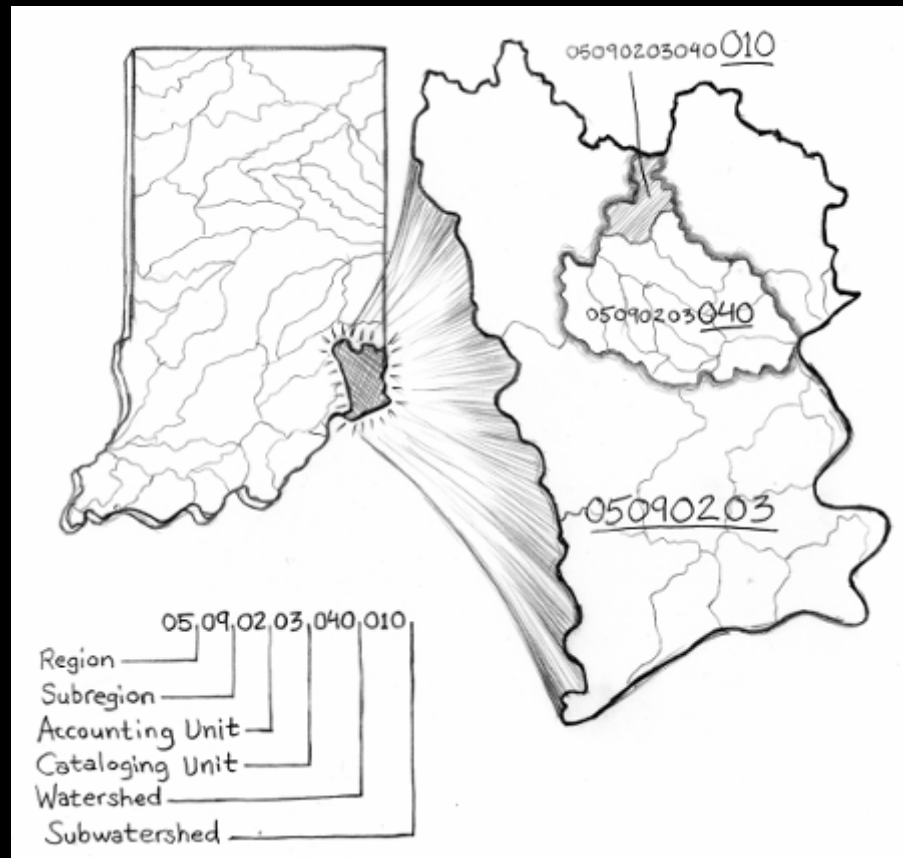


Using Data to Support Watershed Protection and Restoration Decisions



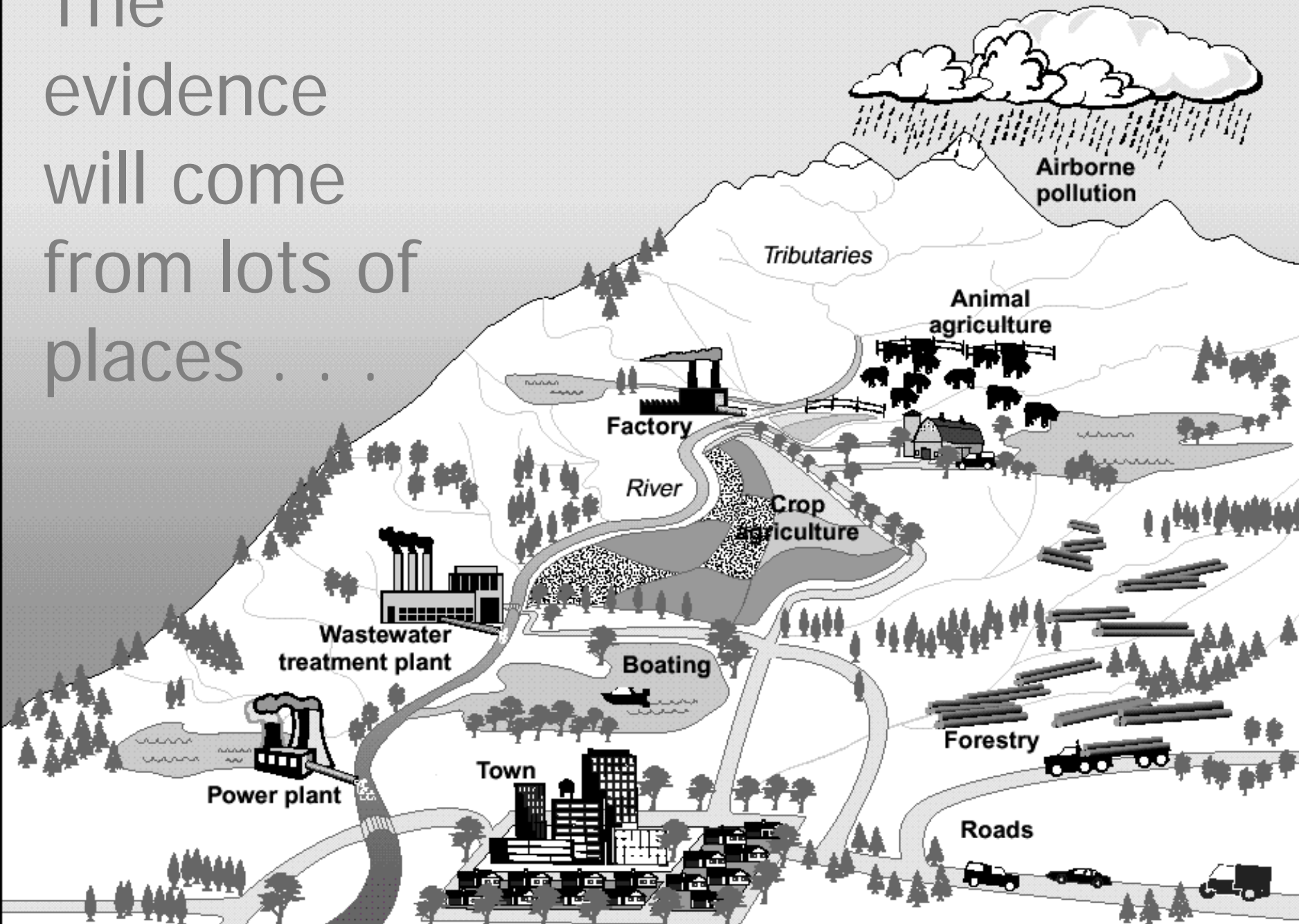
CSI Watershed

You found the (water) body.

