Diversion_To_Recharge data are only required for a ditch that carries water to recharge. If data are not provided, the diversion to recharge is estimated to be zero. The WDID specified in this file should be the same as the Diversion ID to be adjusted.
    - Reservoir_To_Recharge data are only required for a reservoir with recharge. If data are not provided, any accretions or recharge associated with the diversions to recharge are assumed to be zero. The WDID specified in this file should be the same as the Reservoir ID with recharge.

7.2.2 How to Check for Natural Flow Issues

Following are recommended checks to identify problems with natural flow estimates.

Situation: Negative baseflows occurring at stream gages or base flow nodes in model network. Negative baseflows occur when the gage flows is less than the other parameters used in the natural flow calculation. StateMod automatically sets any natural flow estimated to be negative at a gaged location to zero prior to distributing gains to ungaged locations, essentially “creating” water in the system. As natural flows represent the flow in the absence of man, negative natural flows are not physically based and likely caused by data inconsistencies.

Checks:

- Review *.log file from –Base Flow module for the *Negative Flows* summary. Identify extent of negative baseflows by the number of months (“Count” column) and magnitude of negative baseflows (“Est” column). Review monthly distribution of negative baseflows for the stream gage ID or base flow node ID in the Baseflow output (*.xbi) summary file or time series (*.xgn) file.
- For gaged locations, review the data used to calculate baseflows (diversions, return flows, reservoir contents). Filled data in diversion records, streamflow gage records, or reservoir contents can result in negative flow issues.
- Review the Baseflow output (*.xbi) file for months with negative baseflows to determine which of the data used to calculate baseflows is causing the calculation to go negative. This is typically due to simulated return flows greater than historical gaged flows + upstream diversions or data filling techniques; particularly with regard to reservoir contents.

- Review return flows above gage based on topography and acreage location because return flow are subtracted from gage data. Specifically investigate return flows to neighboring tributaries or other locations that bypass a gage. Mis-location of Return Flow ID's (crtnid), Return Flow Percentages (pcttot), and Return Flow Locations (irtndl) in the diversion station (*.dds) file can have a significant impact on calculated baseflows.

Situation: The natural flow at an upstream gage is greater the natural flow at the downstream gage, essentially creating a "losing reach". As natural flows represent the flow in the absence of man, it is expected that as the drainage area increases from upstream to downstream, the natural flow increases from upstream to downstream as well. Often times, the "losing reach" will be limited to sporadic months, however in rare cases, the upstream gage is greater than the downstream gage for the entire period. It is recommended that any "losing reaches" be addressed prior to distributing the gains (or losses) to ungaged locations.

Checks:

- Check that natural flows increase from upstream to downstream. Use a graphical tool, such as TSTool or MS Excel, to quickly add the time series of natural flows from the *.xbm file above each gage to assure they are equal or greater to the natural flow estimated at the downstream gage.
- If losing reaches occur, use the files and techniques outlined in the "negative flow" discussion above to identify issues or data inconsistencies that may be the cause.
- If the "losing reach" is consistent throughout the entire period, it is recommended that the diversions, reservoir storage, imports, and return flows in the upstream reach be analyzed. In some situations, the losing reaches are caused by incorrectly routed return flows, incorrect locations of diversions (above/below the gage), problems with physical representation of the basin, or imports that are included in the natural flow estimates.

Modeling Tip:

- It is recommended that the user address any negative natural flow or losing reach issues prior to distributing the natural flow gains (or losses) to ungaged locations.

Situation: More than 100 percent of the natural flow gains between gages are distributed to an ungaged location, resulting in "created" water and a "losing reach" at the downstream gage. Gains are distributed to ungaged locations using either the "gain approach" or "neighboring gage approach", both of which use a coefficient to distribute the gain or loss.

Checks:

- In the gain approach, the coefficient is based on the *incremental* area below an upstream gage multiplied by the total average annual precipitation for the upstream drainage area. Review the area and precipitation values in the network (*net) to represent the appropriate values.

- In the neighboring gage approach, review the assigned coefficients in the streamflow coefficient/baseflow file (*.rib) to make sure that the distributed gains are not greater than 100 percent, especially if a gage was used for multiple ungaged locations.
- The gain approach assigns the distribution of gains for main stem gages to tributary gages. This may not be an adequate representation, in which case the neighboring gage should be used.

Modeling Tip:

- Once the natural flow at gaged and ungaged locations have been checked for the situations discussed above, they are used as the natural flow input to subsequent simulation models. Additional adjustment to the natural flows may be necessary pending the results of a Historical Calibration scenario.

7.3 How to Simulate Soil Moisture Accounting and Variable Efficiency

StateMod has the ability to store in the soil reservoir and subsequently use soil moisture as a water supply. Additionally, StateMod has the ability to simulate under variable efficiency, whereby the model allows irrigation efficiency to vary from zero to a user-specified maximum value. These two functions are generally used together, and the soil moisture function requires the variable efficiency option be used.

The soil moisture option allows diverted water to be stored in the soil zone up to its defined capacity considering the diverting structures (direct diversion or well) efficiency. It uses an operating rule to specify an administration date that controls when water is available to be taken out of the soil zone to satisfy a consumptive demand. StateMod initializes the soil moisture reservoir contents to be 50% of the soil moisture capacity.

The variable efficiency option allows the model to vary the efficiency in which it meets a demand. For example, variable efficiency will operate at the maximum efficiency when a demand is water-short, but a lower efficiency would be used when a system is water-long. The following notes should be considered with variable efficiency:

- Variable efficiency uses the Modified Direct Solution Algorithm and can be used with or without soil moisture storage.
- When variable efficiency is used, the efficiency data provided in the diversion station (*.dds) file and well station (*.wes) file are ignored for structures with irrigation demands provided in the irrigation water requirement file (*.iwr).
- Variable efficiency capability calculates the maximum system efficiency for a diversion to be the conveyance efficiency times the maximum flood efficiency provided in the annual time series file (*.ipy).
- Variable efficiency capability calculates the maximum system efficiency for a well to be the maximum flood efficiency or maximum sprinkler efficiency provided in the annual time series file (*.ipy). The control file variable *isprnk* controls whether flood or sprinkler efficiency data

are used. Sprinkler efficiency is used preferentially up to the acres served by sprinklers. Thereafter, any remaining acres served by wells are served by using the maximum flood efficiency.

- Variable efficiency capability applies to all direct diversion, well pumping and carrier to diversion structure operations if irrigation demands provided in the irrigation water requirement file (*.iwr).

The following steps are recommended to implement soil moisture accounting and variable efficiency, respectively.

7.3.1 Soil Moisture Implementation

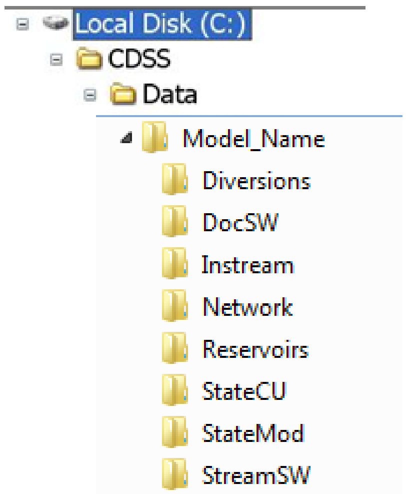
1. In the control file (*.ctl), set the soil moisture switch (*soild*) to a number greater than 0 that represents a typical soil zone depth in feet (e.g. 3.0 feet).
2. In the control file (*.ctl), set the annual time series file switch (*itsfile*) to 10. As described in the control file documentation, an entry of 10 allows variable efficiency and other more complex water use data to be used.
3. If not already created in support of a StateCU model scenario, create a structure file which includes a representative available water capacity (AWC) parameter for each structure in the scenario. The structure file is a primary input to the StateCU model; see the StateCU User’s Manual for information on the format and content of this file.
4. Include the StateCU Structure file (*.str) in the response file (*rsp).
5. In the operating rule file (*.opr), add a Type 22 operating rule that provides the administration number to control when water is available to be taken out of the soil zone to satisfy a consumptive demand.

7.3.2 Variable Efficiency

1. In the control file (*.ctl), set the variable efficiency switch (*ieffmax*) to 1.
2. In the control file (*.ctl), set the annual time series file switch (*itsfile*) to 1 or 10. As described in the control file documentation, when the control variable *itsfile* is set to 10 conveyance, maximum flood, and sprinkler efficiency data provided by structure and year are used. Set the control variable *ieffmax* to 1 so irrigation water requirement (*.iwr) data provided for every diversion and well only structure by year is used.
3. If not already created in support of a StateCU scenario, create an annual time series (*.ipy) file for every irrigation structure served by a diversion or wells only. The annual time series file is a primary input to the StateCU model; see the StateCU User’s Manual for information on the format and content of this file.
4. If not already created in support of a StateCU scenario, create a monthly irrigation water requirement (*.iwr) file for every irrigation structure in the scenario. The StateMod formatted irrigation water requirement file (*.ddc) is an output from StateCU; see the StateCU User’s Manual for information on the format and content of this file.
5. Include the annual time series file (*.ipy) and irrigation water requirement file (*.iwr) in the response file(*.rsp) .

7.4 How to Add or Change Modeled Input Data

This section provides a recommended approach on how to add or change typical model data that follows the standard CDSS data-centered approach. The CDSS data-centered approach focuses on the flow of information from HydroBase or other data sources through data management interfaces (DMI) that correctly format the input files for the CDSS models (StateCU and StateMod). The data-centered approach means the process of developing the model, organizing the files, and documenting the model is consistent for every CDSS StateMod dataset; and that many of the major modeling decisions are documented in the command files of the DMI. There is a file dependency element to the data-centered approach whereby the creation of a StateMod file may be dependent on another file. Therefore it is important for the user to understand these dependencies as well as the recommended method for creating StateMod input files.



To support the data-centered approach, a common directly structure was estimated by CDSS. As shown, the main directory contains subdirectories representing each aspect of the model. For example, the Diversion folder contains command files and supporting files used to create the StateMod input files associated with diversions (e.g. diversion station (*.dds) and diversion rights (*.ddr) file). The actual input files are stored in StateMod folder. The DocSW folder includes the StateMod model documentation.

Table 2 is a quick guide to assist the user as to which files and tools should be revised, or at a minimum reviewed, if a specific structure type is added or modified. The directory where the command files can be found is also shown. Note that the network files are associated input files with most structure types; the network diagram and the river network command file can be found in the ..\Network\ folder.

Table 2: Quick Guide for Modifying StateMod Data Set Input Files

Structure Type	Associated Input Files	Tool Generally Used to Create Input Files
Stream Gage ..\StreamSW\	Network (*.net)	Edit network in StateDMI
	River Network File (*.rin)	Commands in StateDMI
	River Station File (*.ris)	Commands in StateDMI
	Natural Flow (*.xbm)	Output from Natural Flow scenario
Diversion Node ..\Diversions\	Network (*.net)	Edit network in StateDMI
	River Network File (*.rin)	Commands in StateDMI
	Direct Diversion Station File (*.dds)	Commands in StateDMI, generally dependent on a set of DDS and DDH commands
	Direct Diversion Right File (*.ddr)	Commands in StateDMI
	Direct Flow Demand File - Monthly (*.ddm)	Commands in StateDMI
	Delay Table (*.dly or *.urm)	Edit in text editor
Reservoir Node ..\Reservoirs\	Network (*.net)	Edit network in StateDMI
	River Network File (*.rin)	Commands in StateDMI
	Reservoir Station File (*.res)	Commands in StateDMI
	Reservoir Right File (*.rer)	Commands in StateDMI
	Reservoir Target Content File – Monthly (*.tar or *.tam)	Commands in TSTool
	Evaporation Data File – Annual (*.eva)	Edit in text editor
Instream Flow Node ..\Instream\	Network (*.net)	Edit network in StateDMI
	River Network File (*.rin)	Commands in StateDMI
	Instream Flow Station File (*.ifs)	Commands in StateDMI
	Instream Flow Right File (*.ifr)	Commands in StateDMI
	Instream Flow Demand File – Monthly (*.ifm)	Commands in TSTool
Plan Node ..\StateMod\	Network (*.net)	Edit network in StateDMI
	River Network File (*.rin)	Commands in StateDMI
	Plan Data (*.pln)	Edit in text editor
Operating Rules ..\StateMod\	Operating Rule File (*.opr)	Edit in text editor
Model Scenario Files ..\StateMod\	Response File (*.rsp)	Edit in text editor
	Control File (*.ctl)	Edit in text editor

Modeling Tips:

- This section is not all-inclusive and does not provide instructions for more complex changes or additions. If the user needs to implement a change or addition not discussed herein, it is recommended the user refer to the completed CDSS StateMod models available on the CDSS website for examples of how to implement more complex changes.
- StateMod output files reflect the same file name as the response file (*.rsp); use descriptive response file names to manage different scenarios and for easier comparisons.

7.4.1 Change the Period of Record

1. Open the control file (*.ctl) in a text editor.
2. Revise the beginning (iystr) and/or ending years (iyend); note that input data must be complete for the period of record selected.
3. Save the revised control file (*.ctl); consider saving with a new file name to preserve the original file.
4. Confirm the revised control file (*.ctl) is reflected in the response file (*.rsp).
5. Simulate the model.

7.4.2 Add a Diversion Structure

The following approach assumes that the added diversion structure is a “future” structure and not an actual diversion with a valid model identifier (WDID) in HydroBase. If the added structure is in HydroBase, create the input files without set commands first and identify missing information prior to setting input data.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate information and designate the structure type as either diversion (D) or diversion/well (DW).
    a. Note that if the structure type is designated as DW, appropriate well files must be included in the scenario.
    b. Note if a diversion structure is added as a headwater node, it must be made a baseflow node and have a natural flow distribution.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. Add the structure to the diversion station file (*.dds) using the StateDMI commands:
    a. Set the structure capacity in CFS.
    b. Set the structure system efficiency (annual or monthly efficiency values).
    c. Set the demand and use types (see Section 4 for more discussion).
    d. Set the return flow locations and patterns; must reference the delay patterns provided in the delay file (*.dly or *.urm).
4. Add water rights to the diversion right file (*.ddr) using the StateDMI commands:
    a. Set the water right ID as the structure ID with a numeric suffix for each right.
    b. Set the water right priority (administration number) and amount in CFS.
5. Add the structure’s demand to the direct flow demand file (*.ddm) using the StateDMI commands.
    a. Set the monthly demand or read in an external StateMod formatted file (*.stm) with the demand.
6. Confirm the revised diversion files (*.dds, *.ddr, *.ddm) are reflected in the response file (*.rsp).
7. Simulate the model.
8. Review the direct diversion summary output file (*.xdd) and the structure summary output file (*.xss) for output information on the new diversion structure.

7.4.3 Add a Reservoir

The following approach assumes that the added reservoir is a “future” structure and not an actual reservoir with a valid model identifier (WDID) in HydroBase. If the added structure is in HydroBase, create the input files without set commands first and identify missing information prior to setting input data.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate information and designate the structure type as a reservoir.
    a. Note if a reservoir is added as a headwater node, it must be made a baseflow node and have a natural flow distribution.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. Add the structure to the reservoir station file (*.res) using the StateDMI commands:
    a. Set the total capacity of the reservoir in AF.
    b. Set individual accounts (e.g. users in the reservoirs or an inactive pool), their respective capacities, and their starting volumes.
    c. Set the reservoir outlet capacity for off-channel reservoirs or downstream river channel capacity for on-channel reservoirs in CFS.
    d. Set the net evaporation station; must reference the evaporation station provided in the evaporation file (*.eva).
    e. Set the area/capacity/seepage table.
4. Add water rights to the reservoir right file (*.rer) using the StateDMI commands:
    a. Set the water right ID as the structure ID with a numeric suffix for each right.
    b. Set the water right priority (administration number) and amount in AF.
    c. Set the accounts that can be filled with the water rights and whether it is a first-fill or refill right.
5. Add the structure’s demand to the reservoir target file (*.tar) using the TSTool commands.
    a. Set the monthly reservoir minimum and maximum targets (generally zero and the reservoir capacity) or read in an external StateMod formatted file (*.stm) with the capacity target in AF.
6. Confirm the revised diversion files (*.res, *.rer, *.tar) are reflected in the response file (*.rsp).
7. Simulate the model.
8. Review the reservoir summary output file (*.xre) for output information on the new reservoir.

7.4.4 Add an Instream Flow Reach

The following approach assumes that the added instream flow is a “future” structure and not an actual instream flow with a valid model identifier (WDID) in HydroBase. If the added structure is in HydroBase, create the input files without set commands first and identify missing information prior to setting input data.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate information and designate the structure type as an instream flow node. If the instream flow is a reach, also add a downstream node and designate the structure type as an *Other* node.
    a. Downstream nodes are typically named with the instream flow ID and *_Dwn* suffix.

    b. Note if an instream flow is added as a headwater node, it must be made a baseflow node and have a natural flow distribution.
2. Recreate the river network file (*.rin) to reflect the additional structure(s).
3. Add the structure to the instream flow station file (*.ifs) using the StateDMI commands:
    a. Set the ID of the upstream and downstream nodes that define the reach; or set the same ID as the upstream and downstream nodes to reflect a point.
    b. Indicate whether a variable (*.ifm) or constant (*.ifa) demand will be provided.
4. Add water rights to the instream right file (*.ifr) using the StateDMI commands:
    a. Set the water right ID as the structure ID with a numeric suffix for each right.
    b. Set the water right priority (administration number) and amount in CFS.
5. Add the structure's demand to the instream flow demand file (*.ifa or *.ifm) using the TSTool commands.
    a. Set the monthly instream flow demands or read in an external StateMod formatted file (*.stm) with the demand in CFS .
6. Confirm the revised diversion files (*.ifs, *.ifr, *.ifa/m) are reflected in the response file (*.rsp).
7. Simulate the model.
8. Review the instream reach output file (*.xir) for data on the minimum instream diversion and the diversion at every point within the instream flow reach.
    a. When modeled as a reach, the information in the diversion summary output file (*.xdd) represents the minimum amount diverted by the instream flow within the reach. Therefore one may notice the water available in the river exceeds the amount diverted.

7.4.5 Add/Change a Water Right Priority or Amount

1. For direct flow rights: Edit the diversion right file (*.ddr) using the StateDMI commands; use set commands to add a water right or overwrite the water right amount or priority for an existing right.
2. For reservoir rights: Edit the reservoir right file (*.rer) using the StateDMI commands; use set commands to add a water right, overwrite the water right amount or priority for an existing right, or change the accounts that can be filled by that water right.
3. For instream flow rights: Edit the instream flow right file (*.ifr) using the StateDMI commands; use set commands to add a water right or overwrite the water right amount or priority for an existing right.
4. Confirm the revised water rights files (*.ddr, *.rer, *.ifr) are reflected in the response file (*.rsp) and simulate the model.

7.4.6 Add/Change a Demand

1. For direct flow demand: Edit the diversion demand file (*.ddm) using the StateDMI commands and either set the monthly demand or read in an external StateMod formatted file (*.stm) with the demand.
2. For reservoir demand: Edit the reservoir demand file (*.tar) using the TSTool commands and either set the minimum/maximum monthly demands or read in an external StateMod formatted file (*.stm) with the demands.
    a. See Section 4 for information on flood control operations (e.g. use of "-1" in the target file)

3. For instream flow demand: Edit the instream flow demand file (*.ifa/*.ifm) using the TSTool commands and either set the monthly demand or read in an external StateMod formatted file (*.stm) with the demand.
    a. Use a monthly instream flow demand file (*.ifm) to input a demand for each month in the simulation period.
    b. Use an annual instream flow demand file (*.ifa) to input twelve monthly demands to be used for each year.
    c. Set the demand type in the instream flow station file (*.ifs).
5. Confirm the revised demand files (*.ddm, *.tar, *.ifa/m) are reflected in the response file (*.rsp) and simulate the model.

7.4.7 Demand Considerations

StateMod allows demands to be set at the headgate or well structure as an irrigation water requirement at the irrigated land by month or by year (12 values repeated each year). The following are noted.

- When a total demand is provided for a direct diversion structure the variable *idvcom* of the direct diversion station file (*.dds) should be set to 1 for monthly data and 2 for annual data. Similarly for a well structure the variable *idvcomw* of the well station file (*.wes) should be set to 1 for monthly data and 2 for annual data (annual data option for wells is reserved but not yet active). By providing total demand data, StateMod recognizes that a structures demand includes inefficiencies associated with conveyance and on-farm irrigation practices. The fate of inefficient water is controlled by the return flow data provided. This standard approach is recommended when wells are not part of an analysis.
- When an irrigation water requirement is provided for a direct diversion structure the variable *idvcom* of the direct diversion station file (*.dds) should be set to 3 for monthly data and 4 for annual data. Similarly for a well structure the variable *idvcomw* of the well station file (*.wes) should be set to 3 for monthly data and 4 for annual data (annual data option for wells is reserved but not yet active). By providing an irrigation water requirement as demand data, StateMod recognizes that a structure's demand does not includes losses associated with conveyance and on farm irrigation practices. Therefore these adjustments are done within StateMod using the efficiency data provided in the direct diversion station file (*.dds) and the well station file (*.wes). The fate of inefficient water is controlled by the return flow data provided. This approach is recommended when wells are part of an analysis since the system efficiency associated with surface water and ground water are often significantly different.
- When co-mingled supplies (surface and ground water sources) are used to meet a common demand, the control variable *icondem* of the control file (*.ctl) controls how demand data are provided to and treated by StateMod.
    - **Historical Demand Approach**. Set *icondem* = 1 to indicate surface water demands are provided in the diversion demand file (*.ddm), well demands are provided in the well demand file (*.wem) and no addition to determine a total structure demand occurs. This means that any surface water shortages cannot be supplied by ground water and vice versa. Also, the diversion and well station demand type variables (*idvcom* and *idvcomw*) are typically set to 1 or 3 which means monthly total demands (1) or monthly Irrigation

Water Requirement demands (3) will be provided. Note this option is typically used during a historical model calibration when historical diversions and pumping are known or estimated from a StateCU scenario.

- **Historical Sum Demand Approach**. Set *icondem* = 2 to indicate surface water demands are provided in the diversion demand file (*.ddm), well demands are provided in the well demand file (*.wem) and they are added together to determine a total structure demand. This means that any surface water shortages for a structure can be supplied by ground water and vice versa. The priority of the surface and ground water rights (limited by water right, capacity, etc.) dictates which source (surface water or ground water) will try to supply water. Also, the diversion and well station demand type variables (*idvcom and idvcomw*) are typically set to 1 or 3 which means monthly total demands (1) or monthly irrigation water requirement demands (3) will be provided in the monthly well demand file (*.wem). This option is typically used during calibration to quantify the impact of what occurs when priorities dictate the water supply source.
- **Structure Demand Approach**. Set *icondem* =3 to indicate one demand is provided for structures served by both surface and ground water in the direct diversion demand file (*.ddm). For well only lands demand is provided in the well demand file (*.wem). Similar to when *icondem* = 2, this means that any surface water shortages for a structure can be supplied by ground water and vice versa. The priority of the surface and ground water rights (limited by water right, capacity, etc.) dictates which source (surface water or ground water) will try to supply water. Also, the well station demand type variable (*idvcomw*) is typically set to 6 indicating demands will be provided in the direct diversion demand file (.ddm) and no demand data are expected in the monthly well demand file for co-mingled structures. The diversion station demand type variable (*idivcom*) dictates if the data provided in the monthly demand file (*.ddm) is total demand or irrigation water requirement. This option is typically used during calibration and a baseline run when a structure's total demand is known but the mixture of surface water and ground water supplies is not.
- **Supply Demand Approach**. Set *icondem* = 4 to indicate data are provided in the same way as when icondem=3 (e.g. for co-mingled structures one demand is provided in the direct diversion demand file(s) (*.ddm) and for well only lands demand is provided in the well demand file (*.wem)). This method requires the variable efficiency method be operational (control variable *ieffmax=1*). It allows surface water and ground water demands to operate somewhat independently. Like all demand options surface and ground water use under the Supply Demand Approach are dictated by the priority of each source and when diversion or pumping occurs the structures CIR is reduced as a function of the efficiency of the supply source. The Supply Demand Approach allows surface water to be diverted up to the user-supplied demand even if there is no CIR. Ground water is only allowed to pump when a CIR exists. This option is typically used during a calculated model calibration and a baseline run to better match historic operations. Its net effect is to 1. Divert surface water up to the user specified demand when available and in priority regardless of how efficient or inefficient that surface water will be used, and 2. Pump ground water only when there is a CIR. Note it operates most effectively in conjunction with the sprinkler option which allows a

structure to pump preferentially on lands with sprinklers but still divert surface water to meet both CIR and recharge demands.

