NODA
NODA • EDNO
CANADA ONTARIO
Northern Ontario Development Agreement
Entente de développement du nord de l'Ontario
Forestry • Foresterie

FILE REPORT 16

An OBM Terrain Analysis Toolbox for Resource Managers

MITIG Forestry Services Ltd.
4A South Court Street, Suite 17
Thunder Bay, Ontario
P7B 5G6

Natural Resources Canada | Ressources naturelles Canada
Canadian Forest Service | Service canadien des forêts

Ontario Ministry of Natural Resources | Ministère des Richesses naturelles

This file report is an unedited, unpublished report submitted as partial fulfilment of NODA/NFP Project #4221, "An OBM terrain analysis toolbox for resource managers".

The views, conclusions, and recommendations contained herein are those of the authors and should be construed neither as policy nor endorsement by Natural Resources Canada or the Ontario Ministry of Natural Resources.

An OBM Terrain Analysis Toolbox for Resource Managers

Developed by:
MITIG Forestry Services Ltd.
4A South Court Street, Suite 17
Thunder Bay, Ontario P7B 5G6

Funding for this project has been made available through the
Northern Ontario Development Agreement, Northern Forestry Program.

DISCLAIMER

These programs are offered without warranty, but MITIG Forestry Services Ltd. (MITIG) will endeavour to help individual users solve problems associated with these programs.

These programs have not been approved by the Ontario Ministry of Natural Resources (OMNR) for any use, including the production of Timber Management Plans. Any use of the programs in decision making is done at the user's risk. Though an initial assessment of the validity of the results has been made by MITIG, a thorough verification of these programs has not been completed.

TABLE OF CONTENTS

INTRODUCTION

The purpose of NODA/NFP Project 4221, An OBM Terrain Analysis Toolbox for Resource Managers, was to develop, using geographic information system (GIS) technology, a "toolbox" of user-friendly programs that provide decision support for resource managers through the utilization of digital topographic information from the new series of Ontario Base Maps (OBMs).

The resulting products are especially useful to the forest industry for timber management planning, by providing an improved capability for a cost-effective and environmentally sensitive allocation of human and capital resources for harvesting, access road construction, and silvicultural activities.

This toolbox is based on Arc/Info, the GIS standard for the forest industry in Ontario. Arc/Info Version 7.0 has incorporated the ANUDEM software that was developed by Michael Hutchison of the Australia National University. This addition has significantly improved the ability of Arc/Info to process digital elevation data and produces accurate watersheds.

The software has been developed by MITIG Forestry Services Ltd. and is available free of charge on 8 mm tape with this User's and Programmer's Manual, which provides more details than does NODA/NFP Technical Note No. 17. Any comments or questions regarding this software should be addresssed to:

Grant Mitchell
MITIG Forestry Services Ltd.
485 Queen Street East, Suite 102
Sault Ste. Marie, Ontario P6A 6R2
Tel: (705) 254-2073
Fax: (705) 942-1546

TOOLBOX OVERVIEW

A "toolbox" of six Arc/Info applications has been developed by MITIG Forestry Services Ltd. to provide decision support for resource managers through the utilization of Ontario Base Maps. They are written in AML (Arc Macro Language), and are unencrypted.

The toolbox consists of:

Program Description	Command Name
1) a variable width buffering program	SLOPEBUF
2) a watershed delineation program	WSMAKE, WSJOIN, WSSHED
3) a culvert sizing tool	CULVERT
4) a road profiling tool	RDPROFILE
5) a slope mapping tool	SLOPE
6) an aspect mapping tool	ASPECT

Hardware and Software Requirements

These programs are intended to be used on a UNIX workstation.

The toolbox requires Arc/Info, TIN, and GRID Version 6.1 for all modules except the watershed delineation tool. The watershed delineation tool requires Arc/Info and GRID Version 7.0 because the TOPOGRID command is not available in Version 6.1.

Programming Style

The programs use global variables to pass variables between subroutines. Local variables are used only within an individual routine. Variables are defined in the comments at the beginning of each main line.

The programs use the following naming convention: the SLOPEBUF program subroutines and menus are named sb***.aml and sb***.menu. The WATERSHED and CULVERT subroutines are named ws***.aml and cul***.aml. The RDPROFILE programs are named rd****.aml. The SLOPE and ASPECT programs are named sa****.aml.

