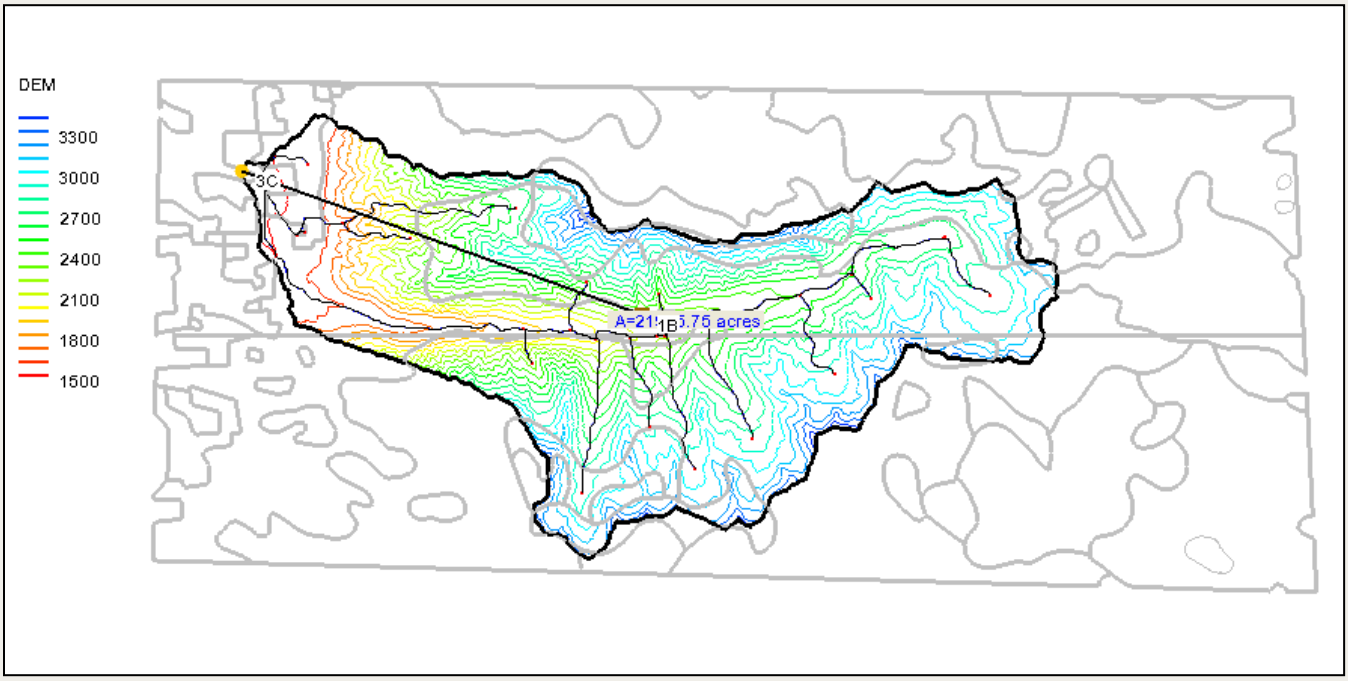
WMS 11.2 Tutorial

HSPF Interface

Set up a basic HSPF model



Objectives

Read a delineated watershed and setup and run an HSPF model for the watershed.

Prerequisite Tutorials

- DEM Delineation
- Time of Concentration and Composite CN with TR-55

Required Components

- WMS Core
- HSPF Model

Time

- 20–40 minutes

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1 Introduction

This tutorial demonstrates how WMS can be used to process digital elevation and land use data to develop an HSPF input (.uci) file. The graphical user interface used to define input parameters is demonstrated for a basic hydrology simulation that includes doing the following:

- Delineating watershed segment boundaries from a digital terrain model and USGS land use file
- Defining segment parameters for a hydrologic analysis
- Developing reach segment parameters
- Defining precipitation time series data from standard WDM database files
- Entering mass links to define transformations from basin to reach

2 Opening the Watershed and Initializing the HSPF Model

The first step is to open a watershed that has been delineated from a USGS DEM in GridFloat format downloaded from USGS' seamless DEM web site at http://seamless.usgs.gov.

1. Open WMS. If WMS is already open select *File* **| New** then click **No** if asked to save changes.
2. Select *File* **| Open** to access the *Open* dialog.
3. Locate the "hspf" folder in the files for this tutorial.
4. Select the file named "lc.wms" and click **Open** to exit the *Open* dialog.