- **Decreed Demand Approach**. Set *icondem* = 5 to indicate data are provided in the same way as when icondem=3 or 4 (e.g. for structures with both a surface and ground water supply one demand is provided in the direct diversion demand file(s) (*.ddm) and for well only lands demand is provided in the well demand file (*.wem). This method requires the variable efficiency method be operational (control variable *ieffmax=1*) and operates surface and ground water supplies exactly the same as when icondem=4. In addition, the Decreed Demand Approach overrides demand data provided for structures with both surface and ground water supplies to equal the total of their surface water decrees if there is a CIR in that time step. Like the Supply Demand Approach, the Decreed Demand Approach 1. Allows surface water to be diverted up to the user-supplied demand (water rights) even if there is no CIR and 2. Allows ground water to be pumped only when a CIR exists. This option is typically used during a calculated model calibration and a baseline run to better match historic operations. Note it operates most effectively in conjunction with the sprinkler option which allows a structure to pump preferentially on lands with sprinklers but still divert surface water to meet both CIR and recharge demands.

Note that the Supply Demand Approach (*icondem=4*) and Decreed Demand Approach (*icondem=5*) could be extended to assist in determining when to use reservoir supplies (i.e. only make a reservoir release if a CIR exists).

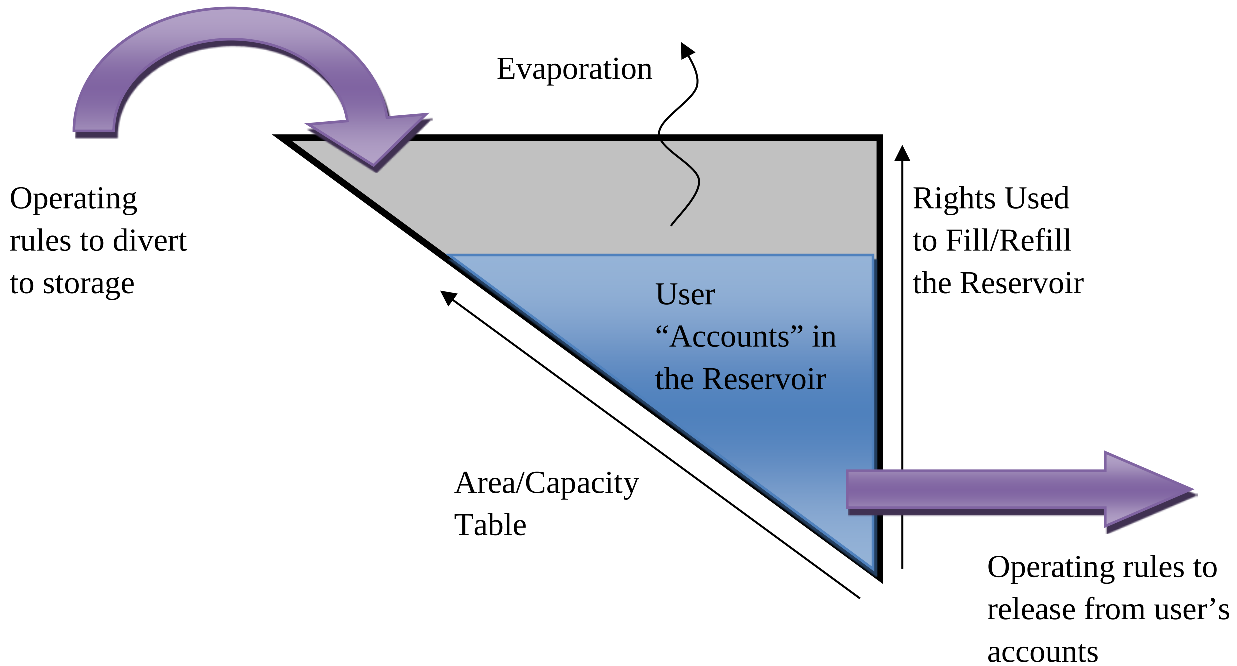
Modeling Tip:

- Co-mingled demand options are complex and all functionality has not been thoroughly tested or vetted; it is up to the user to verify these operations are simulating as desired.

7.5 How to Model Reservoir Operations

This section provides a recommended approach on how to model typical reservoir operations using the standard modeling approaches taken during developing CDSS models. As illustrated in Figure 8, reservoir operations involve the reservoir station file (*.res), reservoir right file (*.rer), reservoir target file (*.tar), evaporation file (*.eva), and the operating rule file (*.opr). StateMod simulates operations of reservoirs in the model based on the input from these files.

Figure 8: Reservoir Operations Illustration



Modeling Tip:

- This section is not all-inclusive and does not provide instructions for more complex reservoir operations. If the user needs to implement a change or addition not discussed herein, it is recommended the user refer to the completed CDSS StateMod models available on the CDSS website for examples of how to implement more complex reservoir operations.
- Review the Colorado DWR General Administrative Guidelines for Reservoirs (Oct. 2011) for more information on the terminology used and impact of specific parameters in the reservoir files.

7.5.1 Distribution of Reservoir Water Rights to Accounts

StateMod has the ability to assign a reservoir (storage) right to one or more accounts. It is particularly important to assign storage rights to specific accounts for on-channel reservoirs as they can store in-priority without an operating rule. For off-channel reservoirs, reservoirs store under water rights that have been carried via operating rules and the user has additional control over which accounts can be filled using specific water rights. See the below for additional information on off-channel reservoirs.

- To assign a reservoir water right to a specific account, set the variable *iresco* of the reservoir right file (*.rer) to the account number specified in the reservoir station file (*.res).
- To assign a reservoir water right to serve several or all accounts, set the variable *iresco* of the reservoir right file (*.rer) to -*n* where *n* is the first *n* accounts specified in the reservoir station file (*.res). When water is stored in-priority under the storage right, it is distributed according to the ratio of space available in each account. For example if 30,000 AF is diverted to two

accounts that have 20,000 AF and 40,000 AF of capacity available (account capacity - current capacity); the first account will receive 10,000 AF and the second will receive 20,000 AF.

- If each account is fully utilized in most years, this approach to distribute reservoir water rights typically works well. However, this approach can result in one reservoir account receiving what may be determined to be an inappropriate share of a reservoir's water right because they typically have less of their available space in use. For such a case it is recommended the storage right be broken into a number of sub-rights which are assigned to each account directly. This approach has the additional benefit of being able to properly implement the one-fill rule between accounts.

7.5.2 Reservoir Release Operations

StateMod has several operating rules that allow water to be released from a reservoir to a direct flow diversion, including operating rule Types 2, 3, 4, 10, 11 and 14. See the Operating Rules Decision Tree in Section 4 for all operating rules associated with reservoirs.

- Releases are limited to available water in the source reservoir and account, the capacity of the diversion structure, the downstream channel capacity, and the structure demand. For operating rules that release via exchange (e.g. Type 4), reservoir releases are also limited to the exchange potential in the intervening reach.
- Operating rules require the user to specify which account the releases will be made from, and releases can be made via the river or via a carrier/conduit depending on the operating rule type selected.

7.5.3 General Replacement Reservoir Operations

The general replacement reservoir operating rule (Type 10) provides a method to supply reservoir water to a large number of structures without supplying individual operating rules for each structure. This operating rule has generic applications but was originally developed to handle the Historic User Pool replacement reservoir obligations of Green Mountain Reservoir in the Colorado River Basin. It serves all water rights which are senior to its Administration number which have the variable *ireptyp* in the direct diversion station file (*.dds) set to offset a diversion (1) or a depletion (-1).

- The replacement reservoir operating rule checks whether reservoir replacement water will be supplied to a diversion by a direct reservoir release or exchange.
- When more than one replacement reservoir is specified, they are sorted by Administration number and operate by priority, most senior first.
- The replacement reservoir-operating rule applies to direct flow structures only. For off-channel structures, a specific operating rule must be included to release from the replacement reservoir to the off-channel structure via a carrier.
- The need to call a replacement reservoir is checked after every direct flow water right is operated. Replacement operations are called only if the right is senior to the most senior replacement reservoir's administration number and it is water short. The replacement routine then checks if a replacement can be provided and ensures that the replacement amount does not exceed the structure's water right, capacity, and demand.

- The replacement reservoir operating rule logic is controlled by subroutine *Replace*. This routine organizes and calls standard StateMod subroutines that control a direct reservoir release (*DivresP2*) and a reservoir exchange (*DivrplP*). Therefore reservoir operations are exactly the same when a reservoir operates as a replacement reservoir as they are when the reservoir operates as a standard reservoir.
- Total releases from a replacement reservoir can be limited to monthly or annual volumetric limits using a Release Limit Plan. See below for additional plan operations or Section 4 for Release Limit Plans (Plan Type 12).

7.5.4 Re-distribute Reservoir Contents

Certain reservoirs do not allow carry-over of storage water in users' accounts from one year to the next; they have provisions that require they re-distribute the total reservoir content pro-rata to each account prior to beginning the next "release season". For these reservoirs, bookover operating rules are used to simulate these operations by re-distributing the reservoir contents in a specific month.

- In the reservoir station file (*.res), create an additional "bookover" account in the reservoir that is equal to the sum of the accounts' capacities that will be re-distributed; often this is the full capacity of the reservoir. Set evaporation for the bookover account to zero.
- In the reservoir right file (*.rer), set the storage rights to only fill the active accounts in the reservoir, not the bookover account.
- Include bookover operating rules (Type 6) in the operating rule file (*.opr) that individually book the active accounts into the bookover account. Use monthly switches and appropriate priorities to control when the bookover occurs.
- At a priority just junior to the step above, include a "re-distribution" bookover operating rule (Type 6) that distributes the contents of the bookover account back to the individual user accounts based on the ratio of the account capacity compared to the full capacity.
    - To prevent StateMod from re-operating the bookover in a single time step, which causes inflated bookover amounts in model output, include the "re-distribution" Type 6 operating rule ID in the initial bookover operating rules to stop the re-operation once the "re-distribution" operating rule triggers. See additional discussion on this functionality using the ciopso(2) and OprLimit flags in the Type 6 operating rule in Section 4.
- Re-distribution can also be used to reflect a specific order in which the accounts should be filled. To do so, first fill a larger bookover account with the reservoir rights and use Type 6 operating rules to bookover the stored water into smaller accounts using appropriate priorities to control the order accounts are filled.
- The amount that is booked over in these operations is reported in the operating rule summary (*.xop) file and in the reservoir summary output (*.xre) file. Note that the reservoir summary for each account reflects the bookover amount coming into or going out of the account. The bookover amount is double-counted in the reservoir summary for the total reservoir (Account 0), because it is reflecting the sum of the bookover amounts for all the accounts, which includes the smaller accounts and the larger "bookover" account. It is recommended the user refer to the individual account summaries in the reservoir summary file (*.xre) or the operating rule summary file (*.xop) for the amount booked over from one account to another.

7.5.5 Reservoir Evaporation

StateMod calculates reservoir evaporation every time step as a function of the reservoir's surface area, and the combination of precipitation and evaporation stations assigned to each reservoir. The calculation is done at the end of a time step after all water rights have operated as follows:

- Net evaporation (evaporation less precipitation) is calculated in units of feet (Evap0).
- The average surface area is calculated to be the average of the surface area at the beginning of the time step and the area at the end of the time step in units of acres (Area0).
- Total net evaporation is calculated to be the product of net evaporation (Evap0) and average surface area (Area0).
- Total net evaporation is distributed to the reservoir accounts that share in net evaporation.
    - If the distribution to accounts equals the total net evaporation, total evaporation is applied.
    - If the distribution to accounts does not equal total net evaporation, distribute any remaining net evaporation beginning with the last reservoir account first.
    - The calculations performed in the last step are sometimes required because the average area is an approximation that can, under certain circumstances, result in more net evaporation than is available in the reservoir at the end of a time step (e.g. net evaporation is calculated to be 10 acre-feet but the ending storage is 2 acre-feet).

7.5.6 Reservoir Spills

StateMod has two methods to spill water from a reservoir; Type 9 and Type 29. The Type 9 rule spills water from a reservoir to meet a reservoir target. The Type 29 spills water from a reservoir for an administrative reason and is typically used as part of a plan operation. When a spill occurs, two key variables associated with StateMod's ability to report streamflow at a river node and allocate water to a demand are affected; River Outflow and Available Flow. River Outflow is reported in the Stream Balance (*.xdd) and represents water leaving a river node.

Available Flow is adjusted each time a diversion occurs during a time step. It is used to determine if water is available for diversion by a node located at or upstream of the reservoir. The Available Flow reported in the Stream Balance (*.xdd) represents the minimum value available at and downstream of the reservoir at the end of the time step after every water right has had an opportunity to divert water. The following are noted with regard to the two methods available to simulate reservoir spills by StateMod:

- <u>Type 9 Operation:</u> When a reservoir spills using a type 9 operating rule (spill to target) the River Outflow at the node containing the reservoir is adjusted to reflect the spill. However the Available flow (term used to determine if water is available to be diverted) does not get adjusted. The net result is that the River Outflow reflects wet water at the reservoir node while the Available Flow limits future diversions at and upstream of the reservoir.

- Type 29 Operation: When a reservoir spills using a type 29 operating rule (spill from a plan or reservoir) the user has the ability to spill from a plan, from a reservoir or from a reservoir and a plan.
  - If a plan is specified, with or without a reservoir, the user has the ability to control if the available flow at the node where the reservoir is located does or does not get adjusted. This capability is often required for a Changed Water Right Plan where the water may be diverted, temporarily stored in a plan that subsequently gets spilt for temporary storage in other plans associated with multiple users and ultimately released.
  - If a plan is not specified, e.g. water is being spilled from a reservoir for an administrative purpose, the spill will occur at the reservoir node and the River Outflow and Available Flow are adjusted using the same approach as a type 9 operating rule.

7.5.7 Reservoir Operations Troubleshooting

Situation: On-channel reservoir will not fill to capacity.

1. Check if there are sufficient storage rights (*.rer) to meet the reservoir capacity, as defined in the reservoir station (*.res) file.
2. Review the reservoir target file (*.tar) to see if the monthly target equals the reservoir capacity set in reservoir structure (*.res) file.
3. Check if the storage right is assigned to the correct accounts in the reservoir rights file (*rer).
4. Check if there is sufficient physically and legally available flow available to the reservoir.
   a. Review the River Balance information in the direct diversion summary output file (*.xdd), specifically reviewing River Inflow, Reach Gain, Available Flow, and Control Location at the reservoir.
   b. If the reservoir is located at the top of a tributary, make sure that natural flow has been distributed up to the reservoir.
   c. If there is physical flow but no available flow, there is a downstream calling right that is causing the reservoir to bypass the physical flow in the river to meet the downstream demand.

Situation: Diversion demand is not being fully satisfied from supplemental storage supplies.

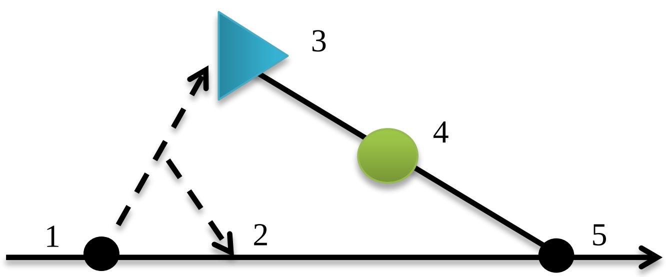
1. Check if reservoir account(s) specified as source(s) in the operating rule file (*.opr) has water in storage available for release; review reservoir contents for each account in the reservoir summary file (*.xre).
2. If the release is via exchange, check if exchange potential is limiting the released amount. Review the River Balance information in the direct diversion summary output file (*.xdd) for each of the intervening structures.
3. Check if the diversion demand capacity in the direct diversion station file (*.dds) is limiting additional releases from being diverted, particularly if the releases are being made via an operating rule with a carrier.
4. Make sure the River Inflow to reservoir (River Inflow (+) column in *.xre file) is not equal to or greater than the reservoir maximum release rate (*FloMax*) assigned in the reservoir station (*.res) file, thus limiting releases due to downstream channel capacity.

7.6 How to Model Off-Channel Reservoir Systems

Off-channel reservoirs require special consideration in StateMod, both during natural flow development and during simulation scenarios. Although off-channel reservoir systems generally reflect off-channel reservoirs that serve irrigation demands, this approach can be adapted for any structure that carries to more than one off-channel demand. For example, a structure that carries to irrigation, municipal, and augmentation demands. As diversions to both off-channel reservoirs and irrigation demands are more common in the South Platte River Basin as compared to other basins, the following standard CDSS modeling approach to representing these systems was developed during the South Platte Decision Support System modeling effort. The key aspects of this approach allow:

- Baseflows to be calculated correctly without special considerations of baseflow gage locations
- Total historical diversion from the river to remain at the river location,
- End-Of-Month (EOM) contents in the reservoir to be represented by historical values,
- Return flows to be accounted for at the correct locations and operated either by variable efficiency (for irrigation structures) or by a constant efficiency (for carrier structures).

Figure 9: Off-Channel Reservoir System Schematic



1. River Diversion
2. Carrier Return Flow
3. Off-Channel Reservoir
4. Off-Channel Demand
5. Demand Return Flow

River Network Setup

The off-channel system is represented as a “mock” tributary in the network diagram and connected to the network at the furthest downstream location of return flows from the off-channel demand(s). It is recommended that the off-channel demands use their primary source WDID as an identifier if appropriate, or an appropriate suffix attached to the river diversion WDID (e.g. 0100503_I for irrigation demands served by 0100503).

Natural Flow Calculations

The natural flow calculations on the mainstem of the river network will be calculated correctly because of the following considerations:

- The river sees the entire historical diversion at Location 1
- Return flows from carrier losses are accounted for in their correct location
- Returns from the river diversion to the off-channel tributary are balanced by increases in storage and diversion at off-channel demand structure(s)
- Reservoir releases are balanced by diversions at off-channel demand structure(s),

- Return flows from off channel demands are accounted for in their correct location.

The following approach is recommended to implement an off-channel reservoir system in natural flow calculations.

River Diversion (Location 1)

- Historical diversions are equal to total river diversions, including all water diverted to storage and to other demands from this location. Note that in some cases total diversions may need to be calculated, especially winter diversions, due to lack of diversion records and changes in diversion coding over time. Winter diversions to storage can be estimated based on the change in reservoir end-of-month content from one month to the next and accounting for evaporation.
- The structure is 0% efficient, as set in the direct diversion station (*.dds) file, which results in 100% of the water diverted at this structure to be returned as follows:
  - Use the return flow location(s), percentage(s), and delay pattern(s) in the direct diversion station (*.dds) file to route the conveyance loss back to the correct location. *This is represented by Location 2 in the figure above*.
  - Use the return flow location(s), percentage(s), and delay pattern(s) in the direct diversion station (*.dds) file to return the total diversions less ditch loss to the upstream most node in the off-channel system in the same time step. *This is represented by Location 3 in the figure above.*
  - For example, if Location 1 is 75 percent efficient, the direct diversion station (*.dds) file for the river diversion will reflect 25 percent lagging back to the river to Location 2, and 75 percent returns in the same time step to Location 3.
- Additional information needs to be set in the direct diversion station (*.dds) file so that the basin wide summary tables do not double account diversions for these systems:
  - irturn(1) set to 3 – carrier
  - demsrc(1) set to 7 – carrier structure.

Off-Channel Reservoir (Location 3)

- Values in the end-of-month (*.eom) file are based on historical end-of-month reservoir content.

Off-Channel Demand (Location 4)

- Historical diversions are equal to water delivered from the river diversion (Location 1) minus conveyance losses plus releases from the off-channel reservoir (Location 3), if applicable. Note that reservoir releases are calculated based on change in reservoir end-of-month content from one month to the next and accounting for evaporation.
- Return flow location(s), percentage(s), and delay pattern(s) in the direct diversion station (*.dds) file for this structure are based on locations of returns from the use. *This is represented by Location 5.*

Modeling Tips:

- If the off-channel system is modeled correctly and all the diversion and reservoir data is consistent, the natural flow for the off-channel tributary would be zero.
- If there are data inconsistencies between diversion and reservoir data or the system is not represented correctly in the model, StateMod will estimate natural flow from this tributary.
- Use a "calibration" streamflow gage (a streamflow gage with zero streamflow) at the bottom of the "mock" tributary to determine if there is natural flow being estimated for the off-channel system.
- Once data inconsistencies are corrected and the estimate of natural flow at the calibration gage is minimal/zero, the gage needs to be removed from the network (or set to an Other structure type) before simulation scenarios are run.

Simulation Scenarios

Simulation scenarios will operate the system correctly because all demands (reservoir, irrigation, etc.) in the off-channel system will be satisfied by carried water from the river diversion via operating rules. This ensures that water is delivered only in amounts up to what is needed for the off-channel system. If setup correctly, there will not be excess water returning from the off-channel system via the physical network connection (via the river). The following approach is recommended to implement an off-channel reservoir system in simulation scenarios.

River Diversion (Location 1)

- Historical and baseline demands are set to zero in the diversion demand (*ddm) files.
- The structure is 0% efficient, as set in the direct diversion station (*.dds) file, which results in 100% of the water diverted at this structure to be returned as follows:
  - Use the return flow location(s), percentage(s), and delay pattern(s) in the direct diversion station (*.dds) file to route the conveyance loss back to the correct location. *This is represented by Location 2 in the figure above*.
  - As operating rules will be simulating the diversions from this structure, the return flows at this structure need to reflect only the conveyance loss routing.
- Use operating rules in the operating rule (*.opr) file to divert water to storage *(Location 3)* and/or to the off-channel demand (*Location 4)* via the river diversion structure.
  - Reservoir water rights are located at the reservoir and operating rules will carry water to the reservoir via the river diversion structure using the reservoir right as the source water right.
  - Diversion rights are located at the river headgate and operating rules will carry water to the off channel demand via the river diversion structure using the diversion right as the source water right.

Off-Channel Reservoir (Location 3)

- Set the demand in the historical reservoir target (*.tar) file to the historical end-of-month reservoir content.
- Set the demand in the baseline reservoir target (*.tar) file to the full reservoir capacity.

- Use operating rules in the operating rule (*.opr) file to release water from storage to the off-channel demand (*Location 4)*.

Off-Channel Demand (Location 4)

- Historical demands in the historical diversion demand (*ddm) file are set to the historical diversions calculated for natural flow calculations; i.e. water delivered from the river diversion (*Location 1*) minus conveyance losses plus releases from the off-channel reservoir (*Location 3*), if applicable.
- Baseline demands in the baseline diversion demand (*ddm) file are based on the irrigation water requirement or other appropriate off-channel demand.

7.7 How to Model Well Operations

This section provides a recommended approach on how to model typical well operations using the standard modeling approaches used to develop CDSS models. In general, these approaches focus on representing a group of wells that provide either the full or supplemental irrigation supply. Although single wells can be represented, it is recommended they be aggregated to collectively supply a co-mingled irrigation demand or ground water only demand. When aggregated, they are represented in the model either tied to an existing direct diversion structure ID or tied to a ground water only aggregate. Single wells modeled explicitly are only recommended if they represent augmentation or recharge wells (see the *How to Model Augmentation Plans* section below).

Sections in this StateMod documentation discuss modeling more complex well operations than discussed in this section; however they have not be thoroughly tested or vetted. This is particularly applicable to the different ways a ground water demand can be included in the model, as indicated by the *icondem* parameter in the control (*.ctl) file. It is recommended the user implement the historical demand approach (*icondem = 1)*, in which demands for structures using surface water and ground water demands are provided in separate demand files (e.g. *.ddm and *.wem) and are not added together (i.e. surface water shortages cannot be supplied by ground water and vice versa). In any scenario, it is up to the user to make sure wells are operating as expected.