The programs are designed to be installed in a single directory, which has been called TOOLBOX by default. The AMLPATH must be set to this directory. In this directory there is an INFO subdirectory with the INFO lookup tables required by some of the plotting programs. The AMLPATH is used to find these lookup tables.

These programs are expected to be used on OBM data, using OBM naming conventions. Coverage names of DTM, CONTOUR, SPOTS, DRAINAGE, and NEAT are expected. The feature coding is expected to be contained in the item MNRCODE. If different naming conventions are used, such as NEATLINE instead of NEAT, the global variables can be changed for each program main line.

The preferred input data source for all programs is the DTM point coverage with a numeric elevation item (default is zvalue). If the DTM point cover is not available, the CONTOUR line coverage and the SPOTS point coverage is used to create the surface. The elevation items must be identical for both the CONTOUR and SPOTS coverage. This was included to reduce the input requirements. The user must ensure that the elevation item is a numeric field. Some older OBM data contains the elevation data in a character field that must be converted to numerals to allow these programs to be used.

The programs are coordinated, not integrated. To save processing time, the TIN (Triangulated Irregular Network) created by each program can be used by other programs. Each program will not recreate the TIN if the SB_TIN TIN exists. Some subroutines are used by more than one application.

Part I: User's Manual

DELINEATING A WATERSHED AND PRODUCING A CULVERT SIZE

There are four steps required to produce the culvert sizes for a given water crossing.

These commands have been modularized because of the iterations required to create the waterflow GRID. Also, it is up to the user to define how many OBMs are required to create an area large enough to contain the required watershed.

The commands are:

- WSMAKE - creates the elevation and waterflow GRIDs for an OBM basemap
  - runs WSSHED to test waterflow GRID quality
- WSJOIN - assembles OBM data and GRIDs for up to 16 OBMs
- WSSHED - creates a polygon coverage of the required watershed
  - prompts the user to determine if a culvert calculation is required
- CULVERT - calculates the required culvert size for a watershed polygon

WSMAKE <elev_cover> {zitem} {line|point} {flow_cov}

Creates an elevation GRID and a waterflow GRID for an OBM workspace.

Arguments

<elev_cover>	- elevation data coverage - default is DTM
{zitem}	- item containing the elevation information - default is ZVALUE
{line|point}	- type of input coverage - default is point
{flow_cov}	- line coverage used for drainage enforcement - default is strmflow

Notes

This AML requires ARC/INFO and GRID Version 7.0 because it uses TOPOGRID, the ARC/INFO GRID implementation of the ANUDEM software.

This program endeavours to produce a hydrologically correct GRID using the TOPOGRID software. This program uses the direction of flow of the {flow_cov} to ensure that the water is flowing in the required direction. Refer to the Arc/Info documentation for more information regarding TOPOGRID.

It is highly recommended that the user create the {flow_cov}. The {flow_cov} is needed so that TOPOGRID can determine the flow direction for flat areas (i.e., lakes and swamps). Streams are chosen using RESELECT from the DRAINAGE coverage if {flow_cov} coverage does not exist.

If the input type of {line} is selected, the SPOTS coverage must already exist with the same {zitem}. The SPOTS points are used to provide the elevations for lakes. They provide additional contour lines to TOPOGRID.

The WSSETUP.AML program provides additional parameters. The tolerances provided for TOPOGRID have provided good results with the OBM data used for testing. These parameters may need to be altered to ensure good results.

This program produces two GRIDs, ELEVGRID and WATEFLOW. These GRIDs are the input required by the WSSHED program used to delineate watersheds.

The WSSHED program is run automatically upon completion of WSMAKE. This allows the user to test the quality of the waterflow GRID.

The AMLPATH must be set to run this program. This AML is meant to be used on single OBM workspaces with standard OBM coverages.

Discussion

The {flow_cov} coverage usually requires substantial manual editing to produce a hydrologically correct GRID. See the Preprocessing Stream Data section of the TOPOGRID command documentation for techniques to produce a proper {flow_cov}.

