Montana's Approach for Developing and Implementing Numeric Nutrient Standards for Wadeable Streams and Rivers

---

Prepared By

Michael Suplee, Ph.D.
Water Quality Standards Section
Montana Department of Environmental Quality
November 20, 2008

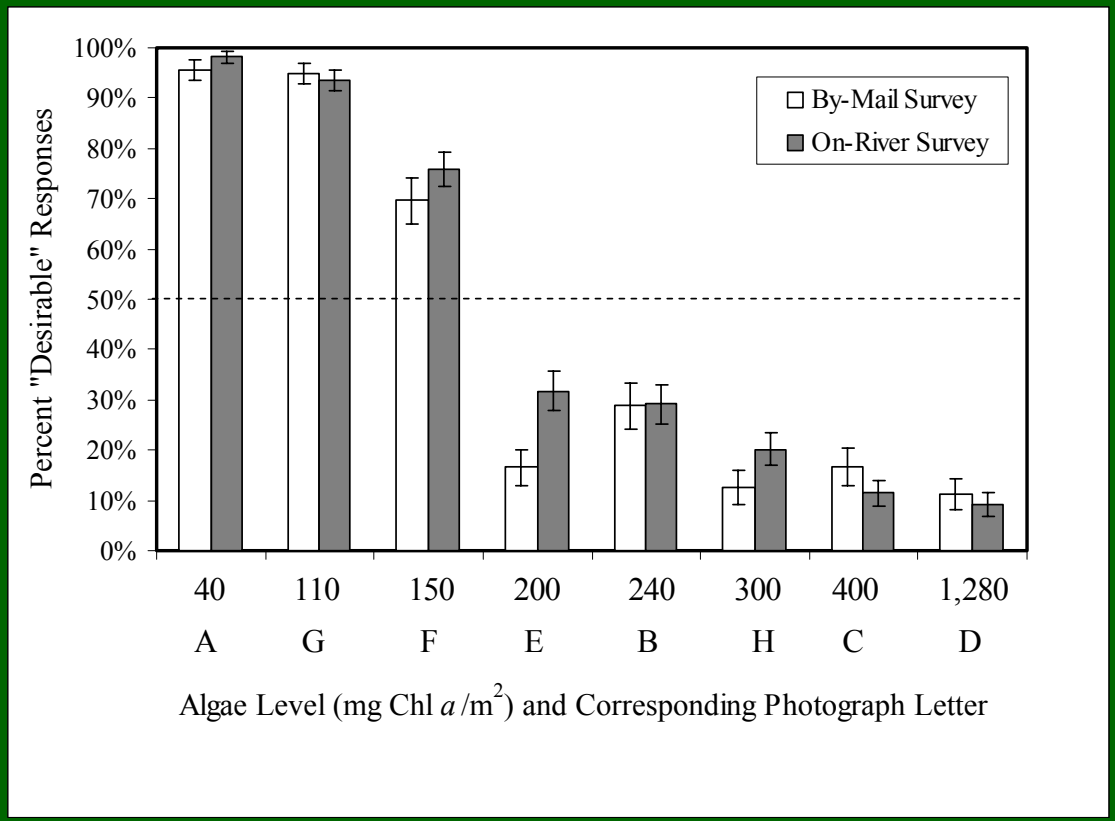
Montana's Approach

- Science determines the criteria
- Policy addresses the difficulties of meeting the criteria

Science: How were the Criteria Derived?

- Based on nutrient concentrations where impact to sensitive beneficial uses begins to occur
  - Recreation
  - Fish and aquatic life
- Impact thresholds are determined using:
  - Stressor-response studies (e.g., TN *vs.* dissolved oxygen concentrations)
  - Public opinion surveys addressing nuisance algae levels
- Final criteria derived by:
  - Considering impact threshold concentrations in light of regional reference data

