

# EPANET-BAM

## Bulk Advective Mixing

**Version:** 1.0

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**Description:** EPANET-BAM 1.0 is an augmented version of EPANET 2.00.10, open-source software distributed by the U.S. Environmental Protection Agency that models flow and contaminant transport through water distribution pipe networks.

EPANET-BAM uses a new Bulk Advective Mixing (BAM) model to predict concentrations of an aqueous solute at the outlets of cross junctions in a water quality simulation.

**Interface Changes:**

- 1) The 'Mixing Parameter' property was added to the Junction property sheet in the graphical user interface.
- 2) The GUI and solver require that an additional 'MixParam' column be added to input files under [JUNCTIONS], between the 'Demand' and 'Pattern' columns. The value under 'MixParam' is the bulk mixing scaling parameter prescribed for each junction. Example:

```
[JUNCTIONS]
;ID      Elev  Demand      MixParam  Pattern
J1       0     10         0.5       P1      ;
J2       0     0          0.5       P2      ;
```

*Note:* EPANET 2 .NET files are incompatible with EPANET-BAM.

To open an EPANET 2 .NET file in EPANET-BAM:

- a) Export the .NET file from EPANET 2 as a .INP input text file (File menu → Export → Network...).
- b) Add the 'MixParam' column to the exported .INP file as described above. A mixing parameter of 0.5 is a good default choice.

The modified .INP file can then be opened in the EPANET-BAM graphical user interface.

- Installation:**
- 1) Extract this archive to any folder.
  - 2) *To execute graphical user interface:* execute epanetBAMw.exe.
  - 3) *To run a simulation from the command line:* execute epanetBAM.exe

with the following syntax:

```
epanetBAM.exe <input file name> <output file name>
```

*Example:* epanetBAM.exe sampleinp.inp sampleout.txt

**Contents:** This package contains:

- 1) epanetBAMw.exe and epanetBAM.dll - the EPANET-BAM executable graphical user interface for Windows 95/98/NT/XP and accompanying DLL version of the solver.
- 2) epanetBAM.exe - command line executable version of the solver.
- 3) The following C-code files. The shaded files were modified for EPANET-BAM. A description of all code modifications is included at the end of this document.

EPANET.C	- main module providing supervisory control
INPUT1.C	- controls processing of input data
INPUT2.C	- reads data from input file
INPUT3.C	- parses individual lines of input data
INPFILE.C	- saves modified input data to a text file
RULES.C	- implements rule-based control of piping system
HYDRAUL.C	- computes extended period hydraulic behavior
QUALITY.C	- tracks transport & fate of water quality
OUTPUT.C	- handles transfer of data to and from binary files
REPORT.C	- handles reporting of results to text file
SMATRIX.C	- sparse matrix linear equation solver routines
HASH.C	- hash table routines
MEMPOOL.C	- memory pool management routines

Also included are the following header files:

TOOLKIT.H	- function prototypes of exported DLL functions
FUNCS.H	- prototypes of all other functions
TYPES.H	- declaration of global constants and data structures
VARS.H	- declaration of global variables
MEMPOOL.H	- header file for memory pool routines
HASH.H	- header file for hash table routines
ENUMSTXT.H	- string constants for enumerated types
TEXT.H	- declaration of all other string constants

## Code Modifications:

### epanet.c

#### [Modified Functions]

geterrmsg(): return error message for new error ERR252, which occurs when not all nodes have coordinates defined.

### input2.c

#### [Modified Functions]

readdata(): ensure all nodes have coordinates defined.

newline(): when COORDINATES or VERTICES section is encountered, call coordsdata() or verticesdata() (input3.c) instead of ignoring.

### input3.c

#### [Modified Functions]

juncdata(): read value from additional BulkMix column under [JUNCTIONS].

#### [New Functions]

coordsdata(): processes node coordinates under [COORDINATES].

verticesdata(): processes vertex coordinates under [VERTICES].

### quality.c

#### [Modified Functions]

openqual(): allocate memory for cross junctions array.

closequal(): free memory for cross junctions array.

transport(): call findcrossjuncs() to collect cross junction data before calling accumulate().

accumulate(): after upstream concentrations are transported downstream, store in cross junction array the concentrations of link segments that are inlets of valid cross junctions.

release(): call bmfastoutconc() and bmslowoutconc() to set concentrations of outlet segments of valid cross junctions using the BAM model.

#### [New Functions]

findcrossjuncs(): fills cross junctions array by determining which junctions are cross junctions valid for BAM model.

bmfastoutconc(): uses BAM model to calculate concentration at the outlet of a valid cross junction corresponding to the larger inlet + outlet flow rate sum.

bmslowoutconc(): uses BAM model to calculate concentration at the outlet of a valid cross junction corresponding to the smaller inlet + outlet flow rate sum.

angle(): calculates angle of the position vector of a point counter-clockwise above the horizontal axis, with specified origin coordinates. Used by nonadjlink().

getlinkcoords(): determines the coordinates of the node or vertex responsible for the angular orientation of a specified link about a specified node.

nonadjlink(): for a specified link connected to a cross junction, determines which of the three other links connected to the cross junction is not adjacent to the specified link.

## funcs.h

Added prototypes for new functions:

input3.c: coordsdata(), verticesdata().  
quality.c: findcrossjuncs(), bmfastoutconc(), bmslowoutconc(), angle(), getlinkcoords(),  
nonadjlink().

## types.h

- New Coordinate Object (Coord) stores a pair of coordinates.
- Modified Node Object (Snode) to store BAM scaling parameter and coordinates.
- New Cross Junction Object stores flow rates for BAM calculations.
- Modified Link Object (Slink) to store coordinates of the two vertices closest to the connected nodes when such vertices exist.

## text.h

- Added error message for new error ERR252, which occurs when not all nodes have coordinates defined.

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