The results of this program depend to a large extent on the input data. DTM data has produced excellent results but CONTOUR data produced mixed results. For areas with relatively steep topography, OBMs with only CONTOUR data perform quite well, while the desired watersheds are not produced in flat areas.

To improve the quality of the output GRIDs it may be necessary to add flow lines to the {flow_cov} coverage. It may also be necessary to alter the TOPOGRID tolerances that are found in the WSSETUP.AML program. The initial tolerances work well for the majority of cases, especially with DTM data, but using the other suggested tolerances may improve the quality of the output GRIDs.

CONTOUR tolerances

	1st	2nd	3rd
tol 1	0.05	0.1	0.15
tol 2	5	8	10
tol 3	10	16	20

DTM tolerances

	1st	2nd	3rd
tol 1	0	0	0
tol 2	5	2.5	10
tol 3	10	5	20

WSJOIN

Assembles data from up to 16 OBM workspaces to allow the delineation of watersheds and culvert calculations.

Arguments

None

Notes

This interactive program will prompt the user for up to 16 OBM workspaces. WATEFLOW and ELEVGRID GRIDs must exist in these workspaces, as must DRAINAGE and NEAT coverages.

This AML should not be run in an OBM workspace. The existing GRIDs and coverages will be deleted.

Please see Part II of this manual to learn how to define the names of the input coverages.

WSSHED

Creates a watershed polygon coverage and optionally calculates the culvert size required for a water crossing at that point.

Arguments

None

Notes

The AMLPATH must be set to run this program.

This program may be run on a single OBM workspace after WSMAKE has created the required GRIDs, or the program may be run on multiple OBMs produced by WSJOIN.

The WATEFLOW and ELEVGRID GRIDs must already exist, as must DRAINAGE and NEAT coverages.

Discussion

This is an interactive program that produces a watershed for pour points or water crossings that are entered by the user using the cursor. The program will draw the lakes and streams on the screen and the user will position the cursor on a stream and press the leftmost button on the mouse. The program creates a 100 m buffer around this position and produces a watershed with a 100 m radius for this polygon. If the user positions the cursor within 100 m upstream of a branch in a stream, the watershed for both branches will be calculated. The watershed delineated will be drawn on the screen and the user will be prompted for a watershed name, <shed_cov>.

If the user does not enter a name (presses only **<ENTER>**) the watershed is not saved. If a name is entered (lower case) the polygon is identified by that name. If coverage already existed under that name it is overwritten. The pour point is saved as the <shed_cov>_pt. The program then prompts the user to produce a culvert calculation. The program will request an upstream point for calculating an average watershed slope, and prompt for the text information needed to do the culvert calculations. See the CULVERT documentation for more information.

The program produces the plot file <shed-cov>.gra and an ascii text file (<shed_cov>.doc) with the culvert information. The program then prompts the user to produce another watershed.

CULVERT <wshed_cov>

Calculates the culvert size required for the input watershed polygon.

Arguments

<wshed_cov> - polygon coverage containing a single watershed

Notes

The AMLPATH must be set to run this program.

The WATEFLOW and ELEVGRID GRIDs must first exist. The DRAINAGE and NEAT coverages must exist in this workspace.

The <wsshed_cov> coverage may contain only a single polygon.

A point coverage, <wshed_cov>_pt, must exist containing the culvert location.

The AML needed to produce the culvert sizing document (CULCALC.AML) is a copy of the BASIC program supplied by the OMNR to produce culvert sizes for northern Ontario. This program creates a plot file <wsshed_cov>.gra for the watershed and the required culvert-sizing information. Also created is an ascii file, <wsshed_cov>.doc, containing the culvert-sizing information.

SLOPEBUF {menu | batch} {input file}

Produces buffers of lakes and streams whose widths are derived from the slope of the land at the shoreline.

Arguments

{menu | batch}	- the method for inputting arguments - default is menu
{input file}	- the text file with the parameters - default is sbset.def

Notes

The required input parameters for these programs are:

1) elevation data source
2) buffer resolution
3) slope and buffer classes
4) features to buffer
5) output buffer polygon name
6) display type

MENU MODE

For each required input parameter the program will select a logical default, which can be changed by the user.

