V.3.3-SSARRESV SSARR RESERVOIR REGULATION OPERATION

Identifier: SSARRESV

Application: Operational Forecast System programs only

Description: This Operation routes streamflows from upstream to downstream points through lake storage and reservoirs under free flow or controlled-flow modes of operation.

The Operation is based on the Streamflow Synthesis and Reservoir Regulation System developed by US Army Corps of Engineers and North West River Forecast Center of National Weather Service. Flows may be routed as a function of multi-variable relationships involving backwater effects from a downstream reservoir.

The following types of reservoir regulation can be specified:

FREEFLOW	-	free flow (lake routing)
SETQ	-	outflow specified (CFS; CMS)
SETH	-	reservoir elevation specified (FT; M)
SETS	-	reservoir storage specified (ACFT; TCUM)
SETDQ	-	change in storage specified (CFSD/DAY; CMSD/DAY)
SETDH	-	daily change of elevation specified (FT/DAY; M/DAY)
SETDS	-	daily change of storage specified (ACFT/DAY; TCUM/DAY)

All the units follow the NWSRFS units convention except TCUM which stands for thousand cubic meters.

The regulation options can change over time and are not specified as part of a segment definition but are specified at run-time via the SSARREG MOD as a sequence of regulation options, dates and values. The specified regulation options are only used to determine the outflow and pool elevation during the forecast period. During the observed portion of a SSARRESV run, observations are used to determine the outflow and elevation based on the procedures described in Section II.4-SSARRESV.

When reservoir regulation options are specified in terms of storage change (SETH, SETS, SETDQ, SETDH and SETDS) the reservoir outflow is being calculated as being parallel to the inflow hydrograph and separated by the stipulated volume amount. When the storage change differs from one period to the next, an instantaneous change in flow must necessarily be utilized. Such a condition is illustrated in Figure 1 in Section II.4-SSARRESV. Since an instantaneous flow change can occur, Operation SSARRESV requires two instantaneous outflow time series: the first contains the flow at the start of a time period and the second contains the flow at the end of the period. Optionally, a mean outflow time series can be generated (average of flows at the start and end of the period). Inflow to Operation SSARRESV can be a single inflow time series or a pair of inflow time series (start and end of period flows) depending on the Operations used to generate the inflow (see II.4-SUMPOINT for more

details). The typical data type code to use for start of period discharges is SQIB and for end of period discharges is SQIE.

The general reservoir regulation rules for a computational interval starting at time t and bracketed by regulation options specified at times T_1 and T_2, are as follows:

1. If no regulation option is specified then:
   - If the discharge/elevation curve is available, FREEFLOW is used.
   - If the discharge/elevation curve is not available, inflow will be passed.

2. If the options at T_1 and T_2 are the same, the regulation value is linearly interpolated between the values specified at T_1 and T_2.

3. If the regulation options at T_1 and T_2 are different then:
   - If the specified option at T_2 is SETH or SETS, the regulation option at T_2 is used and the regulation value is linearly interpolated using the computed value from t and the specified value at T_2.
   - If the specified option at T_2 is neither SETH nor SETS, FREEFLOW is used.

The SSARRESV Operation is normally used for a single reservoir without backwater/tributary effect (SAR/ENDSAR), however, it can also be used for a single reservoir controlled by and/or with backwater effect from tributary flow condition (LWERBKWR/ENDLWERB). A reservoir without backwater/tributary effect is referred to as a non-backwater reservoir and a reservoir with backwater/tributary effect is referred to as a backwater reservoir. A maximum of two reservoirs, where the outflow from the upstream reservoir is affected by backwater from the downstream reservoir, are permitted in Operation SSARRESV . If there are a pair of reservoirs, both reservoirs are included in a single SSARRESV Operation. The upstream reservoir is always referred to as the backwater reservoir (UPERBKWR/ENDUPERB). The downstream reservoir can be a non-backwater reservoir (SAR/ENDSAR) or a backwater reservoir (LWERBKWR/ENDLWERB). The downstream reservoir is assumed and only allowed to have backwater effect solely from tributary flow.

The SSARRESV Operation can also be used to simulate a station in the river with backwater effect from a downstream reservoir. A station with backwater effect is referred to as a backwater station (3-VAR/END3-VAR).

A detailed description of the theoretical background of Operation SSARRESV is in Section II.4-SSARRESV.

Allowable Data Time Intervals: 1, 2, 3, 4, 6, 8, 12 and 24 hours

Time Series Used: Time series used in this Operation are as follows:

Keyword	Dimn	Units	Use	Required	Data Time Interval	Missing Values Allowed
INSTQI1	L3/T	CMS	I	no	3/	no
INSTQI2	L3/T	CMS	I	yes	any	no
INSTQO1	L3/T	CMS	O	1/	3/	no
INSTQO2	L3/T	CMS	O	1/	3/	no
MEANQOUT	L3	CMSD	O	2/	3/	no
POOL	L	M	O	no	3/	no
STORAGE	L3	CMSD	O	no	3/	no
OBSQO	L3/T	CMS	I	no	3/	yes
OBSQOM	L3	CMSD	I	no	3/	yes
OBSH	L	M	I	no	3/	yes
TRIBQL1	L3/T	CMS	I	no	3/	no
TRIBQL2	L3/T	CMS	I	no	3/	no
BACKQI1	L3/T	CMS	O	no	3/	no
BACKQI2	L3/T	CMS	O	no	3/	no
BACKQIM	L3	CMSD	O	no	3/	no

1/ Must be used if outflow from this SSARRESV Operation is used as inflow by another SSARR Operation.