7.7.1 Add Supplemental Wells

Wells that provide a supplemental supply do not need to be represented by a specific structure on the river network, rather they can be tied to a co-mingled direct diversion structure using appropriate flags in the input files.

1. Open the response (*rsp) file in a text editor and include the files specific for well operations.
    a. Well_Station (*.wes)
    b. Well_Right (*.wer)
    c. Well_Demand_Monthly (*.wem)
2. Open the control (*.ctl) file in a text editor and set the *iwell* parameter to 1 to indicate that wells will be included in the scenario and set the *icondem* parameter to 1 to designate the historical demand approach.

3. Open the network (*.net) in StateDMI, right click on the structure(s) to receive supplemental ground water supplies, and revise the structure type from *D* for diversion only structure to *DW* diversion. This indicates to the model which co-mingled structures will be provided well information.
4. Create a well station (*.wes) file using the StateDMI commands:
    a. Read in *DW* structures from the network diagram.
    b. Set the total well capacity in CFS.
    c. Set the well system efficiency (annual or monthly efficiency values).
    d. Set the demand and use types (see Section 4 for more discussion).
    e. Set the *idvcow2* parameter to be the co-mingled structure ID; StateMod considers it to be a ground water only structure if this parameter is left as *N/A*.
    f. Set the depletion and return flow locations and patterns; must reference the delay patterns provided in the delay file (*.dly or *.urm).
        i. Depletion and accretion locations and patterns are typically the same, unless a portion of non-consumed water returns more quickly via overland flow.
5. Create a well right (*.wer) file using the StateDMI commands:
    a. Use HydroBase to pull well rights for each well or set each well water right; in both situations, tie each water right to the co-mingled structure ID.
    b. Set the water right priority (administration number) and amount in CFS.
    c. Review options to determine if a "turn-on" date is appropriate; note that a "turn-off" date has not been implemented and once a well is turned on, it is available to pump for the remainder of the model period.
6. Create the well demand file (*.wem) using the TSTool commands.
    a. The well demand (*.wem) file reflects the co-mingled supplemental supply, and is indicated in this file under the co-mingled structure ID.
    b. Set the monthly demand or read in an external StateMod formatted file (*.stm) with the demand.
    c. The well demand file only reflects the demand on ground water supplies, and when using the historical pumping approach, cannot be met from surface water.
    d. For irrigation structures, the well demand (*.wem) file generally reflects estimated pumping output from StateCU for each co-mingled structure. These pumping estimates are generally used for the historical well pumping (*.weh) file for baseflow calculations as well as simulation scenarios.
7. Simulate the model.
8. Review the direct diversion summary output file (*.xdd) , structure summary output file (*.xss), and the well summary (*.xwe) file for output information on the well structures.

7.7.2 Add Ground Water Only Aggregate Structures

Irrigated parcels that receive only ground water supply are generally grouped together regionally and are modeled as a ground water aggregate. Additionally, the ground water rights are grouped to provide a total supply to the ground water only structure. Unlike supplemental wells, ground water only aggregates need to be reflected explicitly in the model as a unique ground water aggregate structure.

1. Open the response (*rsp) file in a text editor and include the files specific for well operations.

    a. Well_Station (*.wes)
    b. Well_Right (*.wer)
    c. Well_Demand_Monthly (*.wem)
2. Open the control (*.ctl) file in a text editor and set the *iwell* parameter to 1 to indicate that wells will be included in the scenario and set the *icondem* parameter to 1 to designate the historical demand approach.
3. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate information and designate the structure type as a well only structure (*W)*.
4. Recreate the river network file (*.rin) to reflect the additional structure(s).
5. Create a well station (*.wes) file using the StateDMI commands:
    a. Read in *W* structures from the network diagram.
    b. Set the total well capacity in CFS.
    c. Set the well system efficiency (annual or monthly efficiency values).
    d. Set the demand and use types (see Section 4 for more discussion).
    e. Set the *idvcow2* parameter to *N/A.*
    f. Set the depletion and return flow locations and patterns; must reference the delay patterns provided in the delay file (*.dly or *.urm).
        i. Depletion and accretion locations and patterns are typically the same, unless a portion of non-consumed water returns more quickly via overland flow.
6. Create a well right (*.wer) file using the StateDMI commands:
    a. Use HydroBase to pull well rights for each well or set each well water right; in both situations, tie each water right to the ground water only structure ID.
    b. Set the water right priority (administration number) and amount in CFS.
    c. Review options to determine if a "turn-on" date is appropriate; note that a "turn-off" date has not been implemented and once a well is turned on, it is available to pump for the remainder of the model period.
7. Create the well demand file (*.wem) using the TSTool commands.
    a. The well demand (*.wem) file reflects the ground water only supply, and is indicated in this file under the ground water structure ID.
    b. Set the monthly demand or read in an external StateMod formatted file (*.stm) with the demand.
    c. For irrigation demand, the well demand (*.wem) file generally reflects estimated pumping output from StateCU for each ground water only structure. These pumping estimates are generally used for the historical well pumping (*.weh) file for baseflow calculations as well as simulation scenarios.
8. Simulate the model.
9. Review the direct diversion summary output file (*.xdd), structure summary output file (*.xss), and the well summary (*.xwe) file for output information on the well structures.

7.7.3 Well Operational Considerations

- Wells may increase the water supply available at the river at a given time step if well return flows exceed the stream depletion. StateMod checks for such a condition and re-operates to allow senior ditches to benefit from the additional water supply.

- Wells may require two or more delay patterns to represent the delay associated with return flows and depletions. The data for both types of delays are specified in the unit response file (*.dly or *.urm). When the sum of return flows to the river is less than 100%, the balance is treated as a loss (e.g evaporation or phreatophytes). Similarly when the sum of depletions to the river is less than 100%, the balance is assumed to come from ground water storage.
- Wells may cause river flows to go negative when the well's estimated depletion to the river exceeds the streamflow. StateMod treats such an occurrence as an indication that pumping impacts have depleted ground water storage rather than the stream flow. Under such a case, StateMod allows the pumping to occur and accounts for the source of water as originating from ground water storage. This water is presented in the column *From/To GW Stor* for each river node in the diversion summary output (*.xdd) and for the whole basin in the water budget report (*.xwb). Note the quantity of water supplied by ground water storage in a simulation time period is taken out of the stream the next time period before any water allocation occurs. The control file (*.ctl) variable *iwell* = 2 or 3 allows the repayment of this water to be limited to a maximum amount to represent a stream ground water system that are disconnected. Also, since data for this term is generally not observed, baseflow calculations may be influenced by this lack of data.
- Well information is presented in four columns of the diversion summary report (*.xdd). The column titled *From Well* describes the total amount of water pumped and made available to a diversion. The column titled *Well Depletion* represents the impact of a previous months pumping on the river. The column titled *To/From GW Stor* was described above. The column titled *River by Well* represents the impact of the current months pumping on the river. The *Well Depletion* and *River by Well* data are separated because the impact of a previous months pumping on the river influences the water supply available to all users before any diversions occur while the impact of the current months pumping impacts water rights that are junior to the well only. Note by definition, a well structure that is not tied to a diversion has no data under the column *From Well*. However, the columns titled *Well Depletion* and *River by Well* include the impact of all well pumping on the river.

7.7.4 How to Implement the Maximum or Mutual Supply Approaches

StateMod allows the user to simulate wells using a Maximum or Mutual water supply approach. Both require an irrigation parameter (*.ipy) file be provided that contains total ground water acreage, sprinkler acreage, efficiency data, and water use approach parameter (*gwmode* = 1 or 2*)* which controls whether Maximum or Mutual Supply will be used. Additionally, both options require variable efficiency to be turned on in the control (*ctl) file (*ieffmax* = 1). Both approaches operate from senior to junior using water right data provided.

For the Maximum Supply approach, an operating rule allows the water right priority of wells associated with lands served by sprinklers to be made senior in order to apply water to lands served by sprinklers before any other source. To enable this functionality:

1. Open the control (*.ctl) file in a text editor and set the *isprink* parameter to 1. Additionally, confirm variable efficiency is being considering by verifying the *itsfile* parameter is set to 10 and the *ieffmax* parameter is set to 1.

2. Set the water use approach variable (*gwmode*) in the irrigation parameter (*.ipy) file to 1 to indicate the maximum supply option.
3. If appropriate, verify that acreage served by sprinkler and/or ground water supplies is not zero. If the acreage served by sprinklers is zero or no ground water acreage is included, then sprinklers cannot be operated at a senior priority.
4. Include a Type 21 operating right where the administration date reflects a senior value that will cause wells with sprinklers to operate first.

For the Mutual supply approach there is no operating rule required and wells operate according to the priority provided in the well water right file.

1. Open the control (*.ctl) file in a text editor and set the *isprink* parameter to 1. Additionally, confirm variable efficiency is being considering by verifying the *itsfile* parameter is set to 10 and the *ieffmax* parameter is set to 1.
2. Set the water use approach variable (*gwmode*) in the irrigation parameter (*.ipy) file to 2 to indicate the mutual supply option.
3. No operating rule is necessary.

During a natural flow simulation, operating rule data is not read. Therefore natural flows are calculated using a Maximum Supply approach if the irrigation parameter (*.ipy) file variable *gwmode* is set to 1 and the control file (*.ctl) variables are set as follows: *itsfile* = 10, *ieffmax* = 1, *isprnk* = 1. If any of the above are not set appropriately the Mutual Supply approach is used.

Modeling Tips:

- See StateCU Consumptive Use Model User's Manual for additional discussion on Mutual and Maximum Supply options.
- This functionality has not been thoroughly tested or vetted; it is up to the user to verify these operations are simulating as desired.

7.8 How to Model Plan Structures and Operations

StateMod uses plan structures to model complex operations, such a reusable supplies, recharge supply and augmentation demands, terms and conditions, changed water rights, out of priority plans, and imports. The specific operation desired by the user is defined by the type of plan structure used, the associated plan input files, and the array of operating rules required to operate the plan structure.

As with any other structure type, plan structures must be included in the network diagram and river network (*.rin) file at the location where the plan is to be implemented. For example if the terms and conditions of a transfer require historical return flows be maintained at the transfer location, then a Term and Condition (T&C) Plan should be located just downstream of the transfer location. Similarly if a reuse plan allows releases from a water treatment plant to be reused then a Non-Reservoir ReUse Plan should be located just below the treatment plant discharge.

StateMod currently supports the operation of the following 11 plan types; refer to the Modeling Tip at the end of this section to find more information on these operations. The user specifies the plan type and other specific parameters in the plan structure (*.pln) file; see Section 4 for more discussion on the information in and format of this file. Note that Plan Types 5 and 6 are intentionally omitted; they are no longer used in StateMod.

Type 1 - T&C Plan is used to store a future obligation associated with the transfer of water from one structure to another. For example, a water right transfer might require historical return flows be maintained as part of the transfer. When a T&C plan is specified, StateMod calculates the obligation for the time step it occurs and all associated future time steps. Future returns and/or depletions are estimated using the same delay information specified for the source structure or in the operating rule that includes the T&C plan.

Type 2 - Well Augmentation Plan is used to store a future obligation to return water to the river (augment) when a well depletes the river out of priority. When a Well Augmentation Plan is specified, StateMod calculates the current and future obligation for the time step it occurs and all associated future time steps. Future returns and/or depletions are estimated using the same delay information specified for the source well structure.

Type 3 - Reservoir Reuse Plan is used to store a reusable water supply associated with a reservoir. As the reuse plan represents water stored in the reservoir, any unused water can be carried over in the plan to the next time step.

Type 4 - Diversion Reuse Plan is used to store a reusable water supply associated with a diversion. As the reuse plan is associated with a diversion, any unused water must be spilled since it cannot be carried over to the next month.

Type 7 - Transmountain Import Plan is used to account for imported water which, in many cases, may be used to extinction. The return flows generated from deliveries from a Type 7 plan are typically stored in Type 3 or Type 4 Reuse Plans. See the “How to Model Imports” section for more information on this plan type and import operations.

Type 8 - Recharge Plan is used to store a water supply that originated from reservoir, recharge area, or canal seepage. The water supply from this plan is typically used to meet a well augmentation demand generated in a Type 2 plan. The return to the river is controlled by a unit response table therefore it accrues to the river as a supply even if it is not assigned to a demand.

Type 9 - Out of Priority Plan is used to store a future obligation associated with water that is diverted out of priority. These plans are typically used to represent out-of-priority diversions to storage pursuant to the upstream storage statute (e.g. Blue River decree diversions by Denver and Colorado Springs).

Type 10 - Special Well Augmentation Plan is used to store the depletion associated with a well that is not required to be augmented. Examples include pumping in a designated basin or pumping by a well which has been decreed to be non-tributary (i.e. “coffin wells”). A special augmentation plan is typically used to demonstrate that every well in the model is assigned to an augmentation plan even if some wells are not required to augment their depletions.

Type 11 - Accounting Plan is used to "temporarily" divert water in priority which may subsequently be used at a later point in the priority system or by a number of other structures. Note this plan type was historically used for changed water rights, however due to the complexity of those operations, Plan Type 13 was developed exclusively for those operations. The Type 11 plan is still used in special operations such as the South Platte Compact.

Type 12 - Release Limit Plan is used to limit the cumulative supply from multiple sources to monthly and annual values. This plan is typically included in a series of other operating rules to limit the total amount of diversions or reservoir releases to a user-specified monthly or annual amount.

Type 13 – Changed Water Rights Plan is a specific type of accounting plan that is used to handle changed water right operations, allowing water to be "temporarily diverted" in priority, split to other Type 13 plans if the changed right has more than one owner, then released at a later priority to meet demands.

Modeling Tips:

- See the "How to Model Changed Water Rights and Return Flow Obligations" section for more information on Plan Types 1 and 13.
- See the "How to Model Imported Water" section for more information on Plan Type 7.
- See the "How to Model Reusable Supplies" section for more information on Plan Types 3 and 4.
- See the "How to Model Augmentation Plans" section for more information on Plan Types 2, 8, and 10.
- See the "How to Model a Release Limit Plan" section for more information on Plan Type 12.
- See the "Basin-Specific Operations and Compacts" section for more information on Plan Type 9 and 11.

7.9 How to Model a Release Limit Plan

Release limits provide a method to impose monthly and annual limits for one or more operating rules. This capability has generic applications but was developed for the Colorado River Basin where Green Mountain Reservoir and other reservoirs releases to Historic Users during a substitution year are limited by 66,000 acre-feet per year.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a plan.
    a. Note that because this is a Type 12 plan, the location does not need to be site specific.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the release limit plan as a Type 12 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.
4. In the operating rule (*.opr) file, include a Release Limit Operating Rule (Type 47) to define the monthly and annual limits of the release limit plan.

    a. The administration date is generally set to very senior.
    b. The source is the release limit plan; the destination is not defined (NA).
    c. Define the month when the operational limits are reset.
    d. If only an annual limit is needed, the monthly limits should equal the annual limits.
5. In the operating rule (*.opr) file, include the operating rule ID of the Type 47 in reservoir release or plan release operating rules. The inclusion of this rule, along with the appropriate operating limit (OprLimit) field, will limit the combined releases from these rules to the monthly and annual limits in the Type 47 rule.
    a. The Direct Plan/Reservoir Release Operating Rule (Type 27) and the Exchange Plan/Release Operating Rule (Type 28) currently have the most enhanced functionality to work with the release limit operations. See Section 4 for more information on incorporating the limit into these rules.
    b. Release limit operations are also often used with the Replace Reservoir Operating Rule (Type 10). As outlined in Section 4, this rule does not release to a carrier therefore, the Type 27, 28, and 10 rules are often used together to impose a total release limit.
6. Review the plan summary (*.xpl) file, operating rule summary (*.xop), and reservoir summary (*.xre) file for release amounts associated with each operating rule; the accumulation of the releases as compared to the limit amount; and the portion of the limit, if any, that was unused.

7.10 How to Model Augmentation Plans

A well augmentation plan is typically the result of an engineering analysis that allows a well to divert out-of-priority and replace the river depletions with one or more replacement water sources in order to avoid injury to senior water rights. StateMod calculates the depletion at a river associated with well pumping in the current time step and all future time steps based on the amount pumped, the efficiency of its use, and its associated depletion pattern (e.g. unit response function). If a well water right is tied to an augmentation plan, any depletion associated with out-of-priority pumping (i.e. augmentation requirement) is stored in that plan in the current and all future time steps. The augmentation requirement is the difference between the well's depletion on the river and the accretions from any associated return flows. These augmentation requirements may be "offset" by a number of supplies, including:

- Depletions that accrue to the river in the current time step in-priority; accounted for automatically by StateMod
- In-priority depletions that accrue to the river from pumping in prior time steps.
- Accretions from decreed recharge areas or canal seepage
- Releases from a reservoir
- Pumping from Augmentation or Recharge Wells

A Special Augmentation Plan, discussed in more detail below, is used to account for depletions associated with a well or group of wells that are not required to be augmented. Examples include pumping in Designated Basins or pumping by wells decreed to be non-tributary (e.g. Coffin Wells). A

Special Augmentation Plan can track these depletions, however does not generate an “augmentation requirement” and therefore does not have associated supplies.

Modeling Tips:

- See the “How to Model Well Operations” section for information on how to include wells in a StateMod modeling scenario.
- Refer to an existing model, such as the South Platte Model, for more information on how to include augmentation plans and operations in a StateMod model.
- StateMod only accounts for the augmentation requirement and supplies used to offset the requirement; it does not limit well pumping if the supplies are insufficient to meet the full plan demand. The plan demand and supplies are reported in the plan summary (*xpl) file and it is up to the user to confirm, if appropriate, that the full augmentation requirement is being offset.
- Historical records of recharge supplies are limited in HydroBase, and when available, can be quite variable. The user may consider using a release limit plan to provide an overall limit to all of the recharge supplies, basing the monthly and annual limits on the recent or average total of all recharge supplies.

7.10.1 Augmentation Plan Structure

A Plan Type 2 – Well Augmentation Plan structure is used to track the augmentation requirement associated with well pumping in a model scenario for the current and future time steps. The augmentation requirement, or the difference between the depletions to the river and the accretions from any return flows, is generated during model simulation and serves as the plan demand. This plan demand can be “met” by several supplies as discussed in the sections below. Note that StateMod only accounts for the augmentation requirement and supplies used to offset this plan demand; it does not limit well pumping if the supplies are insufficient to meet the full plan demand. The plan demand and supplies are reported in the plan summary (*xpl) file and it is up to the user to confirm, if appropriate, that the full augmentation requirement is being offset.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a plan.
    a. Note that an augmentation plan generally accounts for the augmentation requirement from multiple wells, therefore the plan should be included at a location on the river where a majority of the depletions impact the river.
    b. The augmentation requirement will be administered at the location of the plan, therefore the location can impact how much of the plan demand is in-priority or what supplies are available to offset the demand.
    c. Augmentation plans are assigned WDID’s in HydroBase; it is recommended this identifier be used as the plan ID in the model.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the well augmentation plan as a Type 2 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.

4. Using a text editor, create the well augmentation plan data (*.plw) file to associate individual wells to an augmentation plan. See Section 4 for more discussion on the information in and format of this file.
    a. HydroBase contains the association of well ID's to augmentation plans in its Association Table, however there is not a command driven approach available in current versions of the data management interfaces to query for the information and create the file. Therefore, this file is currently created outside of the of DMI process using information from the Association Table (accessible through the Datastore functionality in TSTool) and the well rights (*wer) file.
    b. Wells can be tied to multiple augmentation plans if the well right ID is distributed to the multiple augmentation plans.

Example Well Augmentation Plan Data (.plw) File*

```
#
# Plan ID    WellRightID  StructureID   Comments
#----------exb----------xb------------exb-------------------
6403392      6406434      64_AWP006     TAYLOR WELL 1-4532
6403392      6406436      64_AWP006     TAYLOR WELL 2-4473-F
6403392      6405982      64_AWP006     NEIN WELL 1-5150-F
6403392      6406513      64_AWP006     SCHUPPE WELL 1
6403392      6406513      64_AWP006     SCHUPPE WELL 1
Coffin_Well  0106641      01_AWP037     GEIB SUMP WELL 359D
Coffin_Well  0106642      01_AWP037     GEIB WELL NO 1
Coffin_Well  0106643      01_AWP037     GEIB WELL NO 2
Coffin_Well  0106644      01_AWP037     GEIB WELL NO 3
Coffin_Well  0106645      01_AWP037     GEIB WELL NO 4
Coffin_Well  0106999      01_AWP037     J W MAE S MILLER 1-182D
Coffin_Well  0106999      01_AWP037     J W MAE S MILLER 1-182D
Coffin_Well  0107000      01_AWP037     J W MAE S MILLER 3-245D
#
```

5. In the operating rule (*.opr) file, include an In-Priority Supply Operating Rule (Type 43) to define the priority date of the augmentation plan indicating when depletions to the river would not need to be augmented. StateMod uses the priorities of the individual wells from the well rights (*wer) file to determine if any depletions that occur in the same time step are in or out of priority. If in-priority, the augmentation requirement is reduced to reflect the in-priority depletion. Due to the number of wells typically included in a model, it is impractical to analyze each individual well priority to determine if future depletions are in or out of priority, therefore a common priority associated with the Type 43 operating rule is used.
    a. In some instances, the augmentation plan decrees include a specific priority at which the depletions do not have to be augmented. If so, use this date as the priority of the Type 43 rule.
    b. If no date is provided in the decree, calculate a decree-weighted average priority for the wells associated with the well augmentation plan.
6. Review the plan summary (*.xpl) file for information on the total augmentation requirement (plan demand) based on the lagged depletions and accretions, and the portion of the augmentation requirement that impacted the river when the well rights or augmentation plan was in-priority. The remainder of the augmentation plan should be offset using one or more of the supplies discussed below, however it is up to the user to ensure the full augmentation requirement is offset.

7.10.2 Canal Loss (Seepage) as an Augmentation Supply

StateMod allows canal loss (seepage) to be used as an augmentation plan supply and estimates the amount of this supply based on the amount of water carried to a demand, the efficiency of the canal, and the location and timing the canal loss (seepage) accrues to the river. The lagged canal loss is stored in a specific recharge plan and can then be “released from” (accounted at) the plan as a supply to offset an augmentation requirement. Canal loss used as an augmentation supply must be designated by an operating rule and therefore requires a carrier structure that diverts to meet a separate demand. Canal loss experienced by a diversion structure diverted based only on a diversion right cannot be stored in a recharge plan. As canal loss is reaching the river regardless if there is an augmentation requirement, the recharge plan only accounts for the loss as a supply in the given time-step the lagged canal loss accrues to the river and the plan does not need to be “spilled”.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a plan.
   a. It is recommended the plan ID reflect the augmentation plan ID it will supply along with a suffix indicating it will store canal loss (e.g. _PlC for the *Pl*an *C*anal).
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the canal loss recharge plan as a Type 8 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.
4. Using a text editor, create the plan return (*.prf) file which includes return flow data used to route the canal loss back to the river. See Section 4 for more discussion on the information in and format of this file.
   a. The return flow location and patterns in the plan return (*prf) file should be similar to the return flow information for the carrier structure in the diversion station (*.dds) file.
   b. Canal loss from the recharge plan may be routed to any number of stream locations using any number of unit response functions, however the unit response functions must be included in the delay table (*.dly or *.urm) file.
5. In the operating rule (*.opr) file, include a Carrier with Transit Loss (Type 45) operating rule from the carrier to the demand including the canal loss recharge plan in the rule (creuse field). The second line of the Type 45 operating rule indicates the percent of canal loss.
   a. Note that in many cases, only the canal loss associated with specific water rights can be used as an augmentation supply. Include the canal loss recharge plan only with operating rules carrying water rights with their canal loss decreed as an augmentation supply.
   b. Consider including a Release Limit Plan in the operating rule to limit the overall total of all recharge supplies, including canal loss recharge.
6. In the operating rule (*.opr) file, include a Plan/Reservoir Reuse to Plan by Direct or Exchange (Type 48 and 49) operating rule in order to apply the water stored in the canal loss recharge plan to offset augmentation requirement.
   a. Note that the water stored in the plan is the lagged accretions to the river and will offset the lagged depletions in the augmentation plan in the same time step, if any.

b. The source in this rule is the canal loss recharge plan and the destination is the augmentation plan.

c. If no Type 48 or 49 rule is included, the canal loss will return to the system but is not considered as an augmentation supply, therefore a Plan Spill (Type 29) operating rule is not needed.