Elevation Data Source

The input elevations source can be provided in four formats:

1)	Existing GRID	- default PIXBUF10 * (*programming note - this will be deleted.)
2)	Existing TIN	- default SB_TIN
3)	DTM point coverage	- default Z item is ZVALUE
4)	CONTOUR line coverage	- default Z item is ZVALUE

The programs produce a TIN (SB_TIN) from the OBM DTM coverage or CONTOUR coverage. The program will choose the TIN SB_TIN, if it exists.

Note: If the CONTOUR line coverage is chosen, the SPOTS point coverage must exist and have the same Zitem.

Buffer Resolution

The user can choose 5 m or 10 m pixel sizes.

Slope and Buffer Classes

The OMNR defaults are found in the Timber Management Guidelines for the Protection of Fish Habitat. These buffers are:

SLOPE	BUFFER WIDTH
0–15%	30 m
15–30%	50 m
30–45%	70 m
45% +	90 m

The user can manually input up to 10 buffer classes by selecting the appropriate button.

Features to Buffer

The user can select 3 options to buffer:

1) Lakes and all streams (default)
2) Lakes and permanent streams
3) Outside water GRID

If options 1 or 2 are selected, the program RESELECTS the lakes and chosen streams from the DRAINAGE coverage and produces a GRID of these features to be buffered. If the user would like to buffer only specific features, the water GRID must be created. To create this GRID, use POLYGRID and LINEGRID to create the individual GRIDs, and MERGE to combine them into a single GRID. The values of the output GRID should be set to 0, with the rest of the GRID set to NODATA.

Output Buffer Polygon Name

The user may enter the output polygon name in the space provided. The selection is chosen when the **<ENTER>** key is typed.

Display Type

The user can choose one of four plotting options. These options will also determine the output polygon coverage. The four choices are:

1) Polygon outline
2) Polygons as buffer zones
3) Polygons as generated
4) No plot

The name of the output plot file will be defined by the menu selection.

Option	Output plot file
1	<bufcov>.gra
2	<bufcov>g.gra
3	<bufcov>z.gra

In all cases, the program will produce a polygon coverage with the outline of the buffer polygon. Program users have expressed interest in defining the extent of each buffer width. Option 2 produces a plot file showing each buffer width in a different colour, and will also produce a second polygon coverage with the buffer zones of each buffer width as separate polygons. The name of this coverage is the output polygon coverage name with "col" concatenated to the end.

Option 3 creates a plot showing how the shoreline pixels are buffered to produce the final polygon coverage. It shows the extent of the shoreline slope and the extent of the buffers generated. This option is useful in determining how specific buffers are generated.

BATCH MODE

The programs can be run without using the menu. To use the batch mode, the batch argument and an input file must be entered. The default input file is sbset.def in the AMLPATH directory.

The file is in ASCII text file format, as follows:

Line number	Variable description	Acceptable input
line 1	elevation data source type	contour/point/TIN/GRID
line 2	source coverage name	
line 3	source zitem	
line 4	pixel size	5 / 10
line 5	obm water source	all / perm / other
line 6	waterGRID name	
line 7	buffer outcover name	
line 8	plot type	none/poly/colour/zone

line 9	slope / buffer type	mnr / manual
line 10–20	slope / buffer sizes	max slope, buffer in metres

The following is an example of an input file:

File content	Description only (not in file)
point	input data is point coverage
dtm	input coverage name is dtm
zvalue	input coverage z item is zvalue
10	10 m pixels
all	all water features to be buffered
none	no input water GRID
buf2	output coverage name
colour	colour plot
manual	manual
20,30	slopes <20% buffered to 30 m
40,60	slopes 20%–40% buffered to 60 m
,90	slopes >40% buffered to 90 m

Discussion

The AMLPATH must be set to run this program. The AMLPATH is used to determine the location of the sbbuff.lut INFO file required for the plotting routine. The batch setup file is also located in the same directory.

This program requires TIN and GRID licenses, and has been successfully run in Arc/Info versions 6.1 and 7.0.

Other commands in the OBM Terrain Analysis Toolbox produce and use the SB_TIN. This TIN can be deleted but need not be recreated for each run. Each of the programs in the toolbox is an independent program, but programs and naming conventions are coordinated to minimize redundant processing

The plot files provide additional information, including the total land and water area, and the area within buffers.