There were signs of a struggle.

What happened?

The evidence will come from lots of places . . .



Indiana Watershed Plan Checklist

- Watershed community
- Watershed inventory
- ID problems & causes
- ID sources, calculate loads
- Set goals, ID critical areas
- Select goals/indicators
- Choose BMPs/measures
- Action register & schedule
- Tracking effectiveness

IDEM Watershed Management Plan (WMP) Checklist (2009)

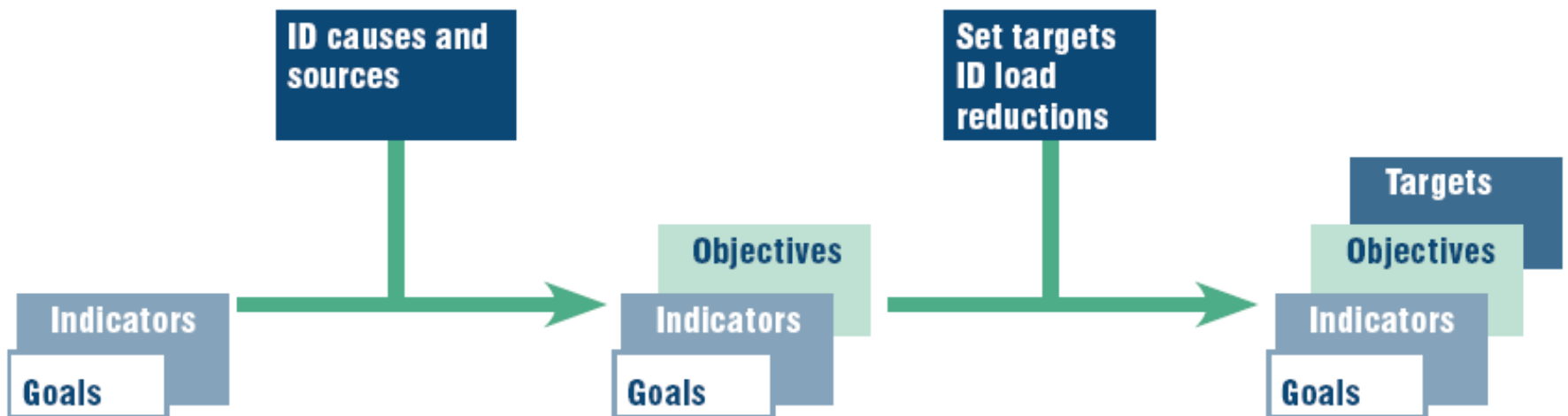
Name of Project:		
WMP Draft Date:		
IDEM Reviewers:		WMP Review Date:
1.	2.	3.

Instructions: The numbered elements (1-33) make up the IDEM WMP Checklist (2009). The items with boxes are the requirements needed to meet the numbered elements. These items come directly from the WMP Checklist instructions. The WMP cannot be approved until all numbered elements are complete.

Page(s) #	Required Content										
WATERSHED COMMUNITY INITIATIVE											
	<p>1. The reasons the community decided to initiate this watershed project.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Explain the concerns that led leaders to initiate the project <input type="checkbox"/> Explain who the local leaders are <input type="checkbox"/> Explain how/why they decided to work together <p>Comments: _____</p>										
	<p>2. A description of the steering committee and who they represent.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Explain how stakeholder involvement was generated <input type="checkbox"/> Explain how additional stakeholder concerns were gathered <input type="checkbox"/> In a figure include: <table border="1" style="width: 100%; margin-top: 5px;"> <tr> <td><input type="checkbox"/> Title</td> <td><input type="checkbox"/> Number</td> </tr> <tr> <td><input type="checkbox"/> Title and Number in Table of Contents</td> <td><input type="checkbox"/> Figure is legible</td> </tr> <tr> <td colspan="2"><input type="checkbox"/> A list of the steering committee members and their affiliation</td> </tr> </table> <input type="checkbox"/> Describe any outreach efforts used to generate stakeholder involvement <p>Comments: _____</p>	<input type="checkbox"/> Title	<input type="checkbox"/> Number	<input type="checkbox"/> Title and Number in Table of Contents	<input type="checkbox"/> Figure is legible	<input type="checkbox"/> A list of the steering committee members and their affiliation					
<input type="checkbox"/> Title	<input type="checkbox"/> Number										
<input type="checkbox"/> Title and Number in Table of Contents	<input type="checkbox"/> Figure is legible										
<input type="checkbox"/> A list of the steering committee members and their affiliation											
	<p>3. A list of stakeholder concerns.</p> <ul style="list-style-type: none"> <input type="checkbox"/> In a figure include: <table border="1" style="width: 100%; margin-top: 5px;"> <tr> <td><input type="checkbox"/> Title</td> <td><input type="checkbox"/> Number</td> </tr> <tr> <td><input type="checkbox"/> Title and Number in Table of Contents</td> <td><input type="checkbox"/> Figure is legible</td> </tr> <tr> <td colspan="2"><input type="checkbox"/> A list of concerns from the steering committee and the stakeholders</td> </tr> </table> <p>Comments: _____</p>	<input type="checkbox"/> Title	<input type="checkbox"/> Number	<input type="checkbox"/> Title and Number in Table of Contents	<input type="checkbox"/> Figure is legible	<input type="checkbox"/> A list of concerns from the steering committee and the stakeholders					
<input type="checkbox"/> Title	<input type="checkbox"/> Number										
<input type="checkbox"/> Title and Number in Table of Contents	<input type="checkbox"/> Figure is legible										
<input type="checkbox"/> A list of concerns from the steering committee and the stakeholders											
WATERSHED INVENTORY											
	<p>Part One of the Watershed Inventory:</p> <p>4. A description of the geology/topography as it pertains to the watershed.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Explain karst magnitude and general distribution <ul style="list-style-type: none"> <input type="checkbox"/> Not applicable <input type="checkbox"/> Explain the topographic features that define the watershed's drainage patterns <p>Comments: _____</p>										
	<p>5. A brief overview of the hydrology as it pertains to the watershed.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Map(s) of project are a showing: <table border="1" style="width: 100%; margin-top: 5px;"> <tr> <td><input type="checkbox"/> Labeled Streams</td> <td><input type="checkbox"/> Lakes</td> </tr> <tr> <td><input type="checkbox"/> Watershed names and boundaries</td> <td><input type="checkbox"/> HUCs</td> </tr> <tr> <td><input type="checkbox"/> Legal drains</td> <td><input type="checkbox"/> Wetlands</td> </tr> <tr> <td><input type="checkbox"/> Labeled Population centers</td> <td><input type="checkbox"/> Labeled Major roads</td> </tr> <tr> <td><input type="checkbox"/> Not applicable</td> <td><input type="checkbox"/> Not applicable</td> </tr> </table> 	<input type="checkbox"/> Labeled Streams	<input type="checkbox"/> Lakes	<input type="checkbox"/> Watershed names and boundaries	<input type="checkbox"/> HUCs	<input type="checkbox"/> Legal drains	<input type="checkbox"/> Wetlands	<input type="checkbox"/> Labeled Population centers	<input type="checkbox"/> Labeled Major roads	<input type="checkbox"/> Not applicable	<input type="checkbox"/> Not applicable
<input type="checkbox"/> Labeled Streams	<input type="checkbox"/> Lakes										
<input type="checkbox"/> Watershed names and boundaries	<input type="checkbox"/> HUCs										
<input type="checkbox"/> Legal drains	<input type="checkbox"/> Wetlands										
<input type="checkbox"/> Labeled Population centers	<input type="checkbox"/> Labeled Major roads										
<input type="checkbox"/> Not applicable	<input type="checkbox"/> Not applicable										

