Appendix A

Application of WEPP-Mine to Western Alkaline Coal Mines: Data Processing

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WEPP-Mine can be accessed using a web browser at http://wepponlinegis.bsyse.wsu.edu/osm. For a given study area, WEPP-Mine delineates a channel network, discretizes watershed and sub-watershed (hillslope) boundaries for a user-specified watershed outlet, and extracts topographic, land management, and soil inputs for a WEPP watershed simulation from digital maps. By default, the system uses the USGS 30-m National Elevation Data, USGS 2006 National Land Cover grid, and the SSURGO soil data that reside on federal web servers for typical WEPP applications. In WEPP-Mine applications to western alkaline coal mines where topography has been substantially altered, a user-specified Digital Elevation Model (DEM) and a reclamation map can be used.

WEPP-Mine requires the user-specified DEM in ASCII format with a UTM projection and its "NoData" values set to 0. The typical digital topographic maps available for the mining areas are contour maps in Computer Aided Design (CAD or .dwg) file format. In the following, we describe the major procedures for preparing a user-specified DEM and a CAD contour map in a case application of WEPP-Mine to Big Sky Mine (Area A) near Colstrip, southeastern Montana.

1. Adding an AutoCAD file to ArcMap 10

Save the topographic CAD (.dwg) file and its projection files in a work directory (e.g., C:\DEMOSM\bs_topo-070510.dwg and C:\DEMOSM\ bs_topo-070510.prj). Open ArcMap10 and add the dwg file to the map. Typically, an AutoCAD file includes multiple layers. To extract topographic features from the multiple layers of the CAD map, right click the Polyline layer in the Table of Contents, select **Properties.** Uncheck all the layers except those for the contour lines (Fig. 1), then click **Apply,** and close the window.

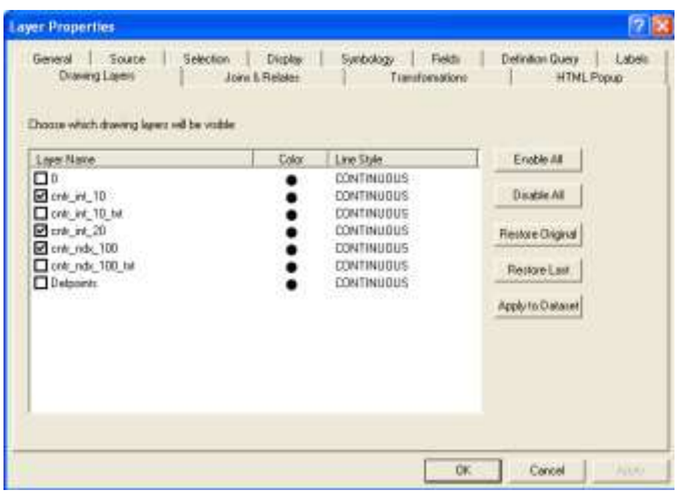

Fig. 1. User-selected contour in the "Layer Properties" window

Right click the selected layer (*bs_topo-070510.dwg Polyline* layer in this case) in the Table of Contents. Click on the “Data” menu, and then “Export Data” (Fig. 2), and add the exported layer to the map.

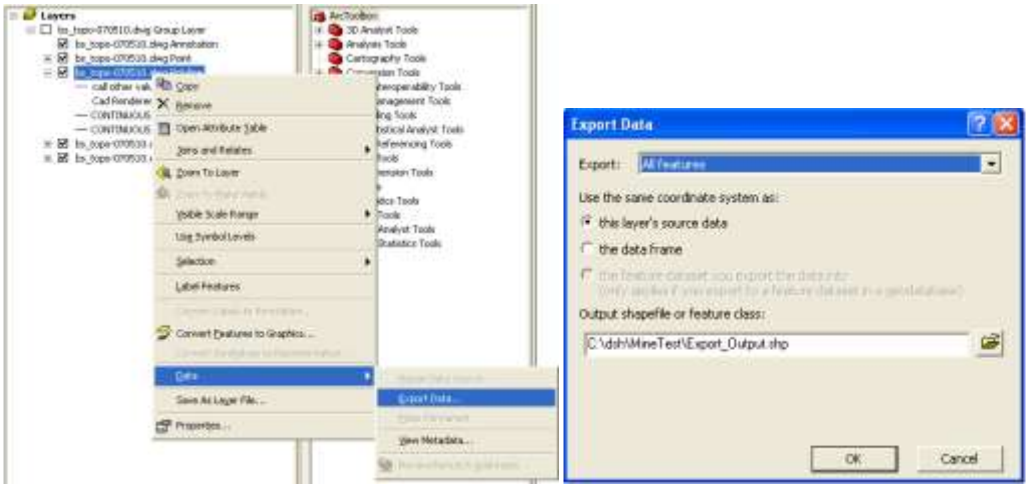

Fig. 2. Exporting contour data

More details for exporting the Polylines of the contour map as a shape file can be found in our quarterly progress report “Developing Model Inputs for WEPP-Mine—Topography” (Dun et al., 2010).

2. Converting contour to UTM projection

Use the “Data Management Tools → Projections and Transformations → Feature → Project” to re-project the exported shape file of the contour to UTM projection (Fig. 3). The UTM projection can be selected in “Projected Coordinate Systems → UTM → NAD 1983”.

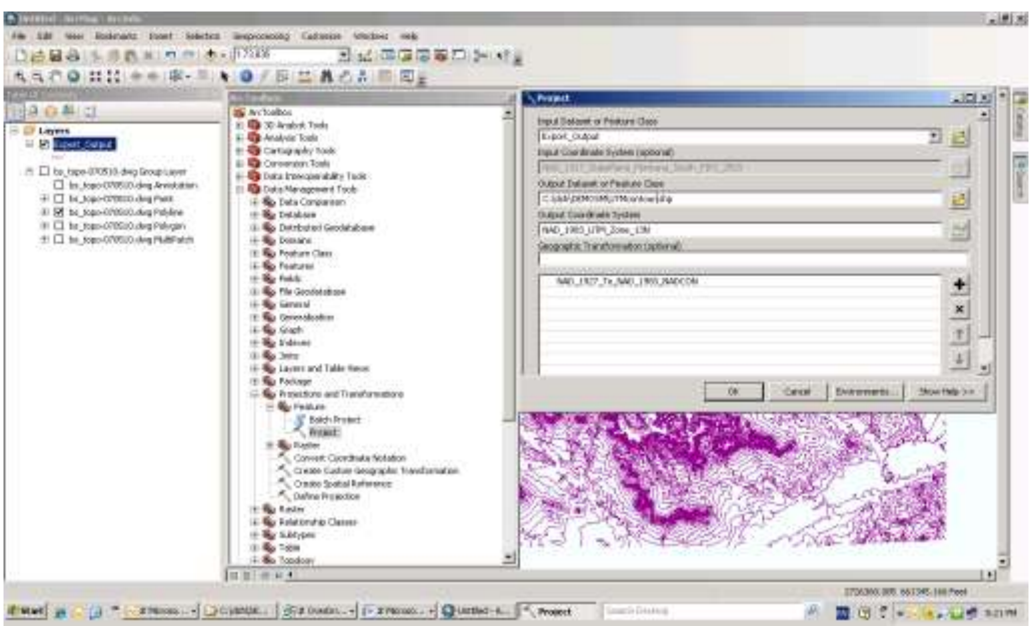

Fig. 3. Projecting contour map to UTM system

3. Converting contour map in UTM projection to raster DEM

Close ArcMap and open an empty map project. Add the UTM contour file as the first layer, which will give the project a UTM projection. Convert the UTM map to a raster file using “3D Analyst Tools → Raster Interpolation → Topo to Raster” (Fig. 4). Select the exported contour layer as the input feature and choose elevation for the field. Since WEPP-Mine uses a 30-m resolution for its maps and the units of the coordinate system of the UTM maps are metric, the “Output cell size” for the raster DEM should be 30.

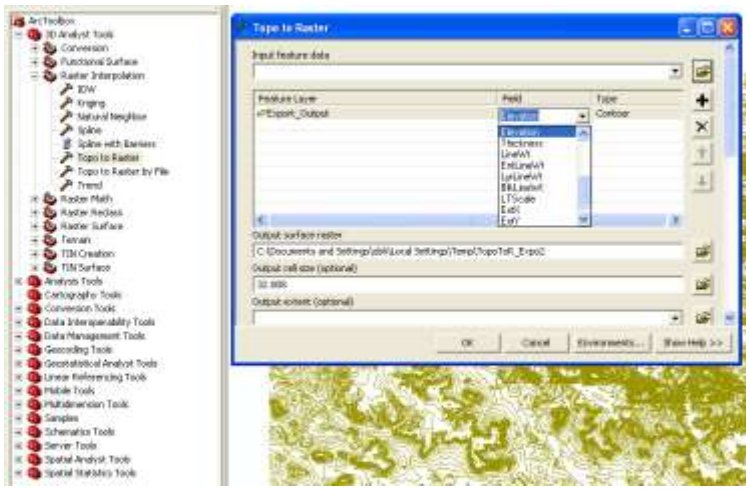

Fig. 4. Feature to Raster

4. Converting the unit of elevation to metric and exporting DEM in ASCII

If the unit of the elevation data in the CAD file is feet, it will be necessary to convert it to meters. To do so, use the raster calculator “Spatial Analyst Tools → Map Algebra → Raster Calculator” (Fig. 5).

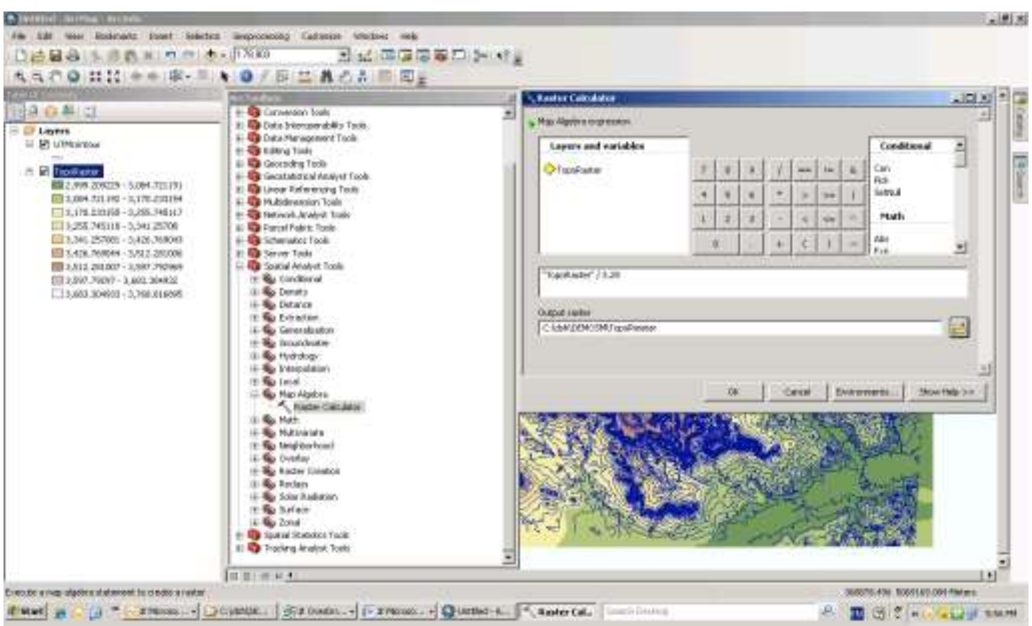

Fig. 5. Raster calculator

WEPP-MINE requires the “NoData” values in a user-specified DEM to be 0. The conversion of the “NoData” values can be done in the raster calculator using the “IsNull” and “Con” commands (ArcGIS, 2012), i.e., Con(IsNull([raster]), 0, [raster]), to generated a new raster (e.g., “TopoRM0null”, Fig. 6).