7. Review the plan summary (*.xpl) file for information on the total canal loss recharge plan supply and the portion of the augmentation requirement that was offset by the supply.

Example Plan Return (.prf) File*

```
#
#     (Free format)
#     ID        cwelid:   Plan ID
#     Dep Id    crtnidw2: River ID return by diversion
#     Dep %     pcttotw2: Percent of return to location
#     Table #   irtndlw2: Return table id
#
# ID          Ret ID           Ret %  Table        Comment (e.g.return type, Name,
#----------exb----------exb------exb----------exb-------------------------------e
0102522_P1C  0100513           60.   100          Canal Rech
0102522_P1C  0100507_D         40.   100          Canal Rech
```

Example Operating Rule (.opr) File*

```
#
# ID        Name                    NA                    Admin#   # Str  On/Off Dest Id     Dest Ac  Sou1 Id      Sou1 Ac  Sou2 Id     Sou2 Ac   Type Plan          Div Type    OprLoss   Limit
# ---------eb----------------------eb----------exxxxb----------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------exb----------exb----------exb------eb------eb--
01025220.02 RIVERSIDE Carrier                            46751.45836      1       1 0102522_R          1 0100503_D.08       1 0100503_D        100      45 0102522_P1C  Diversion      0.00     4.00
                                    0100503_D     25 Carrier
                                    01025180.07
01025220.03 RIVERSIDE Carrier                            50466.00000      1       1 0102522_R          1 0100503_D.10       1 0100503_D        100      45 0102522_P1C  Diversion      0.00     4.00
                                    0100503_D     25 Carrier
                                    01025180.07
01025220.04 RIVERSIDE Carrier                            50712.00000      1       1 0102522_R          1 0100503_D.11       1 0100503_D        100      45 0102522_P1C  Diversion      0.00     4.00
                                    0100503_D     25 Carrier
                                    01025180.07
01025220.05 RIVERSIDE Carrier                            50769.49378      1       1 0102522_R          1 0100503_D.12       1 0100503_D        100      45 0102522_P1C  Diversion      0.00     4.00
                                    0100503_D     25 Carrier
                                    01025180.07
01025220.06 RIVERSIDE Carrier                            51356.00000      1       1 0102522_R          1 0100503_D.13       1 0100503_D        100      45 0102522_P1C  Diversion      0.00     4.00
                                    0100503_D     25 Carrier
                                    01025180.07
#
01025180.07 RIVERSIDE Res Limit                              1.00000      0       1 NA                 1 0102522_RL         1 NA                 0      47 NA           Diversion         0        1
  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995. 24000.
#
01025220.08 RIVERSIDE Canal Recharge                     55637.10000      0       1 0102522            1 0102522_P1C        0 NA                 0      48 NA           Diversion      0.00     0.00
01025220.09 RIVERSIDE Res Recharge                       55637.10000      0       1 0102522            1 0102522_P1R        0 NA                 0      48 NA           Diversion      0.00     0.00
01025220.10 RIVERSIDE Reservoir                          55637.20000      0       1 0102522            1 0103651            1 NA                 0      49 NA           Diversion      0.00     0.00
#
```

7.10.3 Reservoir Recharge (Seepage) as an Augmentation Supply

StateMod allows reservoir recharge (seepage) to be used as an augmentation plan supply and estimates the amount of this supply based on the amount of water carried to the reservoir/recharge area, the efficiency of the carrier, the seepage rate assigned to the reservoir/recharge area, and the location and timing the reservoir recharge (seepage) accrues to the river. The reservoir recharge is stored in a specific recharge plan and can then be "released from" (accounted at) the plan as a supply to offset an augmentation requirement. As reservoir recharge is reaching the river regardless if there is an augmentation requirement, the recharge plan only accounts for the loss as a supply in the given time-step the lagged reservoir recharge accrues to the river and the plan does not need to be "spilled".

Representing reservoir recharge as an augmentation supply requires the inclusion of both a recharge plan and the reservoir recharge area. Recharge areas are included in the model as reservoirs, and as such, require content information to be included in the reservoir target (*.tar) file. As most recharge areas are designed to seep their entire contents, the end-of-month contents of the recharge area is often zero and the target does not serve as a limitation to the amount of water carried to the reservoir. The user may consider implementing a release limit plan on diversions to the recharge area to prevent the recharge area from "over-recharging" therefore simulate operations closer to the historical conditions.

Augmentation plans that have reservoir recharge as a supply generally have several recharge areas associated with the plan. The user may consider aggregating the recharge areas into a single modeled recharge area for the plan, or aggregate the recharge areas by return flow timing (e.g. aggregate those with a longer accretion pattern separate from those with a shorter accretion pattern).

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to Add an Upstream Location. Enter the appropriate location and structure information and designate the structure type as a reservoir.
    a. Recharge areas are assigned WDID's in HydroBase; use this as the model ID if representing the recharge area explicitly. If aggregating recharge areas, it is recommended the reservoir ID reflect the augmentation plan ID it will supply along with a suffix indicating it is a recharge area (e.g. _R).
2. While in the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to Add an Upstream Location. Enter the appropriate location and structure information and designate the structure type as a plan.
    a. It is recommended the recharge plan ID reflect the augmentation plan ID it will supply along with a suffix indicating it will store reservoir recharge (e.g. _PlR).
3. Recreate the river network file (*.rin) to reflect the additional structure.
4. Add the recharge area to the reservoir station file (*.res) using the StateDMI commands:
    a. Set the total capacity of the reservoir in AF.
    b. Set individual accounts (e.g. users in the reservoirs if recharge aggregate serves more than one augmentation plan), their respective capacities, and their starting volumes.
    c. Set the net evaporation station; must reference the evaporation station provided in the evaporation file (*.eva).
    d. Set the area/capacity/seepage table; the seepage information is included as acre-feet of seepage in each time step per volume of the reservoir. For example, if a 500 acre-foot recharge area can seep half of its contents in one month, the seepage for the 500 acre-foot volume would be 250 acre-feet.
5. Add water rights to the reservoir right file (*.rer) using the StateDMI commands:
    a. Recharge operations are generally operated based on a direct recharge right, however a reservoir right is still needed for use in the plan recharge (*plr) file.
    b. Set the water right ID as the structure ID with a numeric suffix for each right.
    c. Set the water right priority (administration number) and amount in AF.
    d. Set the accounts that can be filled with the water rights and whether it is a first-fill or refill right.
6. Add the structure's demand to the reservoir target file (*.tar) using the TSTool commands.
    a. Set the monthly reservoir minimum and maximum targets (generally zero and the reservoir capacity) or read in an external StateMod formatted file (*.stm) with the capacity target in AF. See comments at the beginning of this section regarding issues with recharge areas reaching their target demands.
7. In the plan file (*.pln), include the recharge plan as a Type 8 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.

8. Using a text editor, create the plan recharge (*.plr) file which ties the recharge areas and their rights to a recharge plan ID. Note that recharge areas can be associated with more than one recharge plan. See Section 4 for more discussion on the information in and format of this file.
9. Using a text editor, create the reservoir return (*.rrf) file which includes return flow data used to route the reservoir recharge back to the river. See Section 4 for more discussion on the information in and format of this file.
    a. Reservoir recharge may be routed to any number of stream locations using any number of unit response functions, however the unit response functions must be included in the delay table (*.dly or *.urm) file.
10. In the operating rule (*.opr) file, include a Carrier with Transit Loss (Type 45) operating rule from the carrier to the recharge area, and if appropriate, include the canal loss recharge plan in the rule (creuse field). The second line of the Type 45 operating rule indicates the percent of canal loss.
    a. Note that recharge areas are generally located off-channel and therefore need operating rules that carry recharge water to them.
    b. In many cases, the recharge areas are filled under a direct diversion right decreed for recharge, which allow for credit to be taken on the canal loss associated with the diversions to the recharge area. Therefore the source of the Type 45 operating rule is the direct recharge right and the destination is the recharge area.
    c. Consider including a Release Limit Plan in the operating rule to limit the total overall supplies, including the amount carried to the recharge area each time step.
11. In the operating rule (*.opr) file, include a Plan/Reservoir Reuse to Plan by Direct or Exchange (Type 48 and 49) operating rule in order to apply the water stored in the recharge plan to offset augmentation requirement.
    a. Note that the water stored in the plan is the lagged accretions to the river and will offset the lagged depletions in the augmentation plan in the same time step, if any.
    b. The source in this rule is the recharge plan and the destination is the augmentation plan.
    c. If no Type 48 or 49 rule is included, the reservoir recharge will return to the system but is not considered as an augmentation supply, therefore a Plan Spill (Type 29) operating rule is not needed.
12. Review the plan summary (*.xpl) file for information on the total recharge plan supply and the portion of the augmentation requirement that was offset by the supply.
13. Review the reservoir summary output (*.xre) file for output information on the recharge area, including the total supply, evaporation, and the seepage rate.

Example Plan Recharge (.plr) File*

```
#
# Reservoir  Reservoir    Reservoir
# Plan ID    Right ID     Str ID         Owner Comments
#----------exb----------exb----------exb------exb----------------------e
0102522_PlR  0102522_R.1  0102522_R          1    Res Recharge to Aug Plan
0102528_PlR  0102528_R.1  0102528_R          1    Res Recharge to Aug Plan
0102529_PlR  0102529_R.1  0102529_R          1    Res Recharge to Aug Plan
0102535_PlR  0102535_R.1  0102535_R          1    Res Recharge to Aug Plan
0103334_PlR  0103339_R.1  0103334_R          1    Res Recharge to Aug Plan
0103339_PlR  0103339_R.1  0103339_R          1    Res Recharge to Aug Plan
0103570_PlR  0103570_R.1  0103570            1    Res Recharge to Aug Plan
#
```

Example Reservoir Recharge (.rrf) File*

```
# ID          Ret ID           Ret % Table          Comment (e.g.return type, Name, etc.)
#----------exb----------exb------exb----------exb--------------------------------e
0102522_R     0100513          100.  100503         Res Rech
0102528_R     0100518          100.  100514         Res Rech
0102529_R     0100518          100.  100515         Res Rech
```

Example Operating Rule (.opr) File*

```
#
# ID        Name                    NA                         Admin#   # Str  On/Off Dest Id      Dest Ac  Sou1 Id      Sou1 Ac  Sou2 Id      Sou2 Ac    Type Plan          Div Type     OprLoss    Limit
# ---------eb----------------------eb----------exxxxb----------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------exb----------exb----------exb------eb------eb--
01025220.02 RIVERSIDE Carrier                                 46751.45836      1       1 0102522_R          1 0100503_D.08       1 0100503_D          100      45 0102522_P1C  Diversion       0.00     4.00
                                0100503_D     25 Carrier
                                01025180.07
01025220.03 RIVERSIDE Carrier                                 50466.00000      1       1 0102522_R          1 0100503_D.10       1 0100503_D          100      45 0102522_P1C  Diversion       0.00     4.00
                                0100503_D     25 Carrier
                                01025180.07
01025220.04 RIVERSIDE Carrier                                 50712.00000      1       1 0102522_R          1 0100503_D.11       1 0100503_D          100      45 0102522_P1C  Diversion       0.00     4.00
                                0100503_D     25 Carrier
                                01025180.07
01025220.05 RIVERSIDE Carrier                                 50769.49378      1       1 0102522_R          1 0100503_D.12       1 0100503_D          100      45 0102522_P1C  Diversion       0.00     4.00
                                0100503_D     25 Carrier
                                01025180.07
01025220.06 RIVERSIDE Carrier                                 51356.00000      1       1 0102522_R          1 0100503_D.13       1 0100503_D          100      45 0102522_P1C  Diversion       0.00     4.00
                                0100503_D     25 Carrier
                                01025180.07
#
01025180.07 RIVERSIDE Res Limit                                   1.00000      0       1 NA                 1 0102522_RL         1 NA                   0      47 NA           Diversion          0        1
  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995.  1995. 24000.
#
01025220.08 RIVERSIDE Canal Recharge                          55637.10000      0       1 0102522            1 0102522_P1C        0 NA                   0      48 NA           Diversion       0.00     0.00
01025220.09 RIVERSIDE Res Recharge                            55637.10000      0       1 0102522              0102522_P1R        0 NA                   0      48 NA           Diversion       0.00     0.00
01025220.10 RIVERSIDE Reservoir                               55637.20000      0       1 0102522            1 0103651            1 NA                   0      49 NA           Diversion       0.00     0.00
#
```

7.10.4 Augmentation or Recharge Well Pumping as an Augmentation Supply

StateMod has the ability to pump either a recharge or augmentation well to meet an outstanding augmentation requirement. Due to the pumping costs associate with this supply and the fact that the pumping itself can result in an increased augmentation demand, these supplies are generally used only when other supplies are not available. These wells are generally not exclusively used for augmentation and/or recharge, but also pump to meet irrigation demands.

An augmentation well is generally located farther away from the river (i.e. its depletions generally have a longer depletion pattern) but its pumped water is conveyed directly to the river to offset an augmentation requirement. The augmentation well depletions are generally covered by the same augmentation plan (as tied in the well augmentation plan data (*.plw) file) that the pumping is used to offset, however the future depletions are traded for immediate augmentation supply.

A recharge well is generally located closer to the river (i.e. a short depletion pattern) and pumps water to a recharge area with a longer depletion pattern where it seeps back to the river to offset a future augmentation requirement. StateMod only allows the recharge well to pump when it's in priority, therefore it does not create an augmentation requirement.

Both types of wells can be modeled in StateMod either as explicit well structures or as a group of wells aggregated under a single well structure. As augmentation plans can add or remove augmentation and recharge wells from their plans, the aggregate well structure approach is discussed herein. This approach allows a single file and operating rule to be changed as wells are added or removed, and limits the need to update the network and all well input files.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a well structure.
    a. It is recommended the well structure ID reflect the augmentation plan ID the wells will supply and a suffix indicating the type of wells they are (e.g. _ReW or _AuW).

2. Recreate the river network file (*.rin) to reflect the additional structure.
3. Add the well structure to the well station (*.wes) file using the StateDMI commands:
    a. Set the total well capacity in CFS.
    b. Set the well system efficiency as 0 percent (100 percent returns to either the recharge area or to a river location).
    c. Set the demand and use types (see Section 4 for more discussion).
    d. Set the depletion and return flow locations and patterns; must reference the delay patterns provided in the delay file (*.dly or *.urm).
        i. Recharge wells generally deplete the river in the same time step and pump to the recharge area in the same time step.
        ii. Augmentation wells generally deplete the river with a lagged pattern and pump to the river in the same time step.
4. Add the well structure to well right (*.wer) file using the StateDMI commands:
    a. Use HydroBase to pull well rights for each well or set each well water right; in both situations, tie each water right to the ground water only structure ID.
    b. Set the water right priority (administration number) and amount in CFS.
    c. Review options to determine if a “turn-on” date is appropriate; note that a “turn-off” date has not been implemented and once a well is turned on, it is available to pump for the remainder of the model period.
5. Add the well structure with a zero demand to the well demand file (*.wem) using the TSTool commands. Well pumping will occur based on the augmentation requirement of the augmentation plan.
6. In the operating rule (*.opr) file, include an Augmentation Well (Type 44) operating rule associating the augmentation well structure to the augmentation plan.
    a. The source is the well right ID and the destination is the augmentation plan.
    b. The operating rule generally reflects a junior priority relative to other augmentation supplies.
    c. If appropriate, include the augmentation plan in the operating rule in which the augmentation well depletions will be stored.
7. In the operating rule (*.opr) file, include a Recharge Well (Type 37) operating rule associating the recharge well structure to the recharge area.
    a. The source is the well right ID and the destination is the recharge area.
    b. The operating rule must reflect the priority of the well right used for the recharge operations.
8. Review the plan summary (*.xpl) file for information on the portion of the augmentation requirement that was offset by the recharge or augmentation well supply and the well summary (*.xwe) file for output information on the well structures.

7.10.5 Direct Reservoir Release as an Augmentation Supply

StateMod allows augmentation requirements to be met by reservoir releases either directly or via exchange. This operation generally occurs when a portion of the reservoir water right is decreed for augmentation, among other uses, and the reservoir can release to meet remaining augmentation requirements. The approach below assumes the reservoir is already included in the model; see the “Add a Reservoir” section for more information on adding a reservoir to the model.

1. In the operating rule (*.opr) file, include a Plan/Reservoir Reuse to Plan by Direct or Exchange (Type 48 and 49) operating rule in order to release water from a reservoir to offset an augmentation requirement.
    a. The source in this rule is the reservoir and the destination is the augmentation plan; use more than one operating rule to release from more than one account.
2. Review the plan summary (*.xpl) file, operating rule summary (*.xop), and reservoir summary (*.xre) file for the release amount used to offset the augmentation requirement.

7.10.6 Special Well Augmentation Plans

A Plan Type 10 - Special Well Augmentation Plan is used to track the depletions associated with a well that is not required to be augmented. Examples include pumping in a designated basin or pumping by a well which has been decreed to be non-tributary (i.e. “coffin wells”). A special augmentation plan is typically used to demonstrate that every well in the model is assigned to an augmentation plan even if some wells are not required to augment their depletions. The plan demand, or the difference between the depletions to the river and the accretions from any return flows, is generated during model simulation. Unlike the Augmentation Plan, the Special Well Augmentation Plan is used for accounting only, and no supplies are modeled to “meet” the plan demand.

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a plan.
    a. Note that the special augmentation plan generally accounts for depletions from multiple wells, therefore the plan should be included at a location on the river where a majority of the depletions impact the river.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the well augmentation plan as a Type 10 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.
4. Using a text editor, create the well augmentation plan data (*.plw) file to associate individual wells to a special well augmentation plan. See Section 4 for more discussion on the information in and format of this file.
    a. HydroBase contains the source (e.g. designated basin, non-tributary aquifers) for wells which provide information on which wells would not need to be augmented, however there is not a command driven approach available in current versions of the data management interfaces to query for the information and tie that information to the special well augmentation plan.

Example Well Augmentation Plan Data (.plw) File*

```
#
# Plan ID     WellRightID  StructureID   Comments
#----------exb----------xb------------exb-------------------
6403392       6406434      64_AWP006     TAYLOR WELL 1-4532
6403392       6406436      64_AWP006     TAYLOR WELL 2-4473-F
6403392       6405982      64_AWP006     NEIN WELL 1-5150-F
6403392       6406513      64_AWP006     SCHUPPE WELL 1
6403392       6406513      64_AWP006     SCHUPPE WELL 1
Coffin_Well   0106641      01_AWP037     GEIB SUMP WELL 359D
Coffin_Well   0106642      01_AWP037     GEIB WELL NO 1
Coffin_Well   0106643      01_AWP037     GEIB WELL NO 2
Coffin_Well   0106644      01_AWP037     GEIB WELL NO 3
Coffin_Well   0106645      01_AWP037     GEIB WELL NO 4
Coffin_Well   0106999      01_AWP037     J W MAE S MILLER 1-182D
Coffin_Well   0106999      01_AWP037     J W MAE S MILLER 1-182D
Coffin_Well   0107000      01_AWP037     J W MAE S MILLER 3-245D
#
```

5. In the operating rule (*.opr) file, include a Plan/Reservoir Reuse to Plan by Direct (Type 48) operating rule to indicate to the model that a physical water supply is not required for these wells because well location (e.g. designated basin) or an administrative decision.
    a. The Special Well Augmentation Plan is used as the source and the destination in the operating rule.
    b. The priority is generally set to the most junior in the model but it does not impact other operations.
    c. The user may or may not include an In-Priority Supply Operating Rule (Type 43) with a specific priority to determine what portion of the depletions would not need to be augmented if the depletions were brought into the priority system.
6. Review the plan summary (*.xpl) file for information on the total lagged depletions (plan demand) associated with the special well augmentation plan.

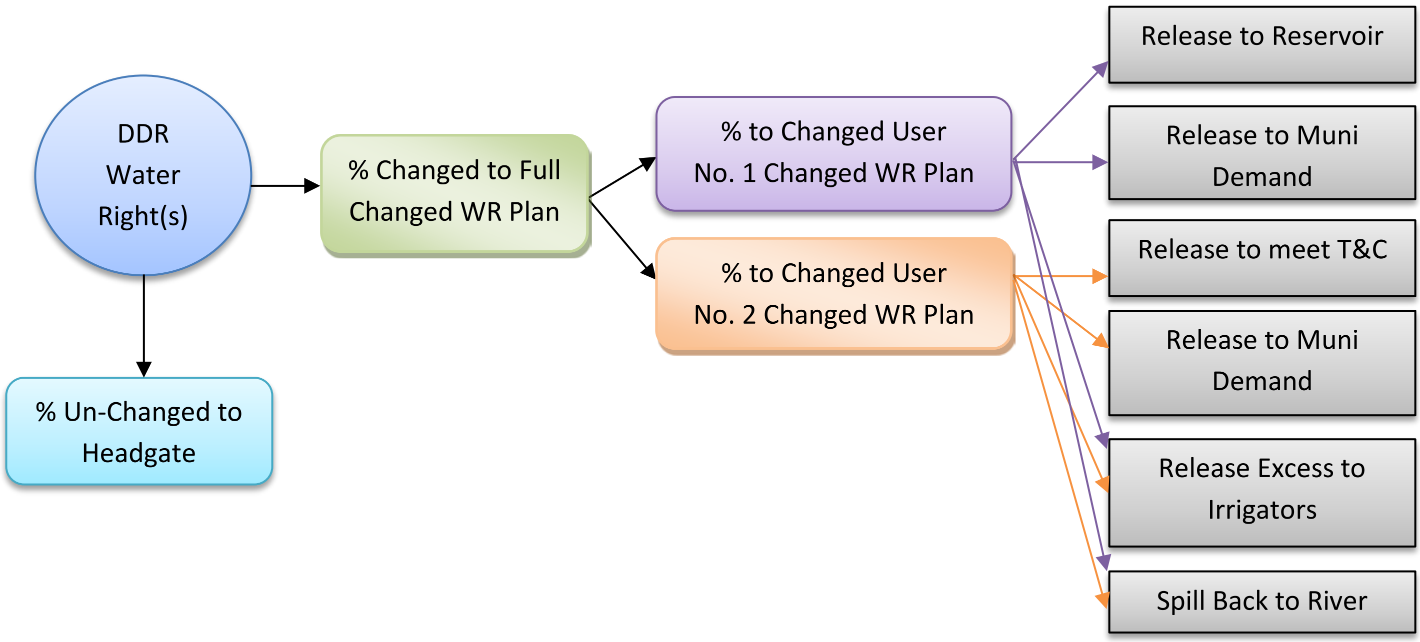
7.11 How to Model Changed Water Rights and Return Flow Obligations

Changed water rights, or water transfers, are represented in StateMod by “temporarily” diverting and storing the water right into a Changed Water Right Plan when in priority, then releasing the water from the plan to meet a demand at a priority determined by the user, often junior to the original right. Water diverted into the Changed Water Right Plan to temporarily store a diversion may or may not be used depending on other water supplies and/or operations. The correct implementation of a Changed Water Right plan and associated operating rules will account for:

- Administration of the changed water right at the correct location and at the correct priority
- Sharing shortages between all users, including any un-changed portion of the water right
- Use of the changed water right at priority different to the water right and relative to other operations in the model
- Capacity limitations of the existing headgate
- Decreed monthly and annual volumetrics and/or associated terms and conditions
- Availability of any unused changed water rights to other users in the system

The following schematic provides an example of Changed Water Rights operations; the plan structures and operating rules used to represent these operations are discussed in more detail below.