2/ Must be used if outflow from this SSARRESV Operation is used as inflow by a non-SSARRESV Operation.

3/ Time interval must be same as time interval of INSTQI2. This is the computational time interval for the Operation.

Input Summary: The input to Operation SSARRESV uses the free format rules described in Section VI.3.4C. An addition to those rules is that a '$' is a comment indicator and any information following a '$' on that line is ignored by the input routine.

Abbreviations for any header, trailer or keyword are indicated by underscores beneath the letters comprising the abbreviation. For example, for PARMS, the abbreviation is P. Optional keywords are indicated by brackets ([ ]). When not supplied default information usually is stored for that keyword.

The following is a list of the section header, section trailer and keywords:

Keyword	Description
SSARRESV	Required keyword to start input.
[TITLE]	Optional 20 character description. If field may contain blanks or commas it must be enclosed by quotes ('text, text1'). Default is all blanks.
[UNITS]	Optional units used for input; followed by [ENGLISH] or [METRIC]. Default is ENGLISH. 1/
INFLOW TIME-SERIES CARRYOVER ENDINFLW	This section is required and is used to input the inflow time series and carryover. See the INFLOW/ENDINFLW section for input details.
[UPERBKWR PARMS TIME-SERIES CARRYOVER ENDUPERB]	This section is used to input the parameters, time series and carryover of the upstream. reservoir with backwater effect from a downstream reservoir. See the UPERBKWR/ENDUPERB section for input details. This section is optional. If used it must be used with either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section.
[3-VAR PARMS TIME-SERIES CARRYOVER END3-VAR]	This section is used to input the parameters, time series and carryover of a station with backwater effect from a downstream reservoir using three-variable relation without backwater routing. See the 3-VAR/END3-VAR section for input details. This section is optional. If used it must be used with either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section.

Only either the 3-VAR/END3-VAR section or the UPERBKWR/ENDUPERB section can be used in each SSARRESV Operation.

[LWERBKWR PARMS TIME-SERIES CARRYOVER ENDLWERB]	This section is used to input the parameters, time series and carryover of the downstream reservoir with backwater/tributary effect solely from tributary flow condition. See the LWERBKWR/ENDLWERB section for input details. This section is optional and can be used alone.
[SAR PARMS TIME-SERIES CARRYOVER ENDSAR]	This section is used to input the parameters, time series and carryovers for a non-backwater reservoir. See the SAR/ENDSAR section for input details. This section is optional and can be used alone.

Keyword	Description

Only either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section can be used in each SSARRESV Operation.

END	Required keyword to end input

INFLOW/ENDINFLW Section

The INFLOW/ENDINFLW section inputs the inflow time series and carryover information to a single reservoir or a two-reservoir/station system. No parameters is needed in this section. This section is always required.

INFLOW	Header to start the INFLOW/ENDINFLW section.
Time Series Input	
TIME-SERIES	Keyword indicating start of time series input.
[INSTQI1]	Defines the instantaneous inflow time series at period start. Only needed if the outflow from another SSARR Operation is used by this SSARRESV Operation as inflow. This keyword is followed by time-series identifying information). Suggested data type is SQIB. 2/
INSTQI2	Defines the instantaneous inflow time series at period end. This keyword is followed by time series identifying information. Suggested data type is SQIE. 2/
ENDTS	Keyword indicating end of time series input.
Carryover Input	Omit if instantaneous inflow time series at period start (INSTQI1) is used.
CARRYOVER	Keyword indicating start of carryover input.
[Q-INST]	Instantaneous inflow at start of run.
ENDCO	Keyword indicating end of carryover input.
ENDINFLW	Trailer to end the INFLOW/ENDINFLW section.

SAR/ENDSAR Section

The SAR/ENDSAR section inputs the information for a reservoir that has no backwater/tributary effect. This reservoir can be a single reservoir or the downstream reservoir of a two-reservoir/station system. To simulate a reservoir with backwater effect from tributary flow, use the LWERBKWR/ENDLWERB section. Only either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section can be used in each SSARRESV Operation.

Keyword	Description

This section is optional and can be used alone.

SAR	Header to start the SAR/ENDSAR section.

Parameter Input

PARMS	Keyword indicating start of parameter input.
ELVSSTOR	Elevation vs storage curve for reservoir; N values of elevation followed by N values of storage contents (maximum N = 50). Elevations and storage contents must be in ascending order and first elevation must be at the zero storage capacity level.
[QVSEL]	Enter N values of outflow, in ascending order, corresponding to elevations specified in ELVSSTOR. This elevation vs discharge relation is used to compute the outflow under free flow condition; if QVSEL is not entered, inflow will be passed.
[MAXEL]	Maximum elevation. Defaults to the highest elevation of the elevation/storage curve. If MAXEL is reached and inflow is less than the hydraulic capacity of all the dam facilities, this elevation will be maintained by passing inflow. If inflow exceeds the hydraulic capacity, free flow routing will be used.
[MINEL]	Minimum elevation allowed. If MINEL is reached, all reservoir release will be cut off completely. Defaults to the lowest elevation of the elevation/storage curve.
[MINQREL]	Minimum reservoir release for fishery or other water use for as long as the reservoir elevation is above MINEL. Defaults to zero release.
ENDP	Keyword indicating end of parameter input.