Identify problems, causes, & sources

- How does water quality compare to criteria limits?
 - What are the problem pollutants?
- What & where are the sources?
 - We need to map their location & estimate their magnitude . . .



<u>Cause/Stressor Category</u>	<u>Impacted Miles</u>
Siltation	1,753.2
Pathogens	1,348.1
Other Habitat Alterations	1,023.1
PCBs	805.5
Organic Enrichment/Low DO	570.2
Nutrients	540.1
Salinity/TDS/Chlorides	499.9
Causes Unknown	463.9
Metals	362.5
Flow Alteration	337.8
Sulfates	240.7
pH	229.7
Dioxins	194.4
Turbidity	141.0
Algal Growth/Chlorophyll <i>a</i>	55.1
Suspended Solids	52.8
Unionized Ammonia	39.5
Thermal Modifications	33.1
Unknown Toxicity	19.3
Priority Organics	18.0
Noxious Aquatic Weeds	13.8
Radiation	13.0
Chlorine	12.2
Oil and Grease	11.5
Other Inorganics	11.5
Exotic Species	8.4
Pesticides	5.3
Nonpriority Organics	5.2
Taste and Odor	1.9

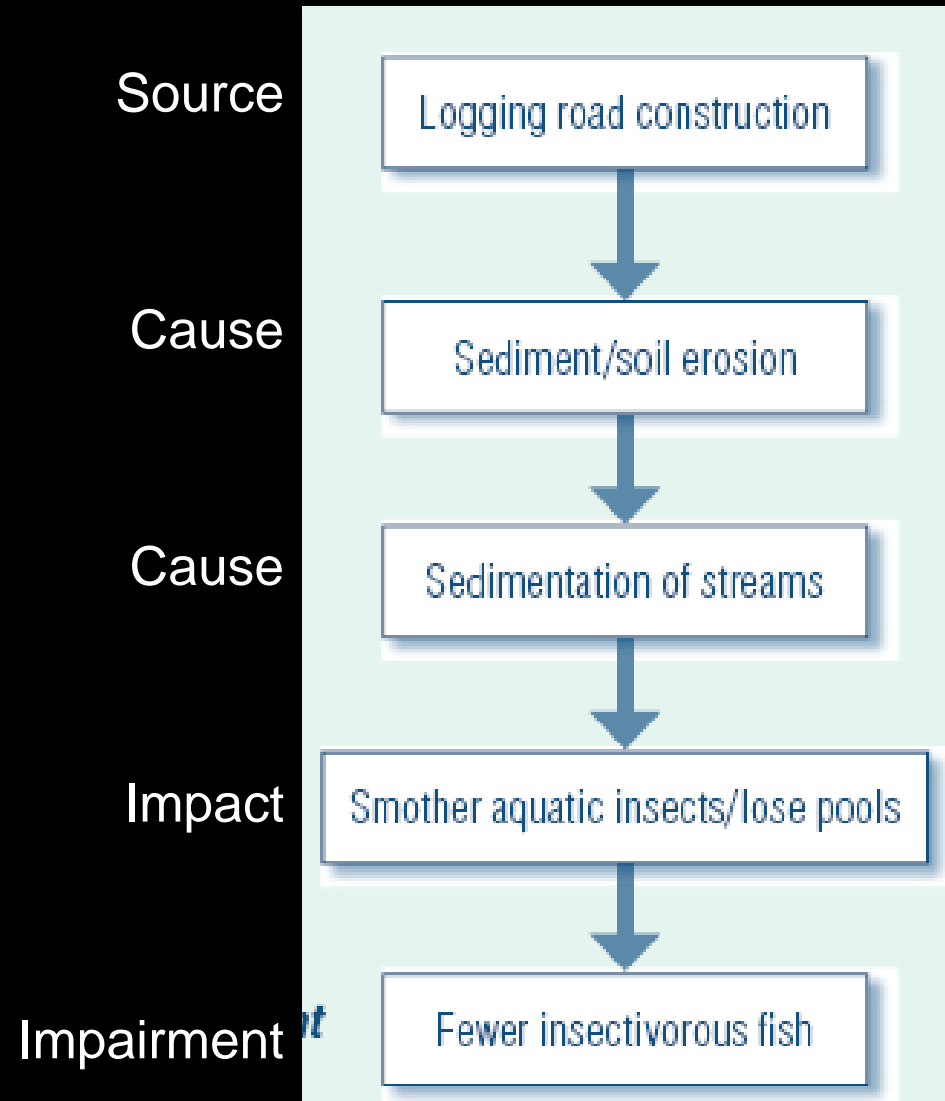
Causes

Sources

<u>Source Category</u>	<u>Miles Impacted</u>
Source Unknown	1,631
Agriculture	1,477.2
Crop-related Sources	634.1
Nonirrigated Crop Production	424.4
Irrigated Crop Production	84.4
Specialty Crop Production	3.6
Grazing related Sources	620.8
Pasture grazing - Riparian and/or Upland	222.9
Pasture grazing - Upland	19.6
Range grazing - Riparian and/or Upland	0.7
Intensive Animal Feeding Operations.....	105.6
Concentrated Animal Feeding Operations (permitted, point source)	22.3
Confined Animal Feeding Operations (NPS)	49.4
Habitat Modification (other than Hydromodification).....	1059.2
Removal of Riparian Vegetation.....	717.7
Bank or Shoreline Modification/Destabilization	265.6
Drainage/Filling of Wetlands.....	10.7
Resource Extraction.....	924.7
Surface Mining.....	525.4
Subsurface Mining.....	222.8
Dredge Mining.....	25.6
Petroleum Activities.....	190.6
Mine Tailings	6.9
Acid Mine Drainage.....	114.5
Abandoned Mining	91
Inactive Mining.....	104.1
Urban Runoff/Storm Sewers.....	721.3
Erosion and Sedimentation	267.3
Non-industrial Permitted.....	4.3
Industrial Permitted.....	15.8
Other Urban Runoff.....	178.3
Illicit Connections/Illegal Hook-ups/Dry Weather Flows	10.6
Hydromodification.....	527.1
Channelization	403.2
Dredging.....	92.4
Dam Construction	3.2
Upstream Impoundment.....	35.1
Flow Regulation/Modification.....	32.1
Silviculture.....	254.4
Harvesting, Restoration, Residue Management.....	156.8
Logging Road Construction/Maintenance	10.5
Silvicultural Point Sources	3.5

Building Conceptual Models

- Summarize hypotheses of perceived linkages between stressors and impacts
- Provide template for determining potential indicator measurements and management practices



Land use/cover impacts: sediment

- High upland erosion potential:
 - Watershed slopes > 15%, row crops, active clearing/grading, erodible soils, few or no BMPs
- High stream channel erosion potential:
 - Impervious area > 15-25%, overgrazed pastures (compacted soil), little or no stream vegetated buffer, active new development, few or no BMPs

Land use/cover impacts: nutrients

- High nutrient runoff potential:
 - Animal feeding operations, overfertilized crops and lawns, high density septic system installations near streams,
