Stream and Lake Gaging (Monitoring) Station File (GAGE)

This document combines the input instructions for stream and lake gaging stations, which were previously described by Prudic and others (2004, p. 52 and 53), Niswonger and Prudic (2005, p. 30 and 31), Merritt and Konikow (2000, p. 57), and online at http://water.usgs.gov/nrp/gwsoftware/modflow2000/MFDOC/guide.html. A new option (option 4) was added in August 2009 to the Lake Package gage output. The option allows for the printing of volumetric flow rates in units of length cubed per time.

A particular stream reach or lake can be designated for a gaging or monitoring station. At each designated stream reach or lake, the time, stream or lake stage, streamflow out of the reach or lake volume, and (if solute transport is being simulated) the concentration of a solute after each time step (and each transport time increment) will be written to a separate output file to facilitate model output evaluation and graphical post processing of the calculated data. Several options are available to also print additional information about a stream reach or lake.

The input file for specifying gaging station locations is read if the file type (Ftype) "GAGE" is included in the MODFLOW name file. The output file will contain two header lines that provide relevant information (the text will be contained within quotes).

FOR EACH SIMULATION, IF GAGE PACKAGE IS USED:

1. Data: NUMGAGE

NUMGAGE   Total number of stream and lake gaging stations

FOR EACH GAGING STATION:

Data sets 2a and 2b are used to specify information for stream or lake gaging stations, respectively. The total number of lines (records) specified for data sets 2a and 2b must equal NUMGAGE. Records in data sets 2a and 2b can be entered in any arbitrary order, and it is permissible to interleaf records for stream gaging stations with those for lake gaging stations if NUMGAGE > 1.

FOR EACH STREAM GAGING STATION:

2a. Data: GAGESEG GAGERCH UNIT OUTTYPE

GAGESEG	An integer value that is the stream segment number where gage is located.
GAGERCH	An integer value that is the stream reach number where gage is located.
UNIT	An integer value that is the unit number of output file for this gage. A unique unit number must be specified for each gage and the unit numbers

must be matched to DATA file types and file names in the MODFLOW name file (see Harbaugh and others, 2000, p. 42-44).

OUTTYPE   An integer value that is a flag for type of expanded listing desired in output file:

0   Use standard default listing of time, stream stage, outflow, and solute concentration.

1   Default values plus depth, width, flow at midpoint, precipitation, evapotranspiration, and runoff. Computed runoff from the UZF Package is added when the UZF Package is active.

2   Default values plus streambed conductance for the reach, head difference across streambed, and hydraulic gradient across streambed.

3   Default values plus solute load in stream (if GWT is active).

4   All of the above.

5   Use for diversions to provide a listing of time, stage, flow diverted, maximum assigned diversion rate, flow at end of upstream segment prior to diversion, solute concentration, and solute load.

6   Use for unsaturated flow routing to provide a listing of time, stream stage, ground-water head beneath stream, streambed seepage, change in unsaturated zone storage, and recharge to ground water.

7   Use for unsaturated flow routing to provide a listing of time and the unsaturated water content profile beneath the stream. Two profiles are printed. The first is the volume averaged water content of all unsaturated zone cells (multiple unsaturated zone cells are allowed) beneath a stream reach. The second profile is the volume averaged water content beneath the low flow channel only. The two profiles are identical when only one unsaturated zone cell is assigned beneath a stream reach.

8   Use for unsaturated flow to provide a listing of time and the following budget components summed over all stream reaches: stream loss; stream gain; infiltration into the unsaturated zone; change of storage in the unsaturated zone; recharge; and storage in the unsaturated zone.

Notes:

Solute load (OUTTYPE options 3, 4, or 5 for a stream gaging station) represents the total mass of solute passing the stream gaging station during a model time unit. Units for solute load depend on the units used for solute concentration, time, and length in the model.

Although a stream segment and reach number are required inputs for a stream gaging station, any active segment and reach number can be specified when OUTTYPE is 8 (recommend using segment 1, reach 1). No information specific to the specified reach is printed when this OUTTYPE option is selected.

FOR EACH LAKE GAGING STATION:

2b. Data: LAKE UNIT {OUTTYPE}

LAKE   A negative integer value that is the lake number where the gage is located.

UNIT   An integer value that is the unit number of output file for this gage. A unique unit number must be specified for each gage and the unit numbers must be matched to DATA file types and file names in the MODFLOW name file (see Harbaugh and others, 2000, p. 42-44). A negative value allows the reading of OUTTYPE.

OUTTYPE   An integer value that is a flag for type of expanded listing desired in output file. It is read only when UNIT is a negative value:

    0   Standard default listing of time, lake stage, lake volume, and solute concentration.

    1   Default values plus all inflows to and outflows from lake (as volumes during time increment), total lake conductance, and time-step budget error (percent). Computed runoff from UZF and lake infiltration to UZF is added whenever the UZF Package is active in MODFLOW-2005. (The UZF Package is not available in MODFLOW-2000.)

    2   Default values plus changes in lake stage, lake volume, and solute concentrations, and cumulative lake budget error (percent).

    3   All of the above except time-step budget error.

    4   Time, lake stage, lake volume, solute concentration, and rate of change of lake volume, as well as volumetric rates for all inflows to and outflows from lakes (L^3/T), total lake conductance (L^2/T), and time-step budget error. Volumetric rates of computed runoff from UZF and lake infiltration to UZF is added whenever the UZF Package is active in MODFLOW-2005.

Notes:
        Total lake conductance (OUTTYPE options 1 and 3 for a lake gaging station) is the sum of the conductance values of each seepage interface for each lake. Changes in lake stage, volume, and solute concentrations (OUTTYPE options 2 or 3) are listed as incremental changes from previous time increment and as cumulative change since start of simulation. Volumetric rates for option 4 are expressed in units of volume per time during a time step increment. Versions of the GAGE Package since 2006 for

MODFLOW-2000 and MODFLOW-2005 had listed groundwater inflows and outflows as volumetric flow rates and listed the other values as volumes per time step for options 1 and 3.

REFERENCES

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model—User guide to modularization concepts and the ground-water flow process: U.S. Geological Survey Open-File Report 00-92, 121 p.

Niswonger, R.G., and Prudic, D.E., 2005, Documentation of the Streamflow-Routing (SFR2) Package to include unsaturated flow beneath streams—a modification to SFR1: U.S. Geological Survey Techniques and Methods Book 6, Chap. A13, 57 p.

Merritt, M.L., and Konikow, L.F., 2000, Documentation of a computer program to simulate lake-aquifer interaction using the MODFLOW ground-water flow model and the MOC3D solute-transport model: U.S. Geological Survey Water-Resources Investigations Report 00-4167, 146 p.

Prudic, D.E., Konikow, L.F., and Banta, E.R., 2004, A new Streamflow-Routing (SFR1) Package to simulate stream-aquifer interaction with MODFLOW-2000: U.S. Geological Survey Open-File Report 2004-1042, 95 p.