Time Series Input

TIME-SERIES	Keyword indicating start of time series input.
[INSTQO1]	Defines the simulated instantaneous outflow time series at period start. Must be used if the outflow from this SSARRESV Operation is used as inflow by another SSARR Operation. Suggested data type is SQIB. 2/
[INSTQO2]	Defines the simulated instantaneous outflow time series at period end. Must be used if the outflow from this SSARRESV Operation is used as inflow by

Keyword	Description
	another SSARR Operation. Suggested data type is SQIE. 2/
[MEANQOUT]	Defines the simulated mean outflow time series. Must be used if the outflow from this SSARRESV Operation is used as inflow by a non-SSARRESV Operation. 2/
[POOL]	Defines the simulated pool elevation time series. 2/
[STORAGE]	Defines the simulated storage contents time series. 2/
[OBSQO]	Defines the observed instantaneous outflow time series. Suggested data type is RQOT. 2/
[OBSQOM]	Defines the observed mean outflow time series. Suggested data type is RQME. 2/
[OBSH]	Defines the observed pool elevation time series. Suggested data type is PELV. 2/
[BACKQI1]	Defines the inflow time series at period start back-computed from the observed pool elevation and discharge. 2/
[BACKQI2]	Defines the inflow time series at period end back-computed from the observed pool elevation and discharge. 2/
[BACKQIM]	Defines the mean inflow time series back-computed from the observed pool elevation and discharge. 2/
ENDTS	Keyword indicating end of time series input.
Carryover Input	
CARRYOVER	Keyword indicating start of carryover input.
Q-INST	Instantaneous discharge at start of run.
[POOL]	Pool elevation at start of run. If omitted, STORAGE must be entered. 3/
[STORAGE]	Storage contents at start of run. If omitted POOL must be entered. 3/
ENDCO	Keyword signaling end of carryover input.
ENDSAR	Trailer to end the SAR/ENDSAR section.

Keyword	Description

UPERBKWR/ENDUPERB Section

The UPERBKWR/ENDUPERB section inputs the information for the upstream reservoir with backwater effect from a downstream reservoir. To simulate a reservoir with backwater effect solely from tributary flow, use the LWERBKWR/ENDLWERB section. To simulate a station with backwater effect from a downstream reservoir using three variable table lookup without backwater routing, use the 3-VAR/END3-VAR section. Only either the 3-VAR/END3-VAR section or the UPERBKWR/ENDUPERB section can be used in each SSARRESV Operation.

This section is optional. If used it must be used with either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section.

UPERBKWR — Header to start the UPERBKWR/ENDUPERB section.

Parameter Input

PARMS — Keyword indicating start of parameter input.

ELVSSTOR — Same as the SAR/ENDSAR section input.

BACKTABL — For a backwater reservoir the backwater table is entered via a series of three variable points (maximum 200 points, 600 total values). The three variables for each point are entered in the sequence of the backwater outflow (Z), the backwater elevation (Y) and the control parameter (X). Notice that in 3VARTABL the three variables are entered in a different sequence of Z, X and Y. The control parameter may be either discharge, if BACKWATR = FLOW; or elevation, if BACKWATR = ELEV. Enter the lowest outflow curve first (Z_1), followed by the second lowest outflow curve (Z_2) then third (Z_3), fourth (Z_4), etc. for all outflow curves. Each outflow curve is arranged in ascending sequence of backwater lake elevation. The first point in the backwater table would be the lowest point in the lowest outflow curve. Points following the first point would have this outflow value and continue on up that curve (Z_1,Y_1,X_1; Z_1,Y_2,X_2; ...). They would be followed by the first point of the lowest elevation of the second outflow curve (Z_2,Y_1,X_1; Z_2,Y_2,X_2; ...). There must be at least two points in the table for every outflow value. The backwater surface must have a positive slope in all directions. Figure 1 shows a typical backwater curve.

BACKWATR — Backwater control indicator:
[FLOW] = reservoir operation controlled by or backwater affected by the discharge of the downstream reservoir

Keyword	Description
	[FLOW] [TRIB] = reservoir operation controlled by or backwater affected by the discharge of the downstream tributary. [ELEV] = reservoir operation controlled by or backwater affected by the elevation of the downstream reservoir [ELEV] [TRIB] = reservoir operation controlled by or backwater affected by the stage of the downstream tributary
[MAXEL]	Same as the SAR/ENDSAR Parameter section input.
[MINEL]	Same as the SAR/ENDSAR Parameter section input.
[SHUTRESV]	Maximum tributary flow above which the reservoir will be shut down. Used only if reservoir is controlled by the flow condition of downstream tributary.
ENDP	Keyword indicating end of parameter input.

Time Series Input

TIME-SERIES	Keyword indicating start of time series input.
[INSTQO1]	Defines the simulated instantaneous outflow time series at the period start. Suggested data type is SQIB. 2/
[INSTQO2]	Defines the simulated instantaneous outflow time series at the period end. Suggested data type is SQIE. 2/
[MEANQOUT]	Same as the SAR/ENDSAR time series input.
[POOL]	Same as the SAR/ENDSAR time series input.
[STORAGE]	Same as the SAR/ENDSAR time series input.
[OBSQO]	Same as the SAR/ENDSAR time series input.
[OBSQOM]	Same as the SAR/ENDSAR time series input.
[OBSH]	Same as the SAR/ENDSAR time series input.
[TRIBQL1]	Defines the instantaneous inflow time series at period start for all the tributary and local flow occurred between the upstream and downstream reservoir. This keyword is followed by time series identifying information. Suggested data type is SQIB. 2/

Keyword	Description
[TRIBQL2]	Defines the instantaneous inflow time series at period end for all the tributary and local flow occurred between the upstream and downstream reservoir. This keyword is followed by time series identifying information. Suggested data type is SQIE. 2/
[BACKQI1]	Same as the SAR/ENDSAR time series input.
[BACKQI2]	Same as the SAR/ENDSAR time series input.
[BACKQIM]	Same as the SAR/ENDSAR time series input.
ENDTS	Keyword indicating end of time series input.