- High nutrient point source potential:
 - Concentrated animal feeding operations, wastewater treatment plants, municipal separate storm sewer systems (MS4s)

Land use/cover impacts: bacteria

- High priority bacteria sources:
 - Poorly operated wastewater treatment plants, combined sewer overflows, high density septic systems near waterways, concentrated animal feeding operations near waterways
- Lower priority bacteria sources:
 - Wildlife, pets in low concentrations, pastured livestock in upland areas

Calculating loads: what is a “load?”

- Maybe measured by weight
 - Kilograms per day
 - Pounds per week
 - Tons per month
- Maybe not
 - Concentration-based expression of the “load” (e.g., milligrams per liter)
 - # of miles of streambank needing stabilization or vegetation
 - # of AFOs requiring nutrient plans



Data-driven Approaches

- Estimate source loads using:
 - Monitoring data
 - Periodic water quality concentrations and flow gauging data
 - Facility discharge monitoring reports
 - Literature
 - Loading rates, often by land use (e.g., lbs/acre/year)
 - Typical facility concentrations and flow

Is a Data-driven Approach Appropriate?

- Monitoring data
 - Does it represent most conditions that occur (low flow, storms, etc.)?
 - Are spatial and source variability well-represented?
 - Have all parameters of interest been monitored?
 - Is there a clear path to a management strategy?

Load Estimates – Monitoring Data

- In simplest terms...

$$\textit{load} = \textit{flow} \times \textit{concentration}$$

- Load duration curves
 - Flow-based presentation
- Statistical techniques
 - Relationships between flow and concentration to “fill in the blanks” when data aren’t available
 - Examples include:
 - Regression approach
 - FLUX

IDEM's load calculation tool

B21		$f_x = (B14-B16)/B14*100$			
	A	B	C	D	E
1	Load Calculation Tool		<i>* User needs to input values in gray boxes</i>		
2					
3	mass based pollutants			E. coli	
4	input				
5	TSS, N, P etc (mg/l)	105	cfu/100 ml	2220	
6	Flow (cfs)	146	Flow	20	
7					
8	Target Concentration		Target Concentration		
9	(mg/l)	80	cfu/100 ml	235	
10					
11					
12	output				
13	Current Load (lb/day)	82,636.00	Current Load (cfu/day)	1.09E+12	
14	Current Load (ton/year)	15,081.07	Current Load (cfu/year)	3.96E+14	
15	Target Load (lb/day)	62,960.76	Target Load (cfu/day)	1.15E+11	
16	Target Load (ton/year)	11,490.34	Target Load (cfu/year)	4.19E+13	
17					
18					
19	load reduction needed				
20	(ton/year)	3,590.73	(cfu/year)	3.54E+14	
21	% reduction	23.8	% reduction	89.4	
22					

- *Need pollutant concentration averages & flow*

Load Estimates – Literature

- Landuse-specific loading rates (typically annual)
- Multiply loading rate by area:
$$load_{all} = (area_{lu1} \times loading\ rate_{lu1}) + (area_{lu2} \times loading\ rate_{lu2}) + \dots$$
- Generally for landuse or watershed-wide analysis
- Many sources: Lin (2004); Beaulac and Reckhow (1982), etc.
- Use with caution (need correct representation for your local watershed)
 - Pollution sources
 - Climate
 - Soils