RDPROFILE <line_cover> {elev_cover} {zitem} {line|point} {plotsize} {lut}

Creates a road profile coverage and graphics file.

Arguments

<line_cover>	- the line coverage of the arc to be profiled. This coverage can contain only one arc.
{elev_cover}	- elevation data coverage - default is DTM
{zitem}	- item containing the elevation information - default is ZVALUE
{line|point}	- type of input coverage - default is point
{plotsize}	- the size of the output plot using ANSI specifications - default is A.
{lut}	- the number corresponding to the lookup table - default is 1

Notes

The AMLPATH must be set to run this program.

This AML is meant to be used on single OBM workspaces with standard OBM coverages.

This AML will produce a TIN, called SB_TIN. If SB_TIN exists the AML will use it to create the road profile. To create the TIN the DTM coverage must exist or the CONTOUR, SPOTS, and DRAINAGE coverages must exist.

The plot sizes available are:

A	8.5" x 11"
B	11" x 17"
D	22" x 34"
E	34" x 44"

The graphics file created is named <line_cover>_prof.gra. The plot will contain both plan and profile views of the line. For both views the line will be coloured based on the slope of that section. The scale of each view will be the smallest scale that will fit within that portion of

the map allocated for the view: 1: 2000, 1: 5000, 1: 10 000, 1: 20 000, 1: 50 000, 1: 100 000, 1: 250 000, 1: 1 000 000.

The colour of the lines is created using a lookup table specified by the {lut}. The slope1.lut and slope2.lut INFO files are available in the AMLPATH directory. Additional lookup tables can be added. slope1.lut and slope2.lut provide 3% and 5% slope classes, respectively.

SLOPE <elev_cover> {zitem} {line | point} {lut}

Creates a slope polygon coverage and graphics file.

Arguments

<elev_cover>	- elevation data coverage - default is DTM
{zitem}	- item containing the elevation information - default is ZVALUE
{line|point}	- type of input coverage - default is point
{lut}	- number corresponding to the lookup table - default is 1

Notes

The AMLPATH must be set to run this program. This AML is meant to be used on single OBM workspaces with standard OBM coverages.

If the input type of {line} is selected, the SPOTS coverage must already exist and have the same {zitem}. The SPOTS points are used to provide the elevations for lakes that are used when creating the TIN.

This AML will produce a slope/aspect polygon coverage called SLPASPP. If SLPASPP exists, the AML will produce a graphics file using the existing SLPASPP coverage.

This AML will produce a TIN called SB_TIN. If SB_TIN exists, the AML will produce a SLPASPP coverage using the existing SB_TIN TIN. To create the TIN, the DTM coverage must exist or the CONTOUR, SPOTS, and DRAINAGE coverages must exist.

The name of the graphics file created is SLPMAP.GRA. The graphics file is created using a lookup table specified by the {lut}. saslp1.lut, saslp2.lut and saslp3.lut are available in the AMLPATH directory. Additional lookup tables can be added. saslp1.lut and saslp2.lut provide 5% and 10% slope classes, respectively. Saslp3.lut provides 15% slope classes, as required by the Timber Management Guidelines for the Protection of Fish Habitat.

Please see Part II for instructions on how to define the names of the input coverages.

ASPECT <elev_cover> {zitem} {line | point} {lut} {min_slope}

Creates an aspect polygon coverage and graphics file.

Arguments

<elev_cover>	- elevation data coverage - default is DTM
{zitem}	- item containing the elevation information - default is ZVALUE
{line|point}	- type of input coverage - default is point
{lut}	- the number corresponding to the lookup table - default is 1
{min_slope}	- the minimum slope in percent that will be plotted - default is 0

Notes

The AMLPATH must be set to run this program. This AML is meant to be used on single OBM workspaces with standard OBM coverages.

If the input type of {line} is selected, the SPOTS coverage must already exist and have the same {zitem}. The SPOTS points are used to provide the elevations for lakes that are used when creating the TIN.

This AML will produce a slope/aspect polygon coverage called SLPASPP. If SLPASPP exists, the AML will produce a graphics file using the existing SLPASPP coverage.

This AML will produce a TIN called SB_TIN. If SB_TIN exists, the AML will produce a SLPASPP coverage using the existing SB_TIN.TIN. To create the TIN, the DTM coverage must exist or the CONTOUR, SPOTS, and DRAINAGE coverages must exist.