Carryover Input

CARRYOVER	Keyword indicating start of carryover input.
Q-INST	Instantaneous discharge at start of run.
[POOL]	Same as the SAR/ENDSAR carryover input.
[STORAGE]	Same as the SAR/ENDSAR carryover input.
[TRIBQL]	Instantaneous tributary and local inflow between the upstream and downstream reservoir. Must be used if TRIBQL2 is used and TRIBQL1 is not used.
ENDCO	Keyword signaling end of carryover input.
ENDUPERB	Trailer to end the UPERBKWR/ENDUPERB section.

LWERBKWR/ENDLWERB Section

The LWERBKWR/ENDLWERB section inputs the information for a reservoir controlled and/or backwater effected by the downstream tributary. This type of reservoir can be alone to simulate a single reservoir or as the downstream reservoir of a two-reservoir/station system. To simulate a reservoir with backwater effect from a downstream reservoir, use the UPERBKWR/ENDUPERB section. To simulate a reservoir without backwater/tributary effect, use the SAR/ENDSAR section. Only either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section can be used in each SSARRESV Operation.

LWERBKWR	Header to start the LWERBKWR/ENDLWERB section.

Parameter Input

PARMS	Keyword indicating start of parameter input.
ELVSSTOR	Same as the SAR/ENDSAR section input.

Keyword	Description
BACKTABL	The backwater table is entered via a series of three variable points (maximum 200 points, 600 total values). The three variables for each point are entered in the sequence of the backwater outflow (Z), the backwater elevation (Y) and the control parameter (X). The control parameter may be either the tributary flow, if BACKWATR = FLOW; or the tributary elevation/stage, if BACKWATR = ELEV. Enter the lowest outflow curve first (Z_1), followed by the second lowest outflow curve (Z_2) then third (Z_3), fourth (Z_4), etc. for all outflow curves. Each outflow curve is arranged in ascending sequence of backwater lake elevation. The first point in the backwater table would be the lowest point in the lowest outflow curve. Points following the first point would have this outflow value and continue on up that curve (Z_1,Y_1,X_1; Z_1,Y_2,X_2; ...). They would be followed by the first point of the lowest elevation of the second outflow curve (Z_2,Y_1,X_1; Z_2,Y_2,X_2; ...). There must be at least two points in the table for every outflow value. The backwater surface must have a positive slope in all directions. Figure 1 shows a typical backwater curve.
BACKWATR	Backwater/tributary control indicator: [FLOW] = controlled or backwater affected by the downstream tributary flow [ELEV] = controlled or backwater affected by the downstream tributary elevation/stage
[MAXEL]	Same as the SAR/ENDSAR Parameter section input.
[MINEL]	Same as the SAR/ENDSAR Parameter section input.
[MINQREL]	Minimum downstream flow requirement (= reservoir release + tributary flow) for fishery or other water use for as long as the reservoir elevation is above MINEL. Defaults to zero release.
[SHUTRESV]	Maximum tributary flow above which the reservoir will be shut down. Used only if reservoir is controlled by the flow condition of downstream tributary.
ENDP	Keyword indicating end of parameter input.

Time Series Input

TIME-SERIES	Keyword indicating start of time series input.
[INSTQO1]	Same as the SAR/ENDSAR time series input.

Keyword	Description
[INSTQO2]	Same as the SAR/ENDSAR time series input.
[MEANQOUT]	Same as the SAR/ENDSAR time series input.
[POOL]	Same as the SAR/ENDSAR time series input.
[STORAGE]	Same as the SAR/ENDSAR time series input.
[OBSQO]	Same as the SAR/ENDSAR time series input.
[OBSQOM]	Same as the SAR/ENDSAR time series input.
[OBSH]	Same as the SAR/ENDSAR time series input.
TRIBQL2	Defines the instantaneous tributary inflow time series at period end for use as control parameter in the backwater routing using the backwater table. This keyword is followed by time series identifying information. Suggested data type is SQIE. 2/
[BACKQI1]	Same as the SAR/ENDSAR time series input if used alone. Omit if used as the downstream reservoir.
[BACKQI2]	Same as the SAR/ENDSAR time series input if used alone. Omit if used as the downstream reservoir.
[BACKQIM]	Same as the SAR/ENDSAR time series input if used alone. Omit if used as the downstream reservoir.
ENDTS	Keyword indicating end of time series input.
Carryover Input	Same as the SAR/ENDSAR Carryover section input.
ENDLWERB	Trailer to end the LWERBKWR/ENDLWERB section.

3-VAR/END3-VAR Section

The 3-VAR/END3-VAR section inputs the three-variable relationship information for a station in the river with backwater effect from a downstream reservoir. In this case, the stage-discharge relationship for the station in the river is specified via a three-variable table when no backwater routing is required. To simulate a reservoir with backwater effect from a downstream reservoir using backwater table, use the UPERBKWR/ENDUPERB section. Only either the 3-VAR/END3-VAR section or the UPERBKWR/ENDUPERB section can be used in each SSARRESV Operation.

This section is optional. If used it must be used with either the SAR/ENDSAR section or the LWERBKWR/ENDLWERB section.