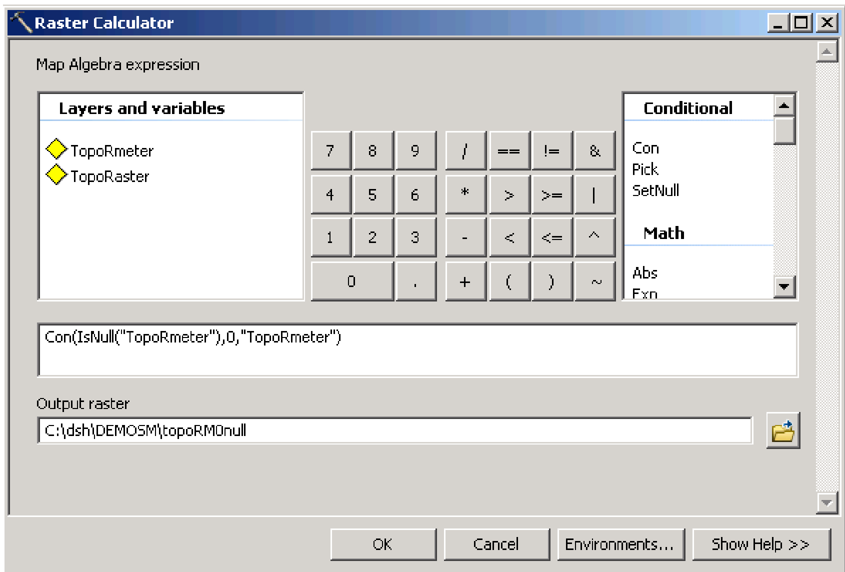

Fig. 6. The use of “IsNull” and “Con”

Export an ASCII format DEM (e.g., “TopoAsc.asc”) from the newly generated raster DEM with “0” for “NoData” and meters for the unit of elevation using “Conversion Tools → From Raster → Raster to ASCII”. Open the exported “TopoAsc.asc” using a word processor, e.g., “Notepad”, and change the “NoData_value” from −9999 to 0 and save the file, which is a valid user-specified DEM for WEPP-Mine applications. The ArcMap project for topographic data processing can now be saved and closed.

5. Post-mining soil and land cover

A map of reclamation and bond status can be used as soil and landuse maps for post-mining WEPP-Mine applications. WEPP-Mine allows a user to upload a raster reclamation map in ASCII format with the same projection as the uploaded DEM file.

In our case application, we used the map of reclamation and bond status in the “Big Sky Mine 2008 Annual Report” (BSCC, 2008). The reclamation map showing different reclamation conditions was in the ArcGIS shape file format (Rec&Bond_Status_ 15MAR2009.shp). To convert the reclamation map to raster grid, open a new ArcMap project and add the DEM (TopoRM0null) from the project of topographic data processing as the first layer so that the reclamation grid to be generated will have the same map extent and projection as the topographic grid.

Add the reclamation shape file to the map project. To assign an index to each of the reclamation conditions, first, right click the reclamation layer in the Table of Contents to open its attribute table (Fig. 7). Click the “Table Options” button at the upper left corner of the attribute table and add a field for the reclamation index (ReclInd) as integer (Figs. 8 and 9). Click the “Select by Attributes” function under the

“Table Options” and select one of the reclamation categories using the “Status08” field (Fig. 10) and click “Show selected records” in the “Table” window (Fig. 10). Right click the title of the newly added column (ReclInd) and click on the “Field calculator” (Fig. 11). Populate the reclamation field with numbers listed in Table 1 (Fig. 12) until the indices of all the categories in the reclamation map are properly assigned.