Figure 9: Changed Water Rights Example Operations



7.11.1 Changed Water Right Plan Structure

A Plan Type 13 – Changed Water Right Plan structure is used to temporarily divert and store a water right that has been changed for uses other than its historical use. This commonly occurs when water users purchase a portion of a senior water right historically used for irrigation, change the use in Water Court, and then use the changed water rights for other uses such as municipal, industrial, or augmentation. If the changed water right is to be divided among more than one user, as shown in the example schematic above, then an overall plan is needed to store the total changed portion, and individual plans are needed for each user for a total of three plans. If more than one water right is changed at the same source location, they can be put into the same overall plan *only if* all the water rights can be split to individual user plans using the same percentages and if the terms and conditions applied when the plans release the water to the end uses are the same.

As the changed water right plan operations are all accounted for at the source water right headgate (administrative) location, all the plans must be modeled off-channel on a "mock" tributary so they do not affect exchange potential or other operations on the mainstem. Note that the changed water rights are only available for use in the same time step they are diverted and must be "spilled" back to the river if they are not used.

The user should keep in mind that the changed water rights plan "demand" is the portion of the water that is changed; regardless if there is a final demand for the changed water when the water is released. For example, if 100 cfs is available under the full water right, and 50 percent of the ditch has been changed, then 50 cfs will be stored in the plan structure and the remaining 50 cfs will go towards meeting the headgate demand. Even if the 50 cfs that was stored in the plan is not used and is ultimately spilled back to the river, and the headgate demand is unmet, the spilled water will *not* go to meet the headgate demand. If the changed water can be used to meet the headgate demand, it is recommended the user set up a separate operating rule to release from the changed water rights plan to the headgate demand. Additionally, if there is no headgate demand, then all of the water right must be put into the plan.

The operating rule used to temporarily store water in the changed water rights plan (Type 26) does not limit the changed water by the capacity of the source water right location; this limitation is performed when the water is released from the plan. This ensures that capacity is not "used" with water that was only temporarily stored, and may not be ultimately used to meet demand. Similar logic can be applied to implementing Terms and Conditions associated with the historical use of the water, generally outlined in the change of use decree. The Terms and Conditions operations, which ultimately generate a plan demand, should be based only on the water that is actually released and used to meet a demand, not based on the water stored in the plan. Therefore it is recommended the user include Terms and Conditions in the plan release operations. See the following Releases from a Changed Water Right Plan section for more information on limiting the changed water right by the source diversion structure's capacity and implementing Terms and Conditions.

1. Open the network (*.net) in StateDMI, navigate to the source water right headgate, and right-click to *Add an Upstream Location*. Create a new tributary, enter the appropriate structure information, and designate the structure type as a plan.
    a. If more than one changed water rights plan will be required to model the operations, as shown in the example schematic above, add the additional plan structures on the mock tributary in this step.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the changed water right plan as a Type 13 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.
4. In the operating rule (*.opr) file, include a Changed Water Right Operating Rule (Type 26) to divert each water right into a changed water right plan.
    a. The source is the changed water right ID and the destination is the changed water right plan.
    b. Set the priority to be the same as the priority of the source water right in the diversion rights (*.ddr) file.
    c. Set the monthly and annual limitations; generally based on limits on the changed right by the decree.
    d. Set the percent of the water right that is changed and therefore stored in the plan. If the portion of the water right to be stored in the plan is not 100 percent, the remaining amount is used to meet any demand at the source water right headgate. The Type 26 turns off the water right so it cannot be used in other operating rules.
    e. The Type 26 operating rule operates only once per time step (i.e. does not re-operate).
5. If more than one changed water right plan is necessary, in the operating rule (*.opr) file, include a Multiple Plan Ownership Operating Rule (Type 46) to split the overall changed water right plan (as referenced as the destination in the Type 26 rule) into multiple owner's plans.
    a. The split percentages to the individual users' changed water rights plan must add up to 100 percent.

    b. Set the priority to be just junior to the Type 26 operating rule.

See the following section for the recommended approach to release water from a changed water rights plan.

6. In the operating rule (*.opr) file, include a Spill Plan Operating Rule (Type 29) for all changed water rights plans.
    a. The source is the changed water rights plan and the destination is the location associated with the source water right (e.g. spill back to the headgate).
    b. Set the priority to spill the plan junior to all release operating rules.
7. Review the plan summary (*.xpl) file, the operating rule summary (*.xop) file, and the diversion structure summary (*.xdd) file for information on the amount of changed water stored in the plan and the amount of water diverted to meet the headgate demand.
    a. When a changed water right (type 26) temporarily stores water in an administrative plan, the available flow in the system (Avail) and the water physically located at the source structure (River) is reduced. This makes the water temporarily stored by this operating rule unavailable for any junior water rights to divert. Because the amount diverted is considered temporary, no diversions are reported in the diversion structure summary (*.xdd) file at the source structure or destination plan unless water is released from the administrative plan as described below. Note, the total amount diverted, including any that may have been released for use or spilled, is reported in the operating rule summary (*.xop) file and the plan summary (*.xpl) file.

7.11.2 Releases from a Changed Water Right Plan

Once the changed water right is temporarily stored in a changed water rights plan, operating rules are used to release the water from the plan to meet a direct diversion demand, to store in a reservoir, to meet return flow obligations (e.g. Terms and Condition Plan requirement), or to offset an Augmentation Plan requirement. The user can release directly from the plan to a downstream user or via exchange using Direct Plan/Reservoir Release Operating Rule (Type 27) and the Exchange Plan/Release Operating Rule (Type 28). The functionality of these operating rules has been modified specifically for the use with changed water rights plans and should be used to simulate releases from the plan.

These operating rules allow for the following options when releasing from the plan:

- Limit the release from the plan by the source water right diversion capacity
- Limit the release based on a release limit plan (Plan Type 12)
- Limit the release based on the amount diverted via another operating rule
- Impose Terms and Conditions based on the released water
- Include a Reuse Plan to track reusable supplies associated with the changed water

1. In the operating rule (*.opr) file, include a Direct Plan/Reservoir Release Operating Rule (Type 27) or the Exchange Plan/Release Operating Rule (Type 28), depending on the location of the destination, to release water from the changed water right plan to a demand.
    a. The source is the changed water right plan and the destination is the demand.
    b. Set the priority relative to the priorities of other water sources available to the demand (e.g. release from the plan to a demand after more junior supplies are used).
    c. Include carriers or monthly switches if necessary.
    d. Include a reuse plan if applicable; see the How to Model Reusable Supplies section for more information.
    e. Use the operating limit flags (OprLimit), as described in Section 4.13.27 and 4.13.28, to limit the release amount to either a release limit plan or to the amount diverted via another operating rule.
        i. OprLimit = 5 ties the release from the plan (or sub-plan if it has been split using a Type 46 operating rule) to the source water right diversion structure and allows the model to limit the release based on available capacity at the source structure. Include the Type 26 operating rule ID that diverted the water into the changed water right plan.
        ii. OprLimit = 2 or 7 limits the release from the changed water rights plan to the release limit plan. Include the Type 47 operating rule ID that defined the monthly and annual release limitations. If more than one release operating rule refers to the release limit plan, the total released from those rules will be limited to the release limit plan.
        iii. OprLimit = 3 or 8 limits the release from the changed water rights plan to the amount diverted and/or carried via another operating rule. Include the operating rule ID of the diversion or carrier operating rule; generally a Type 11 carrier rule. If more than one release operating rule refers to the carrier rule, each individual release rule will be limited by the amount carried (i.e. cumulative releases will *not* be limited).
        iv. OprLimit = 4 or 9 incorporates the limitations from all the limits above. Include the Type 26 operating rule ID, the Type 47 operating rule ID, and the carrier rule ID to apply all three limits.
    f. Include a Terms and Conditions plan ID and indicate whether a standard, fixed, or mixed return flow pattern is used. If a standard pattern is used, include the return flow factors in the operating rule as well. See the following Terms and Conditions Operations section for more information on implementing these plans.
2. Review the plan summary (*.xpl) file, the operating rule summary (*.xop) file, and the diversion structure summary (*.xdd) file for information on the releases from the changed water right plan.
    a. When water diverted from a Changed Water Right Plan for direct use by a Type 27/28 rule the diversion structure summary (*.xdd) files reports this release as:
        i. at the source, the water release to the destination is reported as Carried, Exchanged or Bypassed and,
        ii. at the destination, the water diverted is reported as From River by Other.

7.11.3 Terms and Conditions Operations

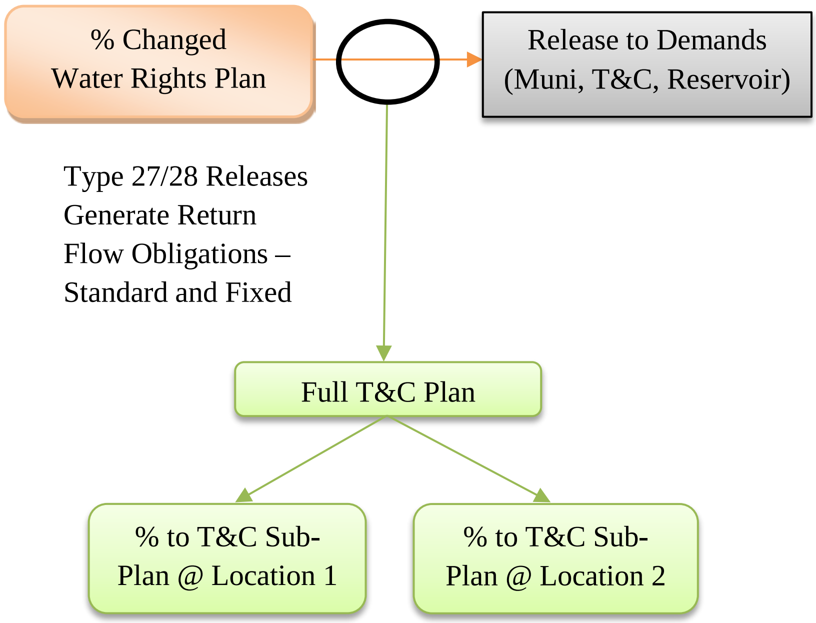
"Terms and Conditions" is language used to collectively represent the return flow obligations associated with the transfer or change of water right. They generally represent the amount, timing, and location of non-consumed water returned to the river from the historical use of the changed water right. StateMod generates these return flow obligations during simulation based on the amount of changed water used to meet a demand, the consumptive use (CU) factors, and the unit response function. The Terms and Condition (T&C) plan stores the return flow obligations (plan demand) for current and future time steps. The obligations can be "offset" by a number of supplies, including changed water rights, reusable supplies, and/or reservoir releases. Note that StateMod only accounts for the return flow obligation and supplies used to offset this plan demand; it does not limit the use of changed water rights if the supplies are insufficient to meet the full plan demand. The plan demand and supplies are reported in the plan summary (*xpl) file and it is up to the user to confirm, if appropriate, that the full return flow obligation is being offset.

There are three types of return flow patterns:

- **Standard Return Pattern** = (Data in the return flow (*.urm/*.dly) file) * (Released Water) * (1.0-CU Factor), where the CU Factor is provided in the operating rule that releases water from the Changed Water Rights Plan. This return flow pattern either reflects the "immediate summer" return flow obligations owed to the river in the same time step as the release of water occurs, or reflects reretun flow boligations strictly based on the original irrigation pattern.
- **Fixed Return Pattern** = (Data in the return flow (*.urm/*.dly) file) * (Released Water), whereby a "fixed" percentage of each month's releases becomes the return flow obligation. Generally used to represent "winter return flows" obligated based on the total amount released or "used" during the summer.
- **Mixed Return Pattern** = Standard Return Pattern + Fixed Return Pattern

Additionally, StateMod allows the user to split the return flow obligation to different locations on the river. The following schematic provides an example of return flow obligations operations; the plan structures and operating rules used to represent these operations are discussed in more detail below.

Figure 10: Terms and Conditions Plan Example Operations



Example T&C Return Pattern Information

Standard Return Pattern Data

Month	*CU Factor*	*1-CU Factor*
April	65%	35%
May	52%	48%
June	42%	58%
July	40%	60%
August	51%	49%
September	73%	27%
October	95%	5%

Fixed Return Pattern Data

Month	*URM/DLY Factor*
November	7.2%
December	5.9%
January	4.8%
February	3.9%
March	2.7%

1. Open the network (*.net) in StateDMI, navigate to the appropriate location, and right-click to *Add an Upstream Location*. Enter the appropriate location and structure information and designate the structure type as a plan.
    a. The T&C plan should be located where the historical return flows generally accrued, or the location set in the decree. The return flow obligation will be administered at the location of the plan, therefore the location can impact how much of the plan demand is in-priority or what supplies are available to offset the demand.
2. Recreate the river network file (*.rin) to reflect the additional structure.
3. In the plan file (*.pln), include the well augmentation plan as a Type 1 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.

Example Plan (.pln) File

```
#
# ID         Name                        RiverLoc      ON/Off  iPtype    Peff    iPrf  iPfail   Psto1 Psource      IPAcc
#----------eb----------------------eb----------eb------eb------eb------eb------eb------eb------exb----------eb------e
#
Total_RF     Total_ReturnFlows           TotalRF            1       1      -1       1       0       0 9900999        0
Loc1_RF      Location_1_RF               Loc1_RF            1       1      -1       0       0       0 Total_RF       0
Loc2_RF      Location_2_RF               Loc2_RF            1       1      -1       0       0       0 Total_RF       0
```

4. Using a text editor, create the plan return flow (*.prf) file to split the return flow obligations between plans and associate return flow patterns to each T&C plan. See Section 4 for more discussion on the information in and format of this file.
    a. The Plan ID reflects the full T&C Plan, the Return ID reflects the sub-plans, and the Ret % reflects the portion of obligations assigned to each sub-plan (T&C Location).
    b. Negative Ret % values indicate a fixed return flow pattern, and the Table field generally corresponds to a lagged pattern.
    c. Positive Ret % values indicate a standard return flow pattern, and the Table field generally corresponds to an “immediate” pattern (i.e. 100 percent returns in the first month).
    d. If a mixed pattern is used, an entry must be included for the standard and the fixed return flow patterns.
    e. In the example below, the full T&C plan is split 46/54 percent to two sub-plans (Loc1_RF and Loc2_RF). Each sub-plan has a standard and fixed return flow pattern; see below for discussion on the Table values for each.

Example Plan Return (.prf) File*

```
#
# Plan ID    NA                          Ret ID          Ret % Table #
#----------eb----------------------eb----------eb------eb------e
Total_RF                                 Loc1_RF         46.00       4
Total_RF                                 Loc2_RF         54.00       4
Total_RF                                 Loc1_RF        -46.00     110
Total_RF                                 Loc2_RF        -54.00     110
```

5. Using a text editor, update the return flow (*.urm/*.dly) file to include the immediate and lagged pattern associated with the standard and fixed return flow obligations, respectively. See Section 4 for more discussion on the information in and format of this file.
    a. The lagged return flows are generally decreed in the change of use decree.

Return Flow File (.urm/*.dly)*

```
# ID      No. Ret 1   Ret 2   Ret 3   Ret 4   Ret 5   Ret 6   Ret 7   Ret 8   Ret 9   Ret 10  Ret 11  Ret 12
#----------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------e
#
        4 1     100
      110 12    7.2     5.9     4.8     3.9     2.7       0       0       0       0       0       0       0
```

6. In the operating rule (*.opr) file, include a Direct Plan/Reservoir Release Operating Rule (Type 27) and the Exchange Plan/Release Operating Rule (Type 28), depending on the location of the destination, to release water from the changed water right plan to a demand.
    a. See the section *Releases from Changed Water Right Plan* for more information on the data included in these operating rules.

b. Specific to the T&C plan, include the plan ID in the *ciopso(2)* field and include the CU Factors if a standard return flow pattern is being simulated.

Operating Rule File (.opr)*

```
#
# ID        Name                        NA                     Admin#   # Str  On/Off_Dest Id     _Dest Ac  Sou1 Id      Sou1 Ac  Sou2 Id      Sou2 Ac     Type ReusePlan    _Div Type
#---------eb----------------------eb---------exxxxb---------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------exb----------exb----------e
#
Ex.01       Oper_ChangedWRPln_Dem                       55835.00000      0       1 Irrig_Dem          1 WRPlan          100 Total_RF           3      27 NA           Diversion
                                Ex.02
 0.    0.    0.    0.    0.    65.   52.   42.   40.   51.   73.   95.
```

In this example, if the Type 27 operating rule carried 10 acre-feet (af) in May:

- The total standard return flow obligation would be 4.8 af (10 af * (1-52%)) in May
- The total fixed return flow obligation would be 0.72 af in November, 0.59 af in December, 0.48 af in January, 0.39 af in February, and 0.27 af in March.
- 46 percent of the total obligation would be owed to the river at Location 1 (Loc1_RF)
- 54 percent of the total obligation would be owed to the river at Location 2 (Loc2_RF)

Once a T&C Plan Return Flow Obligation is generated by the model, it is up to the user to offset these obligations in the time step and location they accrue to. If return flow obligations are not required to be offset after a specific priority, the user can use include a Type 43 operating rule to reduce the obligation based on that priority. There are many possible supplies to offset return flow obligations; in general, Type 27/28 and Type 48/49 operating rules are used to release supplies to meet a return flow obligation. The plan demand and supplies are reported in the plan summary (*xpl) file and it is up to the user to confirm, if appropriate, that the full return flow obligation is being offset.

7.11.4 Augmentation Station Modeling

StateMod has the ability to simulate an Augmentation Station, which is a structure that generally accounts for and returns a portion or all of a changed water right on a ditch directly to the river for subsequent re-diversion. These operations are recommended when the augmentation station is down ditch from the headgate (i.e. changed water isn't available directly at the headgate location) and the changed water right may experience additional canal losses, or additional accounting (e.g. multiple users) at the specific augmentation station location is desired. Augmentation stations can be simulated in StateMod using a Direct Plan/Reservoir Release Operating Rule (Type 27) or Exchange Plan/Release Operating Rule (Type 28), depending on the location of the destination, to release water from a changed water right plan associated with the ditch where the augmentation station is located to a demand.

The following should be noted when including the Type 27/28 operating rules:

- It is recommended that an "Other" node be included in the network diagram to represent the physical location where the augmentation station returns to the river. Note that if the augmentation station has been assigned a WDID, it is recommended this be the "Other" node model ID.
- If the water measured at the augmentation station will meet an on-channel demand, such as a return flow obligation, augmentation requirement, or a municipal/industrial demand, then a minimum of two intervening structures need to be included in the operating rule.

    - The first intervening structure, designated as a *Carrier* structure type in the operating rule, is the structure ID associated with the changed water right so the release can be accounted for by the capacity. The *Carrier* structure can include a loss factor if appropriate.
    - The second intervening structure, designated as a *Return* structure in the operating rule, is the augmentation station ID to indicate where the water returns to the river. Note that losses cannot be designated with *Return* structure types.
    - The destination of the operating rule is the on-channel demand structure ID.
- If the water measured at the augmentation station will meet an off-channel demand, such as a reservoir or municipal/industrial demand, then a minimum of three intervening structures needs to be included in the operating rule.
    - The first intervening structure, designated as a *Carrier* structure type in the operating rule, is the structure ID associated with the changed water right so the release can be accounted for by the capacity. The *Carrier* structure can include a loss factor if appropriate.
    - The second intervening structure, designated as a *Return* structure in the operating rule, is the augmentation station ID to indicate where the water returns to the river. Note that losses cannot be designated with *Return* structure types.
    - The third intervening structure, designated as a *Carrier* structure type in the operating rule, is the structure used to carry the off-channel demand and can include a loss factor if appropriate.
    - The destination of the operating rule is the off-channel demand structure ID.
- When StateMod detects the *Return* structure, it shepherds any water delivered to the river to the destination or another carrier.

7.12 How to Model Alternate Points/Exchanges

In general, StateMod uses operating rules to simulate the operation of alternate points and exchanges of water rights to meet demands. The Type 39 operating rule, discussed in Section 4.13.39, was designed to operate alternate points of diversions for diversion and well structures. This operating rule includes the source alternate point water right and options as to where the water right will be administered and whether the supply is limited to water availability at the source water right location. Note that an alternative to using the Type 39 operating rule, which has not been thoroughly tested, is to assign the alternate point water right to the destination in the diversion right (*.ddr) and/or well right (*.wer) file. This work-around does not check for whether water is physically and legally available at the source water right location, but does allow the destination to divert in-priority under the alternate point water right.

The exchange of a water right can be accomplished in StateMod using two approaches: through a direct exchange of the water right (Type 24 operating rule) or the “temporary” diversion of a water right into a changed water rights plan and subsequent exchange of the released water (Type 26, 27/28). See Section 4.13.24 for more information on the Type 24 operating rule, and see Sections 4 and 7.11 for information on changed water rights operations.

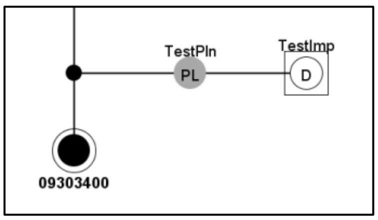
Some exchanges have a decreed exchange priority. If there is limited exchange potential on the specific reach where the decreed exchanges are modeled, it is recommended that the priorities of the modeled exchanges be reflective of the decreed order. Use the changed water rights approach (Type 26, 27/28) to manage the priority and order of the exchanges.

7.13 How to Model Imported Water

This section provides a recommended approach on how to model imported water into a river system using the standard modeling approaches taken during developing CDSS models. Special consideration of imported water in StateMod is recommended to make sure it is not reflected as natural flow or distributed as natural flow gains; it can be distributed to various users in the basin based on a specified order; and it can be tracked as a reusable supply as appropriate. In general, the imported water is brought into the system, stored in a plan structure, and then released from the plan structure to specific users. The steps below discuss how the import can be added or included in an existing model, and do not explicitly discuss the steps required to complete the full model for natural flow or simulation scenarios.

River Network Setup

1. Open the network (*.net) in StateDMI, navigate to the appropriate tributary (or create a new tributary for the imports), right-click to *Add an Upstream Location*, and add a diversion structure that will serve as import location.
    a. Enter the appropriate structure ID and naming information, and if desired, check the "Is Import?" box. This will include a box around the diversion structure in the network diagram, but it is used for visual representation only, and is not used by StateDMI when creating files or by StateMod.



2. In the network (*.net) in StateDMI, right-click to *Add an Upstream Location*, and add a plan structure *directly downstream* of the import diversion structure that will serve as the import plan.
3. Recreate the river network file (*.rin) to reflect the additional structures.
4. In the plan file (*.pln), include the import diversion structure as a Type 7 Import Plan (must be same model identifier) and the import plan structure as a Type 11 Accounting Plan.

Example Operating Rule (.opr) File*

```
#
# ID         Name                     RiverLoc      ON/Off iPtype   Peff    iPrf  iPfail   Psto1 Psource        IPAcc
#----------eb----------------------eb--------exb------eb-------eb------eb------eb------exb----------eb------e
TestImp     TestImpPlan              TestImp            1        7     999     999       0     0.0 ImportPln          0
TestPln     TestAcctPlan             TestPln            1       11     999     999       0     0.0 ImportPln          0
```

5. In the diversion station (*.dds) file, include the import diversion structure with the following parameters:
    a. Set the capacity of the structure to be greater than the maximum import amount

    b. Set the efficiency to be zero (i.e. 100 percent returns)
    c. Set the return flow pattern and location to return the full amount in the same time step to the import plan structure.

Natural Flow Scenario

1. In the historical diversion (*.ddh) file, include the time series of the imported amount as a negative value under the import diversion structure ID.
    a. Note that imported data is generally available in HydroBase under USGS streamflow gage identifiers, and can be converted to negative values using scale function in TSTool.
2. With the import included, run the natural flow simulation using StateMod Option 1 – Baseflow if the input data (e.g. diversions, streamflow) is not complete, or StateMod Option – BaseflowX if the input data is complete.
3. Review the baseflow result information summary (*.xbi) file to ensure that the imported amount is reflected in the Import (Col 2) and accounted for in the natural flow calculations.