The three variable table lookup is available both in Operation SSARRESV and Operation LOOKUP3. However their functions are

Keyword	Description

different. In Operation SSARRESV the three variable table and the regulation options from the downstream reservoir are solved simultaneously. In the Operation LOOKUP3 the discharge or elevation time series at the downstream control point is determined from another Operation. Therefore if flow from the upstream station could impose significant change to the elevation of the downstream reservoir or if the downstream reservoir is to be regulated to achieve certain desired flow conditions at the upstream station Operation SSARRESV should be used. If the backwater effect at the backwater station is solely due to tributary flow or if the downstream reservoir will be operated without regarding the flow condition at the upstream station then Operation LOOKUP3 should be used.

3-VAR	Header to start the 3-VAR/END3-VAR section.

Parameter Input

PARMS	Keyword indicating start of parameter input.
3VARTABL	The three variable relationship table is entered via a series of three variable points (maximum 200 points, 600 total values). For the purpose of table lookup, the first independent variable (X) may be either flow or elevation of the downstream reservoir; the second independent variable (Z) is the flow at the upstream station; and the dependent variable (Y) is the elevation at the upstream station. The three variables for each point are entered in the sequence of the second independent variable (Z), the first independent variable (X) and the dependent variable (Y). Notice that in BACKTABL the three variables are entered in a different sequence of Z, Y and X. Enter the lowest outflow curve first (Z_1), followed by the second lowest outflow curve (Z_2) then third (Z_3), fourth (Z_4), etc. for all outflow curves. Each outflow curve is arranged in ascending sequence of backwater elevation (Y). The first point in the table would be the lowest point in the lowest outflow curve. Points following the first point would have this outflow value and continue on up that curve (Z_1,X_1,Y_1; Z_1,X_2,Y_2; ...). They would be followed by the first point of the lowest elevation of the second outflow curve (Z_2,X_1,Y_1; Z_2,X_2,Y_2; ...). There must be at least two points in the table for every outflow value. The backwater surface must have a positive slope in all directions. Figure 1 shows a typical backwater curve.
BACKWATR	First independent variable (X) backwater indicator: [FLOW] = backwater affected by the

Keyword	Description
[ELEV] =	discharge of downstream reservoir backwater affected by the elevation of downstream reservoir
ENDP	Keyword indicating end of parameter input.
Time Series Input	
TIME-SERIES	Keyword indicating start of time series input.
[INSTQO1]	Defines the simulated instantaneous outflow time series at the period start. Suggested data type is SQIB. 2/
[INSTQO2]	Defines the simulated instantaneous outflow time series at the period end. Suggested data type is SQIE. 2/
[POOL]	Defines the simulated station elevation time series. 2/
[MEANQOUT]	Same as SAR/ENDSAR time series input.
[TRIBQL1]	Defines the instantaneous inflow time series at period start for all the tributary and local flow occurred between the upstream station and the downstream reservoir. This keyword is followed by time series identifying information. Suggested data type is SQIB. 2/
[TRIBQL2]	Defines the instantaneous inflow time series at period end for all the tributary and local flow occurred between the upstream station and the downstream reservoir. This keyword is followed by time series identifying information. Suggested data type is SQIE. 2/
ENDTS	Keyword indicating end of time series input.
Carryover Input	Omit if instantaneous inflow time series at period start (INSTQI1) is used.
CARRYOVER	Keyword indicating start of carryover input.
[TRIBQL]	Instantaneous tributary and local inflow between the upstream station and the downstream reservoir. Must be used if TRIBQL2 is used and TRIBQL1 is not used.
ENDCO	Keyword signaling end of carryover input.
END3-VAR	Trailer to end the 3-VAR/END3-VAR section.

Notes:

Keyword Description

1/ Units for various dimensions are:

Dimension	Metric Unit	English Unit
Height	M	FT
Flow	CMS	CFS
Flow volume	CMSD	CFSD
Storage	TCUM	ACFT

2/ All time series keywords are followed by the following three pieces of identifying information:
   a. tsid - 8 character time series identifier
   b. datatype - data type code
   c. timint - data time interval of time series

3/ One of either POOL or STORAGE is required. If STORAGE is not input, the storage is computed using the POOL elevation and the elevation/storage curve. If POOL is not input, the pool elevation is computed using the STORAGE value and the elevation/storage curve.

Sample Input and Output: Sample input is shown in Figure 2. Sample output from the parameter print routine is shown in Figure 3. There is no execution routine output.

Other Sample Input:

Example 1 - A single reservoir without backwater effect:

```
SSARRESV
TITLE  'DWORSHAK RES. TEST'
UNITS  ENGLISH
INFLOW
TIME-SERIES
INSTQI2   INFLOWND  SQIE   6
ENDTS
CARRYOVER
Q-INST       9500.
ENDCO
ENDINFLW
SAR
PARMS
ELVSSTOR    1000.00                                                  &
            1200.00  1250.00  1300.00  1350.00 1400.00   1410.00  &
            1420.00  1430.00  1440.00  1445.00 1480.00   1485.00  &
            1490.00  1495.00  1500.00  1505.00 1510.00   1515.00  &
            1520.00  1525.00  1540.00  1545.00 1550.00   1555.00  &
            1560.00  1565.00  1570.00  1575.00 1580.00   1585.00  &
            1590.00  1595.00  1600.00  1605.00                     &
                 0.                                                &
            193000.  328000.  520000.  765000. 1098000.  1174000. &
           1252000. 1333000. 1410000. 1452000. 1782000.  1834000. &
           1887000. 1942000. 1998000. 2056000. 2115000.  2175000. &
           2238000. 2301000. 2502000. 2572000. 2644000.  2718000. &
           2794000. 2871000. 2950000. 3032000. 3115000.  3200000. &
           3287000. 3377000. 3468000. 3562000.
MAXEL    1600.00
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MINEL    1200.00
MINQREL  3500.0
ENDP
TIME-SERIES
INSTQO1     INSTQST   SQIB  6
INSTQO2     INSTQND   SQIE  6
POOL        DWRPOOL   SPEL  6
STORAGE     DWRSTOR   RSTE  6
OBSQO       DWROQO    RQOT  6
OBSQOM      DQROQM    RQME  6
OBSH        DWROH     PELV  6
BACKQI1     BACKQI1   SQIB  6
BACKQI2     BACKQI2   SQIE  6
BACKQIM     BACKQIM   SQME  6
ENDTS
CARRYOVER
Q-INST      10000.
POOL       1585.94
STORAGE    3216355.
ENDCO
ENDSAR
END
```