The name of the graphics file created is ASPMAP.GRA. The graphics file is created using a lookup table specified by the {lut}. The files saasp1.lut and saasp2.lut are available in the AMLPATH directory, and additional lookup tables can be added. Saasp1.lut provides four aspect classes using a red/yellow colour scheme, while saasp2.lut provides four classes using a green/brown colour scheme.

Part II: Programmer's Manual

SLOPEBUF {menu ¦ batch} {input file}

This program used TIN and GRID to create buffer polygons whose widths are defined by the shoreline slope.

Program Logic

The program creates a GRID of the water features that require a buffer. By using a GRID, buffers can be created for polygon features (lakes) and line features (streams).

A TIN is created from the input data source—either DTM or CONTOUR and SPOT information. A polygon coverage is created from the TIN and each polygon is coded with the required buffer width, in pixels. The polygon coverage is converted into a GRID, with each pixel representing the required buffer width in pixels. The water GRID is buffered one pixel, and the slope contained in that pixel is used to define the required buffer width. The buffers are created by using EXPAND once for each slope class.

Additional buffering algorithms to colour each buffer separately and to identify buffers according to the buffer width are used in SBBUFF.AML. Upon completion of the buffering, and depending upon the plotting requirements, statistics are calculated and a plot file is created in SBSHOW.AML.

The SLOPEBUF program requires the input of ten variables. These variables can be input by menus (input forms) or by a text file. The menu option is the default setting.

The file is in ASCII text file format, as follows:

Line number	Variable description	Acceptable input
line 1	elevation data source type	contour/point/TIN/GRID
line 2	source coverage name	
line 3	source zitem	
line 4	pixel size	5 / 10
line 5	obm water source	all / perm / other
line 6	waterGRID name	
line 7	buffer outcover name	
line 8	plot type	none/poly/colour/zone
line 9	slope / buffer type	mnr / manual
line 10–20	slope / buffer sizes	max slope, buffer in metres

If the menu option is chosen (the default) the SBMAIN.MENU is executed. The SBMAIN.MENU selects the most appropriate defaults for each input variable and displays them as initial selections in the main menu. The initial selections will change depending upon

the availability of DTM or CONTOUR data, or whether the SB_TIN TIN or PIXBUF10 GRID exists.

The SBMAIN.MENU selects the most processed input data source available. The SLOPEBUF program creates a TIN from the input coverages and then creates a GRID. The SBMAIN.MENU will select, in order, the GRID, the TIN, the DTM point coverage, or the CONTOUR/SPOTS coverages. Submenus are used to alter these selections or to select other coverages, TINs, or GRIDs.

All other menus are executed from the SBMAIN.MENU except SBPLOT.MENU. SBPLOT.MENU is invoked upon completion of the drawing of the plotfile. The mouse button is clicked to clear the selected plotfile drawn on the screen.

Subroutines	(Programs are called from SLOPEBUF.AML file unless otherwise indicated)
SBCLEAN.AML	Kills temporary coverages, TINs, or GRIDs created by the SLOPEBUF programs. Comments can be added or deleted if required.
SBREAD.AML	Used only with the batch option. Reads the text file defined in the command line.
SBCHECK.AML	Checks the existence of the input coverages, GRIDs, TINs, and items.
SBLAKE.AML	Creates a GRID from the drainage features chosen, RESELECTS lakes and stream features from the DRAINAGE coverage, converts them to a GRID, and combines the GRIDs using MERGE.
SBCONLAK.AML	Creates a TIN using the CONTOUR, SPOTS, and DRAINAGE coverage. This program uses the SPOTS point coverage to assign an elevation to lakes. Lakes without elevations are given an elevation 5 m below the closest contour line.
SBBUFF.AML	Creates a buffer for the water GRID according to the slope classes provided, based on the slope of the land adjacent to the water GRID. The program uses EXPAND to create a buffer for the water GRID, once for each slope class.
SBSHOW.AML	Calculates buffering statistics, produces the lookup tables, and produces the output plot file, if required.
SBWRITE.AML	Called from SBFILSEL.MENU, writes SBMAIN.MENU program settings to a user-defined text file.