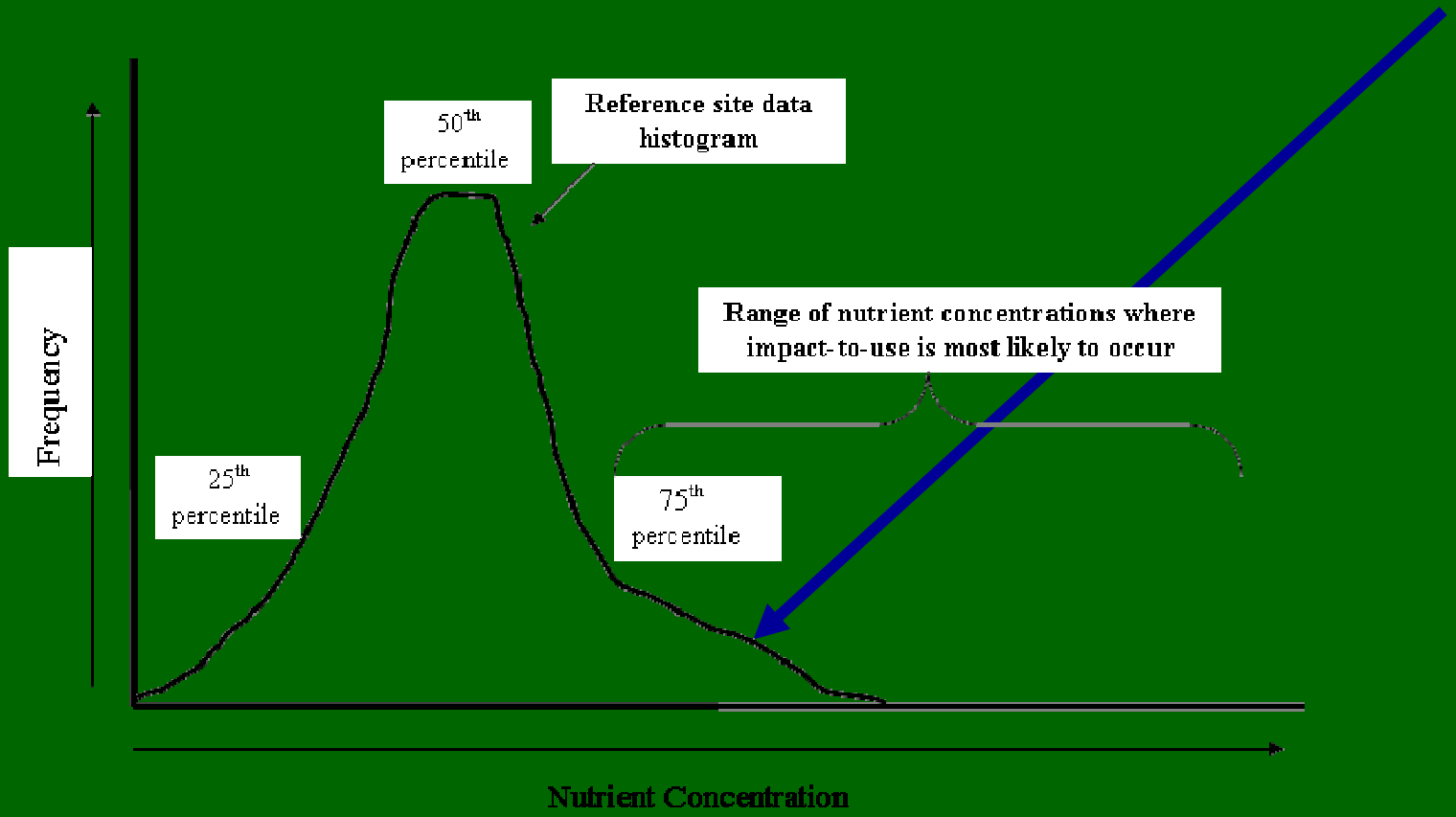
Science: How were the Criteria Derived?



This peer-reviewed study is in press in the *Journal of the American Water Resources Association* (February, 2009). I can provide copies upon request.

Science: Making a Link Between Stressor-response Studies and Regional Reference-site Data

1. From the stressor-response study, determine nutrient concentration at the harm-to-use threshold.
2. Compare the harm-to-use nutrient concentration to corresponding regional reference-site data



*Science: Relationship between regional stressor-response Studies and Corresponding Reference Stream Data**