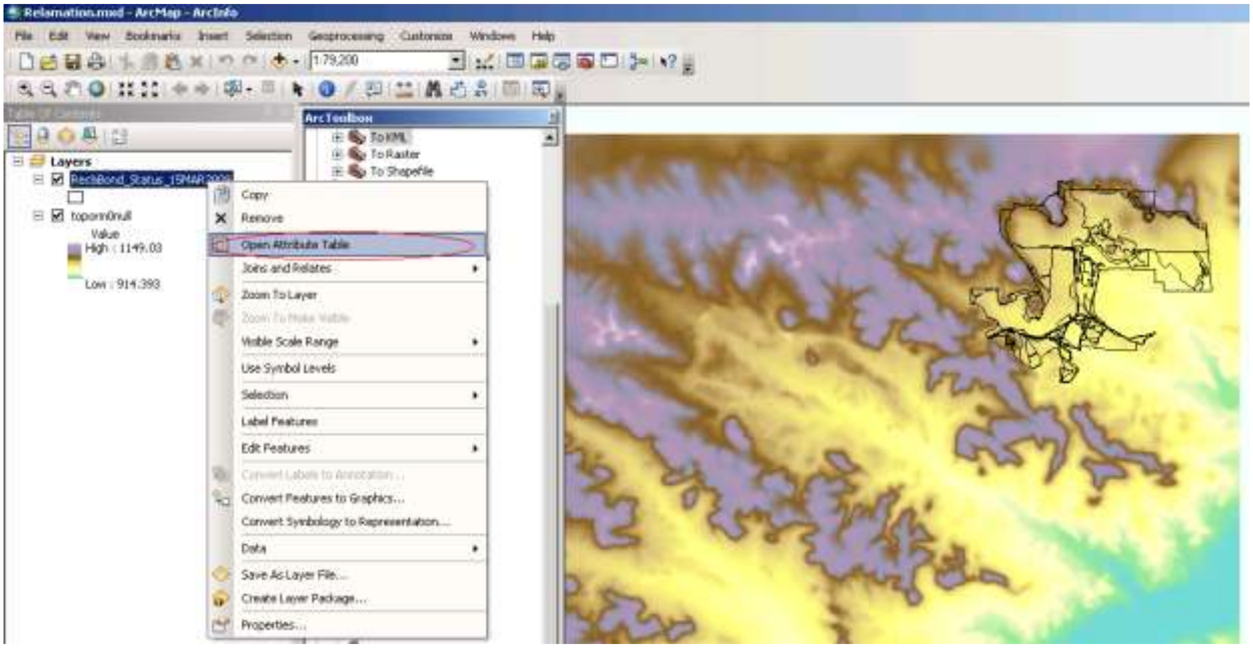

Fig. 7. Opening the attribute table of a map layer

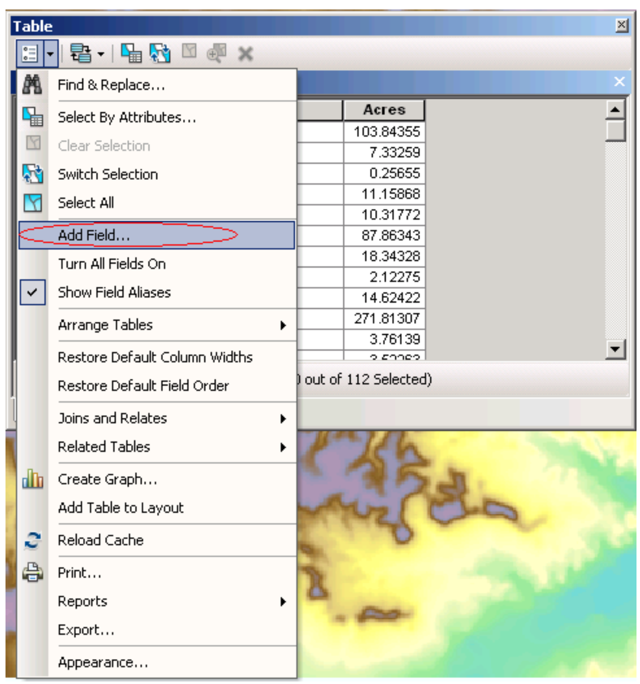

Fig. 8. Adding a field in an attribute table

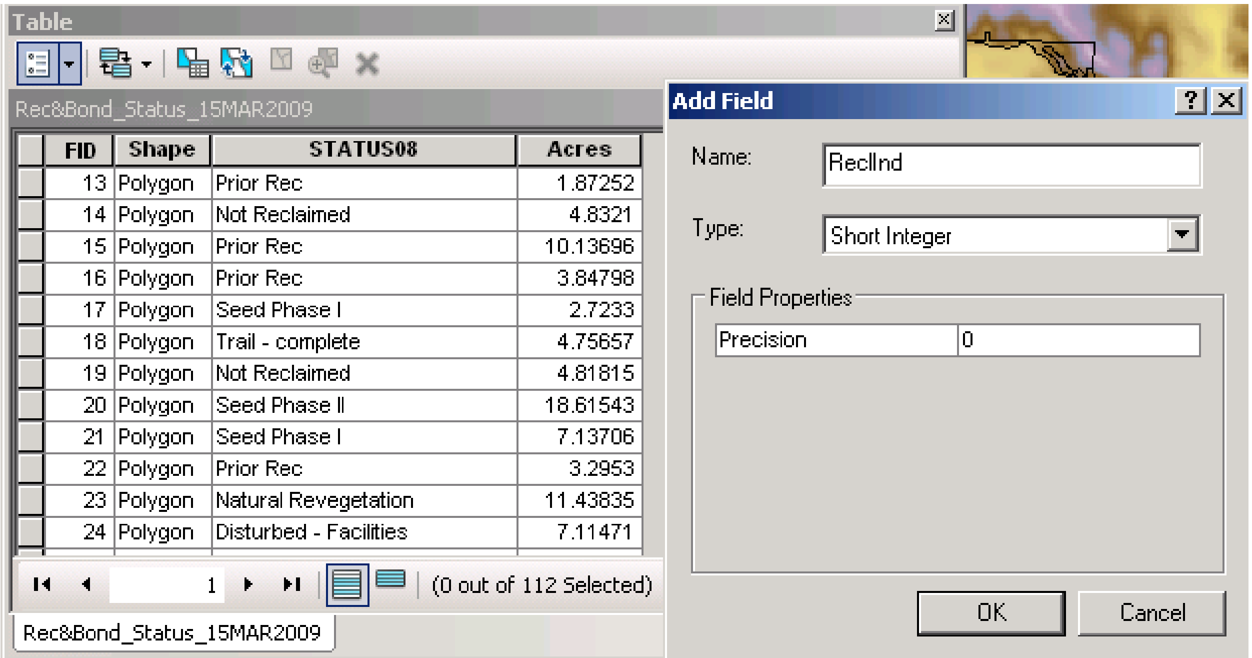

Fig. 9. Specifying the name and type of an added field

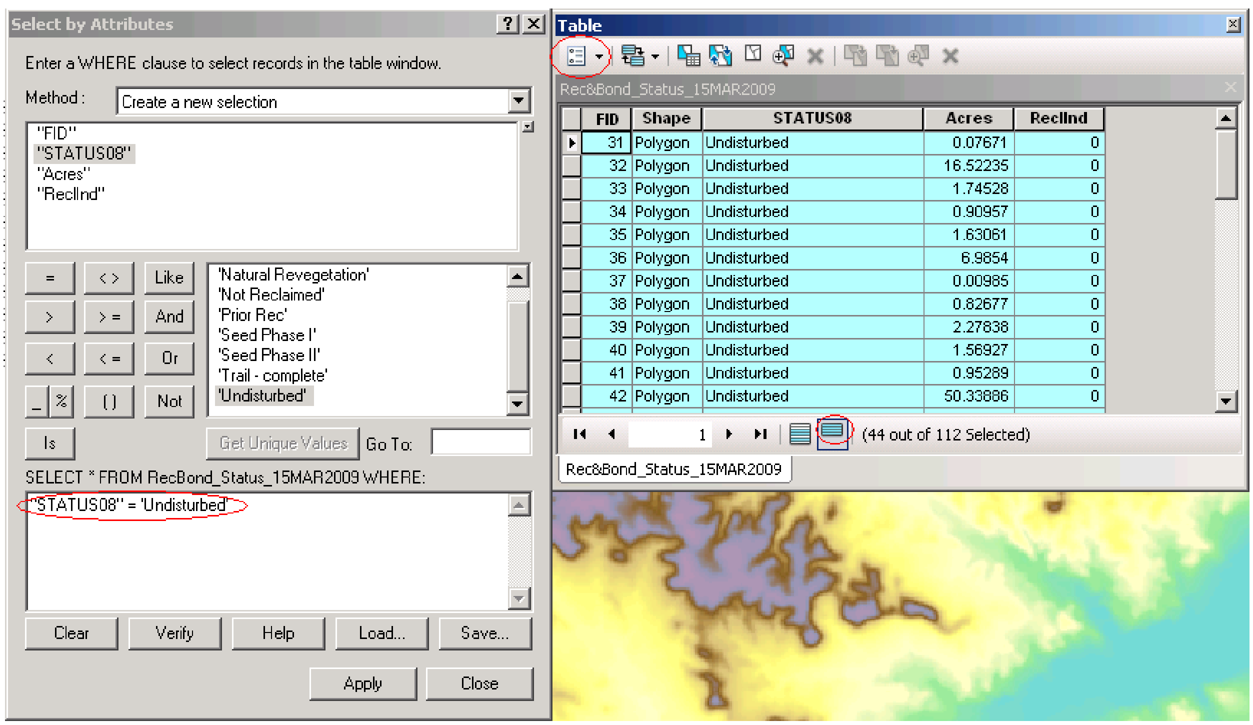

Fig. 10. Selecting records by attributes

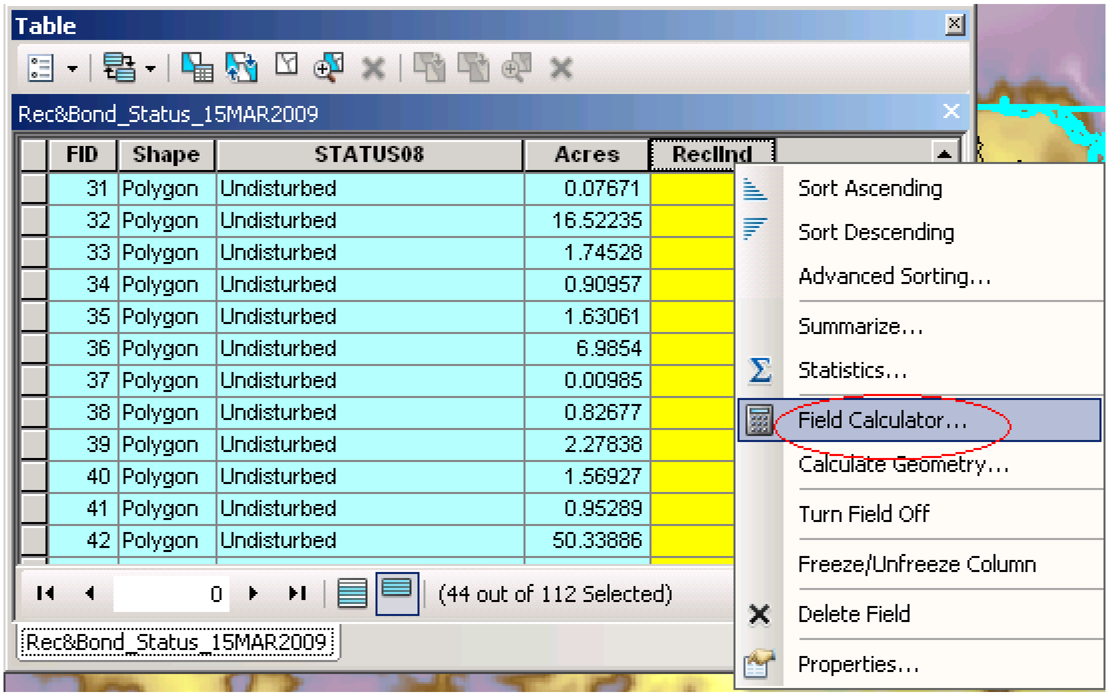

Fig. 11. Field calculator

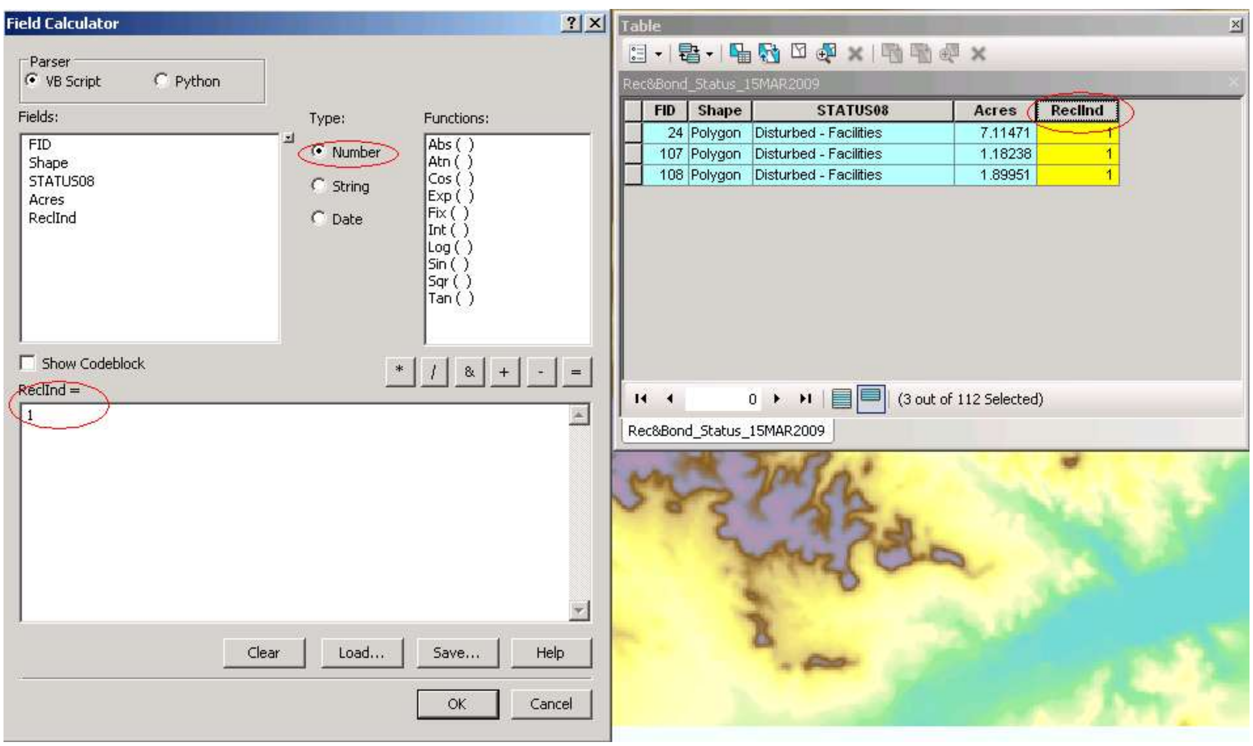

Fig. 12. Assigning indices to the newly added field for selected records

Table 1. Reclamation condition indexes in WEPP-Mine applications

Index	Description
0	Undisturbed or NoData
1	Disturbed—Facilities
2	Not Reclaimed
3	Prior Reclamation
4	Natural Revegetation
5	Seed Phase I
6	Seed Phase II
7	Trail-complete

Use “Data Management Tools → Projections and Transformations → Feature → Project” to re-project the shape file of the reclamation map to the same projection as the DEM layer’s (UTM NAD 1983) by importing the projection from the DEM (Fig. 13). Create the raster grid of the post-mining reclamation map using “Feature to Raster” under “Toolbox → Conversion Tool → To Raster” with the reclamation indexes as raster cell values, 30-m resolution, and the extent of the DEM (Fig. 14). A different extent may be selected using “Processing Extent” in the “Environmental Settings” window (Fig. 14). Fill the “NoData” cells of the reclamation raster with 0 using the raster calculator and the “IsNull” and “Con” commands as in processing the topographic data. Export the reclamation map using “Raster to ASCII” tool and change the “NoData_value” in the Reclamation.asc from −9999 to 0.

