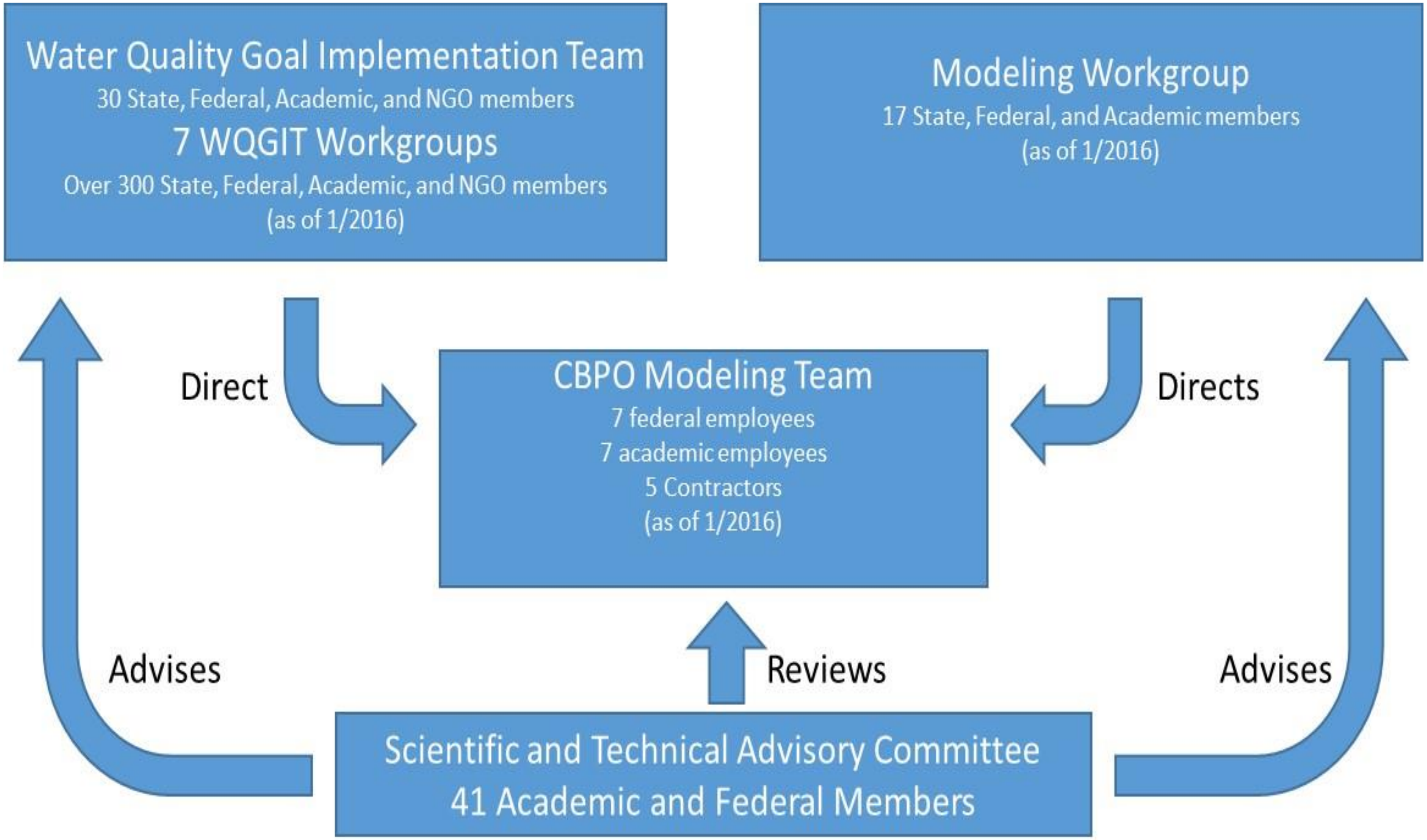
AgWG Comments

Gary Shenk, Matt Johnston, and Andrew Sommerlot

CBPO

8/3/2017

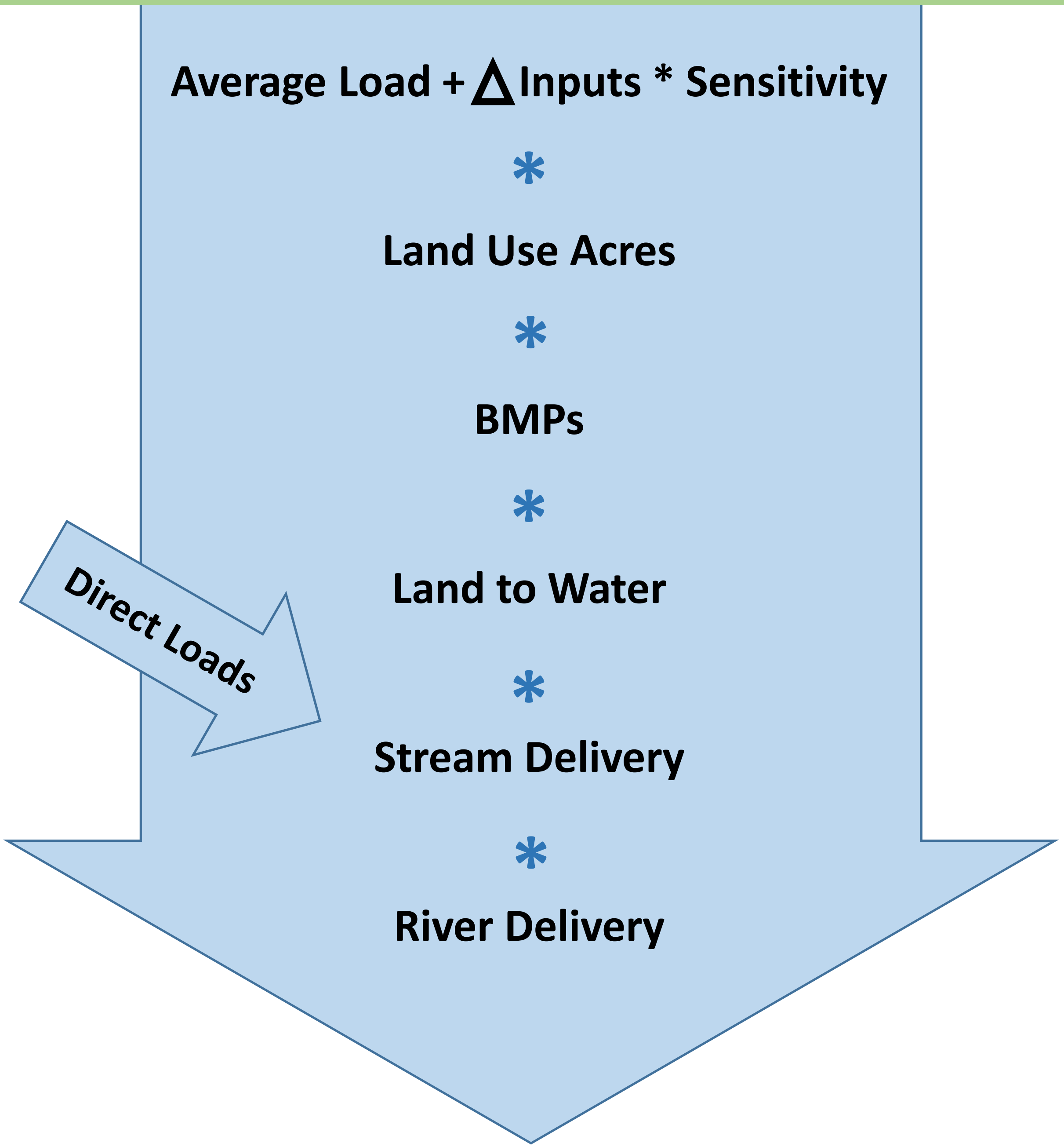
Governance


Water Quality Goal Implementation Team
30 State, Federal, Academic, and NGO members
7 WQGIT Workgroups
Over 300 State, Federal, Academic, and NGO members
(as of 1/2016)
Modeling Workgroup
17 State, Federal, and Academic members
(as of 1/2016)
Direct
Directs
CBPO Modeling Team
7 federal employees
7 academic employees
5 Contractors
(as of 1/2016)
Advises
Reviews
Advises
Scientific and Technical Advisory Committee
41 Academic and Federal Members

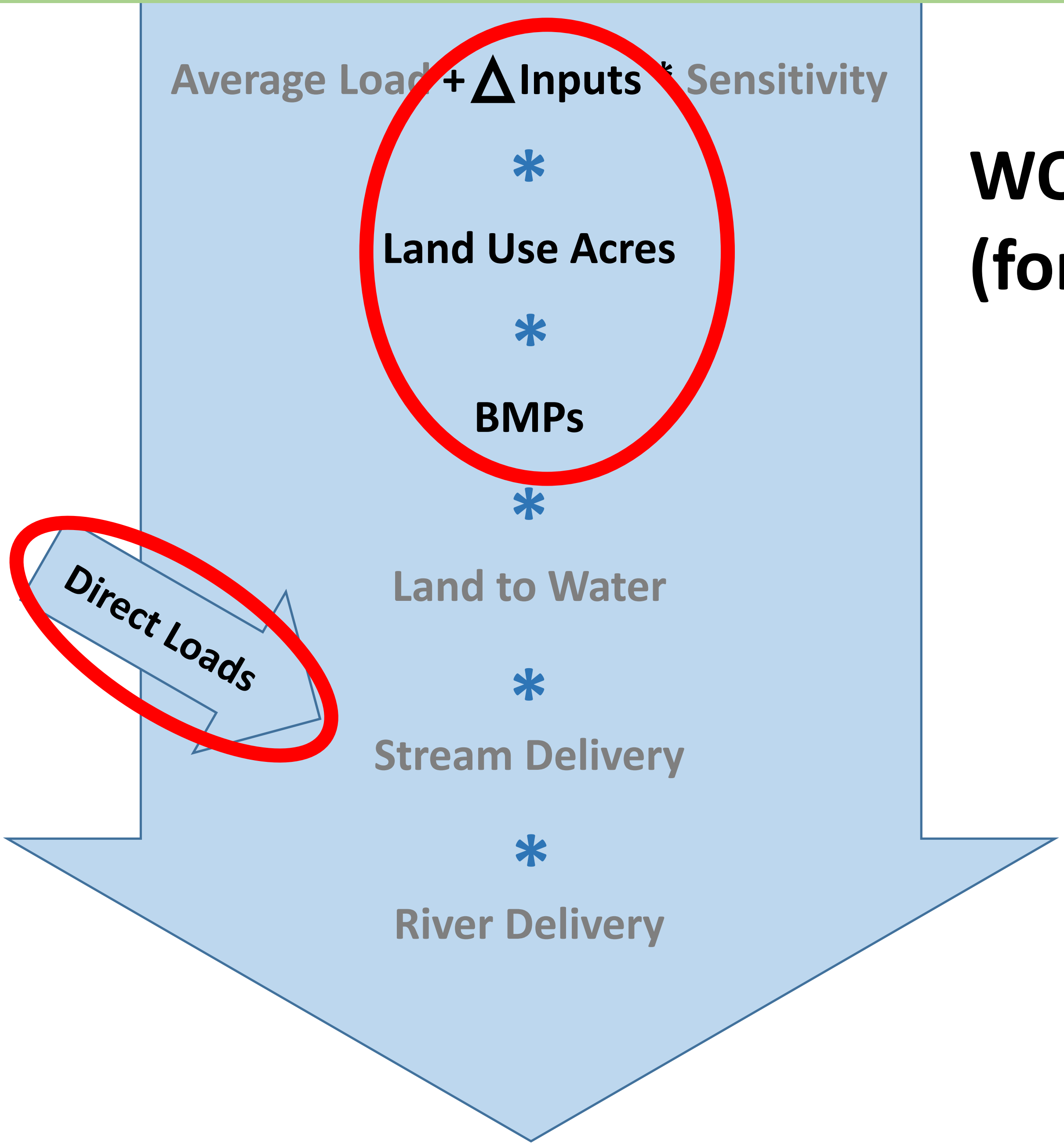
Governance

- WQGIT and workgroups
  - how the models are used to inform policy
  - model inputs and the extent of BMP implementation
  - BMP panels
  - Land use data
- Modeling Workgroup
  - scientific integrity
  - modeling of the physical environment
  - model calibration
  - issues that cross sectors such as average sector land use loading rates.
- CBPO serves these groups
  - Opinions and answers presented are not decisions

Phase 6 Model Structure

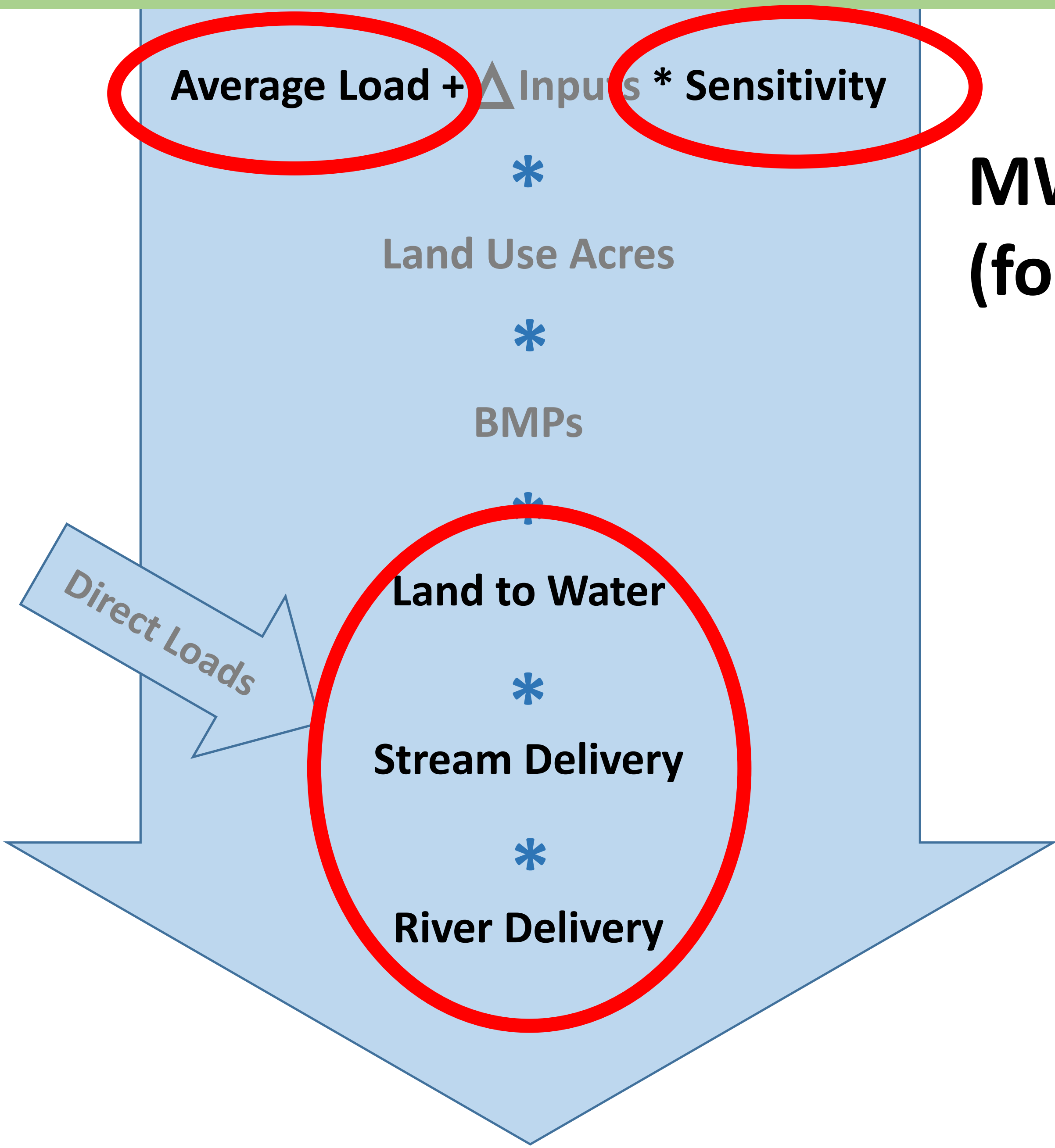


Phase 6 Model Structure



WQGIT
(for the most part)

Phase 6 Model Structure



MWG
(for the most part)

Partnership Feedback

- Email to Gary Shenk, Matt Johnston, and/or Lewis Linker
- Different types of feedback
  - Question
    - simple email or phone call
    - not tracked
  - Discussion
    - Series of emails or calls
    - Emails briefly summarized in posted document
  - Proposed Fatal Flaw
    - After discussion
    - Raised to CBP workgroup as proposed fatal flaw
    - Tracked and recorded

