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DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Conservation & Restoration

Numeric Modeling

Quantifying Reductions in Nonpoint Source Pollution

2014

Objectives

- Outline Nonpoint Source Pollution
- Discuss the Watershed Management Cycle
- Demonstrate how to Model Pollutant Loads and Calculate Load Reductions
- Disseminate Federal and State Requirements

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Nonpoint Source Pollution

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Significant Degradation

- Legacy issues
- Lack a restrictive permit
- Leading causes of water pollution in PA
  - Abandoned Mine Drainage (AMD)
  - Agriculture lacking Best Management Practices
  - Urban Runoff

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Impairment Defined

- What is a water quality impairment?
  - Chemical
  - Biological
- How do we know?
  - Stream Surveys and Sampling
  - Water quality standards, AMD
  - Index of Biotic Integrity Score (IBI Score)

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Aquatic Life Use Survey

- Aquatic life use surveys are the basis for more than 90% of waters classified as impaired/polluted

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Sensitive Biota – EPT taxa

Ephemeroptera, Plecoptera and Tricoptera

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Watershed Management Cycle

- Stream/Watershed survey
- Streams that are polluted are included on the:

  Integrated List of Impaired Waters
- A Total Maximum Daily Load (TMDL) is completed/modeled to address the pollutants for which the water is listed
- Watershed Implementation Plan (WIP) developed
- Restoration funding is awarded to Grantees
- Best Management Plans (BMPs) designed and constructed
- Restoration quantified/modeled, Agriculture and Stormwater
- Watershed is re-surveyed if TMDL goals attained

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Numeric Modeling

Numeric Modeling for Agricultural (Ag) and Urban Stormwater Impairments

- Existing Conditions/Loads
- TMDL goals established
- Load Reductions from BMP Implementation calculated and measured against TMDL goals

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Step 1 - Clipping Basins

- USGS StreamStats
- Zoom in to your watershed
- Clip the basin

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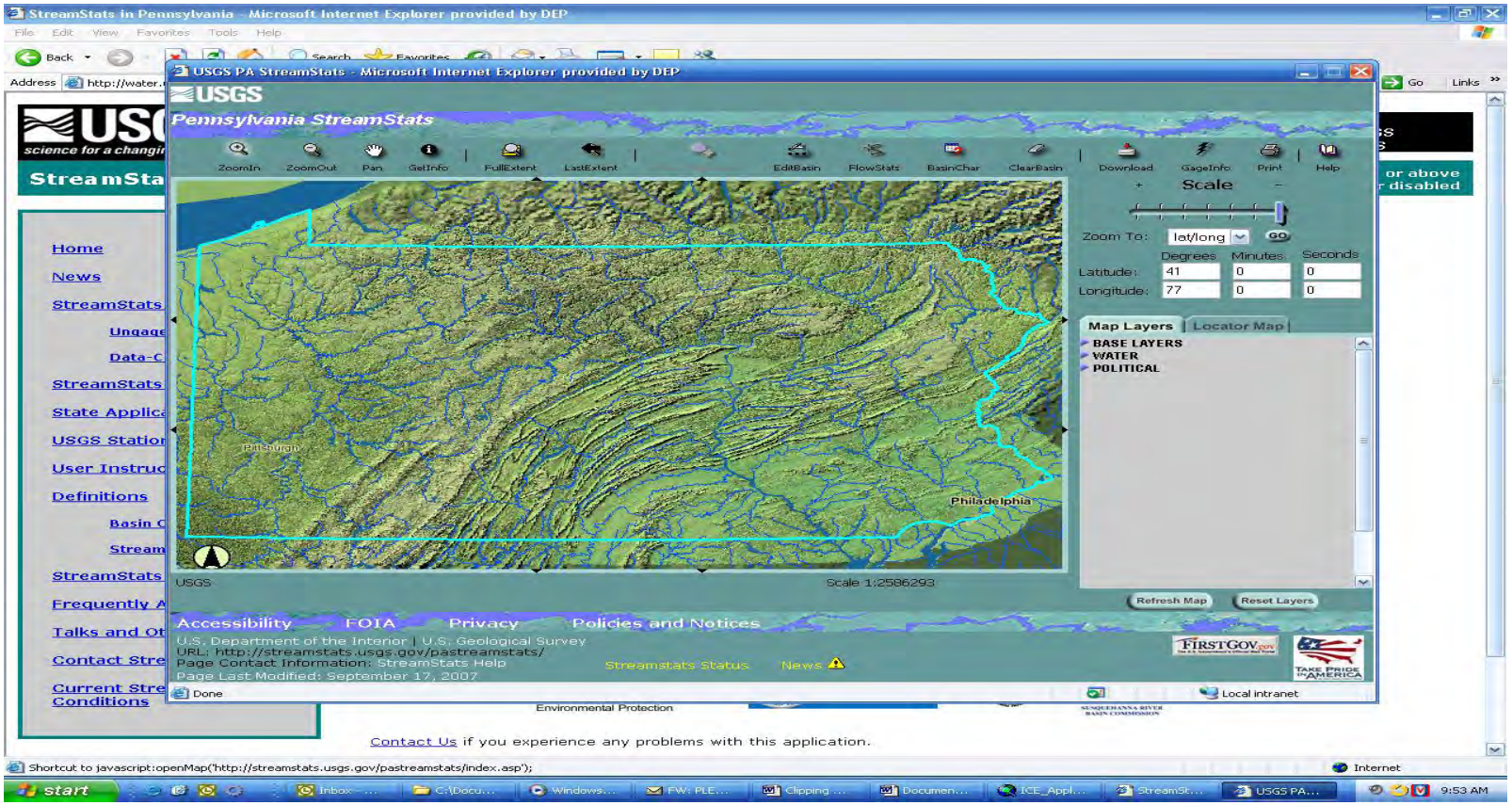
USGS StreamStats