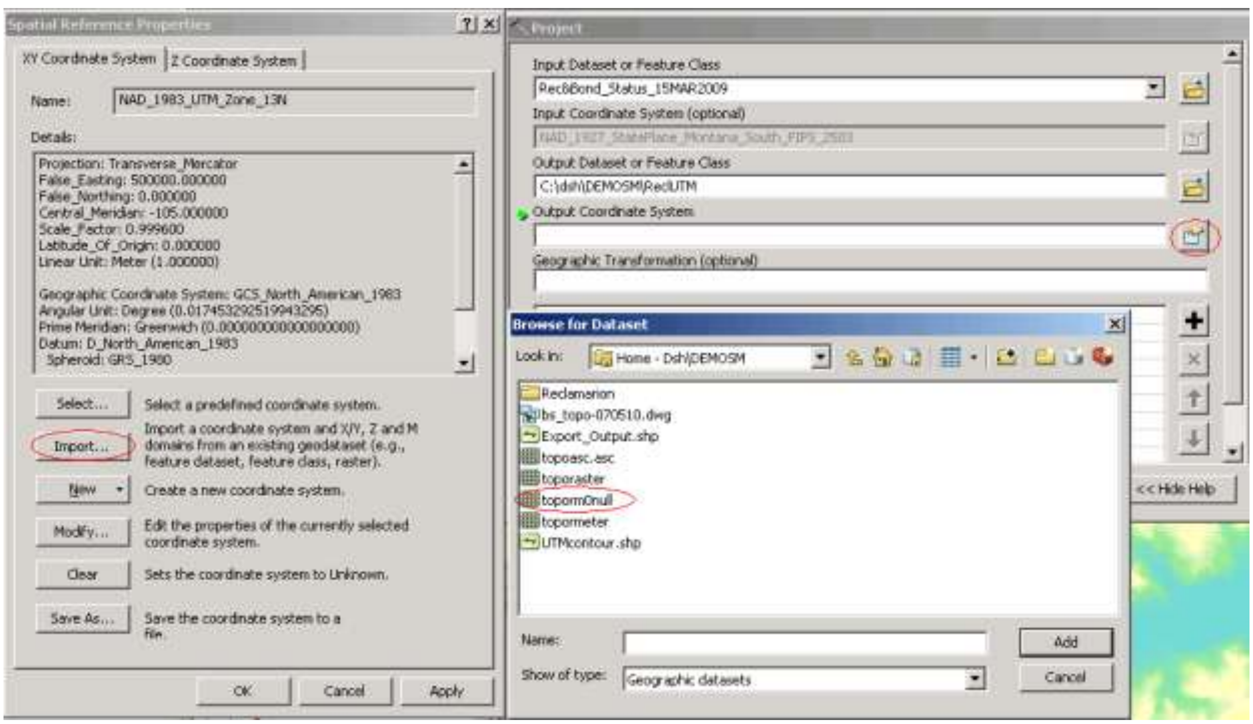

Fig. 13. Importing map projection from an existing map

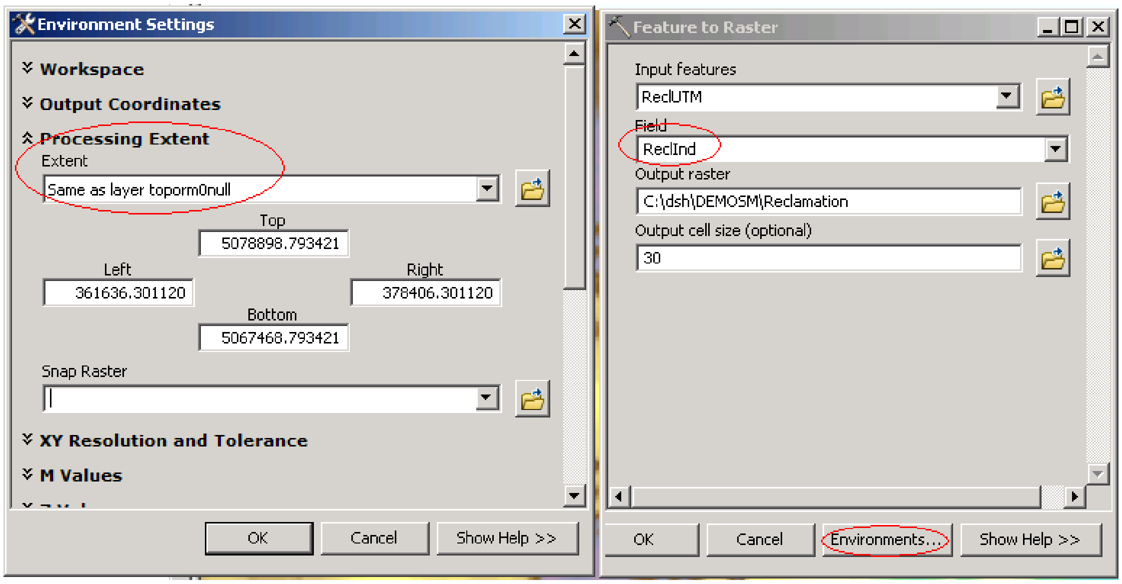

Fig. 14. Feature to raster using an extent from a different map layer

6. Upload the DEM and its projection file for a WEPP-Mine application

Special permission from the WEPP-Mine management team is required to upload user-specified input files, including DEMs, to the system (Fig. 15). A DEM in ASCII format and a UTM projection and its projection file are required to utilize a user-specified DEM. The system allows a user to upload an ASCII DEM file with the extension “asc” and its projection file with the extension “prj”. In our case application, the exported DEM in ASCII from the previous steps and its corresponding projection file were used.

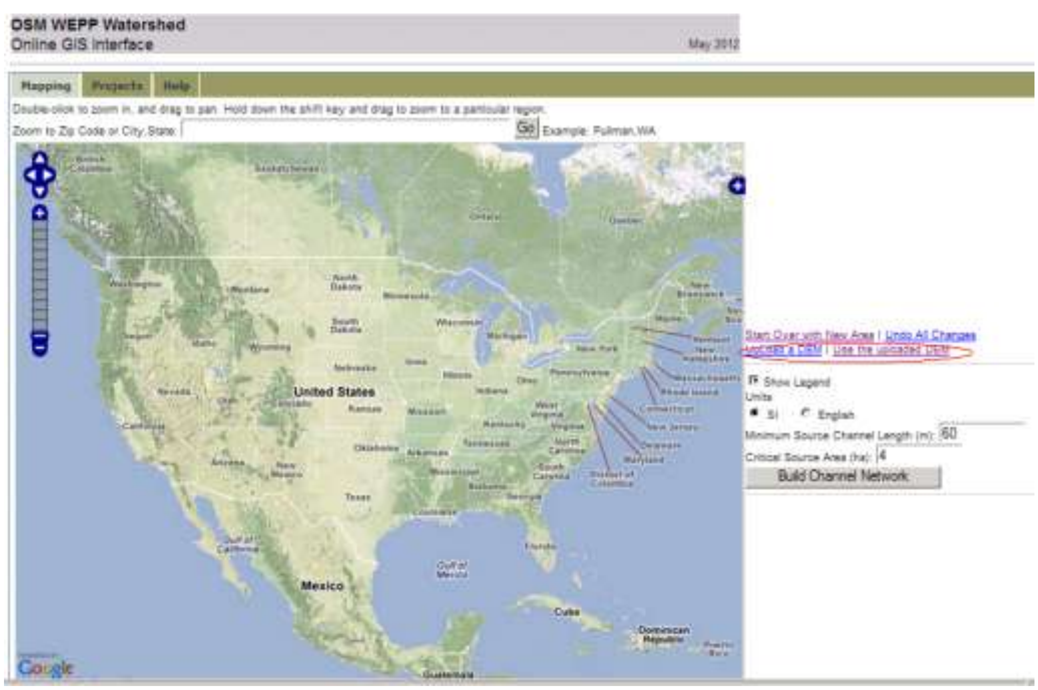

Fig. 15. WEPP-Mine and the link to DEM uploading

Click “Upload a DEM” on the main page and choose the ASCII DEM file (e.g., C:\DEMOSM\TopoAsc.asc) by clicking the “Browse” button in the “Upload a DEM” window (Fig. 16). Click the “Submit” button. The system checks the extent and size of the uploaded file before processing the file. A successful submission brings up a window for submitting the corresponding projection file. Choose the projection file corresponding to the uploaded DEM file and submit it. Close the “Upload a DEM” window. To use the newly uploaded DEM for WEPP-Mine applications, click “Use the uploaded DEM” link on the main page, and the system will zoom to the study area and show the uploaded DEM (Fig. 17).