Fatal Flaw Review

- June and July – Partnership 'Fatal Flaw' Review

  - Criterion #1 – problem with the model
    - Failure to follow partnership instructions as of 12/31/2016
    - Omission of data received by 12/31/2016
    - Overall failure of calibration
    - Illogical results

  AND

  - Criterion #2 – Significant impairment in the ability to
    - Set planning targets
    - Assess progress

A Fatal Flaw is not

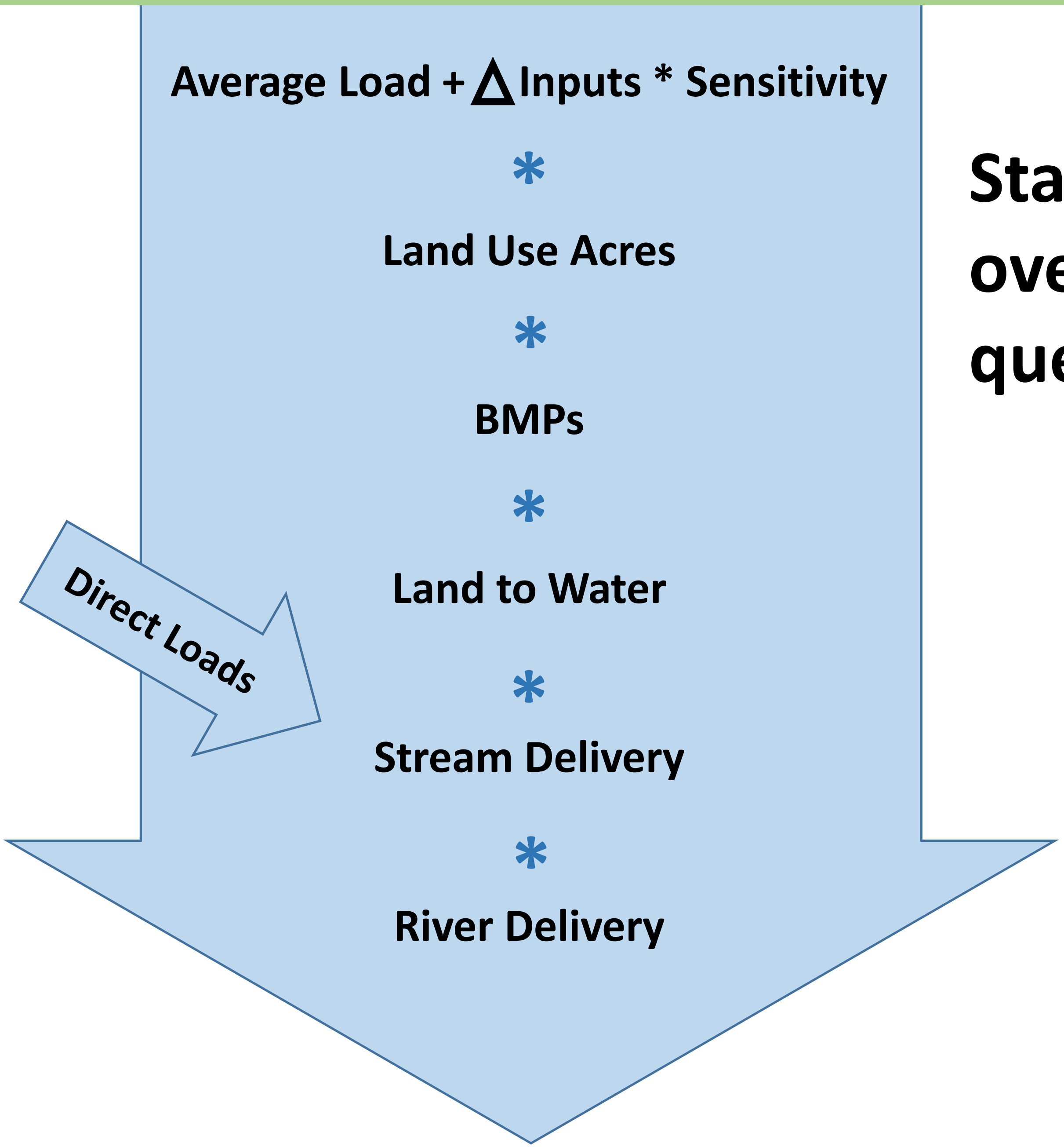
- A disagreement with a final decision that has been made by the partnership
- A disagreement with a scientific or technical method or product in favor of another method or product.
- A failure to match loads for particular monitoring station(s) or constituent(s)
- A disagreement with a planning target

106 Comments received

- 4 Big Categories
  - Land use (LUWG)
  - Inputs (WQGIT)
  - Simulation (MWG)
  - Simple Fixes

- 1st Fatal Flaw already determined by WQGT
  - VA crop and pasture land uses
  - Means that the model <u>will</u> change between draft and final

Phase 6 Model Structure



Start with some overarching questions

Accuracy / Precision / Significant Digits – Steve Levitsky

- Many output numbers are to the tenths, hundredths, and thousands decimal places with many significant digits. Because many of the input parameters have unknown certainty and/or are estimated through other modeling, there is question whether the output data should have this many significant digits. We suggest CBP verify the significant digits in each output parameter. **It seems improbable that N and P load estimates can be extrapolated to the significant digits documented in the different scenarios. A large number of significant digits gives the perception the output is very accurate** with no scientific backing for the significance.

Added emphasis

CBPO agrees…

- Precision of model absolute loads is probably about 1-2 significant digits.
- Suppose Ag in a state has an estimated load of 1,567,123 lbs
- 1.6 million lbs is a reasonable way to report that.

…but need the precision to estimate the effect of BMPs

- Suppose Ag in a county has an estimated load of 1,567,123 lbs in the model
- Implement 10,000 lbs of BMPs
  - New load is 1,557,123 lbs
  - Reported as going from 1.6 million lbs to 1.6 million lbs
  - Zero credit for BMPs
- Implement 20,000 lbs of BMPs
  - New load is 1,547,123 lbs
  - Reported as going from 1.6 million lbs to 1.5 million lbs
  - 100,000 lbs credit for BMPs (5x)

Uncertainty Analysis – Steve Levitsky

- The Scientific and Technical Advisory Committee of the Chesapeake Bay Program (**STAC) has recommended** completing an **uncertainty analysis** of the Chesapeake Bay model in **2005, 2006, 2008, 2011, and 2013** and to date no uncertainty analysis has been completed. This is clearly a **failure to follow partnership instructions**.
- As discussed with Gary Shenk multiple times, STAC recommended in 2013 (most recent recommendation) that an uncertainty analysis be completed with this version of the model and communicated transparently with the public. It has not been completed and CBP has not submitted a legitimate argument to not complete an uncertainty analysis prior to any results being published. **Stating it is too complex is not a legitimate scientific reason, as STAC has made clear**.
- Because an uncertainty analysis has not been completed by CBP the partnership States cannot implement the best policies, management practices, etc. to address real and accurate concerns.

- **DDA -** No uncertainty analysis has been performed to adequately measure performance between sectors and equity of BMP efficacy

Added emphasis

STAC 2013 recommendation

- **Recommendation 2. The Chesapeake Bay Program should exercise the multiple model systems developed under Recommendation 1 to quantify model uncertainty and confidence in key predictions used in decision-making.**
- The inability to estimate uncertainty came up repeatedly during the workshop as a limitation of the current CBP modeling suite in filling its roles as a synthesis of knowledge and as a decision tool. The capability to help estimate uncertainty was repeatedly mentioned as a key advantage of multiple modeling. Balancing risk and uncertainty is critical to good decisions (Section 4.2.1), and STAC has repeatedly recommended that the CBP develop uncertainty estimates for its models (Band et al. 2008, Committee for the ANPC/LimnoTech Review 2011, Friedrichs et al. 2011, 2012). **However, formal uncertainty analysis of very complex simulation models implemented over a large area remains a challenging scientific and computational problem. Multiple modeling provides an alternate way to quantify uncertainty.** For TMDL purposes, quantifying uncertainty is more rigorous, informative, and cost-effective than an arbitrary margin of safety (MOS) as in the current CBP calculations (Reckhow 2003).

Added emphasis

Upcoming STAC reports

- Uncertainty workshop (2016)
- Watershed Model review (2016-2017)

- Both stress importance of uncertainty quantification
- Workshop provides simple first steps, some of which have been taken
- Review starts to outline methods that could be used
- Workshop stressed that the managers must define how uncertainty will be used

Uncertainty in the context of TMDLs

- TMDL = WLA + LA + MOS

- Other ideas:
  - Focus on strategies with a higher probability of success
  - Take measurements that shore up the parts of the model that contribute the most to uncertainty

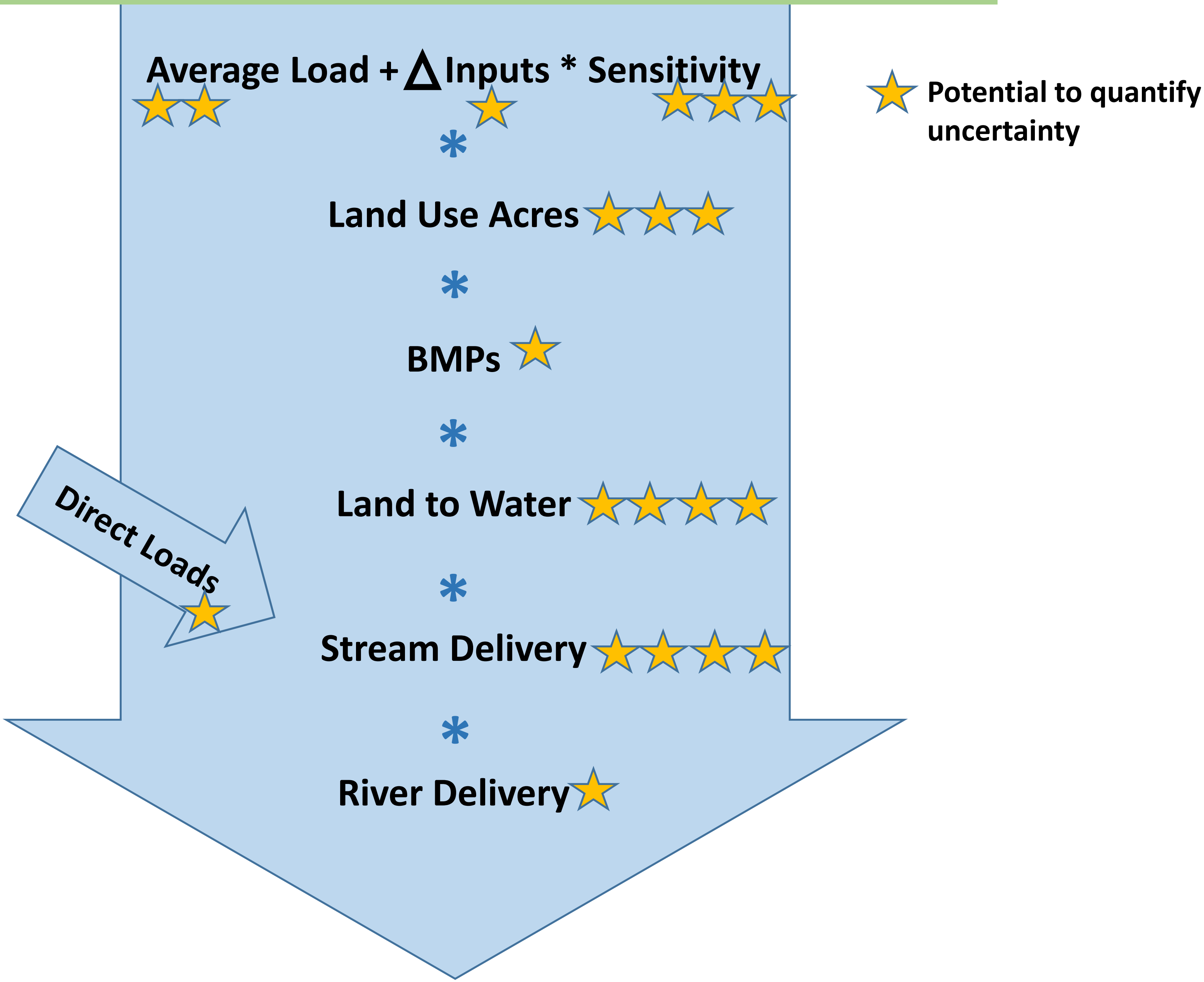
Made similar decisions in the past

- Allocations made in 1987, 1992, 1997, 2003, and 2010 without uncertainty quantification
- More confident in Phase 6
  - Use of multiple models and multiple lines of evidence
  - Extensive input from a greater group of partners
    - Building a Better Bay Model workshop
    - New partners (poultry industry, NASS, USP&E, land grants, private manure haulers)
    - More formal review structure
  - Better calibration results

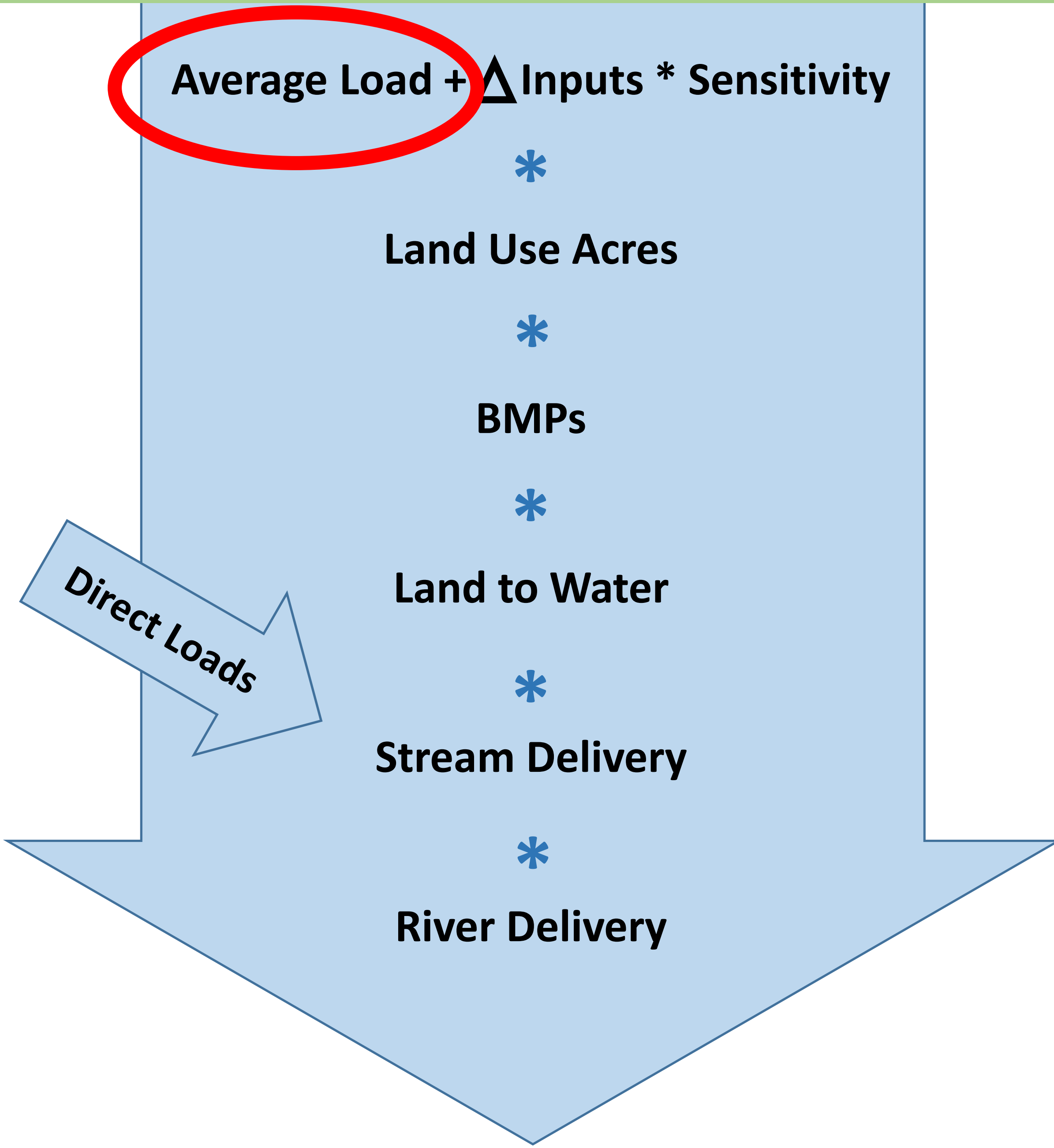
CBPO working toward UA

- General method – estimate the uncertainty of all inputs and run many model runs
  - Phase 6 runs fast
  - Multiple model framework helps estimate the uncertainty
  - Need to complete uncertainty estimate of inputs
- Need the CBP managers to weigh in on how to to use the uncertainty