Example 2 - The Upper Arrow Lake is backwater affected by the elevation of the Lower Arrow Lake and the Lower Arrow Lake is backwater affected by tributary flow:

```
SSARRESV
TITLE  'ARROW LAKE -- JUNE'
UNITS  ENGLISH
INFLOW
TIME-SERIES
INSTQI2   UNAKB9  SQIE  12
ENDTS
CARRYOVER
Q-INST      62500.
ENDCO
ENDINFLW
UPERBKWR
PARMS
ELVSSTOR   1000.00  1361.00   1370.00    1380.00  1390.00  1400.00  &
           1410.00  1420.00   1430.00    1440.00  1450.00  1460.00  &
              0.   50579.   511736.   1045313.  618284.  235237.    &
        2898878. 3611201.  4373802.   5188020. 6055015. 6922010.
BACKTABL       .0   1360.00   1360.00        .0   1450.00  1450.00  &
           7000.    1375.80   1359.70    7000.    1376.00  1371.70  &
           7000.    1376.50   1373.95    7000.    1377.00  1375.10  &
           7000.    1378.00   1376.95    7000.    1381.00  1380.65  &
           7000.    1384.00   1383.90    7000.    1386.00  1385.93  &
           7000.    1394.00   1393.94    7000.    1402.00  1401.95  &
           7000.    1410.00   1409.96    7000.    1418.00  1417.97  &
           7000.    1430.00   1429.98    7000.    1450.00  1449.99  &
          ......  .......   .......     ......  .......  .......    &
          ......  .......   .......     ......  .......  .......    &
         300000.    1450.00   1449.50  400000.    1419.00  1400.70  &
         400000.    1422.00   1416.10  400000.    1426.50  1421.90  &
         400000.    1430.00   1427.10  400000.    1435.00  1433.10  &
         400000.    1450.00   1449.25  900000.    1423.00  1360.00  &
         900000.    1424.00   1411.00  900000.    1455.00  1450.00
BACKWATR  ELEV
MAXEL    1440.00
MINEL    1365.00
ENDP
TIME-SERIES
INSTQO1   UNAKBQO1   SQIB   12
INSTQO2   UNAKBQO2   SQIE   12
POOL      UNAKBPOL   SPEL   12
```

```
    STORAGE   UNAKBST    RSTE   12
    TRIBQL2   FRQB8Q2    SQIE   12
    OBSQO     UNAKBOQO   RQOT   12
    OBSQOM    UNAKBOQM   RQME   12
    OBSH      UNAKBOH    PELV   12
    BACKQI1   BACKQI1    SQIB   12
    BACKQI2   BACKQ12    SQIE   12
    BACKQIM   BACKQIM    SQME   12
    ENDTS
    CARRYOVER
    Q-INST    62500.
    POOL     1392.45
    TRIBQL   3370.
    ENDCO
    ENDUPERB
    LWERBKWR
    PARMS
    ELVSSTOR  1000.00   1360.00   1370.00   1380.00   1390.00   1400.00  &
              1410.00   1420.00   1430.00   1440.00   1450.00            &
                 0.     34732.    375615.   737426.  1114722.  1505312.   &
           1907862.  2321437.  2745330.  3178978.  3621923.

    BACKTABL      .0    1367.00      0.0        .0    1367.00  20000.    &
              5000.     1369.20      0.0    5000.     1369.20  20000.    &
              5000.     1369.80  40000.     5000.     1372.00  60000.    &
              5000.     1374.50  80000.     5000.     1377.00 100000.    &
              5000.     1379.30 120000.     5000.     1381.50 140000.    &
              5000.     1383.50 160000.     5000.     1385.50 180000.    &
              5000.     1387.40 200000.     5000.     1396.40 300000.    &
              5000.     1404.50 400000.    10000.     1371.50      0.0   &
             ......   .......   .......    ......   .......   .......    &
             ......   .......   .......    ......   .......   .......    &
            300000.    1437.70  400000.   400000.     1443.60      0.0   &
            400000.    1444.70  100000.   400000.     1445.50 200000.    &
            400000.    1447.10  300000.   400000.     1448.40 400000.
    MAXEL   1443.85
    MINEL   1361.00
    ENDP
    TIME-SERIES
    INSTQO1   UFQRBQO1   SQIB   12
    INSTQO2   UFQRBQO2   SQIE   12
    POOL      UFQRBPOL   SPEL   12
    STORAGE   UFQRBST    RSTE   12
    TRIBQL2   UCOSL5Q2   SQIE   12
    OBSQO     UFQRBOQO   RQOT   12
    OBSQOM    UFQRBOQM   RQME   12
    OBSH      UFQRBOH    PELV   12
    BACKQI1   BACKQL1    SQIB   12
    BACKQI2   BACKQL2    SQIE   12
    BACKQIM   BACKQLM    SQME   12
    ENDTS
    CARRYOVER
    Q-INST      62500.
    POOL       1389.40
    ENDCO
    ENDLWERB
    END
```