- Open PA Stream Stats at http://water.usgs.gov/osw/streamstats/pennsylvania.htm



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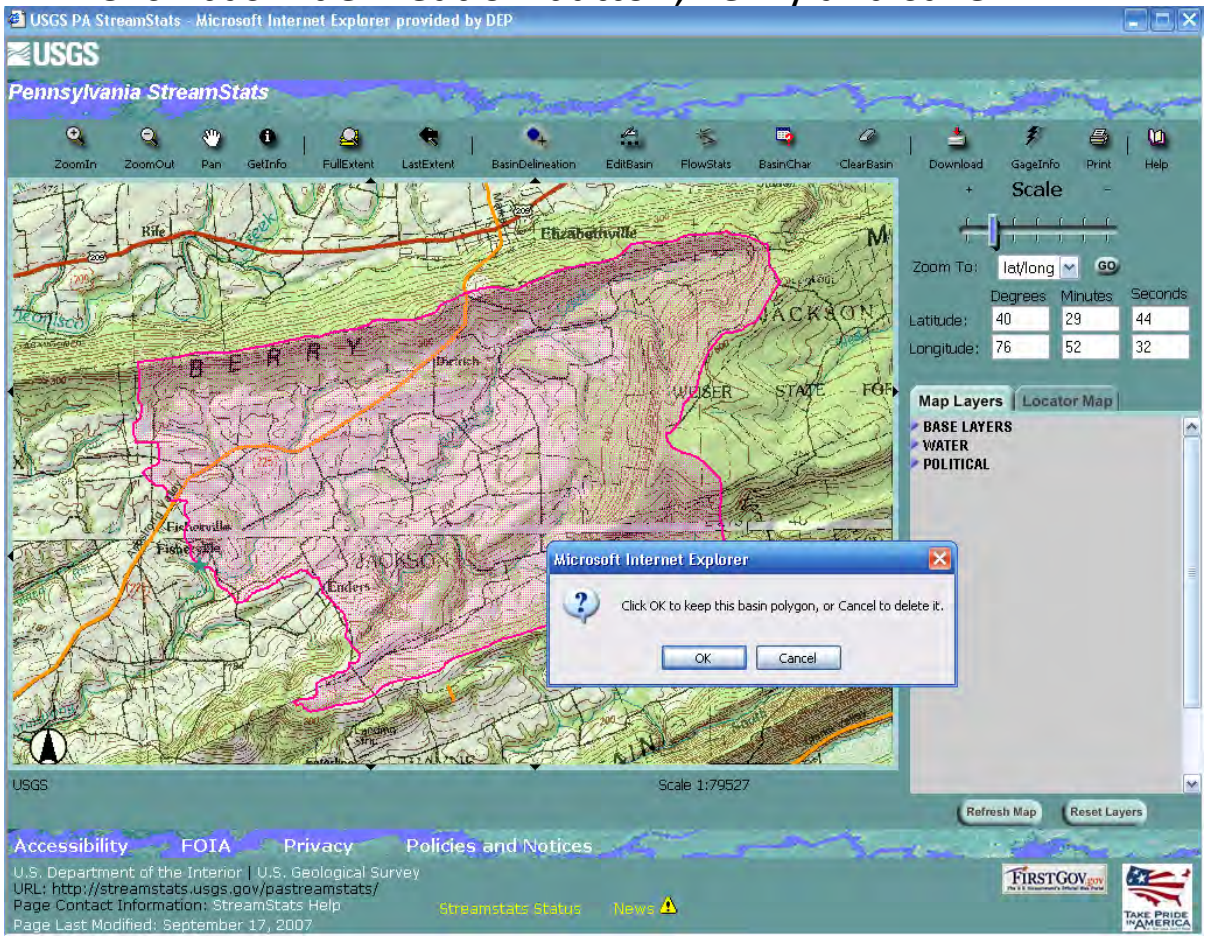
Delineate Your Basin