Phase 6 Model Structure



Phase 6 Model Structure

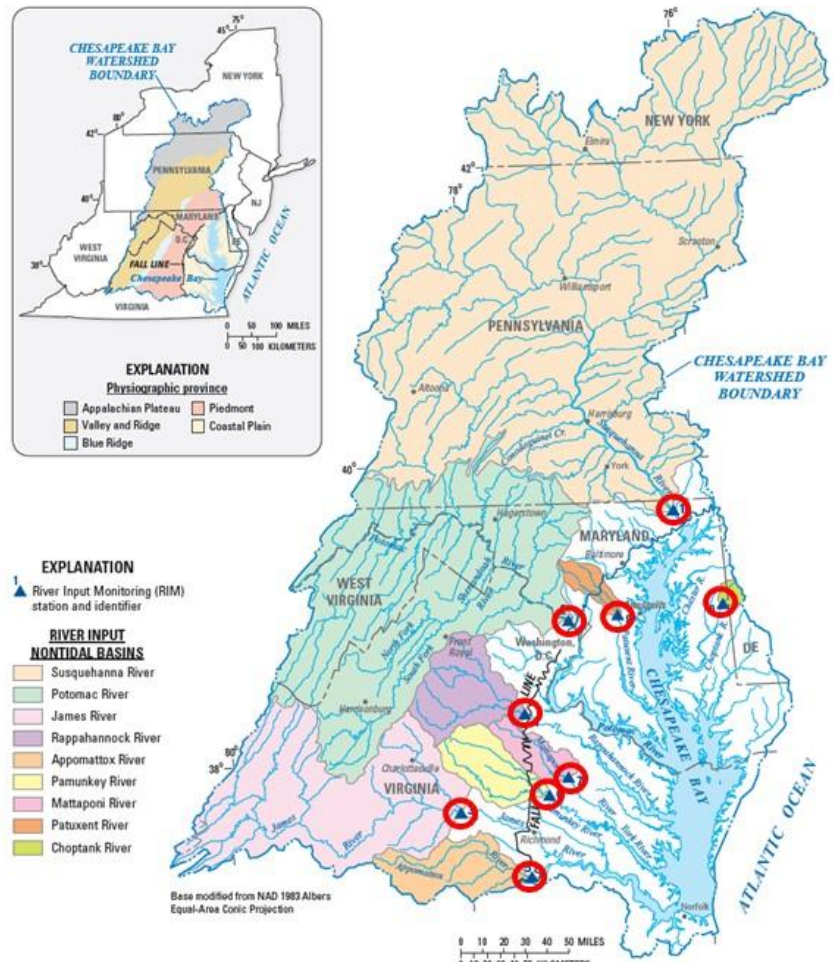


Average Loads

Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed

Estimate Total Non-point Source

Modeling Workgroup



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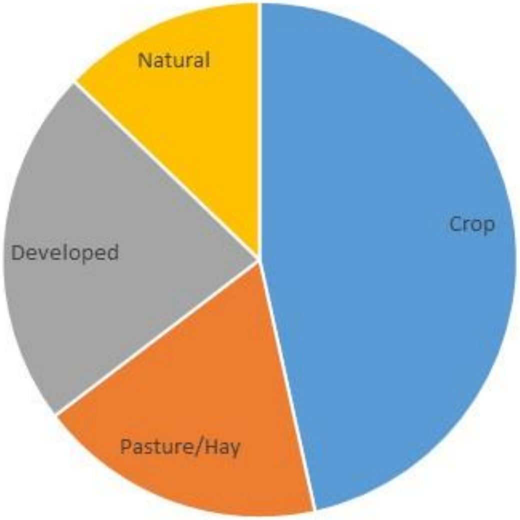
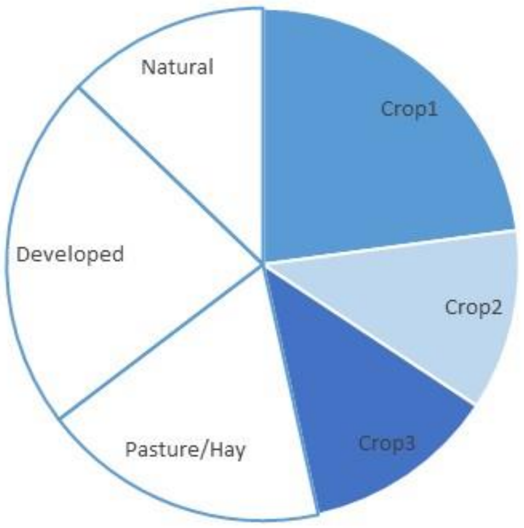


Divide into Broad Classes

Modeling Workgroup

Average Loads



Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed

Split Classes into individual land uses

WQGIT Workgroups

Average Loads – (Everyone)

- *..”the Phase 5.3.2 losses [in free-flowing rivers] of 12.8 million pounds were used in the final version.”*
- **Does this statement suggest an additional 12.8 m lbs of legacy P exist in the stream network that have been unaccounted for in all inputs to the landscape? If yes, …**

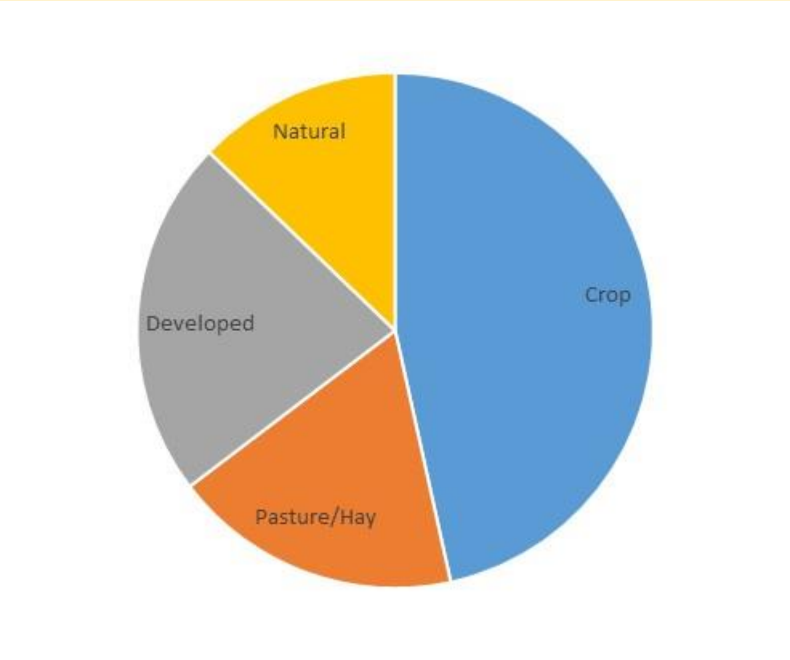
- Response from CBPO: Documentation error. No such assumption was made in the final version.

STAC – "circular logic" quote (multiple partners)

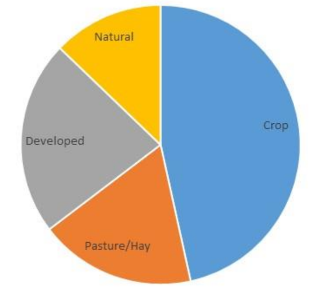
- Of further concern, the static model logic seems circular: First, observed loads at river outlets are decomposed to predict land use land cover (LULC)-specific loading rates, but then the model structure apparently is applied in reverse to predict river discharge. This *may* be justifiable if each component is viewed as a "composite" parameter of the overall framework, and these back-and-forth adjustments actually describe the calibration process.
- Response 1: Yes, the components are composite parameters. Part of calibration is testing different realizations. This is similar to regression analysis
- Response 2: the river outlet loads are used for the mass balance of the overall RIMshed. They are not used individually. The model then predicts spatial differences that are compared against the RIM sites separately.

Average Loads –Perdue

- The calibration methodology assumes cropland is the highest loading land use and then portions the other large land use categories (pasture, developed, and natural) off of this.



Average Loads - MDA



- Global targets for crop have ranged from approximately 47 lbs N (Beta 2) to 30 lbs N (Beta 3) with the final proposed target as 38 lbs N. Variability in target ranges have also occurred for the pasture global land use, as well as P targets for both crop and pasture. However, P6 improved input estimations show significantly less absolute pounds of N and P throughout the calibration period (Figure 1, Jeff Sweeney 062917). **Please provide the justification for selection of the global crop target given the decreased agricultural inputs**, and in the context of STAC's comment on the circular logic of the global target's use (Draft report Nov. 2016).

Nutrient Mass Balance – Bill A

- **Ag Nutrient Mass Balance**
- Phase 5 simulated a nutrient mass balance (Figure 7). (Source: DEVELOPMENT AND APPLICATION OF THE 2010 CHESAPEAKE BAY WATERSHED TOTAL MAXIMUM DAILY LOAD MODEL, Gary W. Shenk and Lewis C. Linker, 2013)
- Phase 6 Cropland inputs have more accurately estimated manure applications, fertilizer applications, and crop yields (uptakes).
- The logical outcome is for non-point nutrient exports of nitrogen and phosphorous to substantial decrease (as displayed in the visualization tool: “Total lbs. N & P Applied to Crop Goals”) in Phase 6 from Phase 5 outputs.
- Request 1: Please update Phase 6 Cropland nitrogen & phosphorous simulated mass balance for the CB watersh[...] revised from 2010 Phase 5.

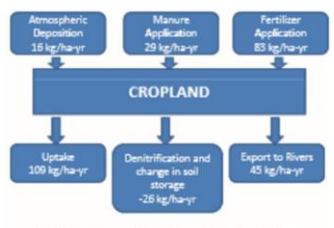
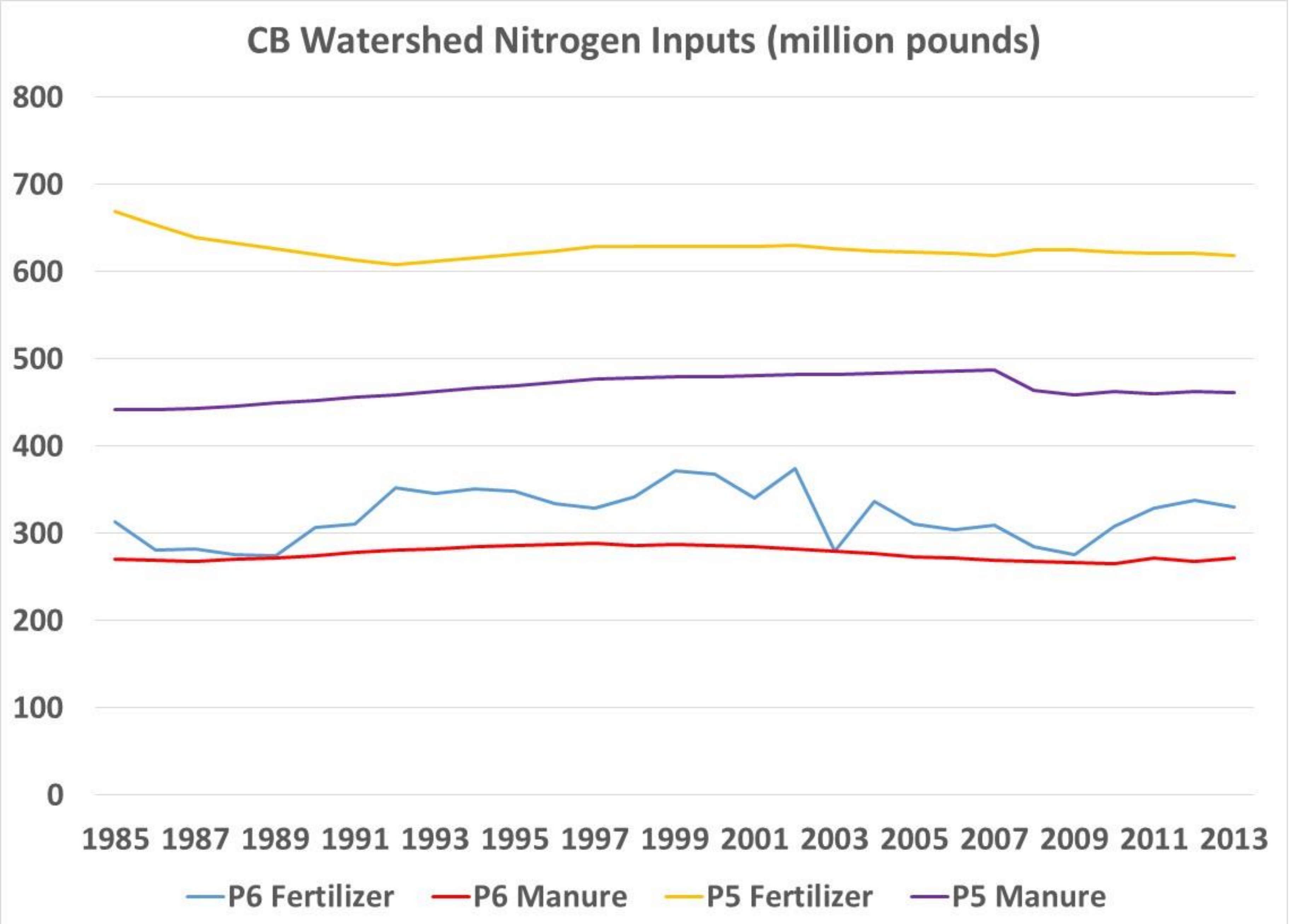
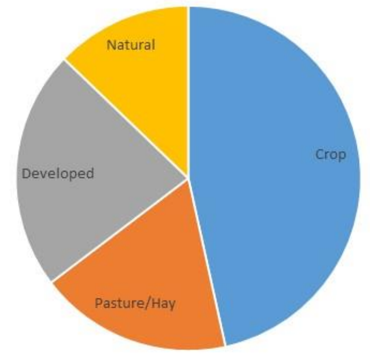


FIGURE 7. Average Mass Balance of Cropland Nitrogen over the Chesapeake Bay Watershed.



CB Watershed Nitrogen Inputs (million pounds)
800
700
600
500
400
300
200
100
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
P6 Fertilizer
P6 Manure
P5 Fertilizer
P5 Manure

Average Loads – Bill A.



- **Average Loads**
- Request 2: Please explain the interconnection between the Phase 6 Cropland nitrogen & phosphorous simulated mass balance to the Average Loading Rate (Phase 6 Model Structure).
- Ag WG (1/21/16) approved the final Phase 6.0 Ag Land Use Loading Ratios Report.
- However, the simulated Cropland Nitrogen Loading Rates (lb/ac/yr) have widely varied from 5.3.2, P6 Beta 2, P6 beta 3, to P6 final draft (Table 2-7, 6/1/17).
- Request 3: Please explain the influence of the “Use of Multiple Models for Nitrogen Export Rate” for Cropland & Hay/Pasture classes (Documentation: Table 2-5) on “Average Load”.

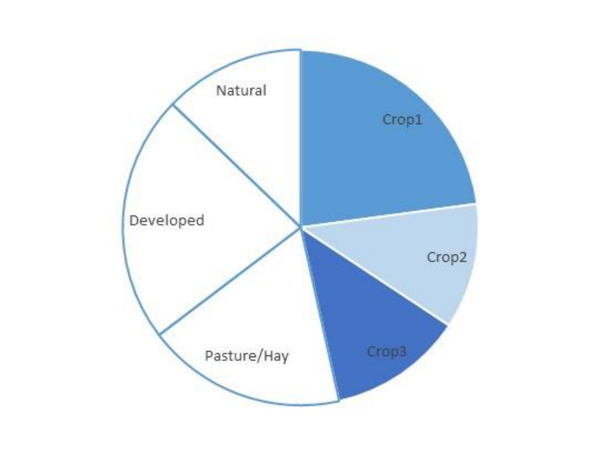
- *Response: No relation to Average Loads. These are determined through multiple models*

Use of Multiple Models for Nitrogen Export Rate

Land class	Crop	Pasture/Hay	Developed	Natural
Acres	2,620,895	4,535,321	2,690,480	21,458,991
P532 No BMP Loading Rate (pounds per acre per year)	47.51	14.95	16.80	4.21
CEAP Loading Rate (pounds per acre per year)	42.52	10.19	Not used	1.61
SPARROW Loading Rate with BMP effects removed (pounds per acre per year)	22.35	7.30	8.35	0.40
Average Ratio to Cropland Rate	1.00	0.29	0.36	0.05
Average Land class Loading Rate (pounds per acre per year)	38.22	11.22	13.90	1.84
Total Land class Load (million pounds per year)	100.16	50.88	37.39	39.45

Average Loads – DDA

- N loading rates have varied widely between Phase 5 and Phase 6 development models based on expert opinion. This variation is not well understood or documented and should not result in a greater responsibility for the Ag sector. If it does, this change has not been adequately documented.