				Reference Stream Sites				
Stressor-response Study	Nutrient	Notes on Study	Stressor-response Study Nutrient Concentration (mg/L)	Season of Application*	Level III Ecoregion	# Samples in Distribution During Growing Season	Percentile in Reference Distribution Matching Stressor-response Study Concentration	Benefical Use the Nutrient Concentration Threshold Applies To
Welch *et al*. (1989)	SRP	The SRP concentration would constrain the distance the Spokane River has algal biomass of 150 mg Chl *a*/m^2 to about 16 km.	0.01	Growing	Northern Rockies	75	**94th**	Recreation
Watson *et al.* (1990)	SRP	The SRP concentration corresponding to algal standing crop of 150 mg Chl *a*/m^2.	0.011	Growing	Middle Rockies	211	**87th**	Recreation
Sosiak, A. (2002)	TP	Based on a nutrient *vs.* benthic-algae regression equation, TP concentration would maintain algal standing crop ≤ 150 mg Chl a/m^2 on the Bow River near Calgary, Alberta, Canada†.	0.018	Growing	Canadian Rockies	68	**97th**	Recreation
Suplee, M.W. (2008) Appendix A, this document	TN	TN concentration would prevent dissolved oxygen (DO) from dropping below state standards in prairie streams. Quantitative relationships (correlation, changepoint analysis) between diatom-inferred DO and TN concentrations were used to derive the TN concentration.	1.12	Growing	Northwestern Glaciated Plains	59	**70th**	Fish & Aquatic Life
						Mean:	**87th**	
						Median:	**91st**	
						CV (%):	**14**	

* *See* Suplee, M.W., Varghese, A., and J. Cleland, 2007. Developing Nutrient Criteria for Streams: An Evaluation of the Frequency Distribution Method. *Journal of the American Water Resources Association* 43: 453-472.

Science: Why Link Stressor-response and Reference Data?

- Individual stressor-response studies are limited in scope and each has its own statistical uncertainties

- The collective relationship observed between stressor-response derived nutrient concentrations and corresponding reference data helps overcome uncertainties in any given stressor-response study

Science: Relationship between Montana's Criteria and Criteria from other Temperate Streams

Study	Where Study Took Place	Notes on Study	Nutrient (mg/L)	
			Total N	Total P
This Document	Middle Rockies Ecoregion, Montana	90th percentile of reference	**0.320**	**0.048**
Perrin *et al.* (1987)	British Columbia, Canada	Total N and total P concentrations quantitatively added to a small, low-nutrient river and resulted in peak benthic algae of 150 mg Chl *a* /m^2 and a shift towards dominance by filamentous algae.	0.4	0.02
Miltner & Rankin (1998)	Ohio	Nutrient concentration threshold beyond which deleterious effects on fish communuties are observed.	n/a	0.06
Chételat *et al.* (1999)	Ontario & Quebec, Canada	Benthic algal biomass and nutrient concentrations examined in 13 rivers. Moderately strong relationship ($r^2 = 0.56$) found between total P and benthic Chl *a* levels. TP concentration shown would maintain algae at 150 mg Chl *a* /m^2.	n/a	0.07
Dodds *et al.* (2006)	Data from North American, Austrailian, New Zealand and European temperate streams	Based on a nutrient *vs.* benthic-algae regression equation, TN and TP concentrations would maintain benthic algae ≤ 150 mg Chl *a* /m^2 (maximum). Concentrations determined using the 9th listed equation of the literature dataset.	0.578	0.080
Wang *et al.* (2007)	Wisconsin	Total N and total P concentration thresholds where the largest change in biometrics occur and beyond which fish and macroinvertebrate assemblages are likely to be degraded.	0.99	0.073

Science: Montana's Criteria

Criteria are seasonal. Also, in addition to N and P, benthic algae criteria are suggested for the western mountainous ecoregions

Ecoregion	Period When Criteria Apply	Nutrient Criteria: Reference Percentile Criteria Are Linked to	TP (mg/L)	TN (mg/L)	NO_{2+3} (mg/L)	Benthic Algae Criteria
Level III Ecoregions						
Northern Rockies	July 1 -Sept. 30	90^{th}	0.012	0.233	0.081	150 mg Chl *a* /m^2 (36 g AFDW/m^2)
Canadian Rockies	July 1 -Sept. 30	90^{th}	0.006	0.209	0.020	150 mg Chl *a* /m^2 (36 g AFDW/m^2)
Middle Rockies	July 1 -Sept. 30	90^{th}	0.048	0.320	0.100	150 mg Chl *a* /m^2 (36 g AFDW/m^2)
Idaho Batholith	July 1 -Sept. 30	90^{th}	0.011	0.130	0.049	150 mg Chl *a* /m^2 (36 g AFDW/m^2)
Northwestern Glaciated Plains	June 16-Sept. 30	75^{th}	0.123	1.311	0.020	n/a
Northwestern Great Plains, Wyoming Basin	July 1 -Sept. 30	75^{th}	0.124	1.358	0.076	n/a