- Zoom to your basin by Latitude and Longitude (lat/long) or by panning
- Click basin delineation button, verify and save



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Step 2 – Modeling Existing Loads

MapShed – NPS model

- Download the software and data layers
- www.mapshed.psu.edu
- Open MapShed and click on Help
- *Read the Manual !!!*

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The Model - MapShed

- Empirical – Observed Data
- Continuous – Climatic and Cumulative
- Lumped Parameter – Discrete entities measurable in space and time/Land uses
- For Agriculture and Urban Storm Water

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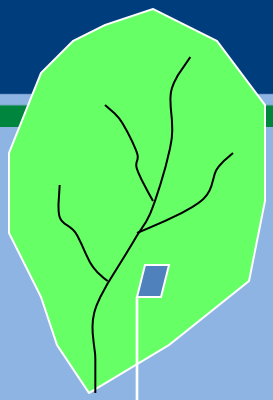
How it works



Loadings from other Unit source areas

Transport and Attenuation

Concentrations

Unit Source Area

Crop, soil, topo-graphy, manage-ment, weather

Runoff Curve Number

dissolved

dissolved

Σ

dissolved pollutants

Edge-of-Field Pollutant Losses

Delivery to Watershed Outlet

Watershed Export

Soil loss USLE

solid-phase

solid-phase

Σ

solid-phase pollutants

Loadings from other Unit source areas

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Existing Conditions

Baseline of pollution pre-BMP implementation

- Enter basin, state and regional data layers
- Calibrate model run and add Animal Units
- Run the model without BMPs
- Save your Run Files and Output Files under specific project folder
- Save and export a jpeg of Existing Loads, Total Loads Output File for future comparison