Split classes into individual land uses – Crop Nitrogen

Land class	Land Use	Acres	Loading Rate Ratio	Loading Rate (lb/ac/yr)
AGWG => AMS => ALRRSC 53 page report **Cropland**	Double Cropped Land	165,396	0.79	30.87
	Full Season Soybeans	282,456	0.71	27.74
	Grain with Manure	389,811	1.4	54.7
	Grain without Manure	451,318	1	39.07
	Other Agronomic Crops	417,838	0.45	17.58
	Silage with Manure	392,156	1.62	63.3
	Silage without Manure	69,204	1.16	45.33
	Small Grains and Grains	291,677	0.84	32.82
	Specialty Crop High	35,525	1.34	52.36
	Specialty Crop Low	125,509	0.31	12.11

Tom Jordan, Chair	SERC
Jack Meisinger	ARS
Ken Staver	UMD
Wade Thomason	VT
Doug Beegle	PSU
John Spargo	PSU
Greg Albrecht	NYS-DAM
Gene Yagow	VT
Jim Cropper	NEPC
Curt Dell	ARS
Don Weller	SERC

Split classes into individual land uses – Crop Phosphorus

Target Land class	Land Use	Acres	Loading Rate Ratio	Loading Rate (pounds per acre per year)
Cropland	Double Cropped Land	165396	1*	1.87*
	Full Season Soybeans	282456		
	Grain with Manure	389811		
	Grain without Manure	451318		
	Other Agronomic Crops	417838		
	Silage with Manure	392156		
	Silage without Manure	69204		
	Small Grains and Grains	291677		
	Specialty Crop High	35525		
	Specialty Crop Low	125509		

At the direction of the Agriculture Loading Rate Review Subcommittee, the entire crop category was treated as a single unit. The weighted average of all crop types is 1.87 lbs/acre. They are differentiated by inputs and sensitivities.

Phase 6 Model Structure

Average Load + ΔInputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

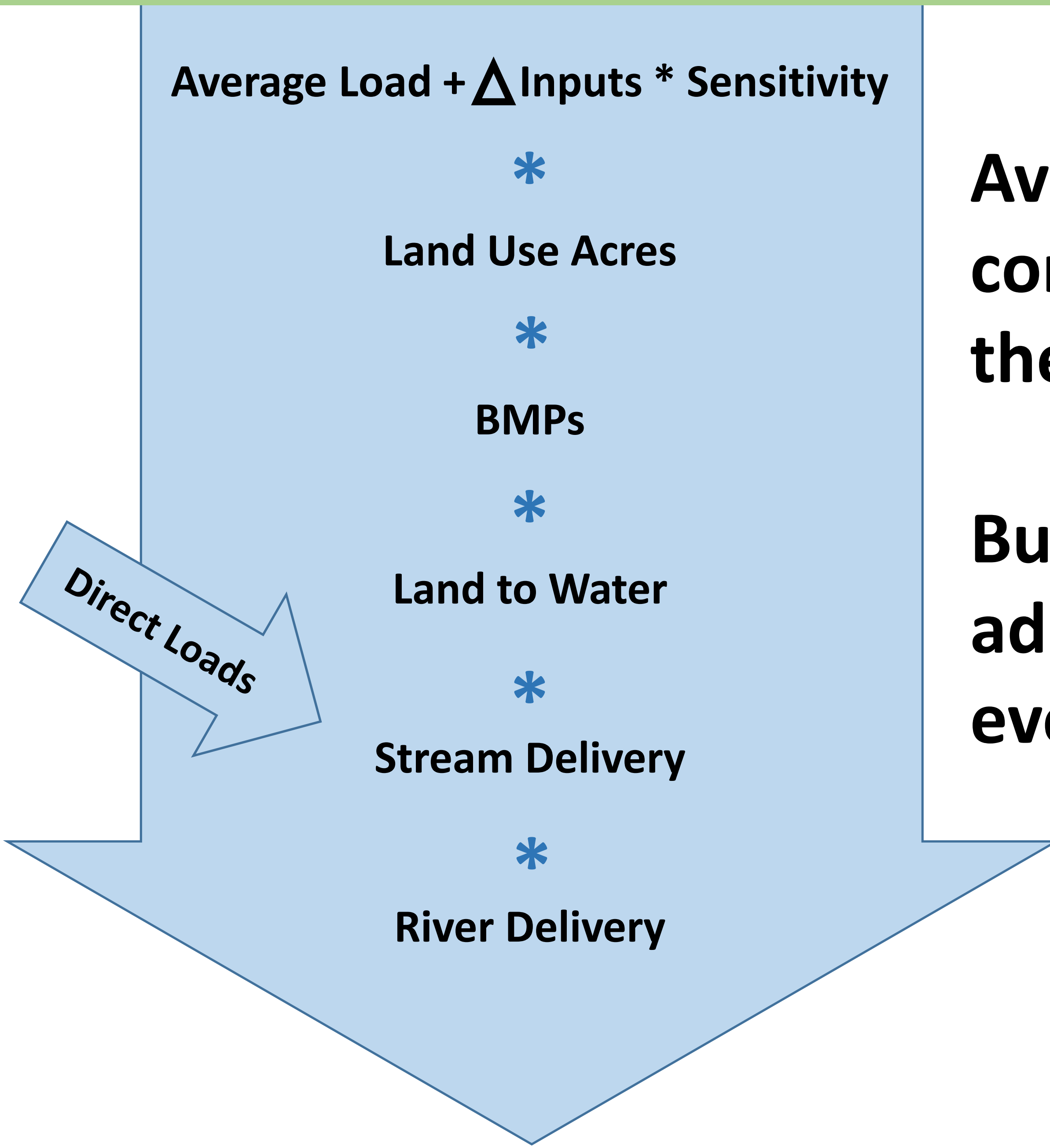
Average load is completely independent of inputs

Inputs, sensitivity, and BMPs determine spatial and scenario change

Average Loads - MDA

- Global target estimations were made for above-RIM locations only to calculate a land use target rate. These target estimates were subsequently applied to below-RIM locations. Is this an appropriate assumption given the lack of observed data and hydrologic connectivity of areas below-RIM stations?

Phase 6 Model Structure



Average load is consistent across the watershed

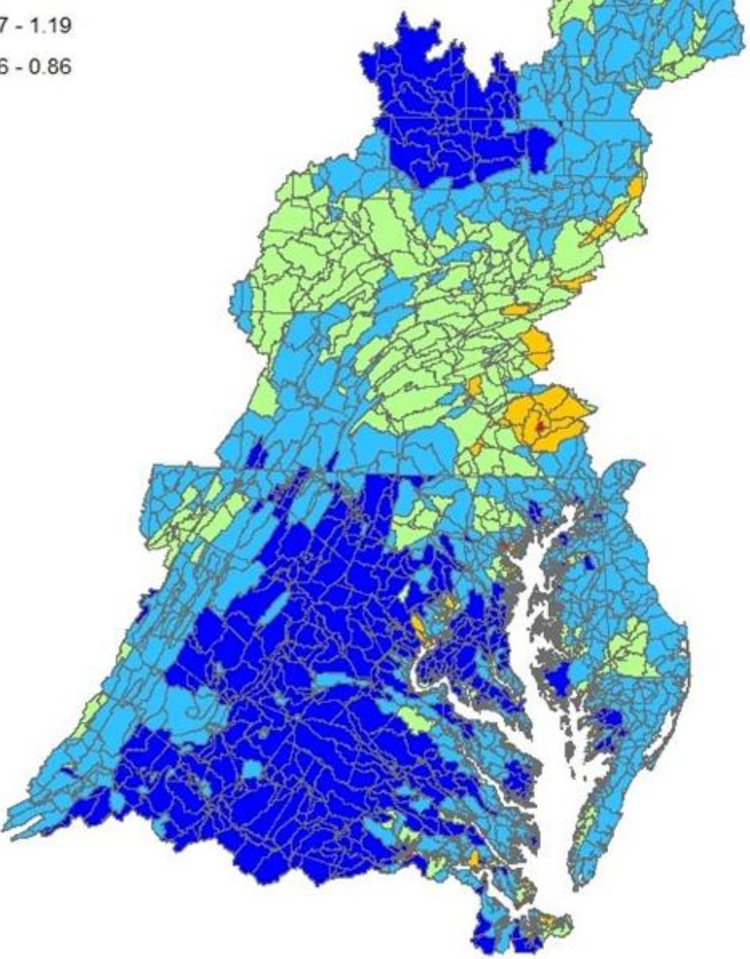
But variability is added by everything else