The watershed will appear on the screen with the area displayed in the center of the basin. This indicates that the basin data has been computed and is ready to set up the HSPF model. To initialize the model:

5. Make sure that the projections are correct by right-clicking "DEM" under "Terrain Data" in the Project Explorer, then selecting *Projection* **| Projection**, which will open the *Projection* dialog.
6. In the *Horizontal* section, make sure that *No projection* is selected and that *Units* is turned on.
7. In both the *Horizontal* and *Vertical* sections, set the *Units* to "Meters".
8. Click **OK** to exit the *Projection* dialog.
9. Switch to the **Hydrologic Modeling Module**.

10. Select *HSPF* **| New Simulation**.
11. Select *HSPF* **| Global Options** to open the *HSPF Global Options* dialog.
12. Enter “Little Cottonwood Canyon Model” in the *Title* field.
13. Set the *Start time* to “1/1/1996” and “12:00:00 AM”.
14. Set the *End time* to “7/31/1999” and “12:00:00 AM”.
15. Under *Time step*, enter “24” in the *hours* field.
16. Ensure that the *Units flag* is set to “English”.
17. Change the *Run flag* to “1”; this indicates that HSPF will interpret the data and run the simulation (0 indicates that HSPF will only interpret – error check – the data).
18. Set the *OUTLEV* to “10” (under *Output Levels*); this indicates maximum output to the Error and Warning files. Leave the *SPOUT* flag at “0” (this is only for Special Actions).
19. In the *Files* section, enter “littleco” in the *Prefix* field.
20. Click the **Update Filenames** button. This names all the HSPF input/output files associated with this model to the same name.

Note that the file “littleco.wdm”, to be used for time series input and output, must be created and named appropriately outside of WMS (this has been done already, in this case). Create a “.wdm” (watershed data management) file using the WDMUtil program installed when installing HSPF from the WMS installation.

21. Select **OK** to close the *HSPF Global Options* dialog.

Everything is now ready to proceed with segmenting the watershed and entering parameters for the segments.

3 Importing Land Use and Segmenting the Watershed

To divide this watershed into hydrologically similar segments, overlay a land-use data layer. Import this data from an ArcView Shapefile:

1. Select *File* **| Open** to access the *Open* dialog.
2. Select the file named “littleclanduse.shp” and click **Open** to exit the *Open* dialog.
3. Right-click on the “ Coverages” folder in the Project Explorer and select **New Coverage** to open the *Properties* dialog.
4. Change the *Coverage type* to “Land Use”.
5. Click **OK** to exit the *Properties* dialog.
6. Switch to the **GIS Module** .
7. Select *Mapping* **| Shapes → Feature Objects** to open the *GIS to Feature Objects Wizard* dialog.
8. Select **Next** to proceed to *Step 2 of 3* in the dialog.
9. Ensure that *LUCODE* is mapped to “Land Use”.
10. Select **Next** to proceed to *Step 3 of* 3 in the dialog.
11. Click **Finish** to exit the *GIS to Feature Objects Wizard* dialog.

12. Turn off the display of "littleclanduse.shp" by deselecting it in the Project Explorer.

Notice the land use data polygons overlaid on the watershed. Everything is now ready to compute HSPF segments based on the land use polygons that fall inside the watershed.

13. Switch to the **Hydrologic Modeling Module**.
14. Select *Calculators* **| Compute GIS Attributes** to open the *Compute GIS Attributes* dialog.
15. Choose "HSPF segments" from the *Computation* drop-down list.
16. In the central section of the dialog, ensure that "coverage" appears next to *Use a* and that "Land Use" is the selected *Land use coverage name*.
17. A text file that correlates the land use ID to land use attributes (name, perviousness, etc.) must be read in. Click the **Import** button to browse for this file and to open the *Open* dialog.
18. Select **OK** to overwrite existing land use table.
19. Select the file named "littleclanduse.txt" and click **Open** to exit the *Open* dialog.
20. Choose **OK** to compute the HSPF segments and to exit the *Compute GIS Attributes* dialog.
21. Click **OK** if warned that "Continuing will delete all HSPF segment data".
22. Turn off the "Land Use" coverage in the Project Explorer.
23. Select the "Drainage" coverage in the Project Explorer to make it the active coverage.

4 Aggregating Segments

Note from the display that there are several land segments in the watershed. Some are quite large, such as the Evergreen Forest Land segment, while others are rather insignificant, like Bare Exposed Rock. To make this simulation simpler, it is possible to aggregate some of these segments.

1. Switch to the **Hydrologic Modeling Module**.
2. Select *Model Selection* | **HSPF**.
3. Double-click on the basin icon (or select it and then select *HSPF* **| Edit Parameters**) to open the *HSPF Segments* dialog.

Note the list of segments in the *Land segments* section. There are 8 separate segments (or land use classifications) in this watershed.