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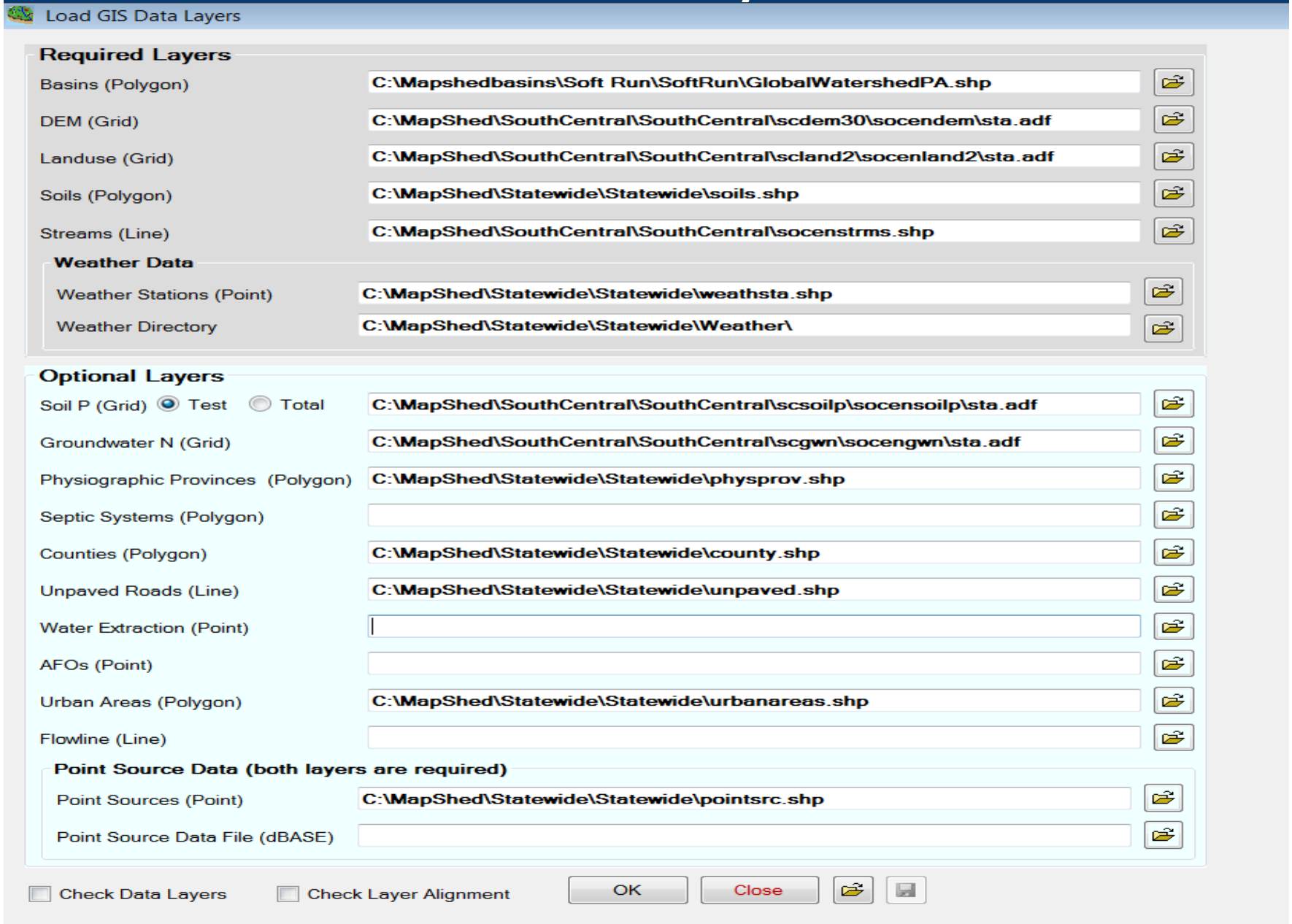
Data Layers


Load GIS Data Layers
Required Layers
Basins (Polygon)
C:\Mapshedbasins\Soft Run\SoftRun\GlobalWatershedPA.shp
DEM (Grid)
C:\MapShed\SouthCentral\SouthCentral\scdem30\socendem\sta.adf
Landuse (Grid)
C:\MapShed\SouthCentral\SouthCentral\scland2\socenland2\sta.adf
Soils (Polygon)
C:\MapShed\Statewide\Statewide\soils.shp
Streams (Line)
C:\MapShed\SouthCentral\SouthCentral\socenstrms.shp
Weather Data
Weather Stations (Point)
C:\MapShed\Statewide\Statewide\weathsta.shp
Weather Directory
C:\MapShed\Statewide\Statewide\Weather\
Optional Layers
Soil P (Grid)
Test
Total
C:\MapShed\SouthCentral\SouthCentral\scsoilp\socensoilp\sta.adf
Groundwater N (Grid)
C:\MapShed\SouthCentral\SouthCentral\scgwn\socengwn\sta.adf
Physiographic Provinces (Polygon)
C:\MapShed\Statewide\Statewide\physprov.shp
Septic Systems (Polygon)
Counties (Polygon)
C:\MapShed\Statewide\Statewide\county.shp
Unpaved Roads (Line)
C:\MapShed\Statewide\Statewide\unpaved.shp
Water Extraction (Point)
AFOs (Point)
Urban Areas (Polygon)
C:\MapShed\Statewide\Statewide\urbanareas.shp
Flowline (Line)
Point Source Data (both layers are required)
Point Sources (Point)
C:\MapShed\Statewide\Statewide\pointsrc.shp
Point Source Data File (dBASE)
Check Data Layers
Check Layer Alignment
OK
Close