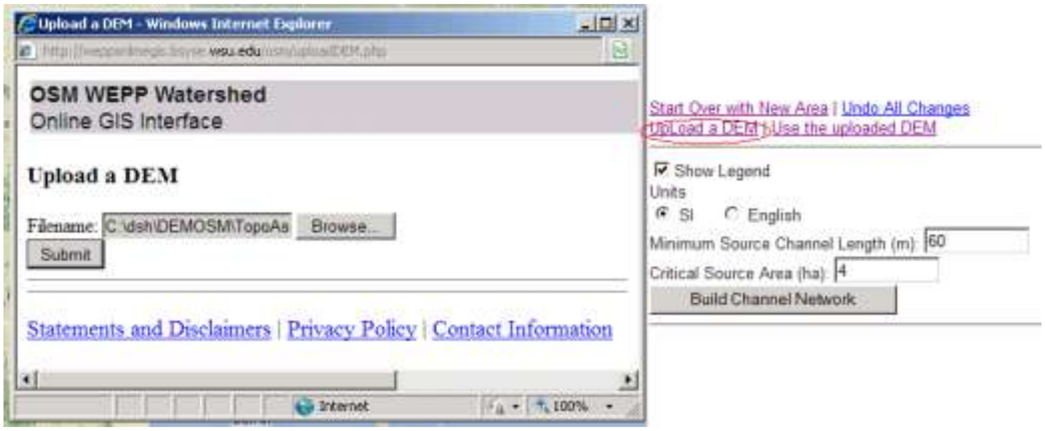

Fig.16. DEM upload window

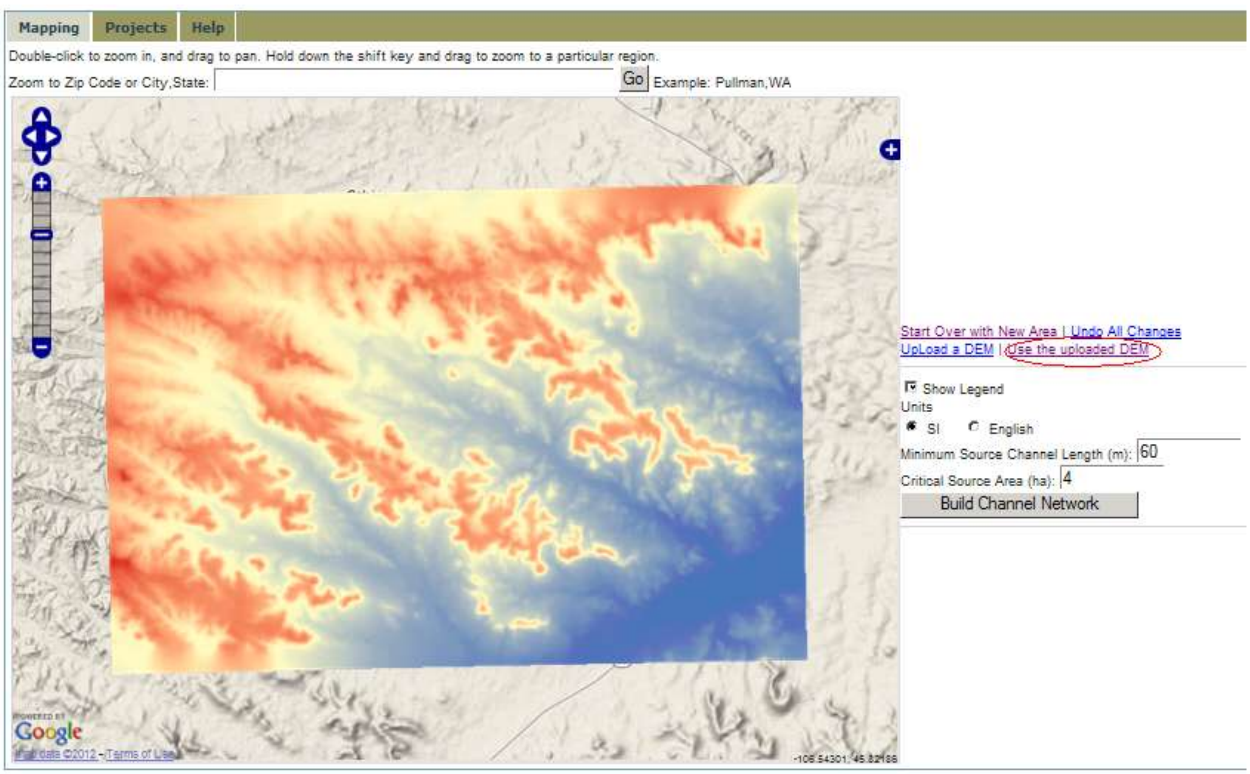

Fig. 17. Using uploaded DEM

Click the "+" symbol at the upper right corner of the map to show the available map layers and check or uncheck the box in front of "User-Specified DEM" to show or hide the uploaded DEM (Fig. 18). To return to the USGS DEM, select "Start Over with New Area" to release the uploaded DEM (Fig. 19).

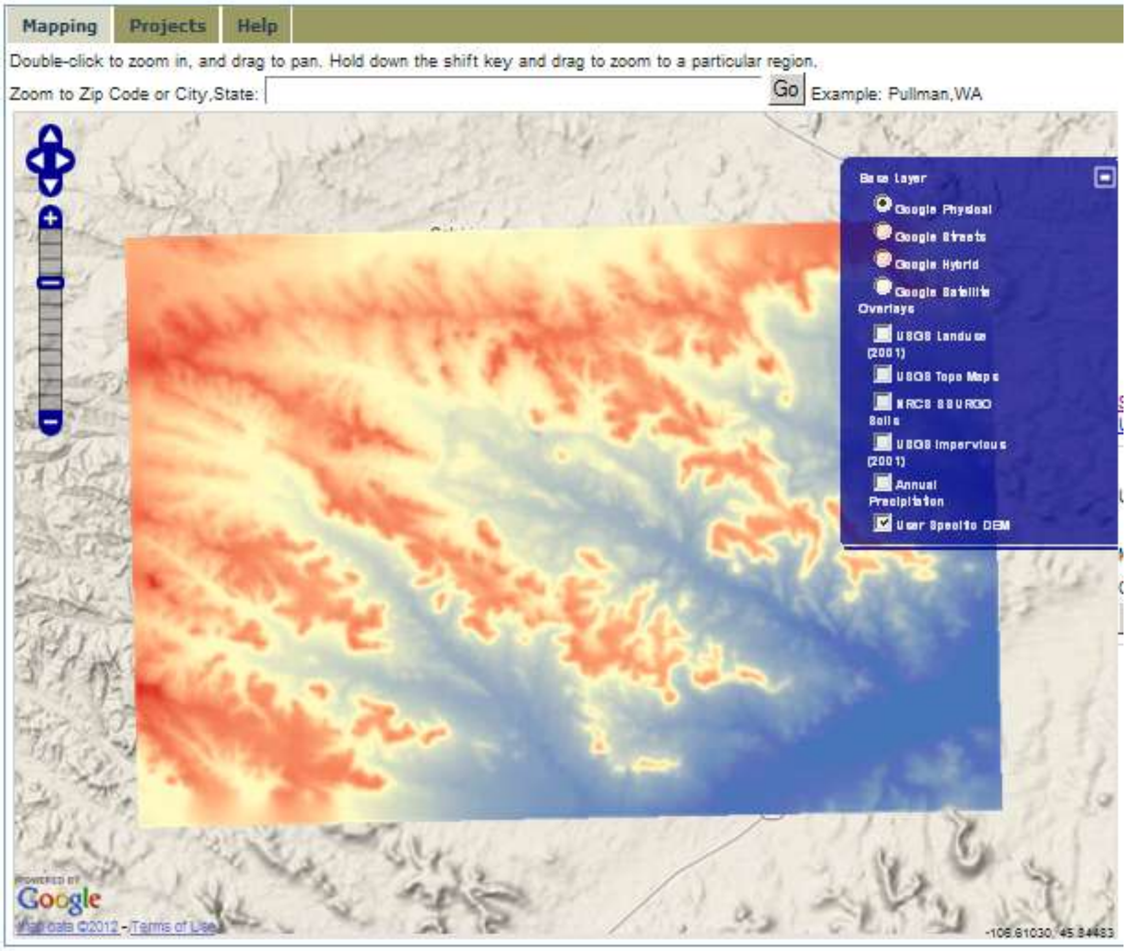

Fig. 18. User-specified DEM

Fig. 19. Releasing a user-specified DEM

7. WEPP-Mine application

There are five major steps in running WEPP-Mine: (1) selecting study area, (2) building channel network, (3) selecting watershed outlet and discretizing the study watershed, (4) setting up and running the WEPP model, and (5) analyzing WEPP simulation results.

(1) A study area is chosen by using the pan and zoom tools of the WEPP-Mine interface. In the case of using a user-specified DEM, the study area is defined by the uploaded DEM.

(2) A channel network is built by clicking the “Build Channel Network” button (Fig. 20). The two parameters, Minimum Source Channel Length and Critical Source Area, can be adjusted to generate the most appropriate channel network. Note that the watershed has to be fully included in the map window when the “Build Channel” command is selected.

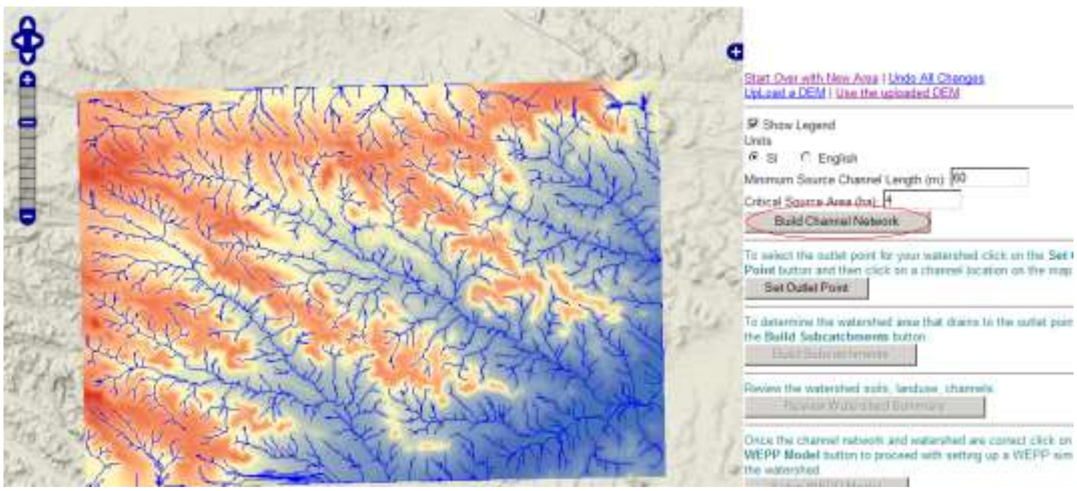

Fig. 20. Building channel network

(3) To discretize a study watershed, select an outlet point on the channel network by clicking the “Set Outlet Point” button (Fig. 21); click “Build Subcatchments” (Fig. 22).