Example Load Estimation Based on Literature Values

Example of Pollutant Budget Estimation Using Export Coefficient Model

Land Use	Area (ha)	Nitrogen Export Coefficient (kg/ha/yr)	Total Nitrogen Load (kg/yr)	Percent of Nitrogen Load	Phosphorous Export Coefficient (kg/ha/yr)	Total Phosphorous Load (kg/yr)	Percent of Phosphorous Load
Forest	100	1.8	180	0.91	0.11	11	0.52
Corn	200	11.1	2220	11.24	2	400	18.95
Cotton	100	10	1000	5.6	4.3	430	20.37
Soybeans	20	12.5	250	1.27	4.6	92	4.36
Small Grain	50	5.3	265	1.34	1.5	75	3.55
Pasture	300	3.1	930	4.71	0.1	30	1.42
Feedlot or Dairy	5	2,900	14,500	73.39	220	1,100	52.11
Idle	30	3.4	102	0.52	0.1	3	0.14
Residential	20	7.5	150	0.76	1.2	24	1.14
Business	10	13.8	138	0.7	3	30	1.42
Industrial	5	4.4	22	0.11	3.8	19	0.9
Total	840	-	19,757	1	-	2,111	100

Note: Agricultural coefficients are from Reckhow et al. (1980), and urban coefficients are from Athayde et al. (1983).

Table 9. Unit loads of pollutants (kg/ha/yr) from different land uses*

Pollutant	Central business district	Other commercial	Industrial	Single family res.	Multi-family res.	Cropland	Pasture	Forest	Open
TSS	1080	840	56	17	440	450	340	85	7
COD	1070	1020	63	28	330	n.a.	n.a.	n.a.	2.0
Pb	7.1	3.0	2.0 - 7.1	0.1	0.7	0.005 - 0.006	0.003 - 0.015	0.01 - 0.03	n.a.
Zn	3.0	3.3	3.5 - 12	0.22	0.33	0.03 - 0.08	0.02 - 0.17	0.01 - 0.03	n.a.
Cu	2.1	n.a.	0.33 - 1.1	0.03	0.33	0.01 - 0.06	0.02 - 0.04	0.02 - 0.03	n.a.
NO ₃ +NO ₂ -N	4.5	0.67	0.45	0.33	3.8	7.9	0.33	0.56	0.33
TKN	15	15	2.2 - 15	1.1 - 5.6	3.4 - 4.5	1.7	0.67	2.9	1.7
TP	2.8	2.7	0.9 - 4.0	0.2 - 1.5	1.3 - 1.6	0.1 - 3.0	0.07 - 3.0	0.02 - 0.45	0.06

* Exact values are given where available; otherwise ranges are reported.

Adapted from Horner et al. (1986)

Limitations of Data-Driven Approaches

- Monitoring data
 - Reflect current/historical conditions (limited use for future predictions)
 - Insight limited by extent of data (usually water quality data)
 - Often not source-specific
 - May reflect a small range of flow conditions
- Literature
 - Not reflective of local conditions
 - Wide variation among literature
 - Often a “static” value (e.g., annual)

Example of Simple Model Application

- Spreadsheet Tool for Estimating Pollutant Load (STEPL)
 - Employs simple algorithms to calculate nutrient and sediment loads from different land uses
 - Also includes estimates of load reductions that would result from the implementation of various BMPs
 - Data driven and highly empirical
 - A customized MS Excel spreadsheet model
 - Simple and easy to use



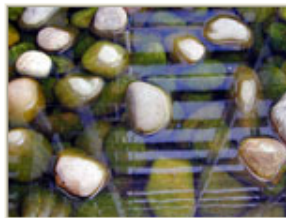
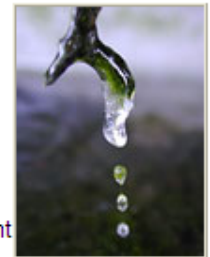
STEPL - Spreadsheet Tool for Estimating Pollutant Load Region 5 Load Estimation Model

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[EPA Home](#) > [STEPL](#)

Welcome to STEPL and Region 5 Model



Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff, nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