Output – Existing Loads

GWLF Total Loads for file: SoftRunNoBMPs-2295243 **Period of analysis:** 24 years from 1975 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2731	2.2	1346.3	210.2	1015.8	1856.4	301.3	621.2
Cropland	1643	3.9	8836.7	1379.4	4263.1	9780.7	327.1	2426.5
Forest	3452	1.9	188.6	29.4	274.8	392.6	14.5	59.3
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	20	2.9	0.0	0.1	2.0	6.6	0.3	0.7
MD Mixed	111	9.2	0.0	3.5	45.4	146.8	6.3	16.4
HD Mixed	114	13.4	0.0	3.6	46.4	150.0	6.5	16.7
LD Residential	44	2.9	0.0	0.3	4.4	14.9	0.6	1.6
MD Residential	304	5.2	0.0	9.6	124.1	401.2	17.3	44.8
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				342.2		341.7		130.1
Groundwater					60979.7	60979.7	684.4	684.4
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					0.0	0.0	0.0	0.0
Totals	8418.9	2.70	10371.5	1978.4	66755.7	74070.6	1358.2	4001.6

Go Back | Pathogen Loads | Export to JPEG | Print | Close

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Step 3 – Quantifying Reductions

- BMP editor
- Enter BMPs into the same project as percent coverage per BMP type and unit
- Run model with BMPs
- Save BMP, Total Loads Output File
- Subtract from Existing Loads Output file

Reductions!

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BMP Key

- BMP 1 - Cover Crops
- BMP 2 - Conservation Tillage
- BMP 3 - Stripcropping & Contour Farming
- BMP 4 - Conservation Plan
- BMP 5 - User Defined
- BMP 6 - Nutrient Management
- BMP 7 - Grazing Land Management
- BMP 8 - Agricultural Land Retirement