Example 3 - A downstream reservoir is used to regulate the flow condition of an upstream backwater station using three variable table without backwater routing:

```
    SSARRESV
    TITLE  'Coeur dAlene Lake'
    UNITS  ENGLISH
    INFLOW
    TIME-SERIES
```

```
INSTQI2   INFLOWND  SQIE   6
ENDTS
CARRYOVER
Q-INST     5500.
ENDCO
ENDINFLW
3-VAR
PARMS
3VARTABL       0.   2120.00   2120.00        0.   2150.00   2150.00 &
            1000.   2122.00   2123.00     1000.   2126.00   2126.50 &
            1000.   2149.90   2150.00     5000.   2122.00   2126.25 &
            5000.   2124.00   2126.75     5000.   2126.00   2127.75 &
            5000.   2130.00   2130.75     5000.   2149.80   2150.00 &
           10000.   2122.00   2128.75    10000.   2126.00   2130.25 &
           10000.   2130.00   2132.50    10000.   2134.00   2135.25 &
           10000.   2138.00   2138.75    10000.   2149.25   2150.00 &
           15000.   2122.00   2131.75    15000.   2126.00   2133.25 &
           15000.   2130.00   2135.25    15000.   2134.00   2137.50 &
           15000.   2149.00   2150.00    20000.   2122.00   2134.00 &
           20000.   2128.00   2136.50    20000.   2132.00   2138.00 &
           20000.   2148.00   2150.00    30000.   2122.00   2137.00 &
           30000.   2126.00   2138.50    30000.   2147.00   2150.00 &
           40000.   2122.00   2140.00    40000.   2126.00   2150.00 &
          100000.   2122.00   2147.00   100000.   2145.00   2150.00
BACKWATR  ELEV
ENDP
TIME-SERIES
POOL      SJMIPOOL  SPEL   6
TRIBQL2   SJMILOCL  SQIN   6
ENDTS
CARRYOVER
TRIBQL     5500.
ENDCO
END3-VAR
SAR
PARMS
ELVSSTOR   2120.00  2124.00   2125.00   2126.50   2127.00   2128.00  &
           2129.00  2130.00   2132.00   2134.00   2135.00   2140.00  &
              0.  107900.   135200.   177900.   195300.   238500.    &
         288100.  339700.   446000.   554400.   609300.   890200.
QVSEL        10.    5700.     7900.    11400.    12700.    15300.    &
          18100.   21100.    27500.    34600.    38200.    57500.
MAXEL      2133.00
MINEL      2120.00
ENDP
TIME-SERIES
POOL      COELPOOL  SPEL   6
ENDTS
CARRYOVER
Q-INST     5500.
POOL       2126.07
ENDCO
ENDSAR
END
```

Carryover Transfer Rules: No carryover transfer takes place if one or more of the following items are changed during segment redefinition:

1. Number of reservoirs: changes from a single reservoir to a two-reservoir system or vice versa.

2. Reservoir/station type: Changes among UPERBKWR/ENDUPERB, LWERBKWR/ENDLWERB, 3-VAR/END3-VAR and SAR/ENDSAR.

3. Input units: changes from English to Metric or vice versa.

Punched Card Limitations: All data read in free format are punched by subroutines that produce cards which can be read in free format. All elevations are punched in F10.2 format. All flow and storage are punched in F10.0 format.

Figure 1. Example of discharge-elevation relationships handled by the SSARR backwater mode