Science: Allowable Exceedence rate for the Criteria (i.e., frequency)

1. Criteria are not "no sample shall exceed"

2. EPA recommends 10-25% exceedence rate for most types of criteria (SOURCE: 303[d] listing guidance)

3. Analysis of a 9-year dataset on Clark Fork River (river has numeric nutrient criteria in place)
   - Some sites consistently have nuisance algae levels, others almost never
   - ~54% of N and P samples from sites with nuisance algae exceed criteria
   - ~6% of N and P samples from sites without nuisance algae exceed criteria
   - 25% exceedence appears to be a threshold. Keeping algae below nuisance levels become untenable at higher exceedences

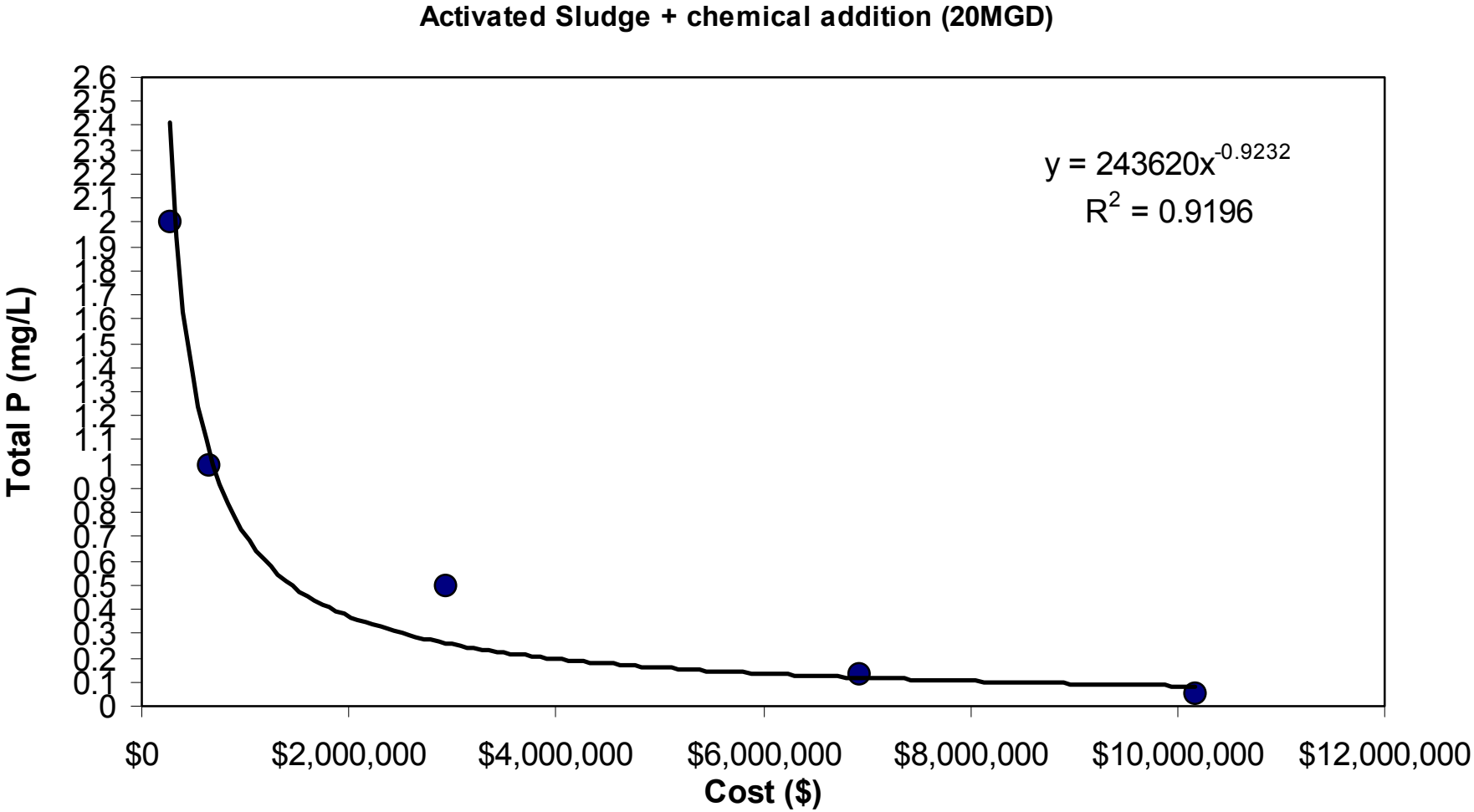
Based on above, recommending a 20% allowable exceedence rate to accompany the numeric nutrient criteria