To reduce the number of segments computed by WMS, first delete one segment, and then add the area of the deleted segment, manually, to another similar segment.

4. Choose the segment entitled "OTHER URBAN OR BUILT-UP" from the *Land segments* window.

Note that the area is 57.89 acres – insignificant in this watershed. This area will be deleted and added to the "SHRUB & BRUSH RANGELAND" segment to aggregate these segments.

5. Select the **Delete** button.

6. Click **Yes** for the message that asks if the segment is to be removed from further use.
7. Repeat steps 3–5 for the segment entitled “BARE GROUND”. Note the area of 378.73 for the segment.
8. Enter a new *Area* of “7999.06” to the SHRUB & BRUSH RANGELAND segment.
9. Repeat steps 3–5 for the “MIXED FOREST LAND” segment.
10. Enter “12162.63” for the *Area* of the “EVERGREEN FOREST LAND” segment.
11. Repeat steps 3–5 for the “BARE EXPOSED ROCK” segment.
12. Enter “1189.25” for the *Area* of the “MIXED TUNDRA” segment.

There are now five remaining land segments. These are the segments for which input parameters must be entered in order to simulate with HSPF.

5 Defining Land Segment Parameters

It is now time to begin defining parameters for the land segments of the HSPF model. This model will be set up for purely hydrologic analysis, so parameters for only the SNOW and WATER modules of HSPF will be activated and have data entered. Further, to decrease the time needed to complete the exercise, fully set up one segment then copy those parameters to the other 3 in the model. Do the following to complete these tasks:

1. Choose the “EVERGREEN FOREST LAND” segment from the *HSPF Segments* dialog.
2. Click the **Define…** button for this segment to bring up the *HSPF* dialog.
3. Turn on *Snow (SNOW)* and *Water (PWAT)*.

The Snow and Water modules have just been activated for this land segment (EVERGREEN FOREST LAND). Now enter the parameters for each active module to allow HSPF to simulate the segment correctly.

4. Click on the *Snow (SNOW)* text to highlight it.
5. Switch between the appropriate tabs to enter the following values in the appropriate fields (leave other fields as the default values; these values are either generally recommended values or HSPF defaults):

SNOW-INIT1	*SNOW-INIT2*	*SNOW-PARM1*	*SNOW-PARM2*
Pack-snow = “4.0” in *Pack-ice* = “2.0” in *Pack-watr* = “2.0” in	*SKYCLR* = “1.0”	*LAT* = “40.5”° *MELEV* = “8410.8”ft *SHADE* = “0.40”	*TSNOW* = “35.0”° F *MWATER* = “0.2”

NOTE: These values were extracted from meteorological datasets.

6. Now that all values are entered for this segment, click the **Apply Parameters to Segments** button, which will activate the *Select Segments* dialog. This allows assigning these same parameters to other segments in the model.
7. Choose “SHRUB & BRUSH RANGELAND” in the *Available Segments* window, then move it to the *Selected Segments* window by clicking the → button.
8. Repeat step 7 for “RESIDENTIAL” and “MIXED TUNDRA”.

9. Click **OK** to exit the *Select Segments* dialog. The selected segments will be assigned the same parameters input here.

The final step in entering parameters for a module in HSPF is to define time series input (external sources) and time series output (external targets).

10. Click on the **External Sources** button with the *Snow (SNOW)* module highlighted. The *Assign External Sources* dialog will appear with a list of the datasets available in the WDM file specified for this model ("littleco.wdm").
11. If the dialog is empty (there may be a warning message that the file is not there), open the "littleco.wdm" file and click **OK**.
12. Assign the following datasets as sources by setting the fields to the appropriate values, then clicking the **Assign** button for each line. If a mistake is made, choose the incorrect line in the lower window and click **Delete**.

Member Name	*Units*	*Missing Data*	*Transformation Function*	*Quality Flag*	*Multiplication Factor*
PREC	ENGL	UNDF	SAME	0	0.25
PREC	ENGL	UNDF	SAME	0	0.75
DTMPG	ENGL	UNDF	AVER	0	1.0
WINMOV	ENGL	UNDF	AVER	0	1.0
SOLRAD	ENGL	UNDF	SAME	0	1.0
AIRTMP	ENGL	UNDF	AVER	0	0.4
AIRTMP	ENGL	UNDF	AVER	0	0.6

13. Since other external sources will be added to this segment with the PWAT module input, the external sources will not be assigned to other segments yet. Click **Done** to exit the *Assign External Sources* dialog and return to the *HSPF* dialog.
14. Click on *Water (PWAT)* to highlight it.
15. Switch between the appropriate tabs to enter the following values in the appropriate fields (leave other fields as the default values):