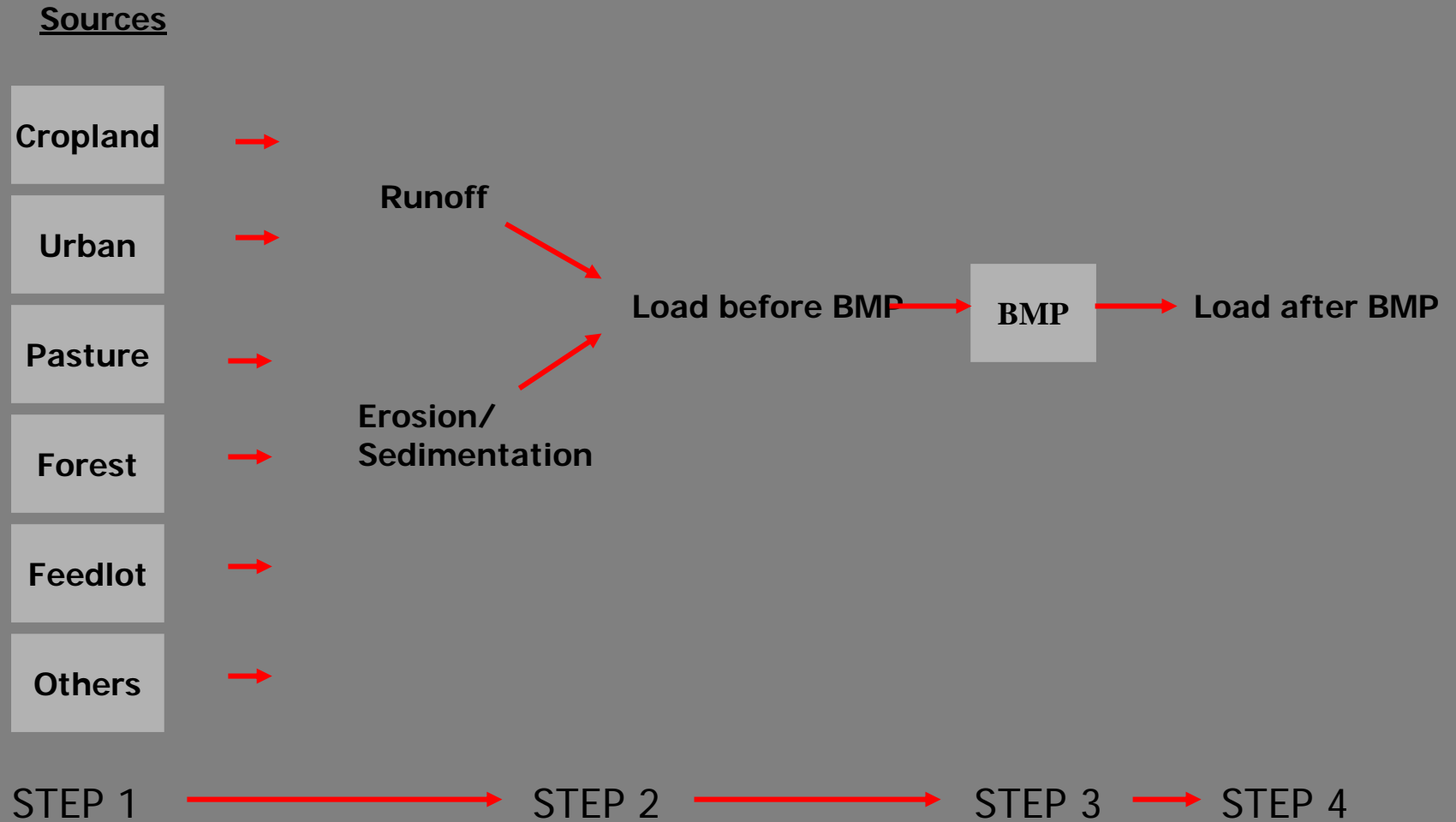


Region 5 Model is an Excel workbook that provides a gross estimate of sediment and nutrient load reductions from the implementation of agricultural and urban BMPs. The algorithms for non-urban BMPs are based on the "Pollutants controlled: Calculation and documentation for Section 319 watersheds training manual" (Michigan Department of Environmental Quality, June 1999). The algorithms for urban BMPs are based on the data and calculations developed by Illinois EPA. Region 5 Model does not estimate pollutant load reductions for dissolved constituents.

Questions? Please contact:

- Home
- Access STEPL Data Server for Input Data
- Models and Documentation
- Frequently Asked Questions

STEPL Process



STEPL Model Input Data Server

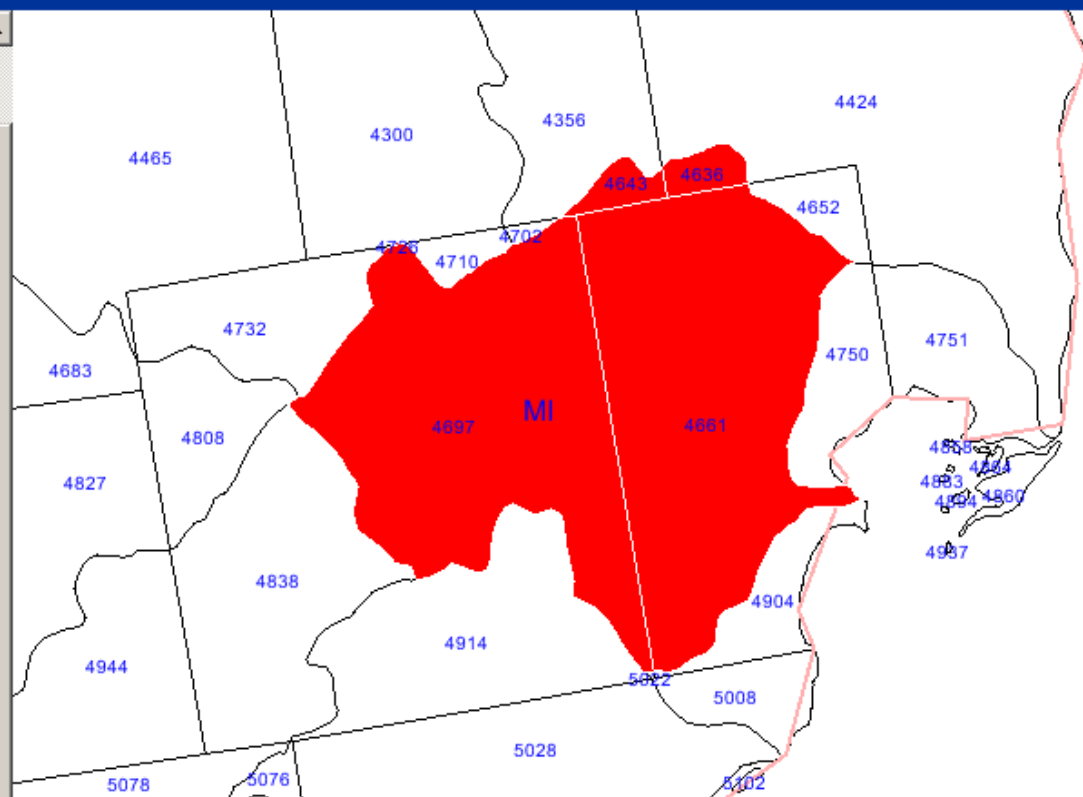
- Maine
- Michigan
- Minnesota
- Missouri
- Mississippi

Step 2: Select a county

- Monroe
- Montcalm
- Montmorency
- Muskegon
- Newaygo
- Dakland

Or select a HUC

- 04080300 : Lake Huron
- 04090001 : St. Clair
- 04090002 : Lake St. Cl
- 04090003 : Clinton
- 04090004 : Detroit
- 04090005 : Huron



Step 3: Activate the Select tool and click on the map to refine the area of interest

Step 4: Select report

- Basic**
Generates a preformatted report with tables that you can paste directly into the STEPL worksheets
- Custom**
Generates preformatted reports using custom percentages of HUC surface area

This tool can be used to estimate the landuse and animal distribution, number of septic system and failure rate, and hydrologic group for your area of interest. These information are required input for the STEPL model. The data are provided by HUCO (overlay of county and 8-digit hydrologic unit boundary).