Nitrogen Delivery Variation Factors

P6 Land River Segments

ndvfcrop

- 3.11 - 6.05
- 1.78 - 3.10
- 1.20 - 1.77
- 0.87 - 1.19
- 0.46 - 0.86

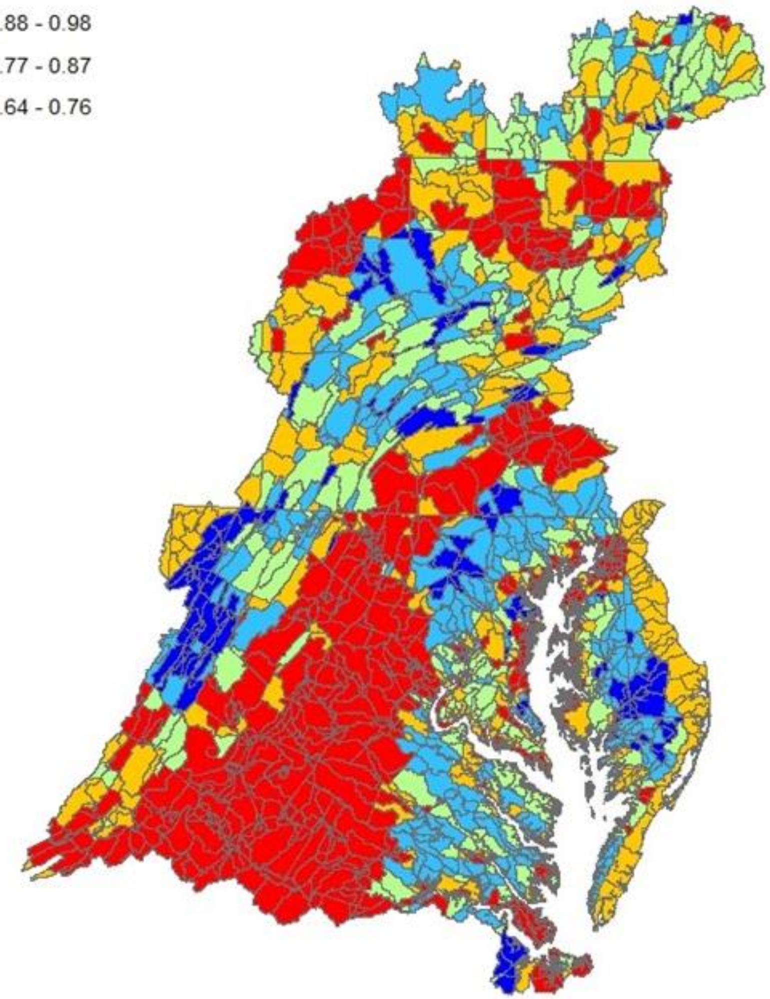


Phosphorus Delivery Variation Factors

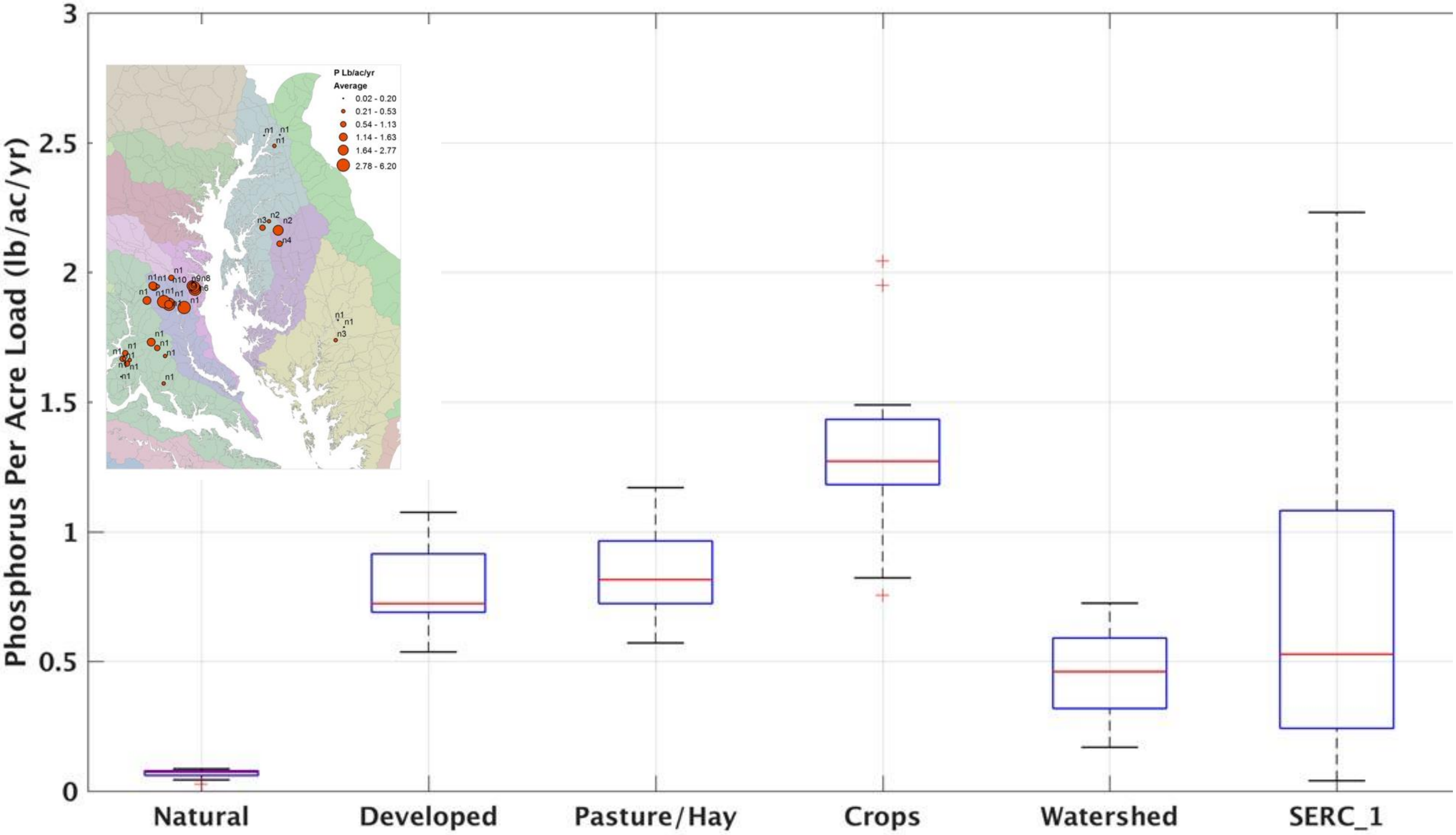
P6 Land River Segments

pdvfcrop

- 1.13 - 1.22
- 0.99 - 1.12
- 0.88 - 0.98
- 0.77 - 0.87
- 0.64 - 0.76



Coastal Plain Phosphorus

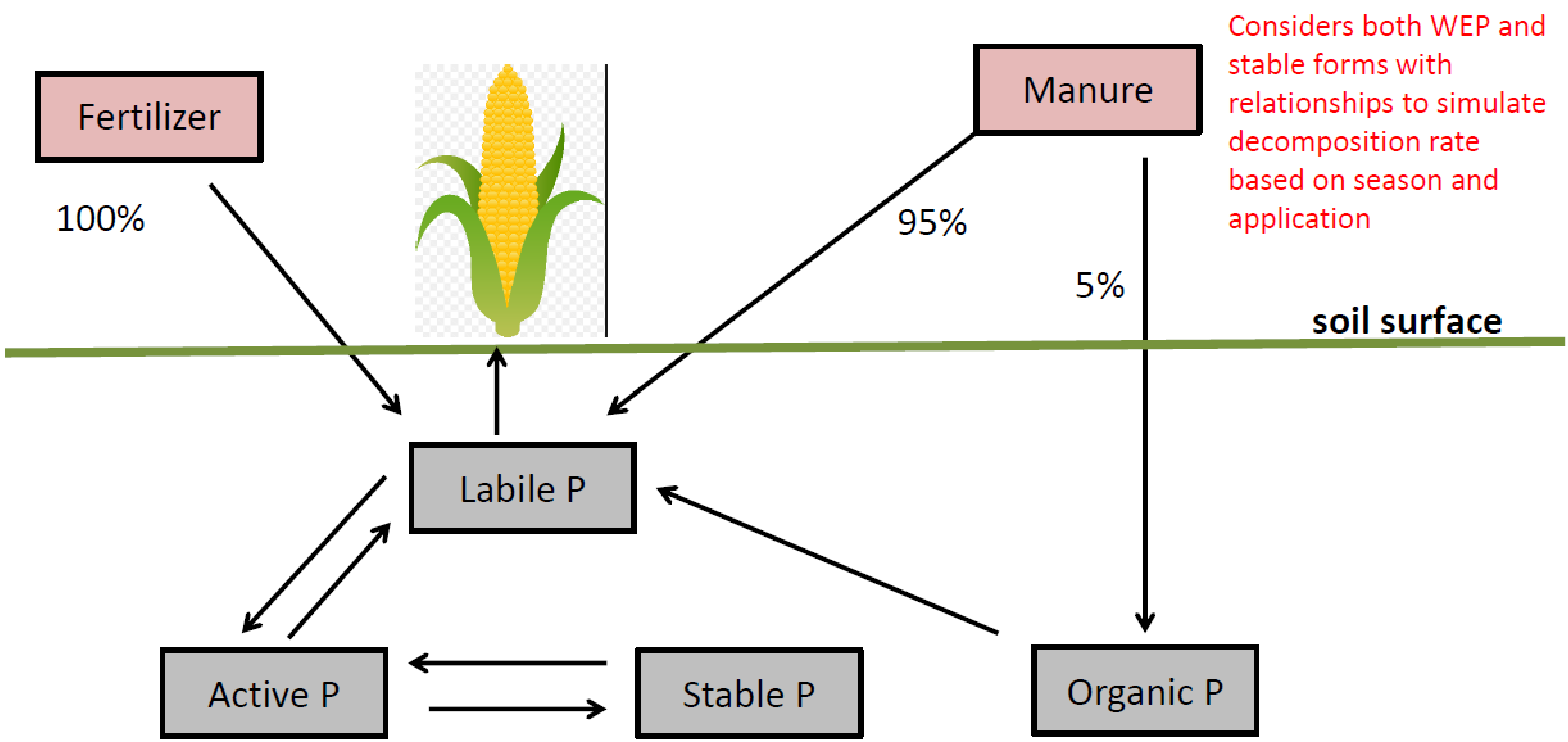


SERC_1 – phosphorus per watershed acres

Soil P – Bill A

- Request 4: How does crop uptake of soil phosphorous contribute to the phosphorous simulated mass balance?
- Ag WG (3/16/17) approved the AMS recommendation to simulate soil P history by using a mass balance modeling approach combining APLE and soil test data. This decision was made with Pennsylvania abstaining.

Diagram of APLE Nutrient Sources and Soil Pools



Equations to estimate Manure runoff P, Fertilizer runoff P, Sediment P loss, and Dissolved Soil P runoff

(Adapted from Vadas, et al. 2007)

Soil P - DDA

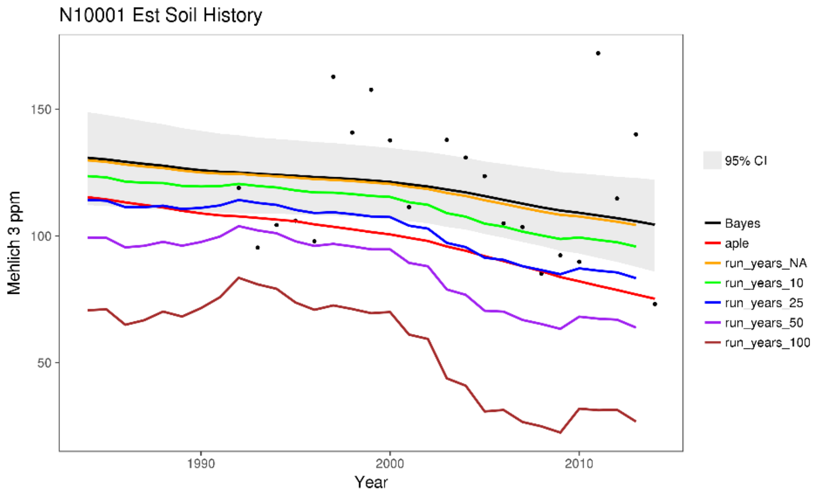
- The Bayesian estimated Mehlich 3 soil test phosphorus in parts per million was not an approved method by the AMS or AGWG. These decisions were made for Ag stakeholders by the MWG, which is a violation of P6 development protocol.

- Modeling workgroup approves modeling methods and WQGIT approves inputs. Bayesian method was approved by MWG and uncertainties were approved by AMS

APLE – Perdue

- An uncertainty analysis has not been completed on the modified, Bayesian APLE model constructed by CBP; therefore its accuracy cannot be verified.

- *APLE is one of the few parts of the system for which uncertainty is explicitly quantified*



Counties with no soil data - Perdue

- There are many counties that have no data. Using adjacent or counties near the county with no data to assume soil phosphorus in that county is not scientifically valid. Urban turfgrass issues have been brought to CBPs attention previously and the response was there was not enough data spatially to estimate turfgrass N and P concentrations. Soil P estimates using APLE are in the same category. APLE and the observed data are not adequately understood spatially to utilize the method throughout the Chesapeake bay region. Otherwise it is suggested that CBP add turfgrass N and P estimates based on real data similar to the estimates for Soil phosphorus.

Andrew

Soil P - DDA

- 'Soil Test P values gleaned from participating lab data are insufficient in time, space and detail to be applied in an APLE model simulation representing Agriculture for calibrating TP loads. In some counties, outside DE, no data was used to build a soil P history. In other areas, like DE, lab data were not indicative of the landuses for which the data was used to represent. Specifically, UD Soil Lab data is skewed toward home garden samples and these would not be appropriate to inform the APLE model. The APLE model has not properly supplied with hydrological connectivity data to accurately simulate TP load from DE soils. No alternative has been offered to remedy this deficiency

Soil P data– Perdue

- Soil Phosphorus Data used to calibrate the model is not well documented. The Section 3.0 documentation notes years and College or organization that collected/analyzed the data, but nothing further. Where were these samples obtained from? Who sampled? What methods? The main concern is these samples were most likely not random and are biased due to the reasons for sampling and specific items the sampler was attempting to look at. If they are biased it could significantly impact the accuracy of the average phosphorus calculations for that area.

Soil P Test Data

The Soil P test data are not ideal

We don't treat them like high-certainty observations of the state we are estimating because: there is uncertainty in their:

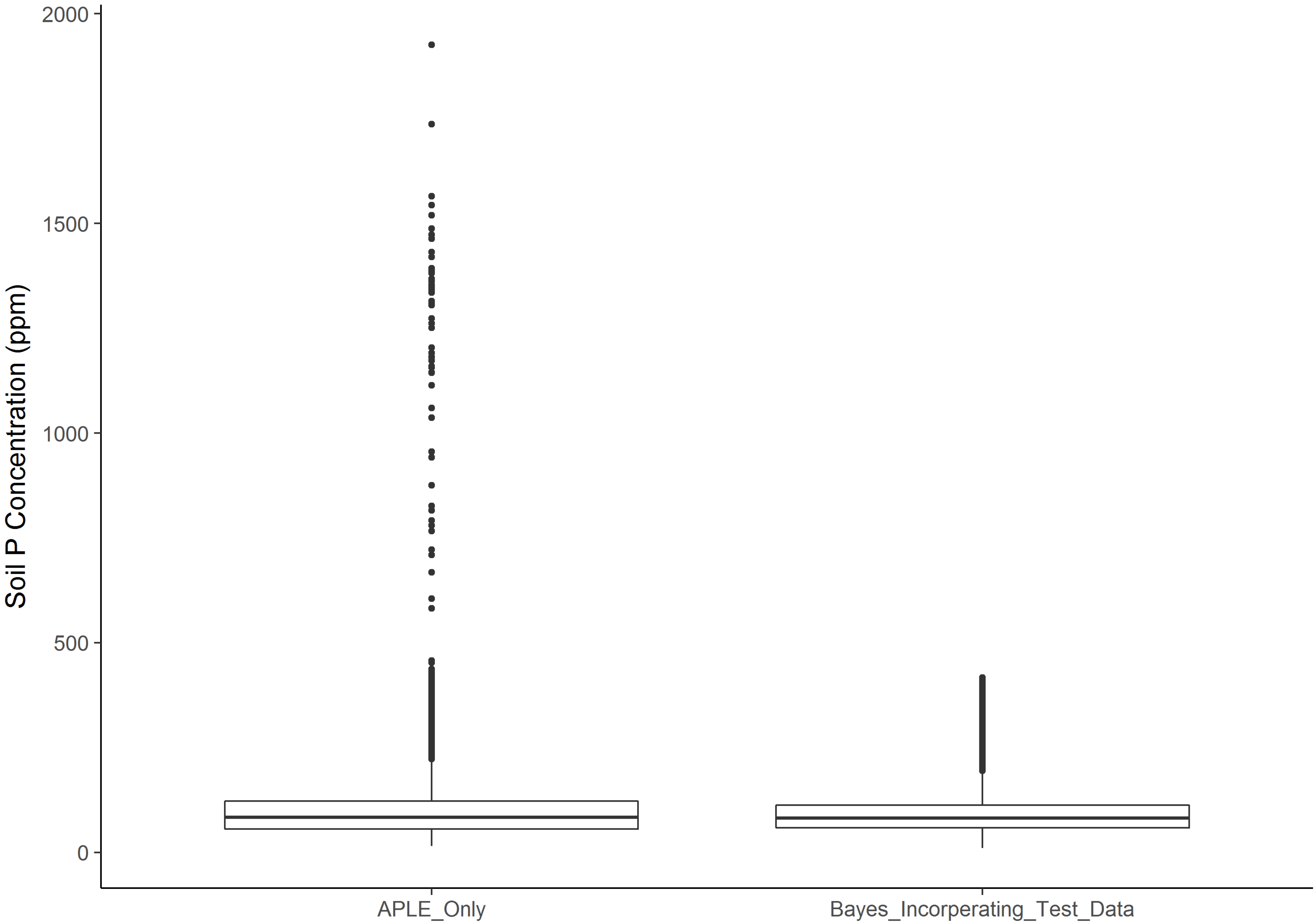
Location

Reporting Methods

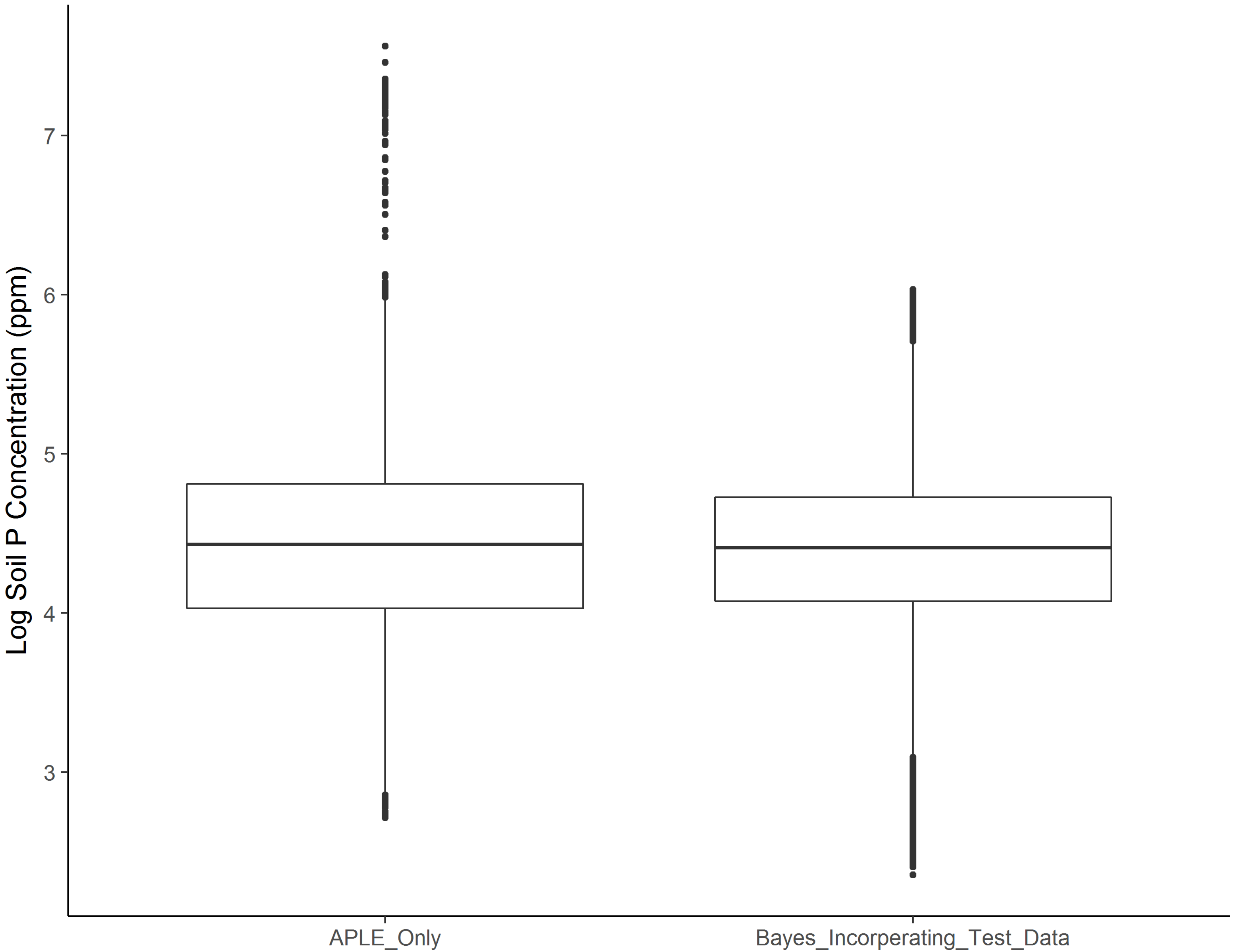
Landuse Disrectization

Context around the sampling process

Why Even Use The Soil Test Data?



Soil P Concentration (ppm)
2000
1500
1000
500
0
APLE_Only
Bayes_Incorperating_Test_Data



Log Soil P Concentration (ppm)
7
6
5
4
3
APLE_Only
Bayes_Incorperating_Test_Data

Using the Test Data Resulted in

Reducing the mean of soil P estimates by 5%

Reducing the max of soil P estimates by 78%

Reducing the 3rd quartile of soil P estimates by 8%

Reducing the positive skew metric of the soil P estimates by 70%

The soil test data is not ideal

The context of the problem was considered and the soil tests are not treated like observed values with high certainty

Incorporating the test data reduced the overall mean by 5%, gave a much more reasonable range (maximum down by 70%), and reduced the positive skew of the estimates

A few Specifics:

Comment: University of Delaware data is skewed by home and garden samples.

Answer: Data were labeled home and garden or commercial ag, we used only commercial ag

Comment: The same method for estimating of soil P values should be extended to turfgrass

Answer: There is no sensitivity to soil P for turfgrass in Phase 6. The partnership decided APLE was only appropriate to use on Ag land.

A few Specifics:

Comment: Data were not indicative of the landuses for which the data was used to represent

Answer: The discretization of data which did not have landuse information is based on the quantification of statistically significant differences from data which did have landuse labels.

Comment: The hydrologic inputs to APLE are insufficient.

Answer: APLE inputs annual precipitation from NLDAS and sediment washoff which we estimate with HSPF.