Simulation Scenario

1. In the diversion demand (*.ddm) file, include the time series of the imported amount as a negative value under the import diversion structure ID.
2. In the operating rule (*.opr) file, include the following rules at a minimum to operate the import plan:
    a. Type 35 rule with the source as the import diversion structure and the destination as the import plan structure. This rule is generally set as the most senior priority in the model.
    b. Type 27 and/or 28 rules with the source as the import plan structure and the destination as any structures that are to receive imported supplies. Note that if the import water that is carried to a specific diversion structure using these rules is a reusable supply, then include a reusable supply plan in the Type 27 or 28 rule. See the "How to Model Reusable Supplies" section for more information.
    c. Type 29 with the source as the import plan structure and the destination as the next downstream node. Note that a destination node is required for any Type 29 plan spill rules with an accounting plan source.
3. With the import and operating rules included, run the simulation using StateMod Option 2 – Simulation.
4. Review the plan summary (*.xpl) file and operating rule summary (*.xop) file for the portion of the imported water that was carried to meet each diversion demand and the portion, if any, that was unused and spilled back to the stream.

7.14 How to Model Reusable Supplies

StateMod uses plan structures to track (color) reusable water in the river, in storage, and from water imported into the river system. This provides the opportunity for users to differentiate between one-time use water and reusable water when making releases from storage or from plans to meet various demands. There are two plan types, a Plan Type 3 – Reservoir Reuse Plan and a Plan Type 4 – Non-reservoir (Diversion) Reuse Plan, which can be used to track reusable water.

Reservoir reuse plans are modeled in conjunction with reservoir accounts and track the portion of the storage that can be reused. Water in reservoir reuse plans can be carried over between time steps and does not need to be spilled at the end of a time step. Reusable water is stored in a reservoir reuse plan by including the reuse plan ID (*creuse* field) in the operating rule used to stored water in the reservoir, "coloring" that water as reusable. Another operating rule can then release the reusable supplies from the reservoir to meet a specific demand.

Non-reservoir reuse plans are used to track reusable supplies associated with imports, direct diversions, and changed water rights. Examples include wastewater treatment plant effluent, imported water that can be used to extinction, or the consumptive use portion of a changed water right. Water in non-reservoir reuse plans cannot be carried over between time steps and must be spilled at the end of the time step. Reusable water is generally stored in a non-reservoir reuse plan by including the reuse plan ID in operating rules:

- used to carry a water right to meet a demand (e.g. Type 24 or 25 operating rules)
- used to release water from a Changed Water Right plan or Import plan to meet a demand (e.g. Type 27 or 28 rules)

The non-consumed portion is then stored in the non-reservoir reuse plan, which can then be released to meet another demand using another operating rule (e.g. Type 32 or 33 rules).

Due to the numerous options available to put water into and release water from reservoir and non-reservoir plans, a step-by-step approach is not provided. The following bulleted list provides a general approach to implementing these operations. Note that this approach does not include the steps to implement a Changed Water Right plan or an Import plan. The user can refer to other information in the documentation for more information on those plan structures.

- Include the reservoir and non-reservoir reuse plans in the network (*.net) and the river network (*.rin) files using StateDMI.
- Include the reservoir and non-reservoir reuse plans in the plan (*.pln) file, designating them as either Plan Type 3 or 4.
- The most common operating rules used to store and release water in a reservoir or non-reservoir reuse plan are Types 24, 25, 27, 28, 32, and 33 operating rules. The reuse plans are generally designated in these operating rules types as an associated reuse plan in either the *ciopso(2)* or the *creuse* fields. These operating rules also allow monthly and annual volumetrics and/or terms and conditions to be specified with the use of the reusable supplies.
- Include a Plan Spill Type 29 operating rule for all non-reservoir reuse plans.
- Review the plan summary (*.xpl) file to review the amount of reusable supplies stored and released from each plan.

Modeling Tips:

- The functionality associated with evaporation and releases from reservoir reuse plans has not been thoroughly tested or vetted; it is up to the user to verify these operations are simulating as desired.

7.15 How to Implement a Futile Call

A futile call, as implemented in StateMod, allows a tributary stream to operate independently of the mainstem. Therefore, the impact of upstream diversions and return flows are not passed downstream of the futile call locations. This operating rule was originally developed for use in the Rio Grande, where dry stretches of the river can occur and create an opportunity for a futile call to extend upstream in these reaches.

1. In the river network (*.rin) file, add a river node downstream of where a futile call occurs and keep the downstream location (*cstadn*) blank.

Example River Network (.rin) File with Futile Call*

```
#>   ID                Name          DownStream     Comment    GWMax
#>---------eb----------------------eb----------exb----------exb------e
Riv_10      RiverDiversion_10       Riv_20       Riv_10           0
Riv_20      RiverDiversion_20       Riv_50       Riv_20           0
Riv_50      RiverDiversion_50       Futile       Riv_50           0
Futile      FutileCallPoint                      Futile           0
Riv_60      RiverDiversion_60       Riv_70       Riv_60           0
```

Modeling Tips:

- The river network (*.rin) file is generally created using StateDMI commands; this operation requires editing this file in text editor. If so, these revisions will not be captured in a commands file and may be overwritten if the river network (*.rin) file is recreated using StateDMI commands.
- This functionality has not been thoroughly tested or vetted; it is up to the user to verify these operations are simulating as desired.

7.16 Basin-Specific Operations and Compacts

There have been several operations implemented in StateMod to represent basin-specific operations and/or administration, most typically Interstate Compacts. The discussion below provides insight as to how StateMod is set up to represent these operations; the user is encouraged to review the basin-specific documentation and the individual basin models for more information.

Although designed for a specific operation, in many cases these operations can be adapted to represent operations in other models or areas of the State. This section discusses how the basin-specific operations have been implemented, however the user should consider other opportunities on how to adapt the functionality to use these operations in other modeling efforts.

7.16.1 Blue River Decree (Upstream Storage and OOP Plans)

In brief, the Blue River Decree allows Dillon Reservoir, Roberts Tunnel, Upper Blue Lakes, and Continental-Hoosier Tunnel to store or divert out of priority with respect to Green Mountain Reservoir's first fill decree. The water diverted or stored out of priority at each structure is tracked in an Out-of-Priority (OOP) plan. If Green Mountain Reservoir does not fill under its storage rights at a user-specified priority, Denver and Colorado Springs are required to "repay" Green Mountain from various reservoirs to meet the OOP obligation.

Blue River Decree operations are very complex and involve several operations and structures; the user should refer to the Colorado River Basin Water Resources User's Manual for information on the specific operations. The summary provided herein is used to illustrate the general functionality of the operations and provide sufficient information for the user to potentially implement these operations in other models.

This summary will focus on a simplified representation of the Blue River Decree operations as they pertain to out-of-priority storage in Dillon Reservoir. When Denver incurs an obligation to repay Green Mountain Reservoir for water stored out-of-priority at Dillon Reservoir, provisions of the Blue River Decree, as more specifically described in a 1964 Stipulation and Agreement, allow Denver to replace the water owed by substituting releases from its Williams Fork Reservoir. In 1991, the agreements were again modified and allowed use of Wolford Mountain Reservoir as an additional source of substitution supply for water owed to Green Mountain Reservoir by Denver. The following structures and operations are used to model these Dillon Reservoir operations.

- **Out-Of-Priority Plans (Plan Type 9).** The OOP plan tracks and stores the OOP storage or diversion amount; the user is then responsible for providing supplies that offset the OOP obligation. An OOP plan should be included for each OOP storage or diversion; the Dillon Storage OOP Plan is modeled as 364512OOPPLN. The OOP plan is included in the network (*net) diagram, river network file (*.rin), and the plan file (*.pln).

Colorado River Basin Model - Plan (.pln) File Excerpt*

```
#
# ID         Name                    RiverLoc      ON/Off  iPtype    Peff    iPrf  iPfail   Psto1 Psource         iPacc
#----------eb----------------------eb----------eb------eb------eb------eb------eb------exb----------exb------e
954683OOPPLN Con-Hoosier_OOP_Plan   954683OOPPLN       1       9     999     999       0       0 GM_Reservoir        0
363570OOPPLN Upper_Blue_OOP_Plan    363570OOPPLN       1       9     999     999       0       0 GM_Reservoir        0
364684OOPPLN Roberts_Tun_OOP_Plan   364684OOPPLN       1       9     999     999       0       0 GM_Reservoir        0
364512OOPPLN Dillon_OOP_Plan        364512OOPPLN       1       9     999     999       0       0 GM_Reservoir        0
HUPLimitPLN  Replacement_Limit_Pln  HUPLimitPLN        1      12     999     999       0       0 GM_Reservoir        0
CSULimitPLN  Replacement_Limit_Pln  CSULimitPLN        1      12     999     999       0       0 UpperBlueLks        0
ColRivPln    Replacement_Limit_Pln  ColRivPln          1      11       0       0       0       0 0721329             0
```

- **Reservoir Structures.** Much of the Blue River Decree operations center on selective use of specific reservoir accounts and bookovers. Dillon Reservoir, shown below, has specific accounts used to manage the OOP bookover operations, these accounts are not tied to any other users of the reservoir.

Colorado River Basin Model – Reservoir Station (.res) File Excerpt*

```
364512       DILLON RESERVOIR        364512              1       4. 5
                            0. 257000.   1940.        0.       5       1       0      15
             Denver/RT    252015. 226047.       0       1
             Summit_Co.     1021.    728.       0       1
             Dead_Pool      3269.   2332.       0       1
             1000_acft      1000.    157.       0       1
             Denver-OOP1  154645.   2228.       0       1
             Evaporation 10008           100.
             CAP-AREA  0     0.00    0.00       0
             CAP-AREA  1    3269.     167       0
             CAP-AREA  2    8207.     376       0
             CAP-AREA  3   11964.     472       0
             CAP-AREA  4   20488.     635       0
             CAP-AREA  5   31293.     794       0
             CAP-AREA  6   44471.     958       0
             CAP-AREA  7   60194.    1121       0
             CAP-AREA  8   78357.    1280       0
             CAP-AREA  9   98768.    1442       0
             CAP-AREA 10  122199.    1668       0
             CAP-AREA 11  159555.    2076       0
             CAP-AREA 12  207326.    2658       0
             CAP-AREA 13  257305.    3233       0
```

- **Operating Rules**. The Blue River Decree operations associated with OOP plans use several operating rules.
    - **OOP Diversions (Type 38)** allows a reservoir to store (or a carrier to divert) OOP with respect to a more senior reservoir storage. This rule was developed based on the Upstream Storage Statute; upstream reservoirs can store before a more senior downstream reservoir, however the upstream storage stored OOP must be repaid to the senior reservoir right if it is not satisfied. Therefore, as shown below, the more junior Dillon Reservoir right can store before the more Green Mountain Reservoir and the OOP obligation is stored in the OOP plan.
        - The destination of the rule is Dillon Reservoir (364512), the primary source is the senior subordinated Green Mountain storage right (363543.01), and the secondary source is the junior Dillon Reservoir storage right (364512.01).
        - The priority of the operating rule is set senior to the Green Mountain storage right, allowing it to simulate prior to storage in Green Mountain Reservoir.

Colorado River Basin Model – Type 38 Rule Example

```
# OOP Rules
3645120.07   OOP_Dillon_Res_to_GM                    31257.99999     12.       1 364512            5 363543.01          0 364512.01          0       38 364512OOPPLN
                                      0 0 0 0 0 0 1 1 1 1 0 0
```

- **Reservoir Storage with Special Limits (Type 41)** allows a reservoir to store under a reservoir right up to the volume of water in an OOP plan. This rule was developed specifically for the Blue River Decree operations, and allows Green Mountain to store, under a 1955 right, the amount of water that was diverted and stored OOP to Green Mountain's senior first fill right. When water is stored under this right, it reduces the OOP obligation owed by Denver and Colorado Springs proportional to their OOP operations. This rule operates after the out-of-priority operations are complete which allows for a pro rata amount to be credited to each of the four out-of-priority plans. When the amount stored under this right equals out-of-priority operations by both cities, the right is satisfied.

Colorado River Basin Model – Type 41 Rule Example

```
# Blue River Decree
3635430.29  Opr_1955_B_R_Decree_Exch              38628.00000    -16.       1 363543           -5 363543.04         0 NA                 0       41 NA
                                             0 0 0 0 0 0 1 1 1 1 0 0
                                             954683OOPPLN363570OOPPLN364684OOPPLN364512OOPPLN
```

- **Plan Demand Reset (Type 42)** is used to reset the OOP plans to zero at a specific priority and specific time step. The Dillon Reservoir OOP plan is reset at the most junior priority in the model (99999.99999) on March 31st of each year.
  - Note that this operating rule can also reset T&C Plans (Plan Type 1) or a Well Augmentation Plan (Plan Type 2), if applicable.
- There are 14 operating rules, including **Bookover with Plan (Type 34)**, **Bookover (Type 6)** and **Direct Plan/Reservoir Release Operating Rule (Type 27),** used to simulate Denver's OOP obligation replacement operations. Denver has the ability to repay OOP obligations from three reservoirs –Dillon Reservoir, Wolford Mountain, and Williams Fork. Wolford Mountain Reservoir and Williams Fork Reservoir each have two accounts to which Denver can transfer water for replacement. Denver prefers to meet the OOP obligation during substitution years using the bookover operations (Type 34 and 6), however if these supplies are not sufficient, Dillon Reservoir can release directly to Green Mountain Reservoir via the Type 27 operating rule.

Colorado River Basin Model – Documentation Excerpt

Right #	Description	Account or Carrier	Admin #	Right Type	Plan Structure
17	Dillon transfer from OOP account to 1000 af account	5 to 4	1.00016	34	364512OOPPLN
18	Wolford transfer from Denver account to Denver R1 account	2 to 5	1.00017	34	364684OOPPLN
19	Wolford transfer from Denver account to Denver R1 account	2 to 5	1.00018	34	364512OOPPLN
20	William Fork transfer from Denver account to WF GMR1 account	2 to 5	1.00019	34	364684OOPPLN
21	William Fork transfer from Denver account to WF GMR1 account	2 to 5	1.00020	34	364512OOPPLN
22	Wolford transfer from Denver account to Denver R2 account	2 to 6	1.00021	34	364684OOPPLN
23	Wolford transfer from Denver account to Denver R2 account	2 to 6	1.00022	34	364512OOPPLN
24	William Fork transfer from Denver account to WF GMR2 account	2 to 6	1.00023	34	364684OOPPLN
25	William Fork transfer from Denver account to WF GMR2 account	2 to 6	1.00024	34	364512OOPPLN
26	Dillon release from OOP account to Green Mountain	5	1.00025	27	364684OOPPLN
27	Dillon release from OOP account to Green Mountain	5	1.00026	27	364512OOPPLN
28	Dillon release from Denver account to Green Mountain	1	1.00027	27	364684OOPPLN
29	Dillon release from Denver account to Green Mountain	1	1.00028	27	364512OOPPLN
30	Dillon transfer remaining OOP water to Denver account	5 to 1	1.00029	6	

Colorado River Basin Model – Type 34 Rule Example

```
#
# Denver Replacement Operations
5036680.12  Opr_Den1_to_GMRepl_Book                      1.00017     12.       1 503668            5 503668            2 364684OOPPLN       0       34 NA
                                  0 0 0 0 0 0 0 0 0 0 -1 0
5036680.13  Opr_Den1_to_GMRepl_Book2                     1.00018     12.       1 503668            5 503668            2 364512OOPPLN       0       34 NA
                                  0 0 0 0 0 0 0 0 0 0 -1 0
5036680.16  Opr_Den2_to_GMRepl_Book                      1.00021     12.       1 503668            6 503668            2 364684OOPPLN       0       34 NA
                                  0 0 0 0 0 0 0 0 0 0 -1 0
5036680.17  Opr_Den2_to_GMRepl_Book2                     1.00022     12.       1 503668            6 503668            2 364512OOPPLN       0       34 NA
                                  0 0 0 0 0 0 0 0 0 0 -1 0
#
```

Modeling Tips:

- If the user is interested in setting up an OOP operation, download the full Upper Colorado River StateMod Model from the CDSS website and use it as an example.
- Section 5.9.18 in the Upper Colorado River Basin Water Resources Planning Model User's Manual provides more information on the Blue River Decree operations.

7.16.2 Rio Grande Compact

The Rio Grande Compact of 1938 apportioned water based on the variable river conditions during the Compact Study period (1928 – 1937). Therefore, the amount of water that Colorado has to deliver downstream varies based on the actual or forecasted river conditions as measured at index gages (Rio Grande near Del Norte, Conejos River near Magote, Los Pinos river near Ortiz and the San Antonio river near Ortiz). The more water produced in the Rio Grande River basin, the more water Colorado owes to downstream states. The State Model allows the Rio Grande Compact to be simulated as an operating rule with the following features:

- Compact demands are reflected as forecasted (negative) data in the monthly instream flow demand file.
- Compact "trigger" parameters are reflected in specific operating rules (Type 17 for the Rio Grande River, Type 18 for the Conejos River).

The following approach summarizes the approach to implement the Rio Grande Compact at both the Rio Grande River and Conejos River locations.

1. In the network (*.net) via StateDMI, add two instream flow structures to the model; one downstream of the Rio Grande River at Labatos streamflow gage and the other downstream of the Conejos River near La Sauses streamflow gage. Navigate to the appropriate locations, right-click to *Add an Upstream Location*, enter the appropriate information, and designate the structure type instream flow.
2. Recreate the river network file (*.rin) to reflect the additional structures.
3. Add the structures to the instream flow station file (*.ifs) using the StateDMI commands:
    a. Set the same ID for the upstream and downstream nodes to reflect a point.
    b. Set the demand type variable (*iifcom)* to a 1 to indicate monthly demand (*.ifm) will be provided.
4. Add the structure's forecasted (negative) demand to the instream flow demand file (*.ifm) using the TSTool commands.
    a. For the Rio Grande demand, enter in the monthly forecast for each year as a negative number based on the April to September forecast for the Rio Grande River Index Station (Rio Grande near Del Norte).

   b. For the Conejos demand, enter in the monthly forecast for each year as a negative number based the April to September forecast for the sum of the Conejos River Index stations (Conejos River near Magote, Los Pinos river near Ortiz and the San Antonio river near Ortiz).
   c. A zero should be entered for months without a forecast.
   d. Set the monthly instream flow demands or read in an external StateMod formatted file (*.stm) with the demand in CFS . Note that if demand is entered in units of acre-feet, adjust the conversion factor (*ffacto*) for instream flow demands in the control (*.ctl) file and confirm all instream flow demands are provided in units consistent with this conversion.
5. In the operating rule (*.opr) file, include a Rio Grande Compact - Rio Grande (Type 17) operating rule to estimate the demand for the Rio Grande instream flow demand.
   a. Set the destination to the Rio Grande instream flow structure
   b. Set source 1 to the stream gage that represents the index flow (e.g. Rio Grande at Del Norte) with a coefficient (account) of 1.
   c. Set source 2 to the stream gage used to adjust to the discharge at the instream flow location (e.g. the combined discharge of the Conejos River near La Sauses) with a coefficient (account) of -1.
   d. Set the appropriate information in the second line of the rule, including:
      i. Year when annual obligation calculation includes an adjustment for cumulative surplus storage
      ii. Initial surplus/shortage for the Rio Grande in the year the operating rule triggers
      iii. Closed Basin annual yield to the Rio Grande River in acre-feet per year.
      iv. Norton Drain South annual yield to the Rio Grande River in acre-feet per year.
6. In the operating rule (*.opr) file, include a Rio Grande Compact - Conejos River (Type 18) operating rule to estimate the demand for the Conejos River instream flow demand.
   a. Set the destination to the Conejos instream flow structure
   b. Set source 1 to the first index stream gage (e.g. Conejos River near Magote) with a coefficient (account) of 1.
   c. Set source 2 to the second index stream gage (e.g. Los Pinos River near Ortiz) with a coefficient of 1.
   d. Set source 3 to the third index stream gage (e.g. San Antonio River at Ortiz) with a coefficient of 1.
   e. Set the appropriate information in the second line of the rule, including:
      i. Year when annual obligation calculation includes an adjustment for cumulative surplus storage
      ii. Initial surplus/shortage for the Conejos River in the year the operating rule triggers
      iii. Closed Basin annual yield to the Conejos River in acre-feet per year.
      iv. Norton Drain South annual yield to the Conejos River in acre-feet per year.
7. Review the instream flow summary (*.xir) file for information on instream flow demands and the portion of the demand met based on the Type 17 and 18 operations.

Modeling Tips:

- It is recommended the user research the full Rio Grande Compact requirements prior to implementing the operations in StateMod. This particularly applies to understanding and implementing the correct forecasted demand.

7.16.3 South Platte Compact

The South Platte Compact requires that Colorado deliver 120 cfs to the Stateline from April 1 to October 15 at an administration date of June 14, 1897, without calling out any diversions located upstream of the Washington County line (i.e. upstream of Water District 64). As StateMod operates water rights from senior to junior over the entire river system, the Washington County limitation was implemented by developing two operating rules specific to the Compact. A Type 50 operating rule is used to temporarily store water available to the South Platte Compact in a plan when in priority and a Type 40 operating rule is used to release water from the plan first to any structure that is water short and outside/upstream of Water District 64 and then to the Compact demand. The Type 40 operating rule is used to determine if exchange potential exist which will allow a junior water right to exchange water from the Compact plan to meet their unmet demand. This check occurs immediately following the priority of a water right that is short.

- If exchange potential exists, water will be exchanged to the diversion limited by the structure's demand, water right and capacity. In addition return flows will be calculated, a re-operation will occur and potentially allow water rights throughout the system to divert more water to meet their demands.
- If exchange potential does not exist, the water stays in the Compact plan.

The Type 40 operating rule determines if the structure is outside/upstream of Water District 64 based on the first two digits of the model ID and does *not* exchange to any diversion structure with a 64* model ID. Additionally, the Type 40 operating rule only exchanges to diversion structures located on-channel; exchanges to any off-channel demands (i.e. off-channel irrigation demands) in upstream reaches of the river will require a separate operating rule (Type 28).

1. In the network (*.net) via StateDMI, add one instream flow structure to the model located directly downstream of the South Platte River at Julesburg streamflow gage. Navigate to the appropriate location, right-click to *Add an Upstream Location*, enter the appropriate information, and designate the structure type instream flow.
2. Recreate the river network file (*.rin) to reflect the additional structures.
3. Add the structure to the instream flow station file (*.ifs) using the StateDMI commands:
    a. Set the same ID for the upstream and downstream nodes to reflect a point.
    b. Set the demand type variable to a 2 to indicate constant demand (*.ifa) will be provided.
4. Add water rights to the instream right file (*.ifr) using the StateDMI commands:
    a. Set a 120 CFS water right with a June 14, 1897 (17332.00000 administration number)
5. Add the structure's demand to the instream flow demand file (*.ifa) using the StateDMI commands.

    a. Set the monthly instream flow demand to 120 CFS for April through September, 60 CFS for October to represent that the Compact is only in effect through October 15th, and zero for the remaining months.

6. In the plan file (*.pln), include an accounting plan as a Type 11 Plan and include the appropriate parameter information. See Section 4 for more discussion on the information in and format of this file.
    a. Set the River ID as the Compact Plan ID (e.g. Compact_Pln) and set the River Location as the Compact instream flow structure ID indicating the Compact Plan will be administered at the instream flow structure location.
7. In the operating rule (*.opr) file, include a South Platte Compact Storage (Type 50) operating rule to temporarily store water available to the Compact in the Compact administrative plan.
    a. Set the administration date to a 17332.00000 administration number (June 14, 1897).
    b. The source is the Compact instream flow right and the destination is Compact plan.
    c. This rule turns off the source instream flow right so that it is completely controlled by the operating rule.
8. In the operating rule (*.opr) file, include a South Platte Compact Release (Type 40) operating rule to exchange Compact plan water to diversion structures located outside/upstream of Water District 64.
    a. Set the administration date to a 17332.00000 administration number; however note that the administration number is not read since this operating rule is called immediately following the priority of any water right that is water short and not located in Water District 64.
    b. The source is the Compact plan and the destination is "64x" indicating all diversion structures with a model ID that does not start with a 64*.
9. In the operating rule (*.opr) file, include a second South Platte Compact Release (Type 40) operating rule to release the water remaining in the Compact plan to the Compact instream flow demand.
    a. Set the administration date to the most junior in the model (99999.99999). The Compact instream flow demand is first satisfied by the physical water in the river, and if short, this rule releases from the Compact plan to meet the remaining demand up to the amount available in the plan. Since the full plan amount is released to the instream flow, a spill plan operating rule is not needed.
    b. The source is the Compact plan and the destination is the Compact instream flow.
10. In the operating rule (*.opr) file, include Exchange Plan/Release (Type 28) operating rules for any off-channel demands located outside/upstream of Water District that are entitled to releases from the Compact plan if exchange potential is available.
    a. Set the administration date to be junior to the diversion structure's most junior supply.
    b. The source is the Compact plan and the destination is the diversion structure ID.
    c. Include carriers with losses, if applicable.