PWAT-PARM1	*PWAT-PARM2*	*PWAT-PARM3*	*PWAT-PARM4*	*PWAT-STATE1*
CSNOFG = "On" RTOPFG = "On" UZFG = "On"	LZSN = 5.0 INFILT = 0.48 LSUR = 2258.0 SLSUR = 0.25 KVARY = 0.7 AGWRC = 0.997	DEEPFR = 0.1 PETMAX = 35.0 PETMIN = 30.0	CEPSC = 0.1 UZSN = 1.0 NSUR = 0.25 INTFW = 3.0 IRC = 0.7 LZETP = 0.8	CEPS = 0.2 UZS = 1.0 LZS = 6.0 AGWS = 1.6 GWVS = 1.9

16. Now that all values are entered for this segment, click the **Apply Parameters to Segments** button to open the *Select Segments* dialog. This allows assigning these same parameters to other segments in the model.
17. Choose "SHRUB & BRUSH RANGELAND" in the *Available Segments* window; move it to the *Selected Segments* window by clicking the → button.
18. Repeat step 17 for "RESIDENTIAL" and "MIXED TUNDRA".
19. Click **OK** to exit the *Select Segments* dialog. The selected segments will be assigned the same parameters input here.

The next step is to define the additional external sources needed for the PWATER simulation. Most of the external sources entered for the SNOW module are also used for the PWATER module, but there is one input series that is not yet entered.

20. Click on the **External Sources** button with the *Water (PWAT)* module highlighted. The *Assign External Sources* dialog will appear with the sources created for this segment in the SNOW module listed in the lower window.
21. Assign the following dataset (evapotranspiration) as a source by setting the fields to the appropriate values, then clicking the **Assign** button. If a mistake is made, choose the incorrect line in the lower window and click **Delete**.

Member Name	*Units*	*Missing Data*	*Transformation*	*Quality Flag*	*Multiplication Factor*
PETINP	ENGL	UNDF	SAME	0	1.0

All the external sources needed for the simulation are now assigned to this segment.

22. Click the **Apply Sources to Segments** button to open the *Select Segments* dialog. This allows assigning these same external sources to other segments in the model.
23. Choose “SHRUB & BRUSH RANGELAND” in the *Available Segments* window; move it to the *Selected Segments* window by clicking the → button.
24. Repeat step 23 for “RESIDENTIAL” and “MIXED TUNDRA”.
25. Click **OK** to exit the *Select Segments* dialog.
26. Select **Done** to exit the *Assign External Sources* dialog, then select **OK** to exit the *HSPF* dialog.

The *HSPF Segments* dialog should now be active. The SNOW and PWATER modules have been successfully set up for all land segments in the model (the modules were explicitly set up for the Evergreen Forest segment and then the parameters were copied to all other segments). Feel free to review the set up for the other segments by choosing the segment in the Basin Data window, then clicking the Define Activities button and reviewing the SNOW and PWATER input.

27. Click **Done** to close the *HSPF Segments* dialog.

6 Defining Reach Segment Parameters

To simulate runoff in-stream, activate the HYDR module for the reach segment of the model. Also specify the output dataset needed (a hydrograph in this case) to view the results of the simulation.

1. Double-click on the watershed outlet in the Graphics Window. The *HSPF Segments* dialog will appear.
2. Click on the **Define…** button for this segment to open the *HSPF* dialog.
3. Check the box to activate the *Hydraulics (HYDR)* module of HSPF for this reach.
4. Switch between the tabs to enter the following values in the appropriate fields (leave other fields as the default values):

HYDR-PARM1	HYDR-PARM2
ODFVFG = 4	Length = 13.82 Delta H = 2200.0

The next input to be entered is the FTABLE for the reach. The FTABLE is a spreadsheet-like table that contains the conveyance parameters of the reach (depth, area, volume,

and outflow). This table may be calculated manually or with the help of the Channel Calculator in WMS.

5. Click on the **Define** button under the *FTABLE* row in the *HYDR-PARM1* tab, to open the *FTABLE* dialog.
6. Enter the following values (it is possible to change the number of rows and columns in the FTABLE, but the default values will be sufficient in this case).