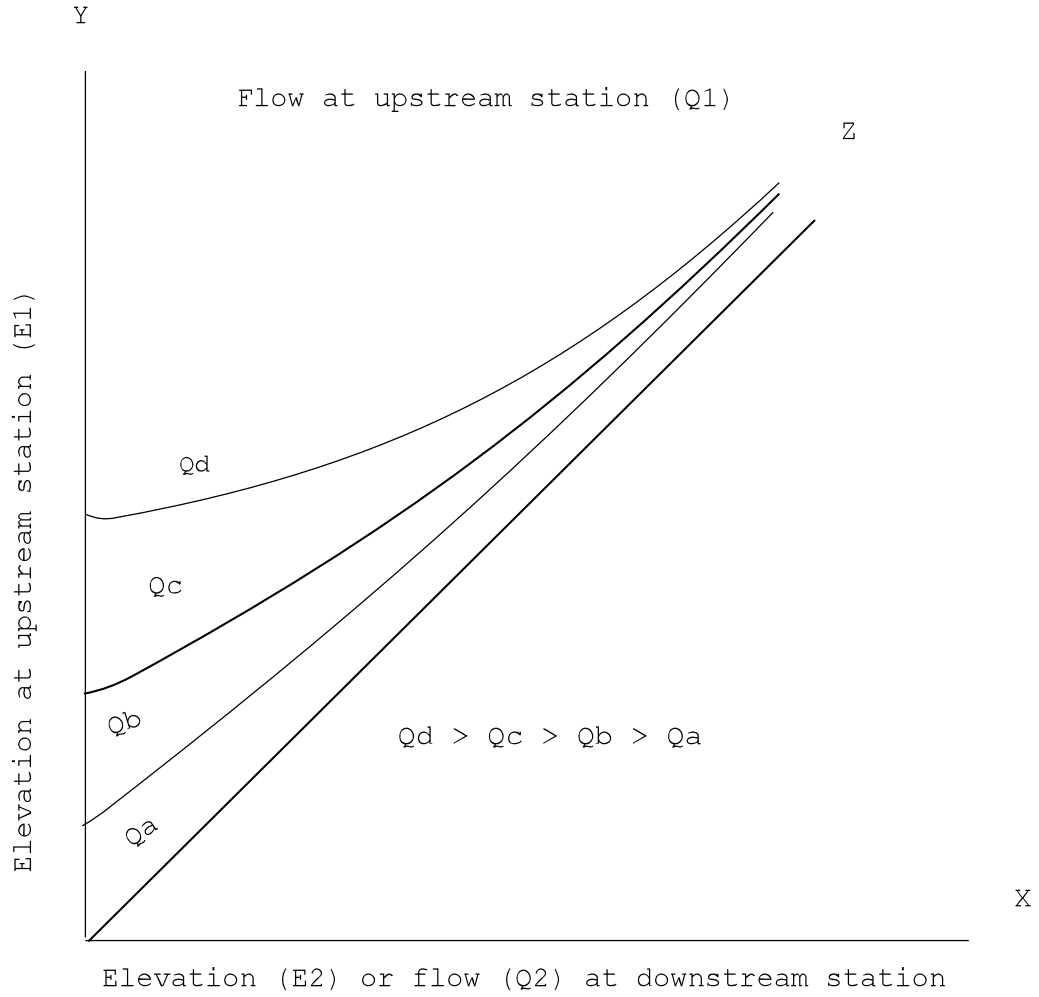

Figure 2. Sample card input for Operation SSARRESV

```
SSARRESV    FLATHEAD  INPUT CO
$ SINGLE RESERVOIR (FLATHEAD RES.) WITHOUT OBSERVED DATA
TITLE  'FLATHEAD RES. TEST'
UNITS  ENGLISH
INFLOW
TIME-SERIES
INSTQI1   SELWEQI1    SQIB   6
INSTQI2   SELWEQI2    SQIE   6
ENDTS
CARRYOVER
Q-INST      100.
ENDCO
ENDINFLW
SAR
PARMS
ELVSSTOR    1000.00   1981.90 &
            1982.00   1983.00   1984.00   1985.00   1986.00   1987.00  &
            1988.00   1989.00   1990.00   1995.00   2000.00   2005.00  &
            2010.00   2015.00   2020.00                                 &
                 0.   45489.0  &
            45490.0   57200.0   69070.0   81010.0   93030.0  105100.0  &
           117200.0  129400.0  141700.0  204500.0  269900.0  340000.0  &
           418000.0  495000.0  550000.0
QVSEL          00.0      100. &
              1000.     4200.     8000.    12100.    16200.    21000.  &
             24000.    29000.    34500.    68000.   102000.   139500.  &
            179000.   224000.   280000.
MAXEL    2010.00
MINEL    1800.00
MINQREL  100.
ENDP
TIME-SERIES
INSTQO1   FLHQO1    SQIB   6
INSTQO2   FLHQO2    SQIE   6
POOL      FLHPOOL   SPEL   6
STORAGE   FLHSTOR   RSTE   6
OBSH      SELWE     STG    6
ENDTS
CARRYOVER
Q-INST       100.
POOL        1981.9
ENDCO
ENDSAR
END
```

Figure 3. Sample output from Operation SSARRESV print parameter routine

```
********************

SSARRESV OPERATION     NAME=FLATHEAD     PREVIOUS NAME=INPUT CO

********************

         RESERVOIR OPERATION FOR FLATHEAD RES. TEST

         COMPUTATIONAL TIME INTERVAL FOR THE OPERATION =  6 HOURS.


                                ***** INFLOW INFORMATION *****

          INFLOW TIME SERIES:             ID          TYPE          TIME(HR)

                    INSTQI1           SELWEQI1        SQIB             6
                    INSTQI2           SELWEQI2        SQIE             6


                                **** SAR INFORMATION *****

         STORAGE VS. ELEVATION CURVE:

                    ELEV(FT  )    1000.00    1981.90    1982.00    1983.00    1984.00    1985.00    1986.00    1987.00
                    STOR(ACFT)          0.     45489.     45490.     57200.     69070.     81010.     93030.    105100.
                   DISCH(CFS )        0.0      100.0     1000.0     4200.0     8000.0    12100.0    16200.0    21000.0

                    ELEV(FT  )    1988.00    1989.00    1990.00    1995.00    2000.00    2005.00    2010.00    2015.00
                    STOR(ACFT)    117200.    129400.    141700.    204500.    269900.    340000.    418000.    495000.
                   DISCH(CFS )    24000.0    29000.0    34500.0    68000.0   102000.0   139500.0   179000.0   224000.0

                    ELEV(FT  )    2020.00
                    STOR(ACFT)    550000.
                   DISCH(CFS )   280000.0

         MAXIMUM ELEVATION (FT  )=        2010.00

         MINIMUM ELEVATION (FT  )=        1800.00

         MINIMUM RESERVOIR RELEASE (CFS )=           100.

                 TIME SERIES:             ID          TYPE          TIME(HR)

                    INSTQO1           FLHQO1          SQIB             6
                    INSTQO2           FLHQO2          SQIE             6
                    POOL              FLHPOOL         SPEL             6
                    STORAGE           FLHSTOR         RSTE             6
                    OBSH              SELWE           STG              6

                                  ***** SAR CARRYOVER *****
               INSTANTANEOUS DISCHARGE =              100.0 CFS
               POOL ELEVATION =                      1981.90 FT
               STORAGE CONTENTS =                     45489. ACFT
```