A few Specifics:

Comment: Specialty crops seems high

Answer: The landuse discretization was based on statistically significant differences between data with landuse labels

Comment: AOP seems high

Answer: There is no P sensitivity to soil P concentration in AOP

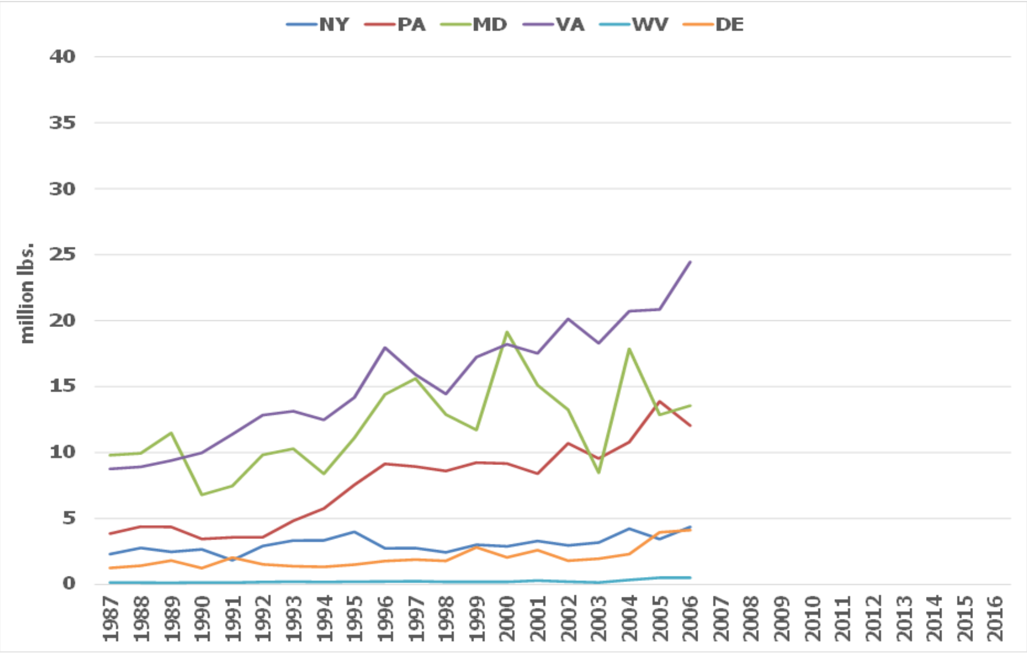
Turfgrass Applications and Uptake – Perdue

- Studies have shown 87 lbs/acre N applied to turfgrass. Phase 6 of the model estimates 10 lbs/acre and assumes this is a 1:1 ratio of turfgrass need to turfgrass uptake. If that is the case 9% of the Chesapeake Basin is underestimating turfgrass nitrogen applied by 70 lbs/acre vs. turfgrass need. This would substantially impact the calibration of the model (see above).

Matt

Turfgrass Applications and Uptake

- Response:
  - 2013 Progress results indicate an average of 11.4 lbs/acre of N application to each acre of pervious land.
  - This average varies depending upon state, and is based upon USGS NAWQA estimates of non-farm fertilizer use and acres of pervious urban lands. *Section 3.5.5*
  - Uptake is likely set too high at 65 lbs/acre for N.
  - **Action: AMS may recommend an alternative value based upon crop uptake from other grass species (e.g., fescue).**



USGS NAWQA Nitrogen Fertilizer Use by State

Inputs – Uptake vs. Removal

P6 is using a hybrid of crop uptake (minor crops) and crop removal (major crops), depending on the crop type. Pasture uptake values were also observed as much too low. Discussion of this decision and implications to loads were brought to the AMS 22 June. It is agreed absolute values may have minimal effect; however, the relative difference between land uses may be important in regions limited to major crops. Additionally, a consistent choice of uptake or removal should be used.

Uptake vs. Removal

- AMS agreed to update numbers for consistency purposes, and members suggested scouring USDA Nutrient Tool Database for more removal data.
- Potential Action: AMS to review results from database and make recommendations for removal values.
  - The model will still be interested in uptake, and uptake is needed for legume fixation values, but a simple ratio of 1.5 can be applied to all removal values to estimate uptake.

Livestock on Pasture - MDA

- Livestock to pasture ratios (animal per acre pasture) are unexplainably high in Kent County, MD. A review of the 2012 Ag Census confirms the total number of livestock (8,743 cows) with approximately 50% being dairy livestock. Pasture acres in the county are minimal. However, MDA provided assumptions to CBP indicating that dairy are largely confined throughout the year rather than on pasture. Please confirm that the livestock animals in Kent County were properly distributed between pasture, barnyard, and riparian pasture.

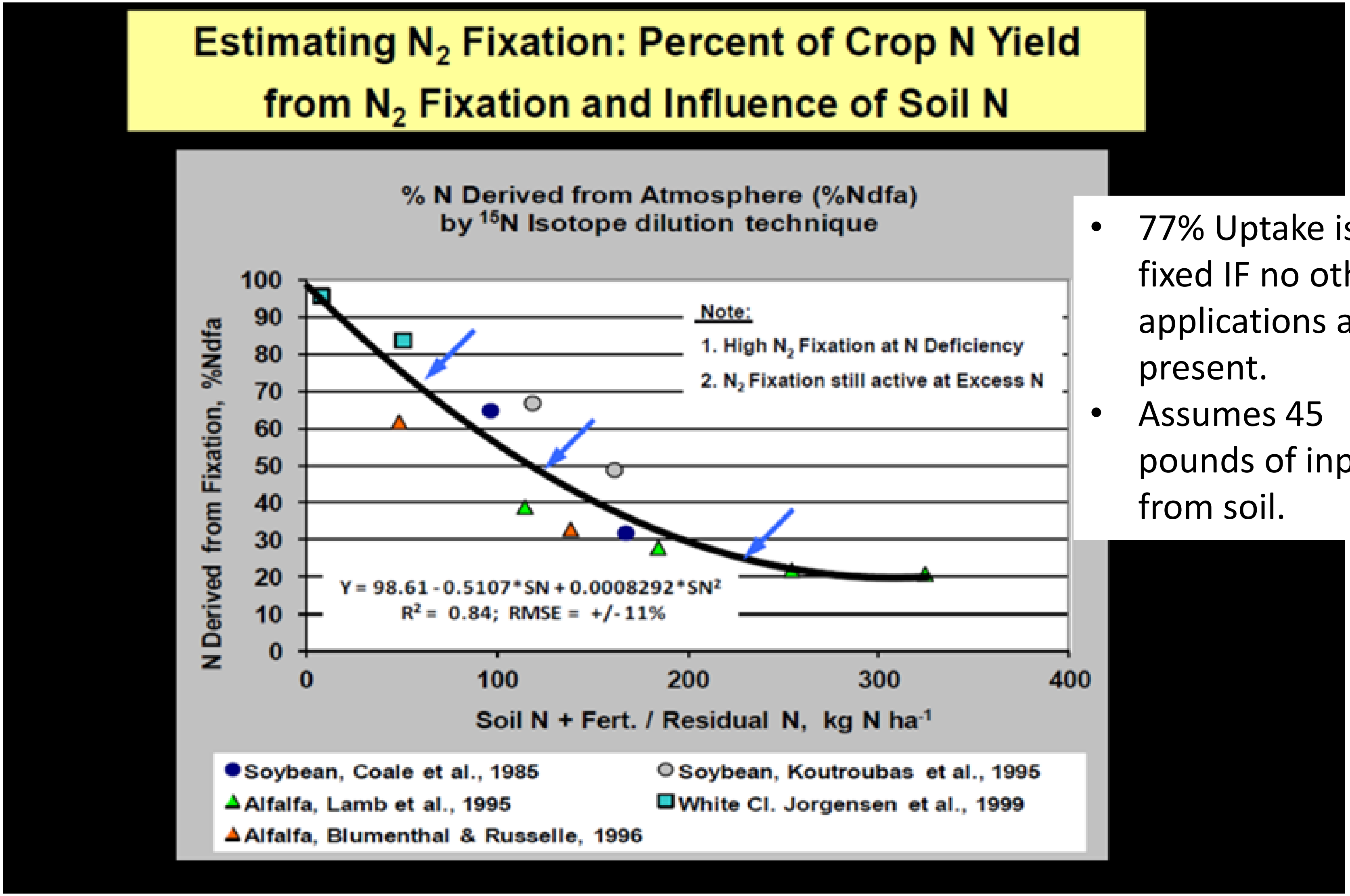
Livestock on Pasture in Kent County, 2013

- Pasture Acres
    - 2,419
    - 1.54 livestock animals/Ac
- Beef
    - Confined 0% of the time (on avg across the year)
    - 388 animals
    - 0.16 beef/Ac
- Other Cattle
    - Confined 0% of the time (on avg across the year)
    - 1406 animals
    - 0.58 other cattle/Ac
- Dairy
    - Confined 58% of the time (on avg across the year)
    - 4,625 animals
    - 0.8 dairy/Ac

Inputs for Soybeans - MDA

- Maryland full-season soybeans according to Tableau indicates an average of 130-140 lbs N applied annually, removal as 107-120 lbs N annually, and fixation rates similar to application rates. Additionally, previous discussions from Meissinger et al. cite ~ 45 lbs PAN contributed from the soil. Please explain the relationship between all legume parameters relative to potential losses of N?

Fixation Method



- 77% Uptake is fixed IF no other applications are present.
- Assumes 45 pounds of input from soil.

Meisinger and Randall, 1991

Inputs for Soybeans in MD 2013

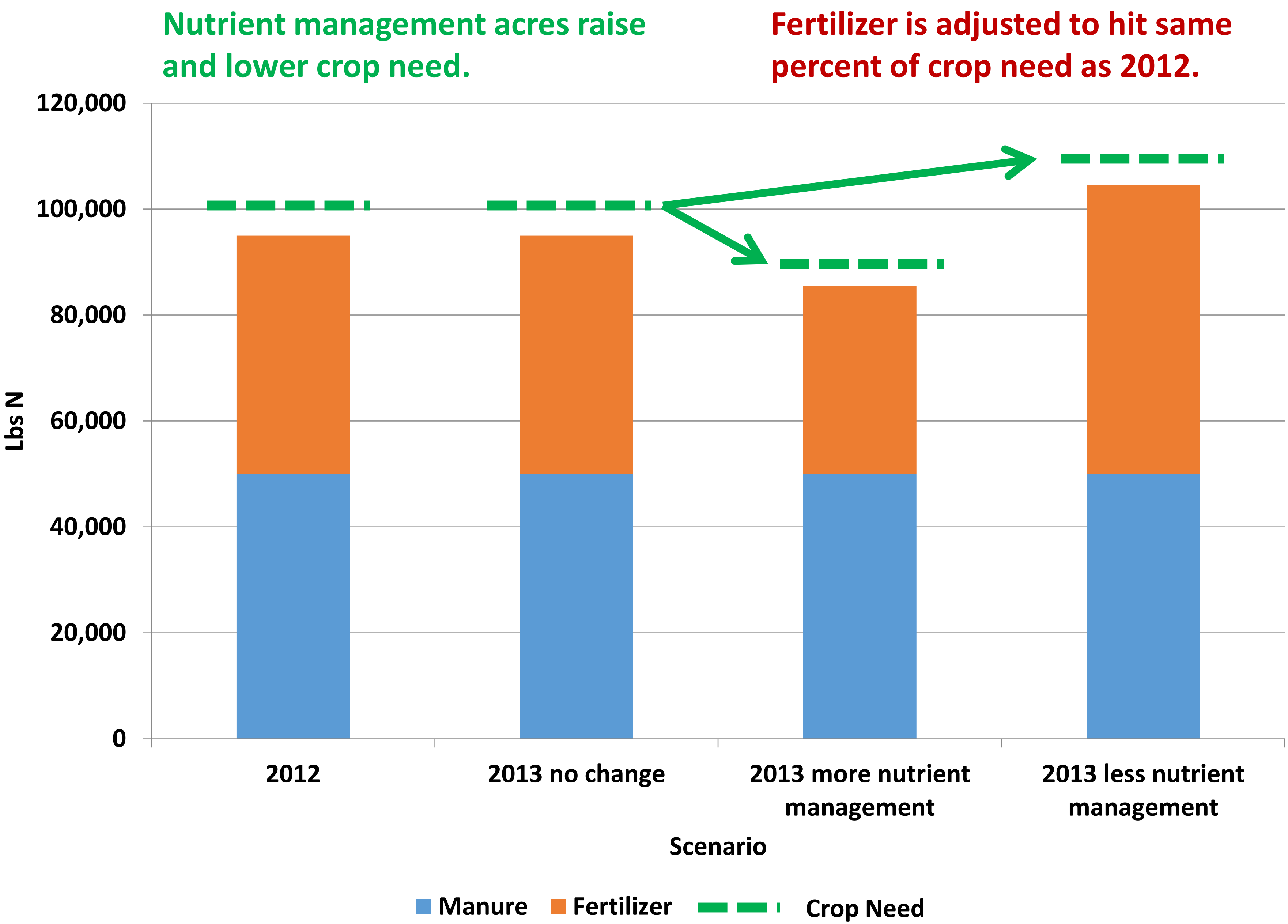
County Name	Fixation	Manure	Fert	Total
Baltimore	152.93	0.00	1.59	154.52
Carroll	147.21	0.00	1.67	148.88
Cecil	150.64	0.00	1.60	152.24
Frederick	146.53	0.00	1.68	148.21
Harford	151.52	0.00	1.56	153.08
Howard	144.48	0.00	1.53	146.01
Montgomery	145.25	0.00	1.54	146.79
Anne Arundel	126.41	0.00	1.36	127.78
Calvert	131.93	0.01	1.21	133.14
Caroline	126.92	6.38	0.00	133.30
Charles	128.85	0.00	1.32	130.18
Dorchester	128.76	5.44	0.00	134.20
Kent	141.06	0.00	1.15	142.20
Prince Georges	129.68	0.00	1.35	131.02
Queen Annes	134.57	2.45	0.00	137.02
St. Marys	128.13	0.00	1.24	129.37
Somerset	130.35	10.67	0.83	141.84
Talbot	132.17	0.01	1.11	133.29
Wicomico	131.94	6.85	0.26	139.06
Allegany	132.88	0.00	2.11	134.98
Garrett	132.86	0.00	2.13	134.99
Washington	133.32	0.00	1.52	134.84
Worcester	131.25	7.22	0.01	138.48

- Fixation varies with yields (because uptake does as well).
- For every additional lb NO3, the following sensitivities are applied:
  - 0.090 Fert
  - 0.090 Fixation
  - 0.032Manure
  - - 0.027 Uptake

Inputs - MDA

- During conversation with CBP, MDE, and MDA, it was explained that crop needs for 2012 were met using actual data and to establish a new crop need baseline for later years (without actuals). For example, if crop applications were 110% of need in 2012, the new baseline for crop need in 2013 was set to 110%. Please confirm if this is an accurate explanation of the model assumptions? If yes, please explain the rationale for setting a new crop need baseline that is counter to agronomic recommendation?

Crediting Nutrient Management with Constant % Application



Benefits of Constant % Application

- NM has direct impact on applications and loads
- Straightforward calculation
- Not likely to have outlier loading rates from diverging projections (cropland down, inputs up)
- Lb per acre export relatively constant unless management changes

NM scenarios - MDA

- A scenario request was made to CBP to demonstrate the benefits of core NM. Staff presented prelim results to AgWG on 29 June (slide 8, http://www.chesapeakebay.net/channel_files/24799/amsupdateagworkgroup06292017.pdf) suggesting measurable results from increased NM acres. However, state efforts (Maryland & Delaware) have not been able to replicate these results in CAST. Maryland has found modest decreases in N and P (<1%) with an additional 10% BMP implementation. Additionally, N loads (and some P) have actually increased in some counties with additional NM BMP coverage. Please provide the raw scenario files as shown to AgWG, and explain the CAST outcomes where increasing BMP coverage results in greater nutrient loads? A similar effect has been found for increased Manure Transport. Maryland must be assured that manure-rich counties (e.g. Somerset) with increased NM and/or Manure Transport, but without changes to broiler populations, would see decreases in loads.

NM and Manure Transport in Somerset County, MD 2013

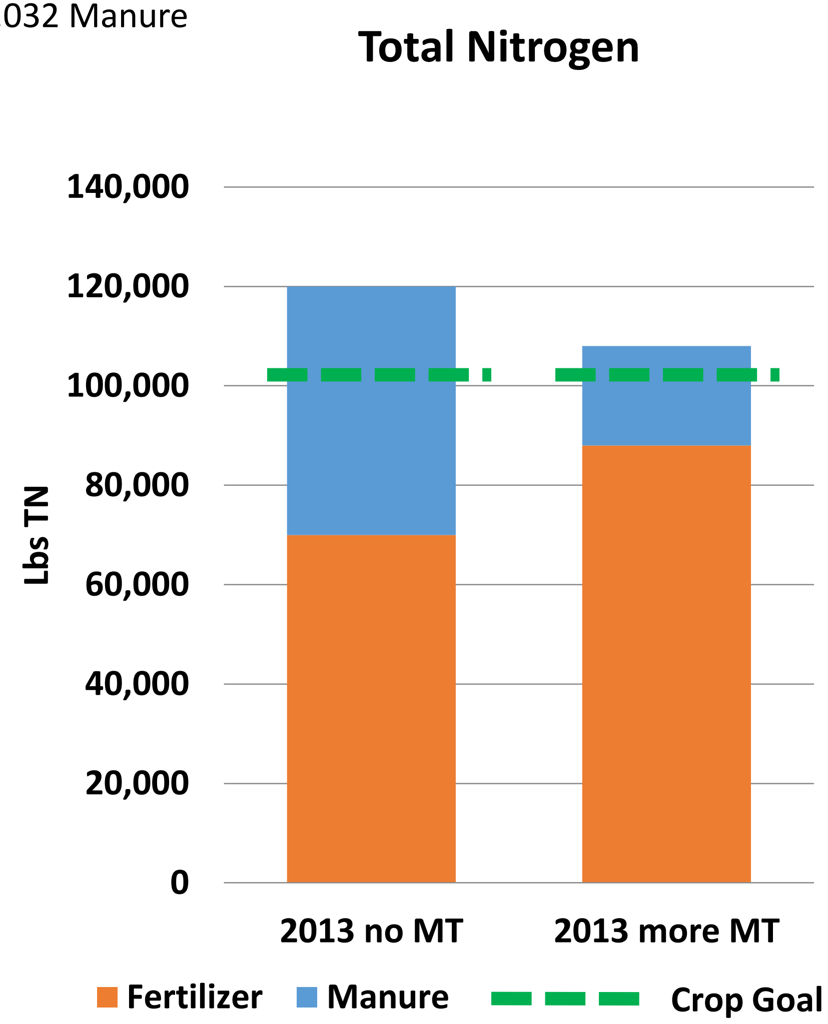
- Core NM reduces loads for N and P because it results in lower applications of inorganic fertilizer.
- Manure transport is a benefit for P, but not for N because it increases inorganic N fertilizer applications to replace all exiting plant-available N from the manure.
- However, when the two scenarios are combined, there is a net benefit for both N and P.