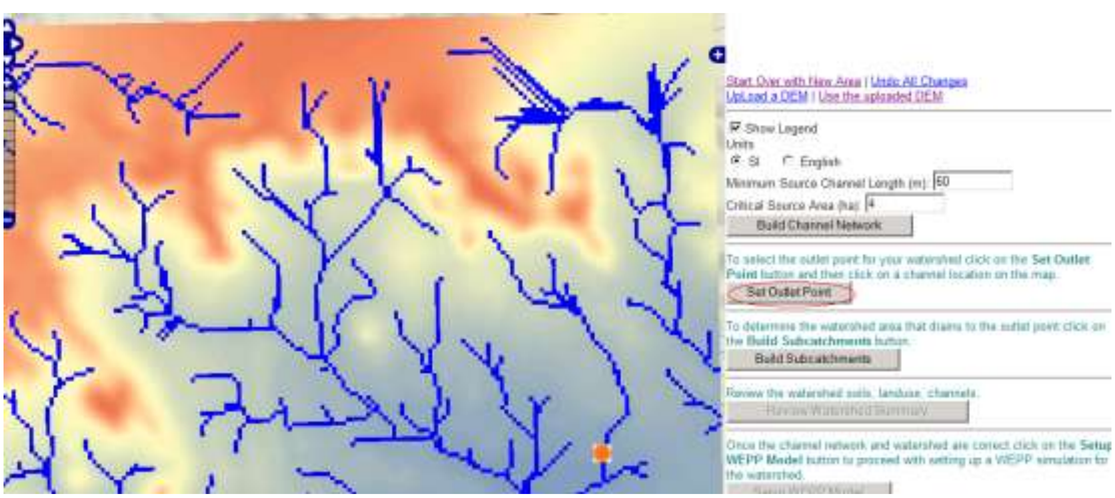

Fig. 21. Selecting watershed outlet point

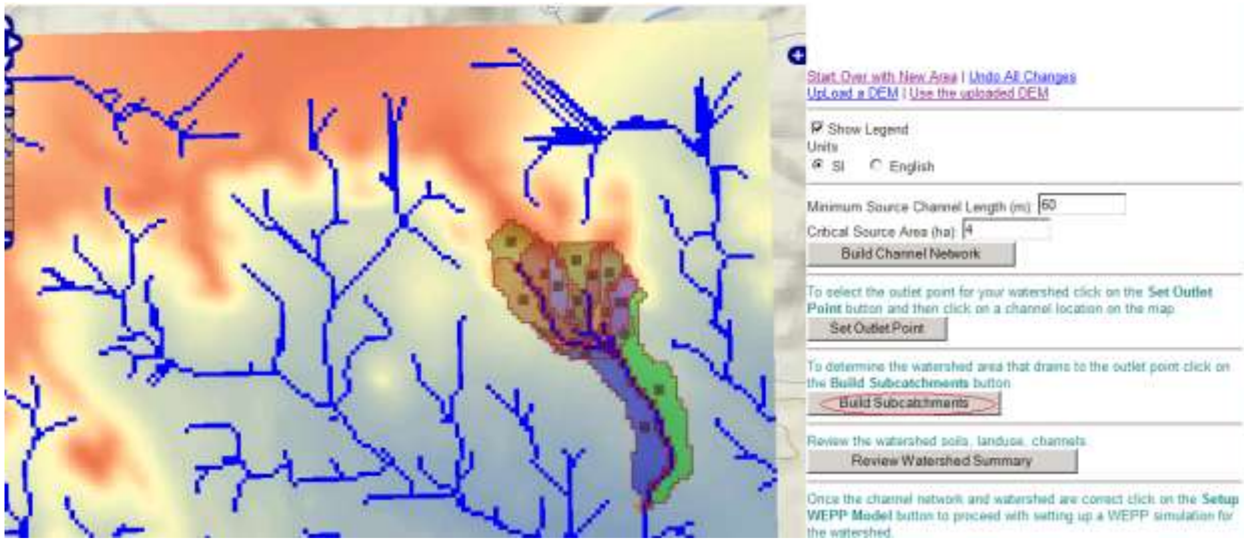

Fig. 22. Discretizing watershed and hillshlops

(4) Click “Review Watershed Summary” to start to set up the WEPP model. The watershed summary page shows the latitude and longitude of the outlet, area, and the number of the channel segments and representative hillslopes of the watershed. It also includes the summary of landuse and soils of the hillslopes and channels determined from the GIS maps.

After closing the Watershed Summary window, the functions for customizing soil and landuse inputs, including those for uploading and activating reclamation maps, will appear (Fig. 23). Uploading and activating a reclamation map works similarly as in uploading a user-specified DEM. When activated, the reclamation map (Fig. 24) is merged with the USGS landuse map to form the post-mining landuse map, and, it is intersected with the SSURGO soil map to create the new soil map.

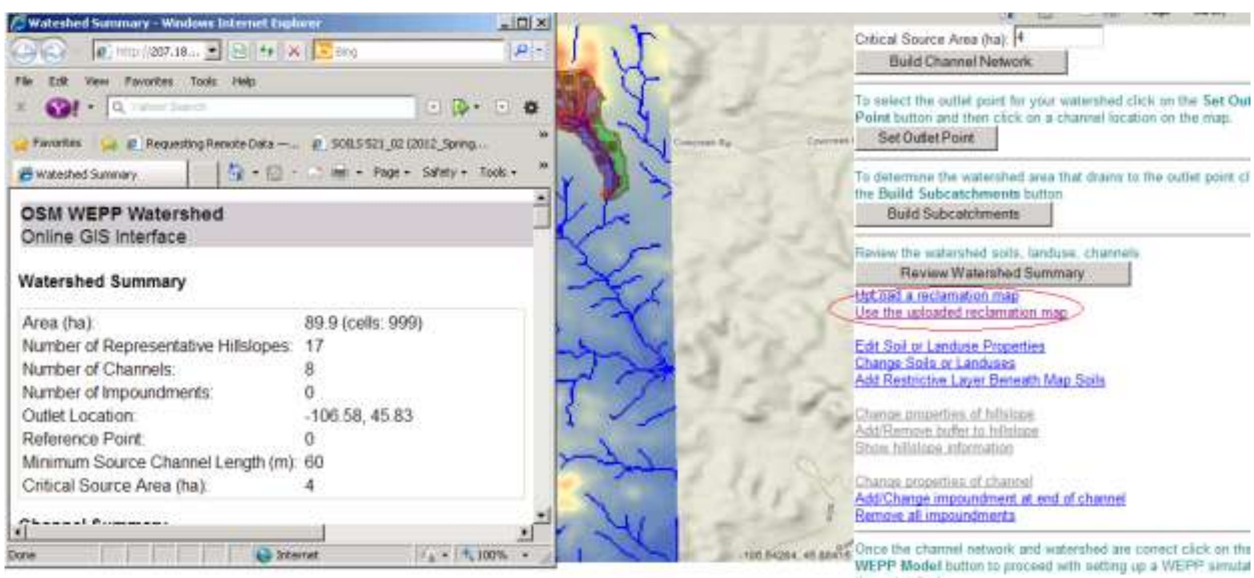

Fig. 23. Functions for uploading and activating a reclamation map

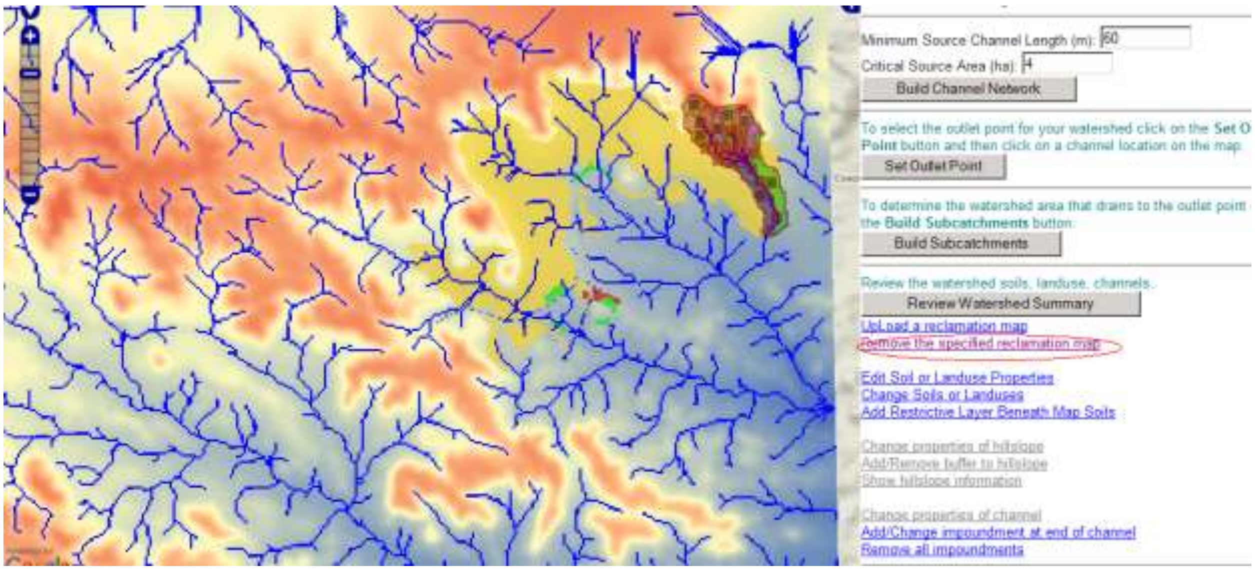

Fig. 24. Activated reclamation map

Post-mining soil and management maps are used for WEPP-Mine simulations. Soil inputs for disturbed areas consist of three parts; surface soil hydraulic and erosion parameters are from the WEPP soil database (Table 2), soil texture data for the top 0.6 m are averages of the corresponding SSURGO soil data for the top 0.6 m, and the soil texture data for the remaining 1.2 m of the soil profile are from mine spoil data for the study area. Management inputs are adapted from the WEPP database (Table 2). Descriptions of commonly used functions in the online WEPP GIS interfaces, including customizing hillslope soil and management inputs for WEPP applications can be found in Frankenberger (2011).

Table 2. Land management and soil data in relation to reclamation conditions WEPP-Mine

Index	Description	WEPP Management	WEPP Soils
0	Undisturbed or NoData	Poor grass	Shrub
1	Disturbed—Facilities	Poor grass	Paved or Bare Rock
2	Not Reclaimed	Bare	Mine Spoil
3	Prior Reclamation	Bare	Regraded Mine Spoil
4	Natural Re-vegetation	Poor grass	Top Soil
5	Seed Phase I	Good grass	Sod Grass
6	Seed Phase II	Good grass	Bunch Grass
7	Trail-complete	Low traffic road	Skid

Options for selecting climatic inputs and WEPP simulation type will appear at the bottom of the main page after clicking the "Setup WEPP model" button (Fig. 25). Two types of simulations, watershed and flowpaths and watershed only, can be made, and the number of simulation years can be specified. The maximum number of simulation years is 10 for a flowpath-type simulation and 100 for a watershed-only run as the former requires much longer run time than the latter. A user can also choose to use a single soil or management for the whole watershed or to use the soil and landuse data determined from the GIS maps. It should be noted that, to best represent pre-mining conditions, future efforts should be devoted to developing functions for using user-specified pre-mining DEMs and landuse and soils maps.

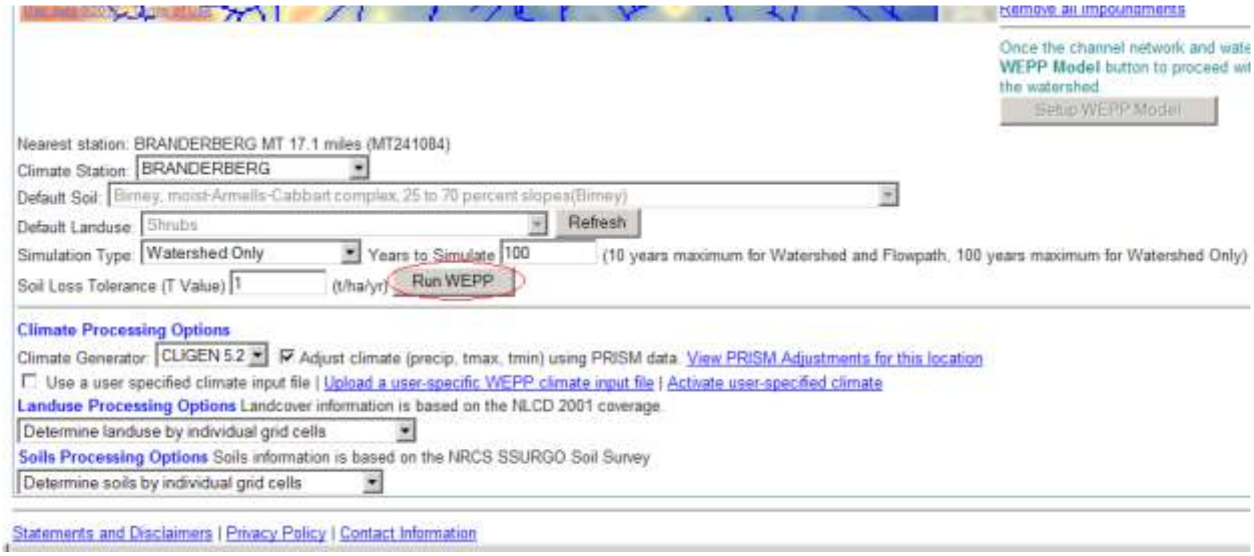

Fig. 25. WEPP simulation options

By default, WEPP-Mine uses stochastically generated files with CLIGEN (Nicks et al., ??) based on long-term statistical climate parameters from the nearest weather station in the WEPP climate database. A user can choose to use the statistical parameters from other weather stations in the database and to further adjust the statistical parameters for precipitation and temperature using PRISM (PRISMCG, 2010).