South Platte River Basin Model – Compact Operations Example

```
# ID        Name                        NA                     Admin#    # Str  On/Off Dest Id     Dest Ac  Sou1 Id     Sou1 Ac  Sou2 Id     Sou2 Ac    Type
# ---------eb----------------------eb----------exxxxb----------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------e
Compact_In  Opr_Compact_In                             17332.00000      0.       1 Compact_Pln       1 6499999.01      0 NA                 0      50
Compact_64x Opr_Compact_Out_64x                        17332.00000      0.       1 64x               1 Compact_Pln     0 NA                 0      40
Compact_Isf Opr_Compact_Out_Isf                        99999.99999      0.       1 6499999           1 Compact_Pln     0 NA                 0      40
#
# Operating rules to meet off-channel irrigation demands in WD 1 and 2 from the Compact
#  No op rules to reservoir or aug pond structures due to timing of Compact demand
#  Applies to 0200834_I, 0100507_I, 0100503_I, 0100687_I (0200834_I direct rights are modeled as senior to Compact)
#  Priorities set just junior to direct irrigation rights
#
CompactEx.1 Compact_to_0100507_I                       18353.10000      1        1 0100507_I         1 Compact_Pln   100 NA                 0      28
                                  0100501   29   Carrier
CompactEx.2 Compact_to_0100503_I                       20969.10000      1        1 0100503_I         1 Compact_Pln   100 NA                 0      28
                                  0100503_D 25   Carrier
CompactEx.3 Compact_to_0100687_I                       26302.23523      1        1 0100687_I         1 Compact_Pln   100 NA                 0      28
                                  0100687   25   Carrier
```

11. Review the operating rule summary (*.xop) file, the diversion structure summary (*.xdd) file, the plan summary (*.xpl) file, and the instream flow summary (*.xir) file for information on the South Platte Compact operations and the amount of water released from the Compact plan for exchange.

7.16.4 La Plata Compact

The La Plata Compact governs the distribution of water on the La Plata River between the states of Colorado and New Mexico. The administration is dependent upon the streamflow at two gaging stations: Hesperus Station (USGS No. 09365500) and Interstate Station (USGS No. 9366500). During the year from December 1 to February 14, each state has the right to use all water within its boundaries. For the remainder of the year, February 15 to November 30, allocation for La Plata River water is performed according to the following guidelines:

- If the flow at Interstate Station is greater than or equal to 100 cubic feet per second (cfs), each state has unrestricted rights to all water within its boundaries.
- If the flow at Interstate Station is less than 100 cfs, the State of Colorado shall deliver at the Interstate Station a quantity of water equal to one-half of the mean flow at the Hesperus Station for the preceding day, not to exceed 100 cfs.

During periods of extreme low flow, the guidelines above may be superseded by a method of administration that allows the delivery of all available water successively to each state in alternating periods. When flow at the Hesperus Station is less than 30 cfs, the lower reaches of the La Plata will run dry, and Colorado cannot deliver any water in accordance with No. 2 above.

The Type 13 operating rule was developed in order to implement the La Plata Compact in the San Juan River Basin model. This rule allows an instream flow to operate based on its location on the river and the flow at an upstream index streamflow gage. Although developed specifically for the La Plata Compact, this rule could be used for more generic applications in other models.

1. In the network (*.net) via StateDMI, add one instream flow structure to the model at the Colorado – New Mexico state line and one “other” structure immediately downstream to reflect the instream flow reach. Navigate to the appropriate location, right-click to *Add an Upstream Location*, enter the appropriate information, and designate the structure type instream flow for the upstream instream flow structure and “other” type for the downstream structure.

   a. 332999 and 332999_Dwn are used as model IDs in the San Juan/Dolores River Basin models for the upstream and downstream structures, respectively.
2. Recreate the river network file (*.rin) to reflect the additional structures.
3. Add the structure to the instream flow station file (*.ifs) using the StateDMI commands:
   a. Set the upstream and downstream model IDs to reflect the reach.
   b. Set the demand type variable to a 2 to indicate constant demand (*.ifa) will be provided.
4. Add water rights to the instream right file (*.ifr) using the StateDMI commands:
   a. Set a 100 CFS water right with the most senior water right in the model (00001.00000 administration number).
5. Add the structure's demand to the instream flow demand file (*.ifa) using the StateDMI commands.
   a. Set the monthly instream flow demand to 100 CFS for April through November and zero for the remaining months.
   b. Note that this demand provides the upper bound of demand; the Type 13 operating rule will calculate the instream flow demand as the minimum of the Compact instream flow water right; the specified percent (e.g. 50%) of the flow at the Compact gage (e.g. 09365500); the instream flow demand (*.ifa); and the available flow at the instream flow.
6. In the operating rule (*.opr) file, include a La Plata Compact (Type 13) operating rule to define the index gages and percentages used to calculate the Compact instream flow demand.
   a. Set the administration number to be senior (00001.0000 administration number).
   b. The primary source is the index streamflow gage ID (09365500) and the percent of flow (50%); the secondary source is the Compact instream flow water right.
   c. This rule turns off the source instream flow right so that it is completely controlled by the operating rule.
   d. Monthly on/off switches can be used to further refine the months when the Compact should be administered.
   e. Using a very senior administration number in this operating rule, the Compact demand is typically equal to the natural flow plus any lagged returns to the gage from upstream diversions in a prior time step multiplied by the specified percent (e.g. 50%).

San Juan River Basin Model – Compact Operations Example

```
# ID        Name                    NA                       Admin#   # Str  On/Off Dest Id      Dest Ac  Sou1 Id      Sou1 Ac  Sou2 Id      Sou2 Ac     Type
# ---------eb----------------------eb----------eb-------------eb------eb------e-b----------eb------e-b----------eb------e-b----------eb------eb------e
3329990.01  Opr Laplata Compact                          0000.00001     12.       1 332999            1 09365500          50 332999.01           1       13
1 1 0 0 0 0 0 1 1 1 1 1
```

7. Review the operating rule summary (*.xop) file, the diversion structure summary (*.xdd) file, and the instream flow summary (*.xir) file for information on the La Plata Compact demand and operations.
   a. As the Compact demands are calculated within the model, the information printed under the column titled "demand" in the diversion station summary (*.xdd) file is the minimum of the specified percent (e.g. 50%) of the flow at the compact gage (e.g. 09365500) and the instream flow demand provided in the instream flow demand files.

b. To obtain additional details (printed in the log file (*.log) on the calculations associated with this operating rule the control file variables ***ichk*** and ***ccall*** should be set to 113 (operating rule 13) and 3329990.01 (the operating right ID for the La Plata Compact).

7.17 How to Add Daily Capability to a Monthly Model

StateMod allows a daily analysis to be performed with or without monthly data being provided. In general providing and preparing a monthly model first is recommended for the following reasons:

- The most difficult part of developing a basin wide model is understanding the system. By first developing a monthly model, the system operation can be investigated without burdening the user with the volume of information required for a daily model.
- Relying on monthly data means that daily natural flow generation is not required. If daily baseflows are developed, then the sum of daily baseflows will equal monthly baseflow estimates.
- A daily model is typically developed to be able to simulate large and small flow events that occur within a monthly time step or to investigate flow requests that vary within a monthly time step. Therefore, although daily streamflow data will be required, the user may want to estimate the other terms required for daily analysis, such as diversion demands or reservoir targets, using a simplified approach. As presented in the table below, StateMod provides six options to provide or estimate daily data.
- Note that the daily ID code/Station ID are generally set in the station files, including the well station (*.wes), diversion station (*.dds), reservoir station (*.res), instream flow (*.ifs), and the river station (*.ris) files.

Table 3: Daily Modeling Options

Distribution Code	Daily ID Code for Station ID	Description	Controlling Data
0	0	Daily data are estimated to be the average of monthly data	Monthly
1	Station ID	Daily data are estimated using the daily pattern provided under the station ID	Monthly
2	Another Station’s ID	Daily data are estimated using the daily pattern provided under another station’s ID	Monthly
3	3	Daily data are provided in a daily file	Daily
4	4	Daily data are estimated by connecting the midpoints of monthly data.	Monthly
5	5	Daily data are estimated by connecting the endpoints of monthly data	Monthly

- As described above, if both daily and monthly data are provided for the same structure and the daily data does not sum to the monthly total, the type of daily distribution specified determines which data (monthly or daily) takes precedence. For example, when option 2 is selected, daily data are used to distribute the monthly value to daily values regardless of what the sum of the daily values equal. Similarly, when option 3 is selected and the sum of daily data does equal the monthly value, the daily values are used.
- For the case where a user supplies monthly data and a representative gage to use for daily data, the sum of daily data typically equals the monthly total. Daily data may not equal the monthly total if the representative gage with daily data contains all zeros.
- The routing of daily streamflows is accounted for by the gain and loss term that results from the natural flows estimated by or provided to the model.
- Routing of reservoir releases are not included for the following reasons:
    1. StateMod is a primarily a planning model.
    2. The additional detail required to properly implement reservoir releases with a travel time component is not justified since the system would have to include some kind of forecasting to know when a reservoir release is required before a reservoir demand actually occurs.
    3. The volume of water potentially delivered early by ignoring a reservoir's travel time is offset by the potential over release that occurs after the demand is satisfied.
- StateMod allows a user to estimate daily demands by providing a monthly total that is decreased each day in the month that a diversion occurs (see the control file (*.ctl) variable *iday*). This "daily decrementing" capability can be important when simulating a ditch with a significant flood right that typically only diverts a few days a month. When this option is used for ditches without a significant flood right, water rights or canal capacity typically limit the amount diverted in a day.

StateMod’s ability to use or estimate daily data requires the user be extremely careful when assigning a daily streamflow gage for a given structure. Following are four examples successfully used in prior StateMod applications. The first two examples (Tables 4 and 5) perform a daily analysis using monthly natural flow results. The last two examples (Table 6 and 7) perform a daily analysis by first calculating daily natural flows.

Table 4 is an example used for a typical Historical Calibration run with natural flows. It does not perform a daily natural flow analysis to estimate daily natural flows. Instead it uses monthly natural flow results and disaggregates them to daily values using historical daily data at a streamflow gage. Daily diversion data are used to estimate daily historical diversion demands and instream flow demands. Interpolation routines are used to estimate daily reservoir targets and well demands. Note that daily diversion demands are typically equal to daily historical diversions for a Historical Calibration run. Also daily instream flow demands often change from one value to another on a specified day of the month that requires daily data.

Table 4: Example 1, Daily ID Assignment for Historical Calibration Scenario with Monthly Natural Flow

File	Daily ID	Comment
River Station (*.ris)	USGS Gage ID	Estimate daily streamflows by distributing monthly natural flows to daily values using daily data at a streamflow gage. Note the monthly totals in the monthly natural flow file (*.rim or *.xbm) control.
Diversion Station (*.dds)	3	Daily diversion data (*.ddd) is used to estimate daily demands. Note the daily data controls.
Reservoir Station	5	Estimate daily reservoir targets by connecting the endpoints of data in the Monthly Target file (*.tar/*.eom).
Instream Flow Station	3	Daily instream flow demand data (*.ifd) is used to estimate daily demands. Note the daily data controls.
Well Station	4	Estimated daily well demands by connecting the midpoints of data in the monthly well demand (*.wem) file.

Table 5 is an example used for a typical Daily Baseline run. Similar to the Historical Calibration run, it does not perform a daily natural flow analysis to estimate daily streamflows. Instead it uses monthly natural flow results and disaggregates them to daily values using historical daily data at a stream gage. Daily data are used to estimate daily instream flow demands. Interpolation routines are used to estimate daily diversion demands, daily reservoir targets and well demands. Note that daily diversion demands are estimated using an interpolation approach because it is the most appropriate technique to estimated future daily diversion demands. The approach used to estimate daily reservoir targets, instream flow demands and well demands are the same as those used in Table 4 above.

Table 5: Example 2, Daily ID Assignment for Daily Calculated/Baseline Scenario with Monthly Natural Flow

File	Daily ID	Comment
River Station (*.ris)	USGS Gage ID	Estimate daily streamflows by distributing monthly natural flows to daily values using daily data at a streamflow gage. Note the monthly totals in the monthly natural flow file (*.rim or *.xbm) control.
Diversion Station (*.dds)	4	Estimated daily diversion demands by connecting the midpoints of data in the calculated monthly demand (*C.ddm) file.
Reservoir Station	5	Estimate daily reservoir targets by connecting the endpoints of data in the calculated monthly reservoir target file (*C.tar)
Instream Flow Station	3	Daily instream flow demand data (*.ifd) is used to estimate daily demands. Note the daily data controls.
Well Station	4	Estimated daily well demands by connecting the midpoints of data in the monthly well demand (*.wem) file.

Table 6 is an example used for a Daily Historical Calibration Run with daily natural flows. Unlike the examples described above, this example does perform a daily natural flow analysis to estimate daily streamflows. Note that daily data are used for streamflow, diversions and instream flows. Interpolation routines are used to estimate daily reservoir contents and daily reservoir targets. An interpolation approach is used for reservoirs and wells because daily reservoir and well data are typically unavailable.

Table 6: Example 3, Daily ID Assignment for a Daily Historical Calibration Scenario with Daily Natural Flows

File	Daily ID	Comment
River Station (*.ris)	3	For the natural flow run, use the daily streamflow data located in the Daily Historical Streamflow file (*.riy). For a simulation run, use the daily natural flow streamflow data located in the Daily Streamflow file (*.rid or *.xby) created by the daily natural flow run.
Diversion Station (*.dds)	3	For the natural flow run, use the Daily Historical Diversion data (*.ddy) to estimate daily historical diversions. For the simulation run, use the Daily Diversion Demand data (*.ddd) to estimate daily historical demands.
Reservoir Station	5	For the natural flow run, estimate daily reservoir end-of-day contents by connecting the endpoints of data in the monthly reservoir target file (*.eom). For the simulation run, estimate daily reservoir targets by connecting the endpoints of data in the Monthly Reservoir Target file (*.tar).
Instream Flow Station	3	For the natural flow run, instream flows are not required because they are non-consumptive. For the simulation run, use daily instream flow demand data (*.ifd).
Well Station	4	Estimated daily well demands by connecting the midpoints of data in the monthly well demand (*.wem) file.

Table 7 is an example used for a Daily Calculated or Baseline Run with daily natural flows. The simulation run uses an interpolation routine for diversion demands and well demands because it is the most appropriate technique to estimate future daily diversion demands. Using a different approach for diversions during a natural flow run and a simulation run requires a different diversion station file be used for each. Interpolation routines are again used to estimate daily historical reservoir contents and daily reservoir targets for both the natural flow and simulation runs because daily reservoir data are typically unavailable.

Table 7: Example 4, Daily ID Assignment for a Daily Calculated/Baseline Scenario with Daily Natural Flows

File	Daily ID	Comment
River Station (*.ris)	3	For the natural flow run, use the daily streamflow data located in the Daily Historical Streamflow file (*.riy). For a simulation run, use the daily natural flow streamflow data located in the Daily Streamflow file (*.rid or *.xby) created by the daily natural flow run.
Diversion Station (*.dds)	3 = natural flow 4 = simulation	For the natural flow run, use the Daily Historical Diversion data (*.ddy) to estimate daily historical diversions. For the simulation run, use the Daily Diversion Demand data (*.ddd) to estimate daily historical demands.
Reservoir Station	5	For the natural flow run, estimate daily reservoir end-of-day contents by connecting the endpoints of data in the monthly reservoir target file (*.eom). For the simulation run, estimate daily reservoir targets by connecting the endpoints of data in the Monthly Reservoir Target file (*.tar).
Instream Flow Station	3	For the natural flow run, instream flows are not required because they are non-consumptive. For the simulation run, use daily instream flow demand data (*.ifd).
Well Station	4	Estimated daily well demands by connecting the midpoints of data in the monthly well demand (*.wem) file.

7.17.1 Implementing Daily Model Capabilities in a Monthly Model

This section provides information as to the specific flags and files required to add daily capability to a monthly model. As daily natural flow generation is not required nor recommended, the approach to implement daily model capabilities in a monthly model *without* generating daily natural flows is provided below. This section does not provide information on the development of the daily files due to the wide variety of information and/or scenarios that could be modeled. It is recommended users refer to a previously developed daily model for specific information and format of the input files.

1. In the response (*rsp) file using a text editor, add the file names for the appropriate daily files that are required for the specific scenario (i.e. exclude well and/or reservoirs if the scenario does not include them).

```
Stream_Base_Daily                    =      Stream Base Daily *.rid
Diversion_Demand_Daily               =      Direct Flow Demand Daily *.ddd
Instreamflow_Demand_Daily            =      Instream Flow Demand Daily *.ifd
Well_Demand_Daily                    =      Well Demand Daily *.wed
Reservoir_Target_Daily               =      Reservoir Target Daily *.tad
DelayTable_Daily                     =      Delay Table Daily *.dld
ConsumptiveWaterRequirement_Daily    =      ConsumptiveWaterReq. Daily *.iwd
StreamGage_Historic_Daily            =      StreamGage Historic Daily *.riy
Diversion_Historic_Daily             =      Diversion Historic Daily *.ddy
Well_Historic_Daily                  =      Well Historic Daily *.wey
Reservoir_Historic_Daily             =      Reservoir Historic Daily *.eoy
```

2. In the control (*.ctl) file using a text editor, set the daily flag (*iday)* to either 1 for a daily analysis or 2 for a daily analysis where the daily demand is a monthly total that is decreased by the amount diverted each day (i.e. "daily decrement approach").
3. Using the StateDMI commands, set the Daily Station IDs in each of the files listed below to indicate the desired method to use or estimate daily data.
    a. River station (*.ris) file = Daily Stream Station ID (*crunidy*) flag; note daily data for the station ID must be provided in the daily streamflow file (*.rid).
    b. Diversion station (*.dds) file = Daily Diversion ID (*cdividy)* flag
    c. Instream station (*.ifs) file = Daily Instream Station ID (*cifridy)* flag
    d. Well station (*.wes) file = Daily Well Station ID (*cdividyw)* flag
    e. Reservoir station (*.res) file = Daily Reservoir Station ID (*cresidy)* flag
4. Using TSTool commands, create the daily input files as appropriate for the scenario:
    a. Daily streamflow (*.rid) file
    b. Direct diversion demand (*.ddd) file.
    c. Daily instream demand (*.ifd) file.
    d. Daily well demand (*.wed) file if wells are simulated.
    e. Daily reservoir target (*.tad) file.
    f. Daily return file (*.dld) file.
    g. Daily Consumptive Requirement (*.ddx) file if variable efficiency is simulated.

Modeling Tip:

- Daily modeling options are complex and all functionality has not been thoroughly tested or vetted; it is up to the user to verify these operations are simulating as desired.

8.0 Supporting Utilities

This section describes supporting utilities which operate outside the State Model to provide additional plotting and linking capabilities. The following sections are available within this chapter:

- 8.1 Big Picture Plot
- 8.2 Basin Linkage
- 8.3 StateMod File Comparison
- 8.4 StateDMI
- 8.5 Tstool DMI
- 8.6 StateCU
- 8.7 SmNewRsp (StateMod Response File Program)
- 8.8 SmDelay (StateMod Delay File Program)

8.1 Big Picture Plot

Description

The Big Picture Plot is generated by a FORTRAN program named **delplt.f**. **Delplt** post processes one or more output files from StateMod to generate a file which may be viewed as a table or provided to a plotting program to generate a 'Big Picture Plot'. Output from **Delplt** is always directed to the directory where the response file is located. It has the following capabilities:

- Single, Multiple, Difference, Diffx or Merge file results.

    The Single option will process the first file only.

    The Multiple option will generate a matrix by ID for up to 5 files.

    The Difference option will subtract data from two files (ID's in one file but not another will be treated as zeros).

    The Diffx option will subtract data from two files (ID's in one file but not another will be ignored).

    The Merge option will concatenate two or more files together.

- Operates on both StateMod ASCII and Binary output files.

    For ASCII diversion = *.xdd, reservoir = *.xre

For Binary diversion - *.b43, reservoir = *.b44

- Provides data for one of 20+/- parameters.
- Prints 1, n, or all ID's.
- Prints a specific year, year and month, or average.
- For the Difference option only allows ID's found in one file not in another.

Constraint:

For the ID Option, the code checks for a -999 as an indicator that no more ID's will be provided.

Options

The program is written in FORTRAN. It expects a command file which, if not provided, defaults to 'delplt.in'. Following is the format of a command files:

```
Line 1: Run type (Single, Multiple, Difference,
    Merge or Help)
Line 2: File Name (can be ASCII (e.g. *.xdd) or Binary (e.g. *.b43))
Line 3: Data Type
    Available data types are
       Diversion
       StreamGage (baseflows)
       Stream (same as StreamGage)
       Reservoir
       Instream
       StreamID (baseflows that begin with a USGS Identifier (e.g. 09… or 08…)
Line 3: Parameter
    Available Diversion or streamGage or streamID parameters:
       Total_Demand
       CU_Demand
       From_River_by_Priority
       From_River_by_Storage
       From_River_by_Exchange
       From_Well
       From_Carrier_by_Priority
       From_Carrier_by_Storage
       Carried_Water
       From_Soil
       Total_Supply
       Total_Short
       CU_Short
       Consumptive_Use
       To_Soil
       Total_Return
       Loss
       Upstream_Inflow
       Reach_Gain
       Return_Flow
       Well_Depletion
       To/From_GW_Storage
       River_Inflow
       River_Divert
```

```
   River_by_Well
   River_Outflow
   Available_Flow

 Available reservoir parameters:
   Initial_Storage
   River_Priority
   River_Storage
   River_Exchange
   Carrier_Priority
   Carrier_Storage
   Total_Supply
   Storage_Use
   Storage_Exchange
   Carrier_Use
   Total_Release
   Evap
   Seep_Spill
   SimEOM
   Target_Limit
   Fill_Limit
   River_Inflow
   Total_Release
   Total_Supply
   River_By_Well
   River_Outflow

Line 4: Station ID (0=all, end with a -999)
Line 5: Time (year, year and month, Ave)
```

Example of a Difference Application

```
#
# Multiple Files, same data type, same parameter,
#   three years (1975, 1976 and average)
#
#       Run Type: (Single, Multiple, Difference, Merge or Help):
#
Difference
########################################
#
#       File:
gunnH.xdd
#
#       Data Type (Diversion, StreamGage, Reservoir, Instream, or
StreamID)
Diversion
#
#       Parameter (same as SMGUI) or type -help
Total_Supply
#
#       ID (0=all, n=ID, end with a -999)
0
-999
#
#       Year or Ave (e.g. Ave or 1989 NOV)
Ave
#
########################################
```

```
#
#
#       File:
gunnC.b43
#
#       Data Type (Diversion, StreamGage, Reservoir, Instream, or
StreamID)
Diversion
#
#       Parameter (same as SMGUI) or type -help
Total_Supply
#
#       ID (0=all, n=ID, end with a -999)
0
-999
#
#       Year or Ave (e.g. Ave or 1989 NOV)
Ave
#
-999
```

8.2 Basin Linkage

Description

The Basin Linkage utility, SmLink, allows the input from one or more StateMod input files to be combined in order to operate as a single model. Smlink does the following:

- Reads 2 to 5 StateMod response (*.rsp) files to generate all the input files required to operate StateMod as a linked basin.
- Allows the user to input replacement commands required to delete nodes where the models overlap or add nodes required to facilitate linkage.
- Generates a log file that records the required dimensions for the StateMod Model and any duplicate ID's that need to be revised before a successful execution of StateMod can be performed.