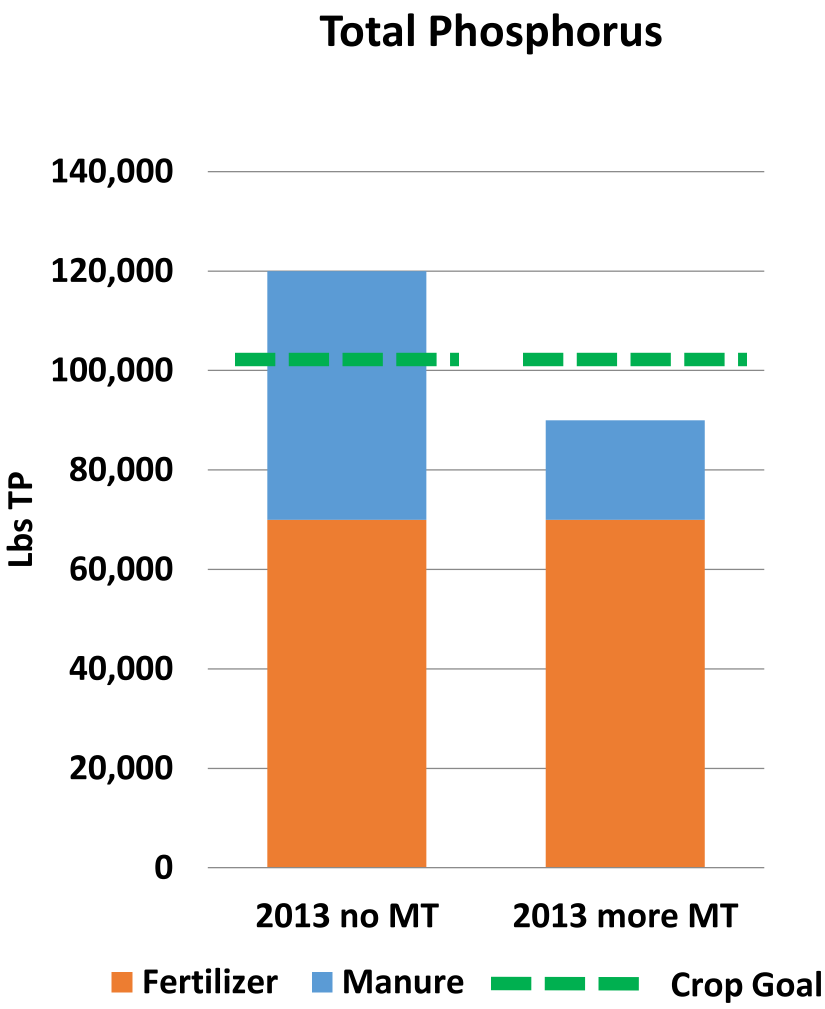
- Note: Scenarios judging impact of NM and MT are best run in 2013. The next release of CAST will better allow users to see similar results in older years.

Crediting Manure Transport

For every additional lb NO3, the following sensitivities are applied:

- 0.09 Fert
- 0.032 Manure





Manure decreases.
Fertilizer increases at a 0.6:1 ratio.
Total applications-to-crop goal decrease.

Manure decreases.
Fertilizer remains constant.
Total applications-to-crop goal decrease.

Applied versus need - Perdue

- Applied nutrients vs. crop needs for several counties are estimated to be up to a 5.7 ratio in the Tableau Visualization Tool. This seems improbable if not impossible. Manure would have to be stacked more than foot high across the entire farm. Please explain how this was developed.

Applied Nutrients Much Higher than Crop Goal

- Manure and fertilizer are estimated for a county, and then spread to fill crop goal.
- In counties with high nutrient levels, nutrients begin to pile up on other hay and pasture.
- Additionally, most applications to hay and pasture are not out of the realm of possibility, but appear so because of the low crop goal set by the Partnership.

CountyName	StateAbbreviation	LoadSource	Acres	NcropGoal/Acre	Napp/Acre	ApptoGoal
Somerset	MD	Other Hay	1,005.2	40.2	361.7	9.0
Somerset	MD	Pasture	1,476.7	15.0	134.8	9.0
Somerset	MD	Specialty Crop Low	40.6	26.4	146.9	5.6
Wicomico	MD	Other Hay	1,921.2	36.2	119.3	3.3
Wicomico	MD	Pasture	2,296.6	15.0	49.4	3.3
Worcester	MD	Other Hay	1,070.2	36.9	133.5	3.6
Worcester	MD	Pasture	1,322.0	15.0	54.2	3.6

E3 scenario - Perdue

- Several scenarios were run to understand some of the impacts when modifying scenarios. When E3 was run for the Eastern Shore the sediment load was calculated to be -700,000 tons. How is this possible?

Response:

- Reductions in stream restoration are likely much too high for E3.
- This may be due to an overestimation of the amount of streams available or an over estimation of the default stream restoration reduction.
- **ACTION: CBPO will work to correct both for the final E3.**

2010 No Action and E3 - Bill A

- Request 8: (Placeholder dependent on 7/20/17 Ag WG – changes to E3) The No-Action Scenario is used with the E3 Scenario to define controllable loads, the difference between No Action and E3 loads.

Response:

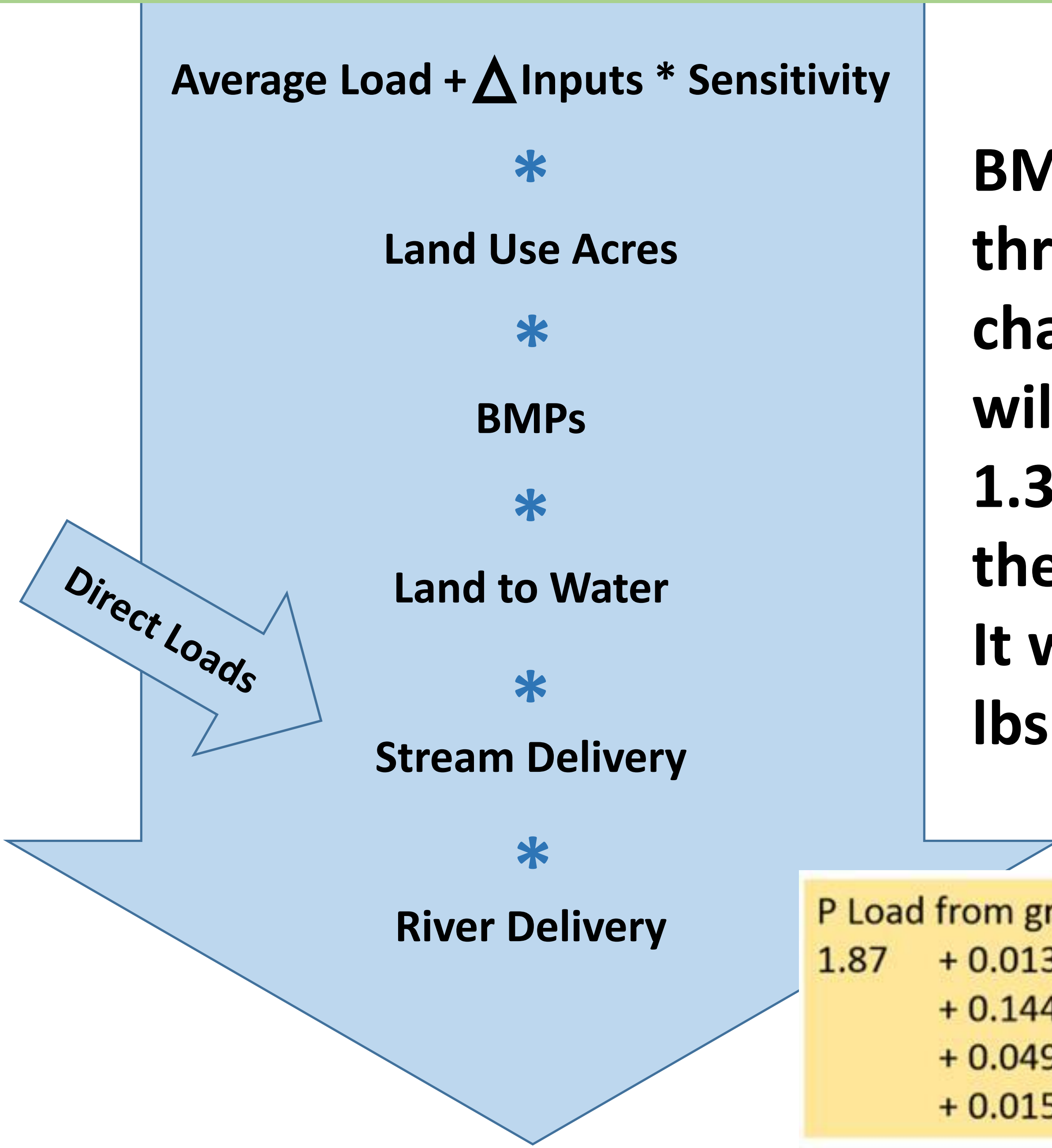
- WQ GIT directed the Agriculture Workgroup to revise its E3 scenario.
- A revised scenario has not yet been designed or run, but results will be provided on CAST and in presentations to the Ag Workgroup and the WQGIT when available.

Sensitivity – Bill A

- **Phosphorous Sensitivities**
- Request 5: P Sensitivity (Section 4.4) is calculated based on sediment loss, storm runoff, and soil test P. Please explain influence of bmps (which are credited after P sensitivity calculation) to adjust P Load (loss).

Gary

Phase 6 Model Structure

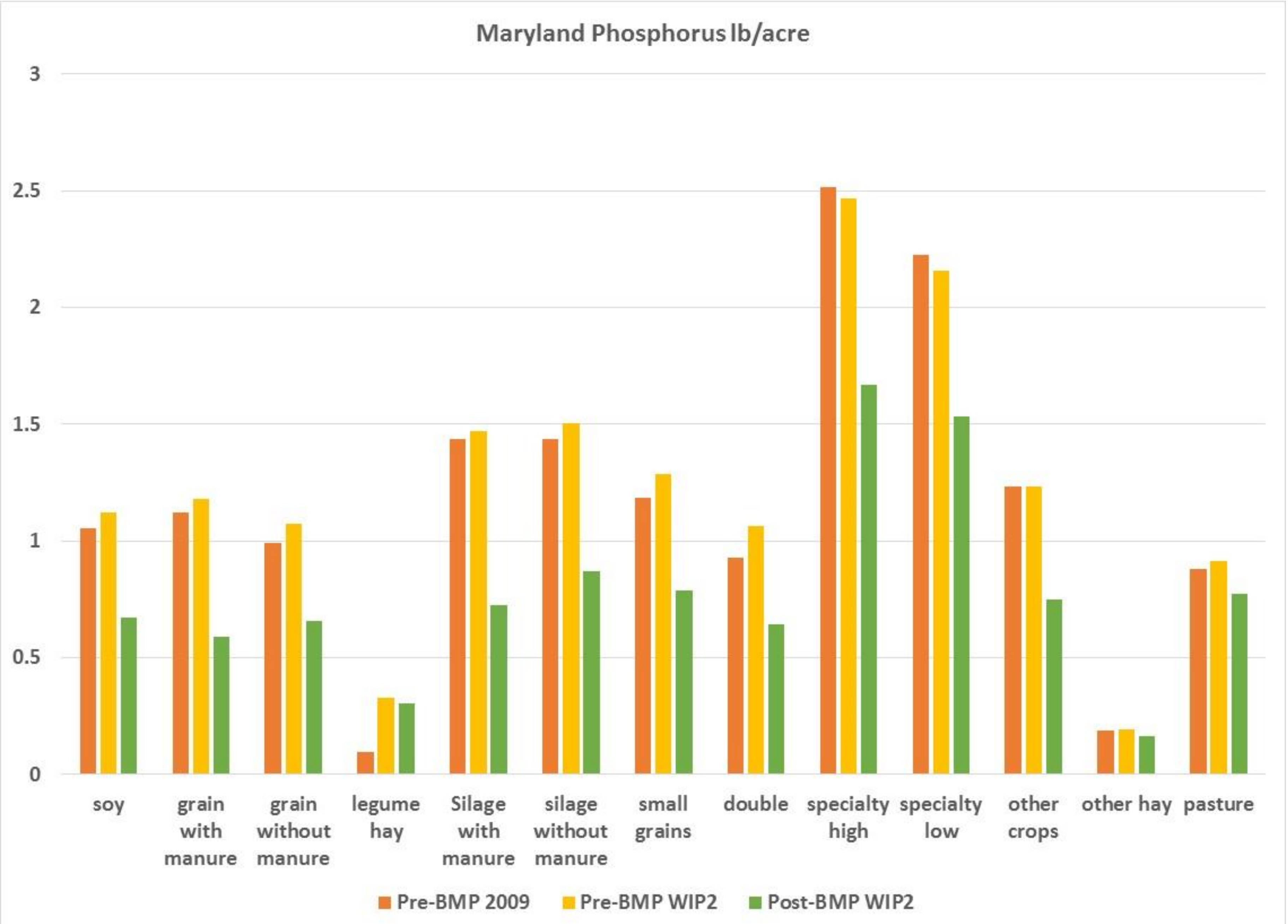


BMPs are multiplied through, so 100 ppm change in Mehlich will not produce a 1.3 lb change where there is a 50% BMP. It will produce a 0.65 lbs change