Menus	(Menus are called from SBMAIN.MENU unless otherwise indicated)
SBMAIN.MENU	Called from SLOPEBUF.AML, main menu. Selects defaults for each required input.
SBCONSEL.MENU	Selects a line coverage and zitem.
SBPTSEL.MENU	Selects a point coverage and zitem.
SBTINSEL.MENU	Selects a TIN.
SBGRDSEL.MENU	Selects a GRID.
SBFILSEL.MENU	Selects output text file name and calls SBWRITE.AML to write the SBMAIN.MENU program settings to that text file.
SBWATSEL.MENU	Selects the input water GRID for buffering.
SBMANSEL.MENU	Defines manual slope/buffer classes.
SBPLOT.MENU	Called from SBMAIN.MENU button to finish viewing the plotfile.

Improvements

The input GRID option may be eliminated in future because it confuses some users.

The option to create buffers only for lakes or streams can be implemented only by altering the MNRCODE in the DRAINAGE coverage. An option to allow buffering of individual line or polygon coverages would be an improvement.

RDPROFILE <line_cover> {in_cover} {zitem} {LINE | POINT} {plotsize} {zscale}

This program produces road profile coverages and a plotfile for a single road. The program requires an input coverage that consists of a single arc. If more than one arc exists in that coverage, the program will exit with an error message.

The program has the same input requirements as the other programs in the toolbox. The {in_cover} can be either a DTM point coverage or a CONTOUR line coverage with a numeric {zitem}. If a CONTOUR line coverage is input, the SPOTS point coverage must exist with the identical {zitem}. If the default TIN SB_TIN exists, the input coverage data is ignored.

Program Logic

The program creates a line density coverage of 50 m, and the vertices are converted into point coverage. The points have x, y, and z values assigned and a sorted text file is created. A generate file is created for each 50 m road segment, with the slope of the segment assigned to the user identity. The road profile, plan view, kilometer markers, and underlying GRID are generated . A plotfile of the planimetric and profile view of the road is created using the plotsize definitions in the command line.

This program produces four coverages, with the coverage names derived from the input road coverage. These coverages are :

<line_cover>_prof	road profile
<line_cover>_plan	road plan view
<line_cover>_km	road kilometer markers
<line_cover>_GRID	underlying GRID and annotation for plotting

Subroutines (All programs are called from RDPROFILE.AML)

SACONTIN.AML	Creates a TIN using the CONTOUR, SPOTS, and DRAINAGE coverage. This program uses the SPOTS point coverage to assign elevation to lakes. Lakes without elevations are given an elevation 5 m below the closest contour line.
RDXYZ.AML	Unloads x, y, and z items to a text file from TABLES.
RDGEN.AML	Reads the text file created by RDXYZ.AML and produces a generated file of the road profile. The z coordinates are exaggerated by the zscale that is selected by the user (default is 5).
RDCOV.AML	Generates output coverages.
RDPLOT.AML	Produces a plot file using input plot size (A to E)

WATERSHED DELINEATION AND CULVERT CALCULATION

The watershed delineation and culvert calculation programs consist of a series of programs that are completed in sequence. These programs are:

1) WSMAKE	Creates an elevation GRID and waterflow GRID for an individual OBM.
2) WSJOIN	Creates a single elevation GRID and waterflow GRID for up to 16 OBMs.
3) WSSHED	Interactively delineates a watershed for a specific pour point or road crossing.
4) CULVERT	Calculates the culvert size required and produces a plot file.

1) WSMAKE <elev_cover> {zitem} {LINE | POINT} {flow_cov}

This program requires Arc/Info Version 7.0 because it uses the TOPOGRID command, the Arc/Info implementation of the ANUDEM software. This program produces a hydrologically correct GRID using the direction of the {flow_cov} to ensure that the water flows in the required direction.

The program has the same input requirements as the other programs in the toolbox. The <in_cover> can be either a DTM point coverage or a CONTOUR line coverage with a numeric {zitem}. If a CONTOUR line coverage is input, the SPOTS point coverage must exist with the identical {zitem}.

These programs are integrated to create a single application without unnecessarily limiting the user. The WSMAKE program calls the WSSHED program to allow the user to test the quality of the waterflow GRID created. The WSSHED program prompts the user to calculate a culvert size once a watershed has been saved.