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Contour Farming BMP

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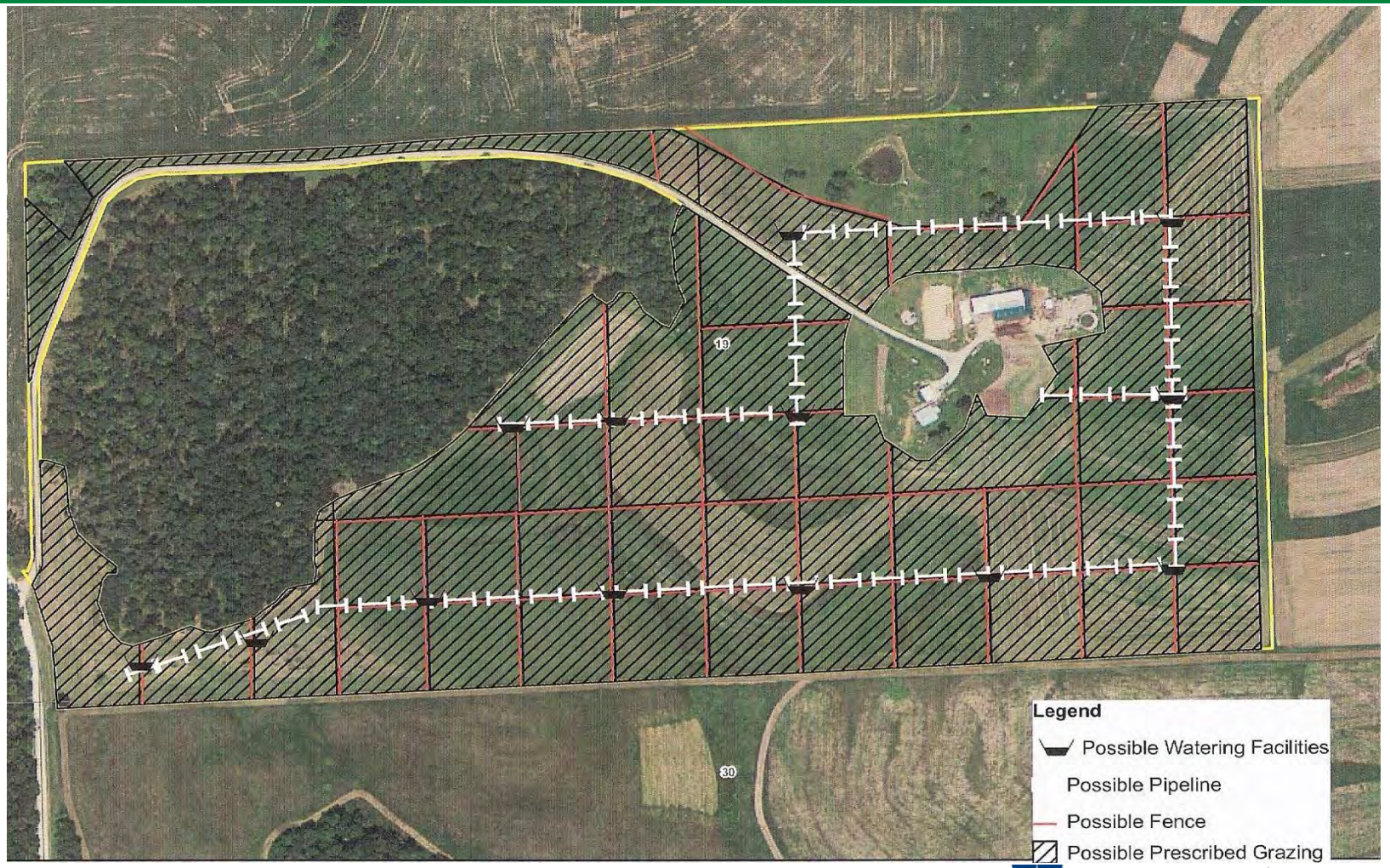
Grazing Land Management BMP



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Enter BMPs

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Output – BMPs Modeled

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			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2731	2.2	1346.3	207.8	1012.2	1849.9	299.2	616.9
Cropland	1643	3.9	8836.7	1339.7	3893.9	8933.7	283.0	2099.8
Forest	3452	1.9	188.6	29.4	274.8	392.6	14.5	59.3
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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Point Sources					0.0	0.0	0.0	0.0
Septic Systems					0.0	0.0	0.0	0.0
Totals	8418.9	2.70	10371.5	1936.3	63902.5	70736.7	1296.2	3654.6

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Calculate Reductions

- Existing Loads File – BMP Loads File =

Load Reductions for Sediment, Nutrients:
Total Nitrogen (TN) & Total Phosphorus (TP)

For example:

74,070.6 Pounds TN Existing

\- 70,736.7 Pounds TN with BMPs

3,333.9 Pounds TN Reduced from Soft Run

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Reductions v TMDLs

- Apply reductions to TMDL goals
- Track progress toward restoration numerically
- Attain numeric TMDL goals
- Verify success by resurveying the watershed
- Delist the waterbody from the list of impaired waters once restored
- Success story!

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Our Goal: Restoration

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Why Restoration Matters

Summary

- Tracking load reductions per BMP is an EPA requirement
- Determine when to resurvey by comparison with TMDL goals
- Grantees can model BMPs - or -
- Provide DEP with:
  - Animal Units
  - BMP type, units, subwatershed
- Load Reductions must be included in the Project Final Report

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