WEPP-Mine also allows uploading of user-specified climate files (Fig. 25) that are in the same format as the CLIGEN-generated and with the extension ".cli". The uploading and activation procedures are the same as those for using a user-specified DEM or reclamation map. When activated, the uploaded climate file can be used by checking the check box (Fig. 25).

Clicking "Run WEPP" (Fig. 25) will start the WEPP simulation. Upon completion of the WEPP simulation, clicking "View Erosion Maps" in the "Running WEPP" window (Fig. 26) will bring the user back to the main page of WEPP-Mine to evaluate the simulation results.

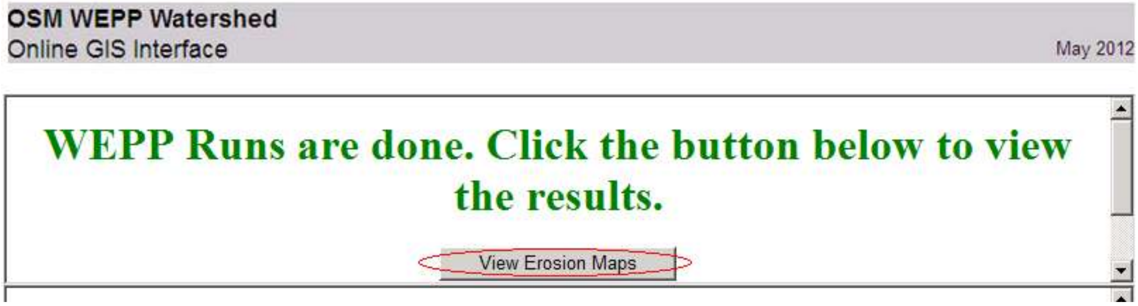

Fig. 26. "Running WEPP" window

(5) WEPP simulation results include maps of runoff, soil loss, and sediment yield (Fig. 27). WEPP-Mine also generates a summary of the simulation results, text outputs, and return-period analysis (Fig. 28).

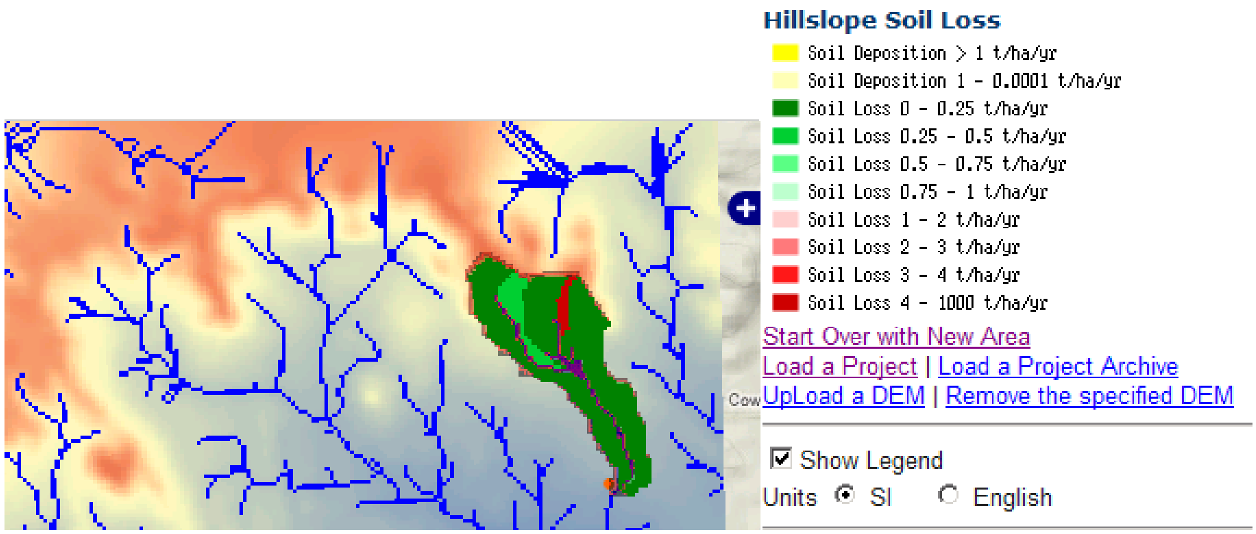

Fig. 27. WEPP-simulated soil loss with user-specified DEM and reclamation map

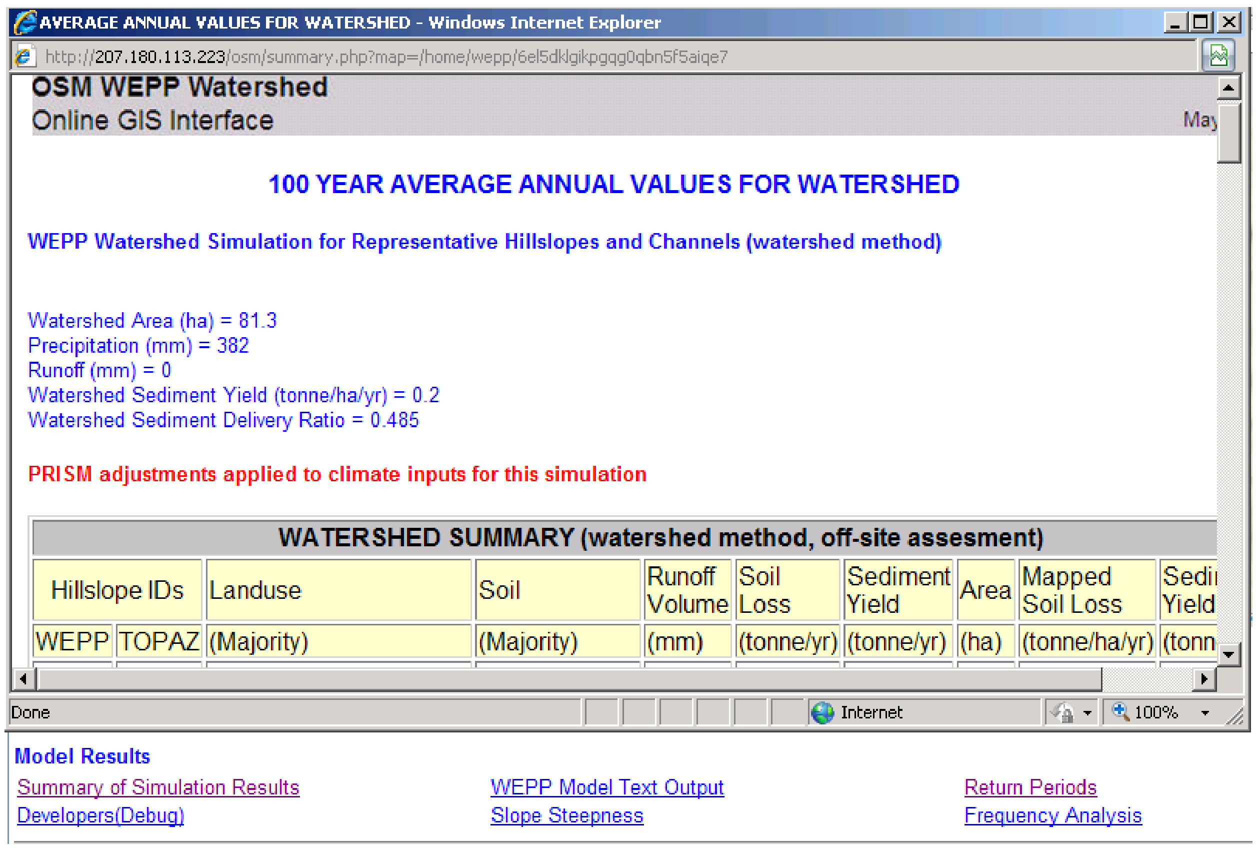

Fig. 28. Links to WEPP simulation results

Return-period analysis of long-term WEPP simulation results can be used to assess post-mining erosion risk. Typically, simulation results for post- and pre-mining conditions are compared. Table 3 shows a comparison of the simulated runoff and sediment yield under presumed pre- and post-mining conditions with return periods of 2, 5, 10, 20, and 25 years. For our case application, the USGS DEM and land cover and the SSURGO soil data, default inputs in WEPP-Mine, were presumed to represent pre-mining conditions, and the user-specified DEM and the reclamation map were intended to describe the post-mining conditions. The following is a summary of the major WEPP inputs and outputs for the two sets of simulations. In general, simulated runoff rate and sediment yield are increased under post-mining conditions in our case study.

Table 3. WEPP-simulated runoff and sediment yield for different return periods

Return Period (yrs)	Under Default Settings		With User-specified DEM and Reclamation map	
	Runoff (mm)	Sediment Yield (t/ha)	Runoff (mm)	Sediment Yield (t/ha)
2	0	0	0	0
5	0.04	0	0.57	0.29
10	0.24	0.03	0.91	0.48
20	1.33	0.19	1.67	0.88
25	1.64	0.30	1.67	0.92

WEPP Inputs and Simulation Results with Default Settings

Watershed Summary

Area (ha):	89.7 (cells: 997)
Number of Representative Hillslopes:	8
Number of Channels:	3
Number of Impoundments:	0
Outlet Location:	−106.5756, 45.8258
Reference Point:	0
Minimum Source Channel Length (m):	60
Critical Source Area (ha):	4

Landuse Summary

The watershed contains the following landuse as detemined by the USGS National Land Cover Database 2001 - http://www.mrlc.gov/nlcd.php

ID	Name	WEPP File	Number of Cells	Area(ha)	Percent Watershed
21	Developed, Open Space	Good grass.rot	21	1.89	2.1
31	Barren Land	Good grass.rot	26	2.34	2.6
42	Evergreen Forest	Mature forest.rot	34	3.06	3.4
52	Shrub/Scrub	Shrubs.rot	326	29.34	32.7
71	Grasslands/Herbaceous	Good grass.rot	582	52.38	58.4
82	Cultivated Crops	GeoWEPP/corn,soybean-fall mulch till.rot	8	0.72	0.8

Soils Summary

The watershed contains the following soils as determined by the NRCS Soil Survey. The data is requested directly from the NRCS soils database. Information on the NRCS Soils Data structure and how it can be accessed are found at: http://sdmdataaccess.nrcs.usda.gov/