WSMAKE.AML	Checks the command line arguments, uses TOPOGRID to create the waterflow GRID, and FILL to fill in the sinks in the waterflow GRID and create the elevation GRID required.
WSSETUP.AML	Called from WSMAKE, assigns variable names and TOPOGRID tolerances. It was created as a separate program to allow the user to easily change the tolerances and coverage names.
WSCONLAK.AML	Called from WSMAKE, assigns SPOTS elevations to the lake shorelines to add as contours to the TOPOGRID.
WSSHED.AML	Called to check the quality of the output GRIDs.
WSCLEAN.AML	Kills temporary coverages created.

2) WSJOIN

WSJOIN prompts the user for up to 16 OBM basemaps and uses CLIP, MAPJOIN, LATTICECLIP and LATTICEMERGE to create a contiguous database for the delineation of watersheds.

3) WSSHED

WSSHED is an interactive program that draws the current drainage features on the screen and prompts the user to enter a pour point or road crossing. The point input buffer is 100 m (default) and the Arc/Info GRID WATERSHED command is used to define the polygon that defines the watershed for that point. The user is prompted to save the defined watershed and to calculate the required culvert size for that watershed.

4) CULVERT <wshed_cov>

The CULVERT program requires polygon coverage and a point coverage <wshed_cov>_pt of the culvert location.

Subroutines	(Called from CULVERT or from WSSHED)
WSDATA.AML	Calculates the watershed statistics required by the culvert calculation program. The watershed area, the swamp area, and lake area are derived by clipping the DRAINAGE coverage with the watershed polygon. The average slope is derived interactively by prompting the user for a point in the watershed. The elevation of the water crossing and the upstream point are derived from the elevation GRID and the euclidean distance between the points is calculated. The slope is calculated by dividing the elevation difference by the euclidean distance. A minimum slope of 0.001 m/m is enforced.
CULCALC.AML	This program is a translation into AML of the BASIC program provided by the regional engineers. The inputs of watershed area, lake area, swamp area, and average watershed slope produce a set of culvert sizes for 5, 10, 25, and 100 year flows.
WSWRITE.AML	Creates the text file <wsshed>.doc with the culvert sizes and additional statistics calculated by CULCALC.AML.
WSPLOT.AML	Creates a plot file of the watershed, road crossing, and the suggested culvert sizes.

Programming Note

An additional method of determining the average watershed slope is provided in WSDATA2.AML. This program calculates the difference between the maximum and minimum elevation in the watershed and divides this value by the maximum extent of the watershed in the x or y direction.

This method has the advantage of not being interactive, and as such does not allow the manipulation of the average watershed slope by choosing the upstream point. While this might provide a better average slope calculation by eliminating the ability of the user to manipulate the slope, it does seem to increase the average slope dramatically in some instances.

To use this method, rename WSDATA.AML to WSDATA2.AML (MV WSDATA.AML WSDATA3.AML) and rename WSDATA2.AML to WSDATA.AML.

Because there seems to be very little agreement between OMNR and industry foresters contacted by MITIG, it is up to users to determine the appropriate method of determining the average watershed slope.

SLOPE <cover> {zitem} {LINE | POINT} {LUT}
ASPECT <cover> {zitem} {LINE | POINT} {LUT} {min.slope}

Both SLOPE and ASPECT create a TIN using the input elevation data set and create a polygon coverage (SLPASPP) from that TIN. Plotting programs are called from each to produce plot files depicting the information required.

Subroutines

SACONTIN.AML — Called from both SLOPE and ASPECT, create a TIN using the CONTOUR, SPOTS, and DRAINAGE coverage. This program uses the SPOTS point coverage to assign elevation to lakes. Lakes without elevations are given an elevation 5 m below the closest contour line.

SAASPLOT.AML — Produces a plot of the aspect of each polygon in SLPASPP, which has a slope greater than {min.slope}, using the lookup table requested. Additional user-defined lookup tables can be created in the toolbox directory.

SASLLPPLT.AML — Produces a plot of the slope of each polygon in SLPASPP using the lookup table requested. Additional user-defined lookup tables can be created in the toolbox directory.