Constraints used by the model include:

To link the *.rin file the code searches for a river node named 'End' or 'END'.

The code warns the user if duplicate ID's are provided in the log file.

The path of each input file is taken from the path specified in the command files unless a path is provided in the response (*.rsp) file.

The information in the control (*.ctl) files must be exactly the same (unit conversions, beginning year, etc.) to avoid any warnings. If inconsistent data is provided the information in the first file read is used for the linked control (*.ctl) file.

Because it is common for several StateMod input files to use the same evaporation, precipitation and delay files the user can specify input data that controls whether or not these files should to be linked.

Because it is common for several StateMod input files to use the StateCU input and output files that span an entire watershed the user can specify input data that controls whether or not these files should to be linked.

StateMod allows a unit response (*.urm) or delay *.dly) file data to be provided in a free format. In order for SmLink to differentiate between an ID and data, columns 1-12 should be reserved for an ID. See below for an example free format unit response file where the ID is URM_1, 12 unit response values of 10 are provided as input, and columns 1-12 are reserved for an ID designation.

```
URM_1       12  10. 10. 10. 10. 10. 10. 10. 10. 10. 10.
            10. 10  (data begins in column 13)
```

StateMod allows an operating rule (*.opr) file to be provided in free format. In order for SmLink to differentiate between an ID and data, columns 1-12 should be reserved for an ID. See below for an example free format operating rule file with monthly on off switch.

```
Opr_Mead.01 Opr_Meadow_D&S_01                100.00000    12.     1
         1 1 1 1 -15 0 0 0 0 0 0 0 (on/off data begins in column 13)
```

Options

Smlink expects a command file which, if not provided, defaults to 'smlink.rsp'.

SmLink has the capability to perform the following types of edits to an input file

-delsta(fn,id) Delete station ID from file fn

-addrec(fn,rec) Adds a record (rec) to file (fn).

-repzero(fn,id,zero) Set data for station (id) in file (fn) to zero.

Example

```
#       SmLink.rsp
#
#       Output File name (e.g. wslope)
wslope
#
#
# _________________________________________________________
#       Compare and link selected files
#      (0=no compare and use first file read, 1 yes compare and link files)
#       nEva = evap; nPre = precip; nStr = structure, nIpy = Irrigation Practice,
#       nDly = delay file; nUnit output units = 1 cfs, 2=af, 3=kaf
# nEva nPre nStr nIpy nDdc nDly nUnit
     0    0    0    0    0    0     3
# _________________________________________________________
#
#       Input File names (e.g. cm2009H.rsp)
\w\statem\Verification\Base\YM2009\ym2009H.rsp
\w\statem\Verification\Base\WM2009\wm2009H.rsp
\w\statem\Verification\Base\SJ2009\SJ2009H2.rsp
```

```
\w\statem\Verification\Base\CM2009\cm2009H2.rsp
\w\statem\Verification\Base\GM2009\gm2009H2.rsp
#
#       River Network
#       09152500 is Gunison R nr Grand Junction
#       420541 is Redlands Power
#       950050 is Redlands Irrig
-delsta(cm2009.rin,09152500)
-delsta(cm2009.rin,420541)
-delsta(gm2009.rin,680636)
#
#       Diversion Stations
-delsta(gm2009.dds,420541)
-delsta(gm2009.dds,680636)
#
#       Add compact node Station, water right and demand
-addrec(gm2009.ifs,Compact_Dem Compact_Dem             Compact_Dem        1
COMPACT_DEM  0                 2)
-addrec(gm2009.ifr,Compact_Dem Compact_Dem             Compact_Dem         1.00000
99999.99       1)
-addrec(gm2009.ifa,     Compact_Dem  9999999 9999999 9999999 9999999 9999999
9999999 9999999 9999999 9999999 9999999 9999999 9999999)
#

-repzero(cm2009.rih,950040,zero)
-repzero(cm2009.rih,504600,zero)
-repzero(ym2009.ddh,584686,zero)
-repzero(ym2009H.ddm,584686,zero)
#
-addrec(gm2009.rin,End_File_1  File 1-Compact_Dem  _OTHCompact_Dem  End_File_1
-999)
-addrec(gm2009.rin,End_File_2  File 2-420541       _OTH420541       End_File_2
-999)
-addrec(gm2009.rin,End_File_3  File 3-Compact_Dem  _OTHCompact_Dem  End_File_3
-999)
-addrec(gm2009.rin,End_File_4  File 4-Compact_Dem  _OTHCompact_Dem  End_File_4
-999)
-addrec(gm2009.rin,End_File_5  File 5-Compact_Dem  _OTHCompact_Dem  End_File_5
-999)
-addrec(gm2009.rin,Compact_Dem Compact_Dem         _IFSEnd_All      Compact_Dem
-999)
-addrec(gm2009.rin,End_All     End)
```

8.3 StateMod File Comparison

The smfc program is written in FORTRAN and expects a command file with data. Smfc does the following for StateMod applications:

- Reads and compares 2 or more StateMod input or output files. The user has the ability to:

    Compare all StateMod input files associated with a run if the file to be compared is a response (*.rsp) file.

    Compare just one file if the file to be compares is anything except a response file (e.g. *.dds, *.res, *.xpl, etc.).

Constraints used by the model include:

StateMod allows a unit response (*.urm *.urd or *.dly) file data to be provided in a free format. In order for SmFc to differentiate between an ID and data, columns 1-12 of a unit response file should be reserved for an ID. See below for an example free format *.urm file where the ID is URM_1, 12 unit response values of 10 are provided as input, and columns 1-12 are reserved for the ID designation.

```
URM_1       12  10. 10. 10. 10. 10. 10. 10. 10. 10. 10.
                10. 10
```

StateMod allows an operating rule (*.opr) file to be provided in free format. In order for SmLink to differentiate between an ID and data, columns 1-12 should be reserved for an ID. See below for an example free format operating rule file with monthly on off switch.

```
Opr_Mead.01 Opr_Meadow_D&S_01               100.00000    12.     1
            1 1 1 1 -15 0 0 0 0 0 0 0 (on/off data begins in column 13)
```

It is common for a well water right to be assigned more than one structure and a well plan to include many wells. Therefore when comparing a well right file or a well plan file, differences may be expected.

Options

If a command file is not provided, the program defaults to smfc.rsp.

If a response (*rsp) file is provided on the file to compare (line 2) then the code will compare all files contained in the response files.

If any file other than a response if provided then it only compares those two files.

Has the option to print all lines in a comparison (iprint=0) or only lines where differences occur (iprint=1).

Following is the information in a typical command file:

```
  Line 1: Print control (iprint) 0=print all; 1=print only delta
  Line 2: Comparison control (e.g. .rsp, .dds, etc)
  Line 3: Output file name
  Line 4: File 1 to compare
  Line 5: File 2 to compare
```

Example

```
#
# Smfc.rsp; response file to smfc.for; StateMod file compare
#
# 1. iprint 0=print all; 1=print only delta
1
#
# 2. Files to compare (.rsp = all)
.rsp
#
```

```
# 3. Output File name
SmFc.out
#
# 4. File 1 to compare
/usr2/crdsswork/statemod/white/whiteH.rsp
#
# 5. File 2 to compare
/usr2/crdsswork/statemod/whiteT/whiteTH.rsp
```

8.4 StateDMI

The StateDMI provides the following assistance to the StateMod Model:

- Creates a river network (*.rin) file that identifies relative location (upstream or downstream) of nodes in a model network.
- Creates a river station (*.ris) file that describes the names and locations of nodes where baseflows are known.
- Creates a stream estimate station coefficient data (*.rib) file with proration coefficients to calculate baseflows for nodes where baseflows are not known.
- Creates a reservoir structure (*.res) file that describes the physical properties of each reservoir in the system.
- Creates a reservoir rights (*.rer) file that contains data associated with reservoir storage rights.
- Creates an instream flow structure (*.ifs) file that describes the physical properties of each instream flow in the system.
- Creates an instream flow rights (*.ifr) file that contains data associated with instream flow water rights.
- Create an instream flow demand (*.ifa) file that contains annual instream flow demands (12 monthly values) for each instream flow.
- Creates a well structure (*.wes) file that describes the physical properties of each well in the system.
- Creates a well rights (*.wer) file that contains data associated with ground water rights.
- Create a well demand (*.wem) file that contains demands for well structures.
- Creates a direct diversion structure (*.dds) file that describes the physical properties of each direct diversion in the system.
- Creates a direct diversion rights (*.ddr) file that contains data associated with diversion water rights.
- Creates an historic diversion (*.ddh) file by extracting diversion data from the CDSS database.
- Fills missing historic diversion data from user supplied information.

- Calculates the average system efficiency for irrigation structures based on historic diversion data and irrigation water requirement data provided by the CU model, StateCU (see below).

- Creates a demand (*.ddm) file based on calculated or user supplied efficiency data and farm irrigation water requirement data provided by the CU model, StateCU (see below).

- Extracts irrigated acreage and crop mix (*.cds) data from the CDSS database.

For a complete description of the StateDMI see CDSS web site (http://cdss.state.co.us).

8.5 TSTool DMI

The TSTool DMI provides the following assistance to the StateMod Model:

- Extracts historic streamflow data from CDSS database.

- Fills missing streamflow data from user supplied parameters.

- Extracts historic reservoir End-of-Month data from CDSS database.

- Fills missing EOM data from user supplied parameters.

- Extracts precipitation and evaporation data to build the net evaporation file (*.eva) for StateMod.

For a complete description of the TSTool DMI see CDSS web site (http://cdss.state.co.us).

8.6 StateCU Model

The StateCU Model provides the following assistance to the StateMod Model:

Provides irrigation water requirement data for estimating irrigation structure efficiencies and calculated demands (as opposed to historic diversions).

For a complete description of the StateCU Model see CDSS web site (http://cdss.state.co.us).

8.7 SmNewRsp StateMod Response

The StateMod Response File preprocessor (SmNewRsp) allows a discontinued StateMod response file to be read and a new StateMod file constructed that is consistent with the Version 10.30 update that allows files to be provide in any order using a file descriptor. As presented below SmNewRsp keys on the suffix recommended and typically used in an existing StateMod response file to build a control file that is consistent with version 10.30 and greater. Note that if any existing file that does not contain a standard, recommended name SmNewRsp will warn the user but will not try to determine the file type. Also, since the new response file format was adopted with version 10.30, any files added after that time (e.g. Plans, Reservoir Return Data, etc.) are not processed. Similar to files with a non-standard suffix, SmNewRsp will warn the user but will not try to determine the file type. When a warning is encountered, the output from SmNewRsp will typically require hand editing before they can be successfully used by StateMod.

To execute SmNewName the user simply types:

SmNewName flname.rsp

where flname.rsp is an old sequential StateMod response. The new random response file is named SmNewRsp.out. Also execution notes and warnings are reported in file named SmNewRsp.log.

Files processed by SmNewRsp (those in existence before version 10.30)

#	Standard Suffix	File Descriptor	Example Name
1	*.ctl	Control	rgTWD.ctl
2	*.rin	River_Network	rgTW.rin
3	*.res	Reservoir_Station	rgTW.res
4	*.dds	Diversion_Station	rgTW.dds
5	*.ris	StreamGage_Station	rgTW.ris
6	*.ifs	Instreamflow_Station	rgTW.ifs
7	*.wes	Well_Station	rgTW.wes
8	*.ifr	Instreamflow_Right	rgTW.ifr
9	*.rer	Reservoir_Right	rgTW.rer
10	*.ddr	Diversion_Right	rgTW.ddr
11	*.opr	Operational_Right	rgTW.opr
12	*.wer	Well_Right	rgTW.wer
13	*.dum	Precipitation Monthly	rgTW.pre
14	*.eva	Evaporation_Monthly	rgTW.eva
15	*.rim	Stream_Base_Monthly	rgtw.rim
16	*.ddm	Diversion_Demand_Monthly	rgTW.ddm
17	*.dda	Diversion Demand Average Monthly	rgTW.dda
18	*.ddo	Diversion Demand Override	rgTW.ddo
19	*.ifm	Instreamflow_Demand_Monthly	rgTW.ifm
20	*.ifa	Instreamflow_Demand_AverageMonthly	rgTW.ifa
21	*.wem	Well_Demand_Monthly	rgTW.wem
22	*.dly	DelayTable_Monthly	rgTW.dly
23	*.tar	Reservoir_Target_Monthly	rgTW.tar
24	*.ipy	IrrigationPractice_Yearly	rg.ipy
25	*.iwr	ConsumptiveWaterRequirement_Monthly	rg.iwr
26	*.par	SoilMoisture	rg.par
27	*.eom	Reservoir_Historic_Monthly	rgTW.eom
28	*.rib	StreamEstimate_Coefficients	rgTW.rib
29	*.rih	StreamGage_Historic_Monthly	rgTW.rih
30	*.ddh	Diversion_Historic_Monthly	rgTW.ddh
31	*.weh	Well_Historic_Monthly	rgTW.weh
32	*.gvp	GeographicInformation	rgTW_StateMod.gvp
33	*.out	OutputRequest	RgTW.out
34	*.rid	Stream_Base_Daily	rgTWD.rid
35	*.dum	Dummy	rgTWD.dum
36	*.dum	Dummy	rgTWD.dum
37	*.dum	Dummy	rgTWD.dum
38	*.dum	Dummy	rgTWD.dum
39	*.dld	DelayTable_Daily	rgTwD.dld
40	*.iwd	ConsumptiveWaterRequirement_Daily	rgTWD.iwd
41	*.rhy	StreamGage_Historic_Daily	rgTWD.rhy
42	*.dhy	Diversion_Historic_Daily	RgTWD.dhy
43	*.why	Well_Historic_Daily	RgTWD.why
44	*.eoy	Reservoir_Historic_Daily	RgTWD.eoy

8.8 SmDelay StateMod Delay File Program

The StateMod Delay File Program (SmDelay) allows a daily StateMod delay file (*.dly or *.urD) to be created from an existing StateMod monthly delay file (*.dly or .urM). The approach used to estimate daily data is to construct a pattern by connecting the midpoints of monthly data. The result is a smooth daily estimate.

To execute SmDelay the user simply types:

SmDelay flname.rsp

where flname.rsp is a response file that that includes the name of the existing monthly delay file and the name of the new daily delay file to be created. Following is an example:

```
#
# smDelay.rsp;
#   Response file to create a daily delay file from a monthly file
#
#
# Name
#---------------
rg2005.urM                Existing Monthly delay file
rg2005.urD                New Daily delay file
```

9.0 Discontinued but Supported File Formats

This section describes input files that are discontinued but continue to be supported. This support is provided to allow prior developments to continue to operate. They include:

- 9.1 Response File (Sequential)
- 9.2 Soil Moisture Parameter File (*.par)
- 9.3 Irrigation Practice (*.ipy) File
- 9.4 Operating Rule (*.opr) File

9.1 Response File (*.rsp)

The response file contains the names of all other data files required to run the model. This file is read by subroutine StateM. Note that Version 10.30 and greater allows a user to enter response file data using one of two formats; random and sequential. StateMod reads the first file type and based on the occurrence of the character '=' in the first file name it determines if the file is random (contains a '=') or sequential (does not contain a '=').

The random file approach allows file names to be entered in any order as described below under Random Response Format. Any file type that is not required for a simulation is simply not included. Also any file name may be commented out by including a '#' character in column 1. Its format is described in the Chapter 4.0 Input Description.

The sequential file contains file names or a dummy name for every file type. It is described below. Also to allow StateMod to be backward compatible, well data (*.wes, *.wer, *.wem, and *.weh), the monthly instream demand (*.ifm), San Juan Recovery Plan sediment file (*.sjr), annual time series file (*.ipy), irrigation water requirement file (*.iwr) and soil moisture file (*.par) should not be provided unless specified in the control (*.ctl) file. See files with footnotes in the following table.

Sequential File Format

Row-data	**Variable**	**Description**
		Format (a72)
Control and Network Files		
1-1	filena	Control file (*.ctl)
2-1	filena	River Network file (*.rin)
Station Files		
3-1	filena	Reservoir Station file (*.res)
4-1	filena	Direct Diversion Station file (*.dds)
5-1	filena	River Station file (*.ris)
6-1	filena	Instream Flow Station file (*.ifs)
7-1	filena (1)	Well Station file (*.wes)

Right Files

8-1	filena	Instream Flow Right file (*.ifr)
9-1	filena	Reservoir Right file (*.rer)
10-1	filena	Direct Diversion Right file (*.ddr)
11-1	filena	Operational Right file (.opr)
12-1	filena (1)	Well Right file (*.wer)

Climate and Stream Files

13-1	filena	Precipitation file - monthly (*.pre)
14-1	filena	Evaporation file - mon or ann (*eva)
15-1	filena	Streamflow file - mon (*.rim or *.xbm)

Demand Files

16-1	filena	Direct Flow demand file - mon (*.ddm)
17-1	filena	Direct Flow demand overwrite - mon (*.ddo)
18-1	filena	Direct Flow demand file - ann (*.dda)
19-1	filena (2)	Instream demand file - monthly (*.ifm)
20-1	filena	Instream demand file - annual (*.ifa)
21-1	filena (1)	Well structure demand file - mon(*.wem)

Delay and Reservoir Target Files

22-1	filena	Delay Table file - monthly (*.dly)
23-1	filena	Reservoir Target file - mon (*.tar)

Optional Files

24-1	filena (3)	SJRIP sediment file - annual (*.sjr)
25-1	filena (4)	Annual Time series file - annual (*.ipy)
26-1	filena (5)	Consumptive Water Req. - monthly (*.iwr)
27-1	filena (6)	Soil Moisture file - annual (*.par)

Historical and Base Streamflow Files

28-1	filena	Historic Res. EOM data - monthly (*.eom)
29-1	filena	Base Streamflow data (*.rib)
30-1	filena	Historic Streamflow data - monthly (*.rih)
31-1	filena	Historic Diversion data - monthly (*.ddh)
32-1	filena (1)	Historic Well Pumping - monthly (*.weh)

Output Control Files

33-1	filena	GIS data files (*.gis)
34-1	filena	Output Control file (*.out)

Daily Files

35-1	filena (7)	Streamflow file - daily (*.rid)
36-1	filena (7)	Direct Flow demand file - daily (*.ddd)
37-1	filena (7)	Instream demand file - daily (*.ifd)
38-1	filena (1,7)	Well demand file - daily (*.wed)
39-1	filena (7)	Reservoir Target file - daily (*.tad)
40-1	filena (7)	Delay Table file - daily (*.dld)
41-1	filena (5,7)	Consumptive Water Req. - daily (*.iwd)
42-1	filena (7)	Historic Streamflow data - daily (*.riy)
43-1	filena (7)	Historic Diversion data - daily (*.ddy)
44-1	filena (7)	Historic Well Pumping - daily (*.wey)
45-1	filena (7)	Historic Res. EOM data - daily (*.eoy)

(1)Well data (.wes, *.wer, *.wem, and *.weh) should only be provided when variable iwell = 1 in the control (*.ctl) file*
(2) A monthly instream flow file (.ifm) should only be provided when variable ireach = 2 or 3 in the control (*.ctl) file*
(3) A San Juan Recovery Sediment file (.sjr) should only be provided when the variable isjrip is not zero in the control (*.ctl) file*

(4) An Annual time series file (.ipy) should only be provided when the variable itsfile is not zero in the control (*.ctl) file*
(5) An Irrigation water requirement file should only be provided when the variable ieffmax is not zero in the control (.ctl) file*
(6) A Soil Moisture Parameter file (.par) should only be provided when the variable soild is not zero in the control (*.ctl) file*
(7) Daily data should only be provided when the variable iday is not zero in the control file.

9.2 Soil Parameter File (*.par)

The structure parameter file (*.par) contains soil moisture data required to perform soil moisture accounting. The soil moisture reservoir available to each structure is the parameter *awcr* multiplied by the structures area multiplied by average depth for every structure in the system specified in the control file (*.ctl) by variable *soild* (feet). It is formatted exactly the same as the soil parameter file used by the consumptive use model (StateCU), therefore it often contains data prior to and beyond the variable *awcr* that is not used by StateMod. Data can be entered in any order.

When this discontinued format is provided the following format string should be entered at the top of the file: # FileFormatVersion 1. If the above string is not provided StateMod will try to read the file and try to determine the appropriate type.

Row-data	**Variable**	**Description**
Control Data		
1		Format (i4, 1x, a12, 12f8.0)
1-1	cistat	Station ID
1-2	awcr(1-12,1)	Available soil moisture (inches per inch)
		Repeat for the number of stations numdiv

9.3 Irrigation Parameter Yearly Data File - Annual (*.ipy)

The annual CU time series file contains information required to perform calculations using a variable efficiency approach. The current standard is to provide 4 water supply and irrigation method combinations (Surface Supply Flood Irrigation, Surface Supply Sprinkler Irrigation, Ground Supply Flood Irrigation and Ground Supply Sprinkler Irrigation). A discontinued but still supported format includes total ground water and total sprinkler data.

When this discontinued format is provided the following format string should be entered at the top of the file: # FileFormatVersion 1. If the above string is not provided StateMod will try to read the file and try to determine the appropriate file type. Regardless if the file format string is or is not provided the discontinued total ground water and sprinkler data are distributed to four land use types as follows:

Water Supply Irrigation Method	Approach
Ground Supply Sprinkler Irrigation	= Minimum (Total Ground Water and Total Sprinkler Irrigation)
Surface Supply Sprinkler Irrigation	= Total Sprinkler – Ground Supply Sprinkler Irrigation
Ground Supply Flood Irrigation	= Total Ground Water – Ground Supply Sprinkler Irrigation
Surface Supply Flood Irrigation	= Maximum (0.0 or Total Area - Ground Supply Sprinkler Irrigation – Surface Supply Sprinkler Irrigation – Ground Supply Flood Irrigation).

```
Row-data       Variable             Description

Control Data
1                                   Format (i5,1x,i4,5x,i5,1x,i4,a5,a5)
1-1            ibm                  Beginning month of data (e.g. 1=Jan)
1-2            iby                  Beginning year of data (e.g. 1975)
1-3            iem                  Ending month of data
1-4            iey                  Ending year of data
1-5            cunit                Units of data ('   NA')
1-6            cyr                  Year type
                                       '  CYR'= calendar year (1-12)
                                       '  WYR'= water year (10-9)
                                       '  IYR'= irrigation year (11-10)

Time Series Data
2                                   Format (i4,1x,a12,3f6.0,2f8.0,f12.0,f3.0,f8.0)
2-1            idly                 year
2-2            ID                   Structure ID
2-3            ceff                 Conveyance efficiency (decimal)
2-4            feff                 Maximum flood efficiency (decimal)
2-5            seff                 Maximum sprinkler efficiency (decimal)
2-6            gacre                Acres with a ground water supply
2-7            sacre                Acres with a sprinkler supply
2-8            mprate               Maximum pumping rate (af/mo)
2-9            gwmode               Ground water use mode
                                      1 = maximum supply mode
                                      2 = mutual ditch supply mode
2-10           areax                Irrigated acreage for year idly (ac)
```

9.4 Operational Right File (*.opr)

Beginning with version 12.0 an operating rule file format was adopted that includes six (6) additional variables associated with water reuse, diversion type, etc.(see table below). When this discontinued format is provided the following format string should be entered at the top of the file: # FileFormatVersion 1. If the above string is not provided StateMod will try to read the file and try to determine the appropriate file type. Regardless if the file format string is or is not provided the discontinued operating rule file will assign the following default values:

Data Type	**Variable**	**Default Value**
Associated Plan Data	creuse	NA
Diversion Type	cdivtyp	NA
Conveyance Loss (%)	OprLoss	0
Miscellaneous Limits	OprLimit	0
Start Date	IoBeg	First year of operation
End Date	IoEnd	Last year of operation