Policy: Economic Considerations

- As a wastewater facility works to achieve lower and lower nutrient concentrations, the cost to achieve those concentrations goes up nearly exponentially

- In Montana, the nutrient concentrations indicated by the science are sometimes at or below current wastewater technologies

Policy: Economic Considerations



Policy: Economic Considerations

- We are building in an option for communities to receive relief from very stringent requirements based on:
  - Ability to pay for treatment (affordability)
  - Availability of treatment technology (limits of technology)

Case-by-case evaluations

- *These options apply only to wastewater treatment beyond the federally mandated technology-based regulations*

Policy: Two Types of Temporary Variances

- *Affordability*:
  - Community needs to demonstrate it would have substantial and widespread (S&W) economic impacts resulting from compliance with the nutrient criteria
  - IF community would have S&W economic impacts, THEN it could receive a variance. It would be expected to pay for wastewater treatment at some pre-defined level (e.g., 2% of median household income)
- *Limits of Technology:*
  - Some communities could afford almost any proven and available technology, but still can't meet the criteria
  - Limits-of-technology variance (0.05 mg TP/L, 3 mg TN/L)

Policy: Substantial & Widespread Impacts — Remedies

Why go the variance route?

(Options: Remove designated use, create use subcategories, variance)

- Variance is better option because:
  - Designated use not removed — retained as goal, creates review process
  - Applies only to parameter's infeasible to achieve
  - EPA Headquarters and Region VIII agree it's a better choice
  - Time limit (in practice) can be up to 20 years
    - Variance would need to be re-justified every 3-5 years
    - Allows time for technology to catch up, become less expensive

Policy: Variances are only Part of a Larger Review Process

- Variances are the final option. An alternatives analysis will be carried out before granting a variance
- Go to flow chart 

Policy: Using the Variance-Based Approach

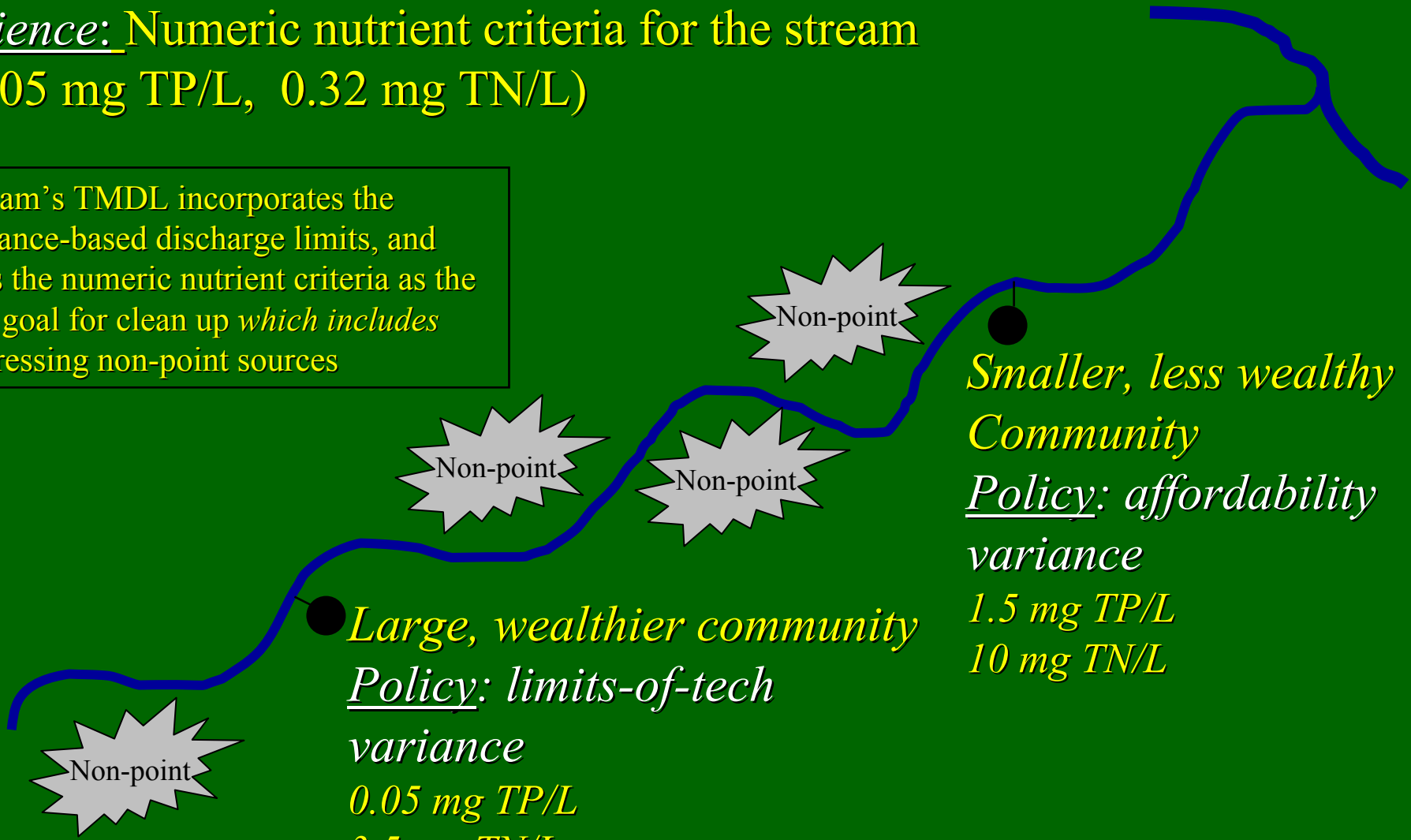
- MT DEQ has a draft legislative bill allowing the Board of Environmental Review to grant variances from numeric nutrient criteria on a point source-by-point source basis.