Depth (ft)	*Area* (ac)	*Volume* (ac-ft)	*Outflow* (cfs)
0.0	0.0	0.0	0.0
0.25	25.99	6.393	13.876
0.5	26.828	12.995	43.954
0.75	27.666	19.807	86.269
1.0	25.50	26.828	139.241
1.25	29.340	34.059	201.950
1.5	30.181	41.499	273.794
1.75	31.019	49.150	354.355
2.0	31.858	57.009	443.334
2.25	35.211	90.540	879.902

7. Click **OK** to exit the *FTABLE* dialog.

The final task in defining the reach parameters is to specify the desired output from the reach and select where HSPF will write the output. This is done by defining an external target. Specify that a hydrograph should be output to a dataset in the WDM (*littleco.wdm*) file for this reach.

8. With the *Hydraulics (HYDR)* option selected, click on the **External Targets** button to activate the *Assign External Targets* dialog.
9. Set the following fields to the specified values:

Member Name	*Units*	*Access*	*Aggregation*	*Multiplication Factor*	*Quality Flag*	*Transformation Function*
RO	ENGL	REPL	Aggregate	1.0	0	AVER

10. Select the *Use existing dataset* option.
11. Click on the **Select dataset** button to open the *Select WDM Time Series* dialog.
12. Scroll down and select dataset “20 TMAX Flow”, then click the **OK** button to exit the *Select WDM Time Series* dialog.
13. The *Dataset name*, *type*, and *number* should appear in the *Assign External Targets* dialog.
14. Click **Assign** to add the external target line to the lower window.
15. Click **Done** to exit the *Assign External Targets* dialog.

The HYDR module in this reach has now been completed. This will be the only module active for this simulation.

16. Click **OK** to exit the *HSPF* dialog, then click **Done** to exit the *HSPF Segments* dialog.

The input for all land and reach segments is now complete in the model. The last task before saving and running the HSPF model is to assign mass links.

7 Creating Mass Links

Mass links control how materials (water, sediment, constituents) are transferred from land segments to reaches, and from one reach to the next. Conversions in units, such as inches/acre per day of runoff to cubic feet per second, are defined in the mass links also.

1. Select *HSPF* **| Mass Link Editor** to open the *Mass Link Editor* dialog.
2. Set the fields to the values below:

Volume Name	*Volume Group*	*Volume Member Name*	*Multiplication Factor*	*Target Name*	*Target Group*	*Target Member Name*
PERLND	PWATER	PERO	0.08333	RCHRES	INFLOW	IVOL

NOTE: 0.08333 is the conversion for inches/acre per day to cfs.

3. Click **Add Link** (if a mistake is made, select the link in the window and click the **Delete Link** button).
4. Change the *Segment type* (upper left) to “IMPLND”.
5. Set the fields to the values below:

Volume Name	*Group*	*Member Name*	*Multiplication Factor*	*Target Name*	*Target Group*	*Target Member Name*
IMPLND	IWATER	SURO	0.08333	RCHRES	INFLOW	IVOL

6. Click **Add Link**.
7. Change the *Segment type* (upper left) to “RCHRES”.
8. Set the fields to the values below:

Volume Name	*Volume Group*	*Volume Member Name*	*Multiplication Factor*	*Target Name*	*Target Group*	*Target Member Name*
RCHRES	HYDR	ROVOL	1.00	RCHRES	INFLOW	IVOL

9. Click **Add Link**.

The mass links needed for PERLND, IMPLND, and RCHRES segments are set up.

10. Click **OK** to exit the *Mass Link Editor* dialog.

8 Saving and Running an HSPF Simulation

The last step is to save and run the HSPF file.

1. Select *HSPF* **| Save HSPF UCI File…** to launch the *Select UCI filename* dialog.
2. Select **Save** to exit the *Select UCI filename* dialog.

WMS will save the HSPF UCI file. Save the project from WMS, close WMS, and try running the project in either WinHSPF or WinHSPFLt. WinHSPF and WinHSPFLt are installed when HSPF is installed during the WMS installation. If trying to run the UCI file from WinHSPF while WMS is open, an error will occur. Both WMS and WinHSPF are trying to access the WDM file associated with the UCI file, and only one program can access the WDM file at a time.

TIP: HSPF cannot read WDM files in folders with long path/file names (combined path/file names longer than 64 characters). If the WDM file is located in a folder with a long path

name, move the .wdm file to another folder with a short path name (such as "c:\models\hspf") and save the .uci file from WMS here. Then save the WMS project file, close WMS, read the .uci file into WinHSPF or WinHSPFLT, and run the model.

9 Conclusion

This tutorial demonstrated how to use WMS to process digital elevation and land use data to develop an HSPF input (.uci) file. The following topics were discussed:

- Delineate watershed segment boundaries from a digital terrain model and USGS land use file
- Define segment parameters for a hydrologic analysis
- Develop reach segment parameters
- Define precipitation time series data from standard WDM database files
- Enter mass links to define transformations from basin to reach