Selected watershed(s) information

Polygon ID	County Name	State	HUC	HUC NAME	Area (acre)	% in County	% in HUC
1535	HOUGHTON	MI	4020104	Sturgeon	221349.20	33.96%	48.98%
1612	BARAGA	MI	4020104	Sturgeon	203770.31	34.77%	45.09%
1738	ONTONAGON	MI	4020104	Sturgeon	6822.40	0.80%	1.51%
2063	IRON	MI	4020104	Sturgeon	19931.45	2.58%	4.41%

1. Landuse area (acre)

Polygon ID	Urban/Transportation	Cropland	Pasture/Rangeland	Forest	User Defined	Feedlots	Water	Others
1535	800.00	13600.00	0.00	139800.00	0.00	0.26	3600.00	64800.00
1612	1500.00	9700.00	5300.00	168900.00	0.00	0.14	4800.00	46700.00
1738	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
2063	100.00	0.00	0.00	17600.00	0.00	0.02	1600.00	9000.00
Total	2400.00	23300.00	5300.00	326300.00	0.00	0.42	10000.00	120500.00

Source: USDA Natural Resources Conservation Service 1997 National Resources Inventory

Feedlot area is estimated based on the minimum space requirement by animals

2. Agricultural animals

Polygon ID	Beef Cattle	Dairy Cattle	Swine(Hog)	Sheep	Horse	Chicken	Turkey	Duck
1535	141	161	16	118	0	83	10	3
1612	188	33	D	D	0	82	D	0
1738	6	4	D	D	0	0	0	0
2063	23	1	0	4	0	12	0	0
Total	358	199	16	122	0	177	10	3

But do your data measure up?

- What are the data quality objectives?
- Do you have a comprehensive picture?
- How old are your sampling results?
- Can you move forward with what you have?



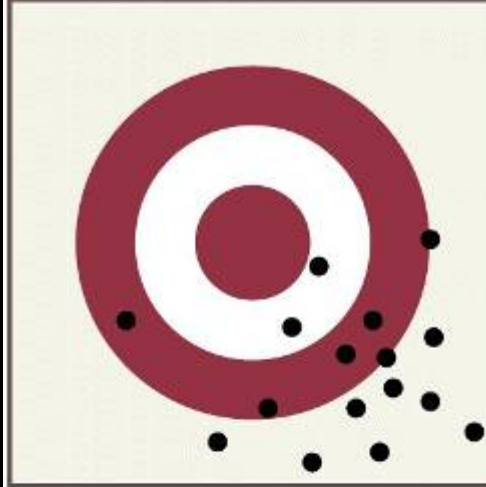
Data quality objectives

- Quantify or qualify how good data must be to achieve the goals of monitoring / assessment
- Described in terms of:
 - precision
 - accuracy
 - representativeness
 - comparability
 - completeness

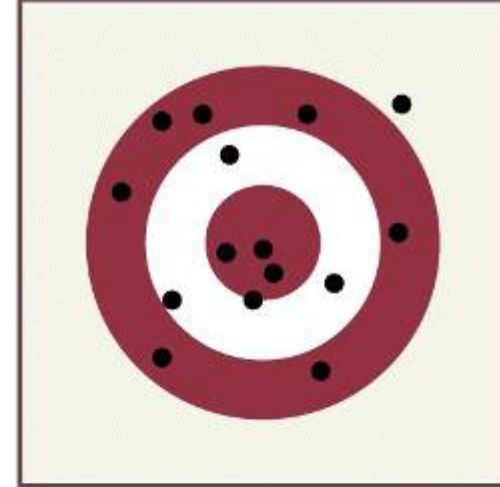
	A	B	C	D	E
31					
32	Data Quality Objectives for Water Chemistry Parameters -- HACH Kit				
33	Parameter	Completeness	Precision	Accuracy¹	Measurement Range
34	Fecal Coliform/E. coli			High ¹	> or < 200 colonies/100 ml
35	Dissolved Oxygen (high range test)			+/- 1 mg/L	0-17 mg/L
36	Dissolved Oxygen (low range test)			+/- 0.02 mg/L	0.2-0.4 mg/L
37	BOD ₅ (high range test)			+/- 1 mg/L	0-17 mg/L
38	BOD ₅ (low range test)			+/- 0.02 mg/L	0.2-0.4 mg/L
39	pH			+/- 0.2 pH units	0-14 pH units
40	Total Phosphate (low range test)			+/- 10%	0-1 mg/L
41	Total Phosphate (medium range test)			+/- 10%	0-5 mg/L
42	Total Phosphate (high range test)			+/- 10%	0-50 mg/L
43	Orthophosphate (low range test)			+/- 10%	0-1 mg/L
44	Orthophosphate (medium range test)			+/- 10%	0-5 mg/L
45	Orthophosphate (high range test)			+/- 10%	0-50 mg/L
46	Nitrates (low range test)			+/- 10%	0-1 mg/L
47	Nitrates (medium range test)			+/- 10%	0-10 mg/L
48	Nitrates (high range test)			+/- 10%	0-50 mg/L
49	Turbidity			+/- 10 NTU (+/- 10 JTU)	0 - >100 NTU (JTU)
50	Total Solids ²			+/- 0.0001 g	
51	Temperature Change ³			+/- 1 degree	
52	¹ Accuracies reported as percentages are for parameters measured with the HACH colorimeter and, according to the manufacturer, are typical of				
53	accuracies achieved with this device. Accuracy of E. coli counts are expected to be high given that results are reported as > or < 200 colonies/100ml.				
54	² The measurement range for Total Solids depends on the analytical scale you will use (consult the manufacturer's literature). For Temperature				
55	Change, state the range of the thermometer used and indicate the units of measurement (i.e. Celsius or Fahrenheit).				
56					
57	Note that accuracy in colorimeter results vary according to individual color perception. Replicate values may be averaged to				
58	obtain more accurate results and to identify obvious outliers. If replicates are averaged to ensure accuracy, at least one additional				
59	set of averaged readings will be necessary for the purposes of calculating precision (i.e. RPD or RSD). Indicate in Section 3 of the				
60	QAPP if individual measurements will be taken or if, for the purposes of enhancing the accuracy of your data, two or more				
61	measurements will be taken instead and averaged into one result.				