- Variances would be based on either (1) substantial and widespread economic impacts or (2) limits of technology

How This Would Look Along a Stream

Science: Numeric nutrient criteria for the stream (0.05 mg TP/L, 0.32 mg TN/L)

Stream's TMDL incorporates the variance-based discharge limits, and uses the numeric nutrient criteria as the end goal for clean up *which includes* addressing non-point sources



Thank You.

msuplee@mt.gov
(406) 444-0831

Science: Criteria Exceedence Rate

Sites on the Clark Fork River (CFR) Not Exceeding the Maximum Benthic Algae Standard (Growing Season, 1998-2006)

Clark Fork River Site #	Site Name	Long-term Benthic Algal Biomass (mg Chl *a* /m^2, growing season) Mean [median]	Percentile in Site's Nutrient Frequency Distribution Matching CFR Standard		**Criteria Exceedance Rate (%)**	
			TN	**TP**	**TN**	**TP**
15.5	Clark Fork above Missoula	96 [80]	0.90	0.95	10.2%	5.4%
22	Clark Fork at Huson	72 [52]	0.76	0.96	24.0%	3.8%
25	Clark Fork above Flathead	35 [20]	1.00	0.99	0.1%	1.5%
					Grand Mean:	**7.5%**
					Grand Median:	**4.6%**
					Maximum:	**24.0%**
					Minimum:	**0.1%**

Sites on the Clark Fork River (CFR) Consistently Exceeding the Maximum Benthic Algae Standard (Growing Season, 1998-2006).

Clark Fork River Site #	Site Name	Long-term Benthic Algal Biomass (mg Chl *a* /m^2, growing season) Mean [median]	Percentile in Site's Nutrient Frequency Distribution Matching CFR Standards		**Criteria Exceedance Rate (%)**	
			TN	TP	**TN**	**TP**
9	Clark Fork at Deer Lodge	180 [147]	0.23	0.50	77.0%	50.0%
10	Clark Fork above Little Blackfoot River	163 [117]	0.48	0.12	52.0%	88.0%
18	Cark Fork at Shuffields	197 [181]	0.50	0.72	50.4%	27.7%
					Grand Mean:	**57.5%**
					Grand Median:	**51.2%**
					Maximum:	**88.0%**
					Minimum:	**27.7%**

N & P criteria will have allowable exceedence rate = 20%, based on analysis and EPA.