MuKey	Soil Name	Number of Cells	Area(ha)	Percent Watershed
347929	Kirby-Cabbart-Rock outcrop complex, 25 to 70 percent slopes	264	23.76	26.5
348028	Yamac loam, 2 to 8 percent slopes	92	8.28	9.2
348037	Yamacall-Busby complex, 2 to 8 percent slopes	1	0.09	0.1
348038	Yamac-Busby complex, 8 to 15 percent slopes	69	6.21	6.9
348042	Birney, moist-Armells-Cabbart complex, 25 to 70 percent slopes	40	3.6	4.0
348075	Busby fine sandy loam, 2 to 8 percent slopes	33	2.97	3.3
348076	Busby fine sandy loam, 8 to 15 percent slopes	113	10.17	11.3
348078	Busby-Rock outcrop complex, 8 to 15 percent slopes	152	13.68	15.2
348080	Busby-Twilight-Blackhall, warm, fine sandy loams, 8 to 25 percent slopes	80	7.2	8.0

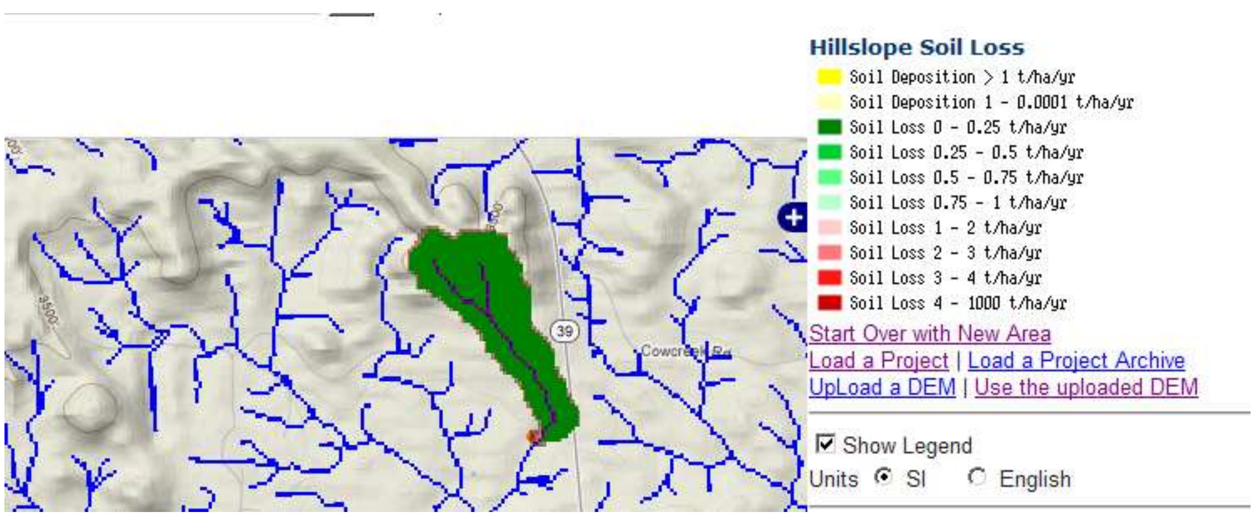

Fig. 29. WEPP-simulate soil loss under default settings

Number of events: 362

100 YEAR SIMULATION FOR WATERSHED

WEPP Watershed Simulation for Representative Hillslopes and Channels (watershed method, off-site assesment)

Note that return period of the events are estimated by applying the Weibull formula on annual maxima series.
T = (N + 1)/m
where T is the return period, N is the number of simulation years, and m is the rank of the annual maxima event.

Return Period of PRECIPITATION in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2	30	8	77	28.9	0.00605	0.00325	0.000133
5	18	10	59	37.3	0.00169	0.00097	0
10	16	5	100	43.7	0.0109	0.0055	1.43E-5
20	22	7	17	53.5	6.21	1.67	2.1
25	1	10	34	54.5	0.0155	0.00714	0

Return Period of RUNOFF in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2	7	8	24	24.8	0.00855	0.00443	0.000187
5	2	4	90	36	0.0446	0.0199	0.000908
10	7	8	9	25.9	0.235	0.0874	0.0251
20	23	8	73	33.7	1.33	0.418	0.123
25	17	6	80	25.8	1.64	0.502	0.55

Return Period of PEAK RUNOFF in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2	7	8	24	24.8	0.00855	0.00443	0.000187
5	2	4	90	36	0.0446	0.0199	0.000908
10	7	8	9	25.9	0.235	0.0874	0.0251
20	23	8	73	33.7	1.33	0.418	0.123
25	17	6	80	25.8	1.64	0.502	0.55

Return Period of SEDIMENT YIELD in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2	8	7	10	21.4	0.0059	0.00317	0.000131
5	2	4	90	36	0.0446	0.0199	0.000908
10	7	8	9	25.9	0.235	0.0874	0.0251
20	28	6	95	36.5	1.81	0.55	0.195
25	26	8	35	29.4	1.3	0.409	0.3

WEPP Inputs and Simulation Results with User-Specified DEM and Reclamation Map

Watershed Summary

Area (ha):	89.9 (cells: 999)
Number of Representative Hillslopes:	17
Number of Channels:	8
Number of Impoundments:	0
Outlet Location:	−106.5756, 45.8258
Reference Point:	0
Minimum Source Channel Length (m):	60
Critical Source Area (ha):	4

Landuse Summary

The watershed contains the following landuse as detemined by the USGS National Land Cover Database 2001 - http://www.mrlc.gov/nlcd.php

ID	Name	WEPP File	Number of Cells	Area(ha)	Percent Watershed
2	Disturbed, Not Reclaimed	Bare.rot	8	0.72	0.8
3	Prior Reclamation	Bare.rot	713	64.17	71.4
21	Developed, Open Space	Good grass.rot	7	0.63	0.7
31	Barren Land	Poor grass.rot	18	1.62	1.8
42	Evergreen Forest	Mature forest.rot	18	1.62	1.8
52	Shrub/Scrub	Shrubs.rot	68	6.12	6.8
71	Grasslands/Herbaceous	Good grass.rot	166	14.94	16.6
82	Cultivated Crops	GeoWEPP/corn,soybean-fall mulch till.rot	1	0.09	0.1

Soils Summary

The watershed contains the following soils as determined by the NRCS Soil Survey. The data is requested directly from the NRCS soils database. Information on the NRCS Soils Data structure and how it can be accessed are found at: http://sdmdataaccess.nrcs.usda.gov/

MuKey	Soil Name	Number of Cells	Area(ha)	Percent Watershed
3480420	Birney, moist-Armells-Cabbart complex, 25 to 70 percent slopes(Birney)	33	2.97	3.3
3479290	Kirby-Cabbart-Rock outcrop complex, 25 to 70 percent slopes(Kirby)	172	15.48	17.2
3479293	Regraded Mine Spoil/Kirby-Cabbart-Rock outcrop complex, 25 to 70 percent slopes(Kirby)	126	11.34	12.6
3480803	Regraded Mine Spoil/Busby-Twilight-Blackhall, warm, fine sandy loams, 8 to 25 percent slopes(Busby)	76	6.84	7.6
3480800	Busby-Twilight-Blackhall, warm, fine sandy loams, 8 to 25 percent slopes(Busby)	2	0.18	0.2
3480783	Regraded Mine Spoil/Yamac-Busby complex, 8 to 15 percent slopes(Yamac)	154	13.86	15.4
3480780	Yamac-Busby complex, 8 to 15 percent slopes(Yamac)	3	0.27	0.3
3480763	Regraded Mine Spoil/Busby fine sandy loam, 8 to 15 percent slopes(Busby)	106	9.54	10.6
3480383	Regraded Mine Spoil/Yamac-Busby complex, 8 to 15 percent slopes(Yamac)	60	5.4	6.0
3481073	Regraded Mine Spoil/Delpoint-Yamacall-Cabbart loams, 8 to 25 percent slopes(Delpoint)	93	8.37	9.3
3480373	Regraded Mine Spoil/Yamacall-Busby complex, 2 to 8 percent slopes(Yamacall)	5	0.45	0.5
3480283	Regraded Mine Spoil/Yamac loam, 2 to 8 percent slopes(Yamacall)	61	5.49	6.1
3480280	Yamac loam, 2 to 8 percent slopes(Yamacall)	14	1.26	1.4
3480753	Regraded Mine Spoil/Busby fine sandy loam, 2 to 8 percent slopes(Busby)	32	2.88	3.2
3481070	Delpoint-Yamacall-Cabbart loams, 8 to 25 percent slopes(Delpoint)	49	4.41	4.9
3480750	Busby fine sandy loam, 2 to 8 percent slopes(Busby)	5	0.45	0.5
3481072	Mine Spoil/Delpoint-Yamacall-Cabbart loams, 8 to 25 percent slopes(Delpoint)	7	0.63	0.7
3480752	Mine Spoil/Busby fine sandy loam, 2 to 8 percent slopes(Busby)	1	0.09	0.1

Number of events: 59

100 YEAR SIMULATION FOR WATERSHED

WEPP Watershed Simulation for Representative Hillslopes and Channels (watershed method, off-site assesment)

Note that return period of the events are eatimated by applying Weibull formula on annual maxima series.
T = (N + 1)/m
where T is the return period, N is the number of simulation years, and m is the rank of the annual maxima event.

Return Period of PRECIPITATION in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2				0	0	0	0
5	23	8	73	33.7	0.329	0.112	0.15
10	1	6	3	39.9	0.5	0.163	0.278
20	19	6	66	49.6	0.909	0.271	0.482
25	5	5	47	53.2	0.918	0.274	0.52

Return Period of RUNOFF in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2				0	0	0	0
5	7	8	9	25.9	0.571	0.179	0.279
10	19	6	66	49.6	0.909	0.271	0.482
20	22	8	80	36.2	1.67	0.468	0.881
25	2	6	97	41.7	1.67	0.47	0.916

Return Period of PEAK RUNOFF in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2				0	0	0	0
5	7	8	9	25.9	0.571	0.179	0.279
10	19	6	66	49.6	0.909	0.271	0.482
20	22	8	80	36.2	1.67	0.468	0.881
25	2	6	97	41.7	1.67	0.47	0.916

Return Period of SEDIMENT YIELD in Event by Event Output							
Recurrence Interval	Day	Month	Year	Precipitation	Runoff	Peak	Sediment Yield
years				(mm)	(mm)	(m^3/s)	(t/ha)
2				0	0	0	0
5	1	6	60	34.7	0.501	0.159	0.294
10	19	6	66	49.6	0.909	0.271	0.482
20	22	8	80	36.2	1.67	0.468	0.881
25	2	6	97	41.7	1.67	0.47	0.916

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