Accuracy & precision

- Both needed to reflect true water body condition
- Can be biased away from target
- Addressed by following protocols, using field blanks, spiked samples in lab



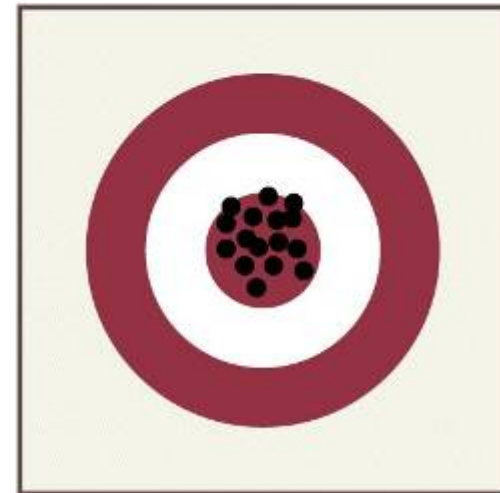
high bias
+ low precision
= low accuracy



low bias
+ low precision
= low accuracy



high bias
+ high precision
= low accuracy



low bias
+ high precision
= high accuracy

Completeness, representativeness, and comparability

- Collecting all samples planned
- Collecting samples that represent “true condition” of the water body
 - During various seasons, flows?
 - Following sampling protocols?
- Confidence in comparing different data sets
 - Use similar data quality objectives
 - Avoids differences in methods, accuracy, precision

Comprehensiveness

- Do you have a clear picture of the problems?
 - Land use, cover, and watershed activities indicate likely pollutants
 - Biological assessments provide excellent screening info
- DO, pH, temp are primary parameters
- Conductivity, pesticides, herbicides, metals, and bacteria help to refine & focus results

Age and applicability

- Data age considerations
 - Stable land use & cover makes older data (5-7 yrs) more useful
 - Developing watersheds require newer data (2-4 years old)
 - Rapidly developing watersheds may be difficult to characterize (apply LID & BMPs)
 - Note new or altered NPDES discharger info

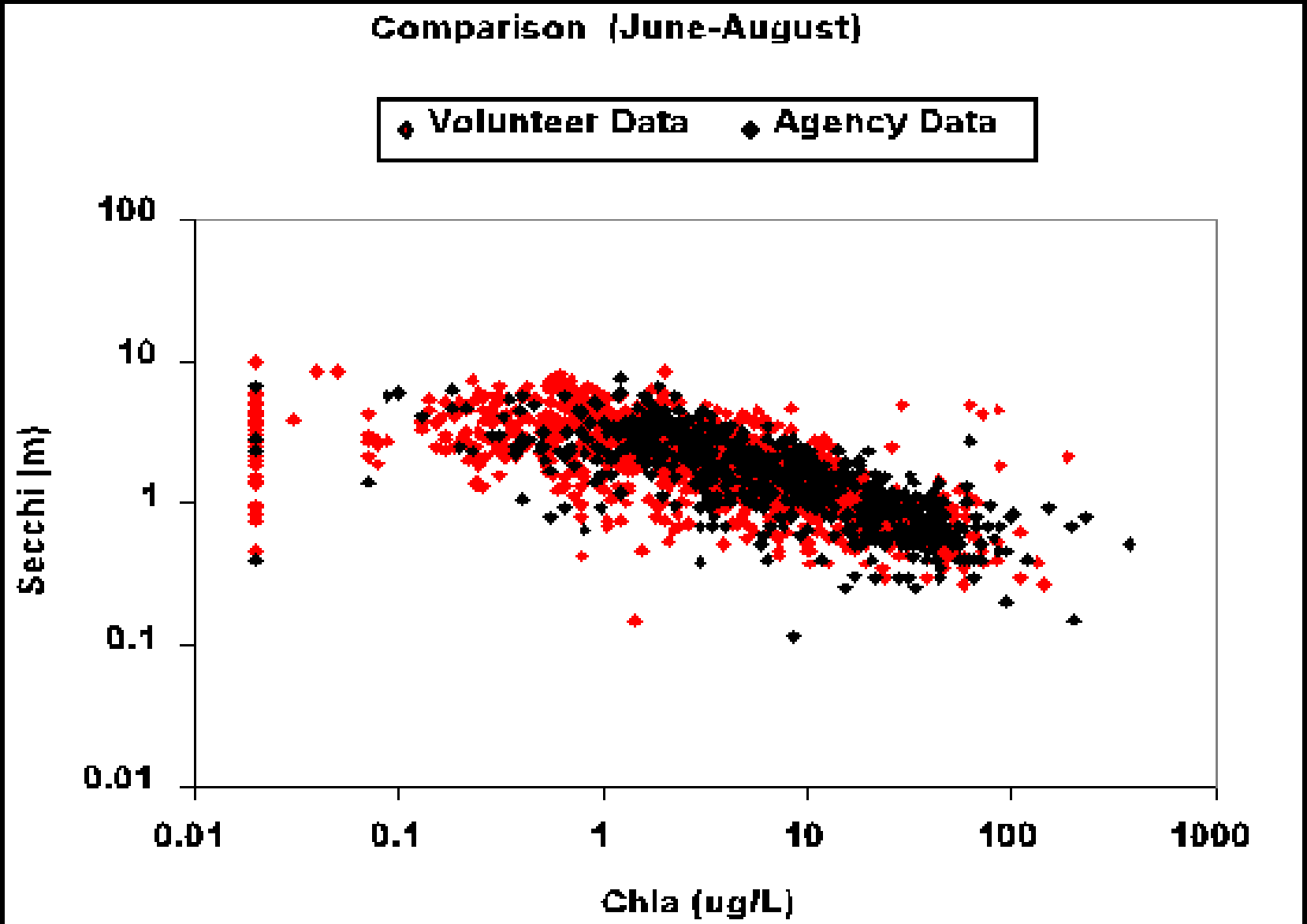


Volunteer derived data

- Credibility is improved when:
 - Volunteers are trained by professionals
 - Sampling and analytical procedures match accepted protocols
 - Sampling is conducted under a Quality Assurance Project Plan



Volunteer vs agency data (1989 - 2005)



How IDEM uses data to make impairment & other decisions

- Andrew Pellosi slides here