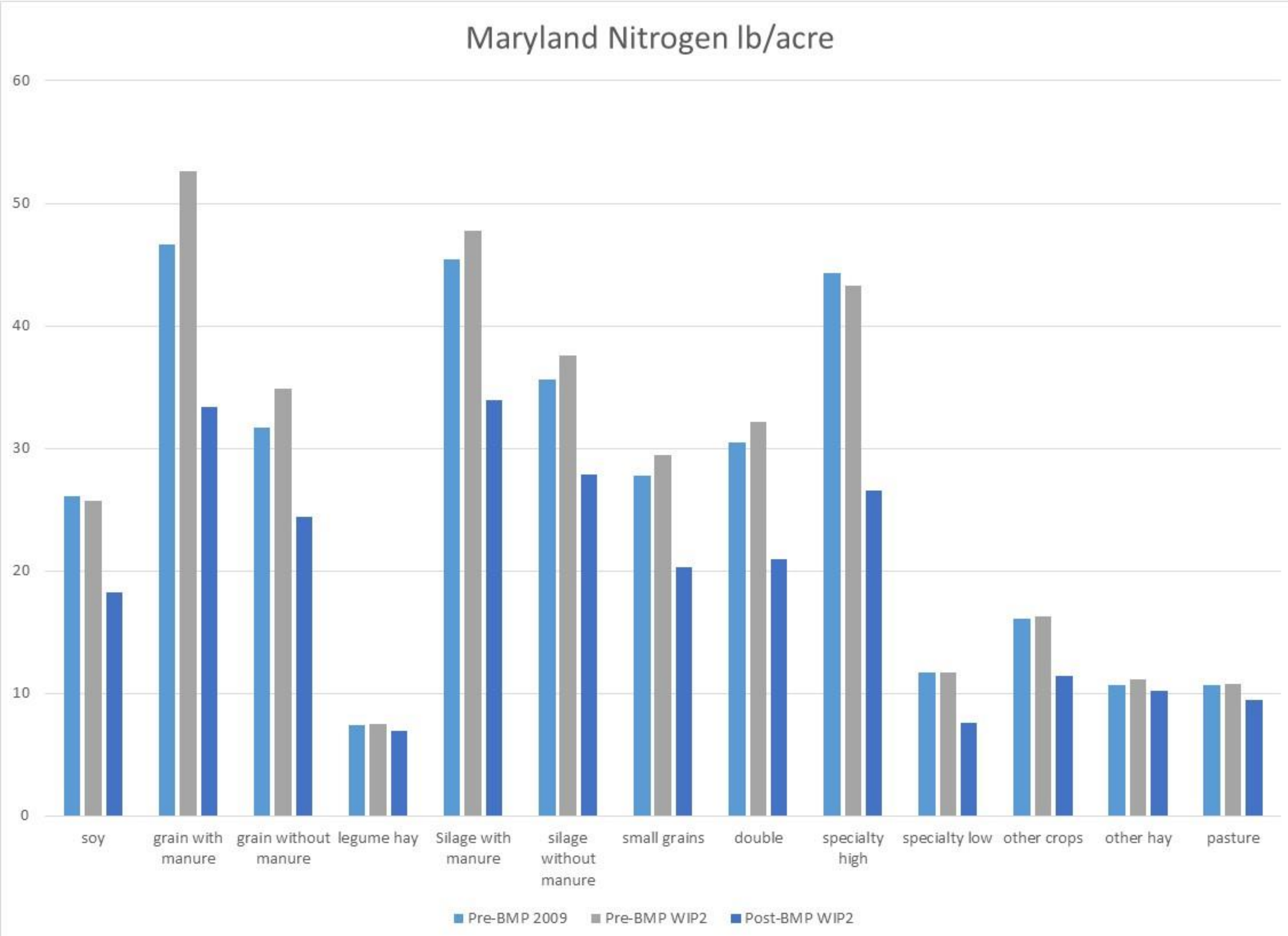
P Load from grain without manure =
1.87 + 0.013 * (Mehlich – 98.2) ppm
+ 0.144 * (storm runoff - 6.73) inches
+ 0.049 * (sediment loss - 4.75) tons
+ 0.015 * (WEP – 14.3) lbs

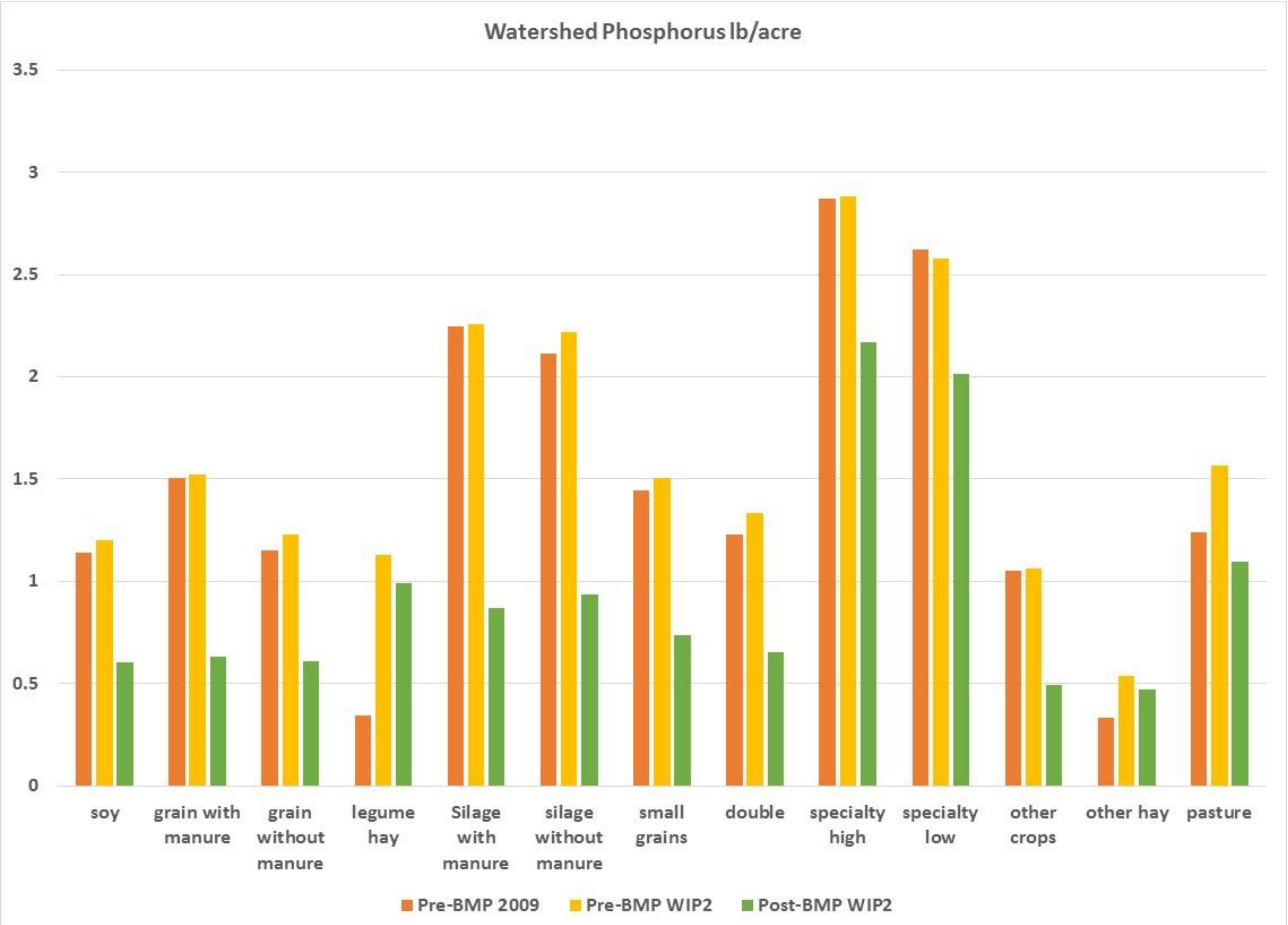
Sensitivity - MDA

- Local land use targets were provided with the release of the P6 documentation. Local targets are those loads reaching the EOSS that account for sensitivity to inputs; however, **variability among all watershed segments is approximately +/- 2 lbs N and less than 1 lb P for most agricultural land uses.** This suggests that inputs across the watershed (both nutrient inputs and soil P) are largely homogenous and variation in load delivery, beyond EOSS, is attributed to transport mechanisms (e.g. Stream-to-River factors). Please explain a jurisdiction's ability to affect meaningful change in water quality if load delivery is primarily attributed to transport factors (e.g. percent catchment in Piedmont carbonate)? And secondly, **do the local targets sufficiently represent states (such as Maryland) who have greater documented nutrient management adoption (extent and time) than other jurisdictions**?

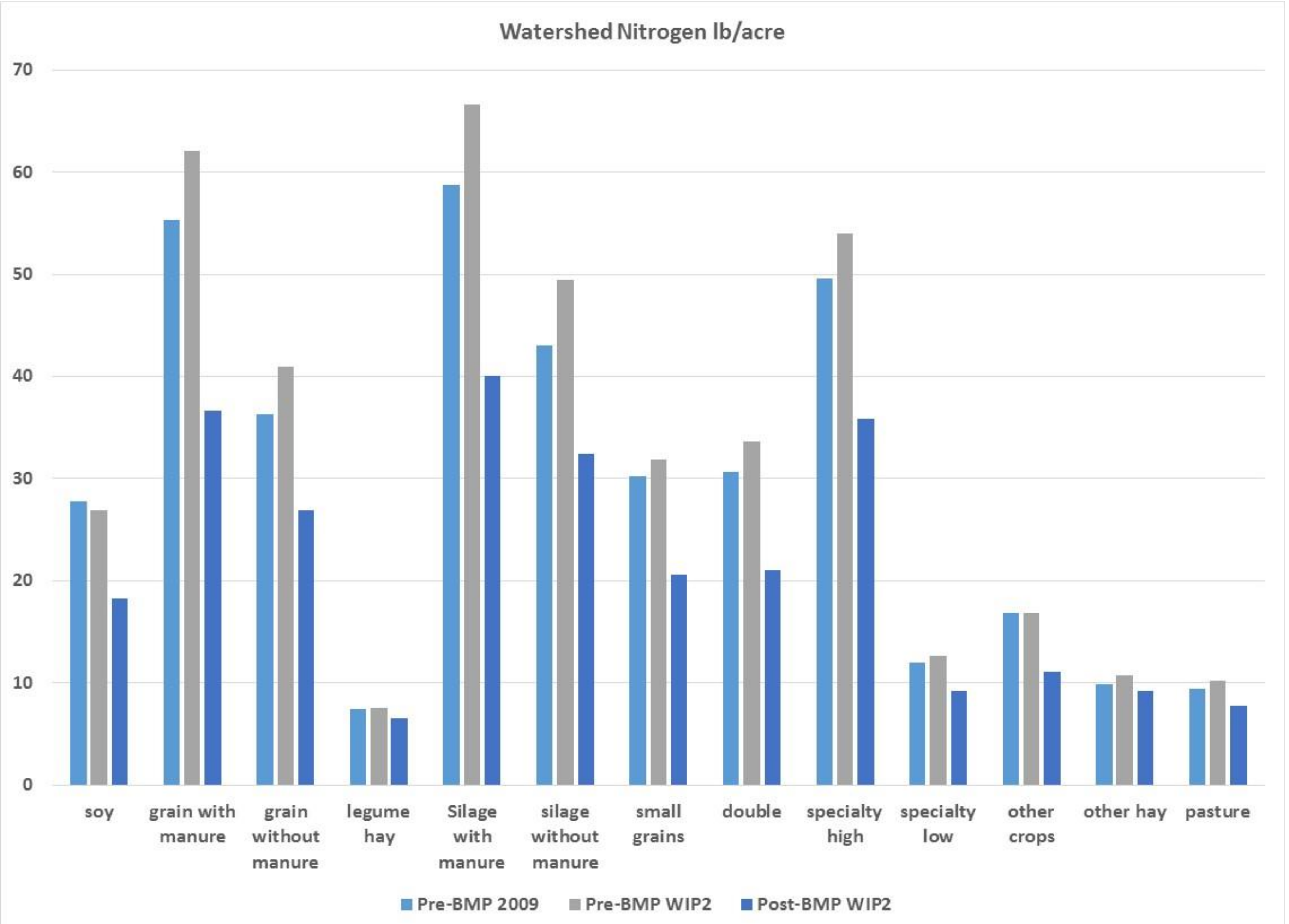


Maryland Phosphorus lb/acre
3
2.5
2
1.5
1
0.5
0
soy
grain with manure
grain without manure
legume hay
Silage with manure
silage without manure
small grains
double
specialty high
specialty low
other crops
other hay
pasture
Pre-BMP 2009
Pre-BMP WIP2
Post-BMP WIP2


Maryland Nitrogen lb/acre
60
50
40
30
20
10
0
soy
grain with manure
grain without manure
legume hay
Silage with manure
silage without manure
small grains
double
specialty high
specialty low
other crops
other hay
pasture
Pre-BMP 2009
Pre-BMP WIP2
Post-BMP WIP2



Watershed Phosphorus lb/acre
3.5
3
2.5
2
1.5
1
0.5
0
soy
grain with manure
grain without manure
legume hay
Silage with manure
silage without manure
small grains
double
specialty high
specialty low
other crops
other hay
pasture
Pre-BMP 2009
Pre-BMP WIP2
Post-BMP WIP2


Watershed Nitrogen lb/acre
70
60
50
40
30
20
10
0
soy
grain with manure
grain without manure
legume hay
Silage with manure
silage without manure
small grains
double
specialty high
specialty low
other crops
other hay
pasture
Pre-BMP 2009
Pre-BMP WIP2
Post-BMP WIP2

Sensitivity - MDA

- Crop uptake is a N sensitivity component with N specie fractions (NO_3, NH_3, and organic N). Why are sensitivity factors for NO_3 uptake negative values, while NH_3 uptake and organic N uptake are positive values according to the P6 documentation?
- For each pound of additional uptake in Grain without manure there is reduction of
    - .1032 NO3
    - and an increase of
    - .0017 ORGN
    - .0006 NH3
- TKN small compared to NO3. Results of the model runs as specified by the modeling workgroup.
- Increased organic matter decomposition

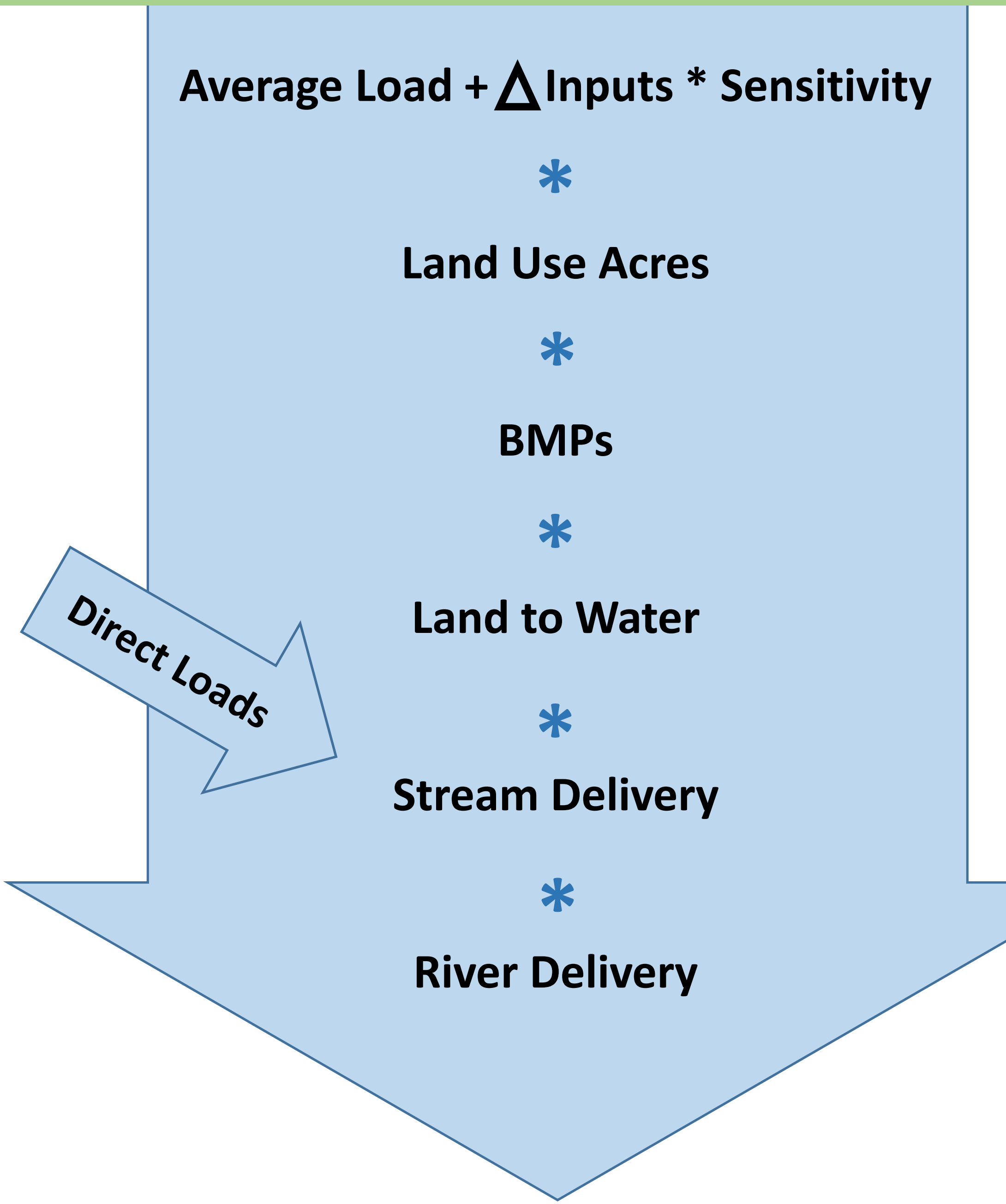
Sensitivity - DDA

- APLE simulation on agricultural land is inequitable with the developed sector. Soil samples and relative load should be simulated in a similar fashion; either the P5 or APLE method.
- The APLE simulation does not sufficiently demonstrate soil P decline as a result of P-based applications. This is due, in part, to P-based applications not being accurately simulated in the model, but also because some lag effect of the soil test P in the model was rudimentarily tested based upon an Agriculture Work Group and Water Quality Goal Implementation Team emergency decision
- Phase 6 developed according to partnership decisions. Data and models are more limited in developed settings.
- APLE model well-validated for drawdown

Land to Water – Bill A

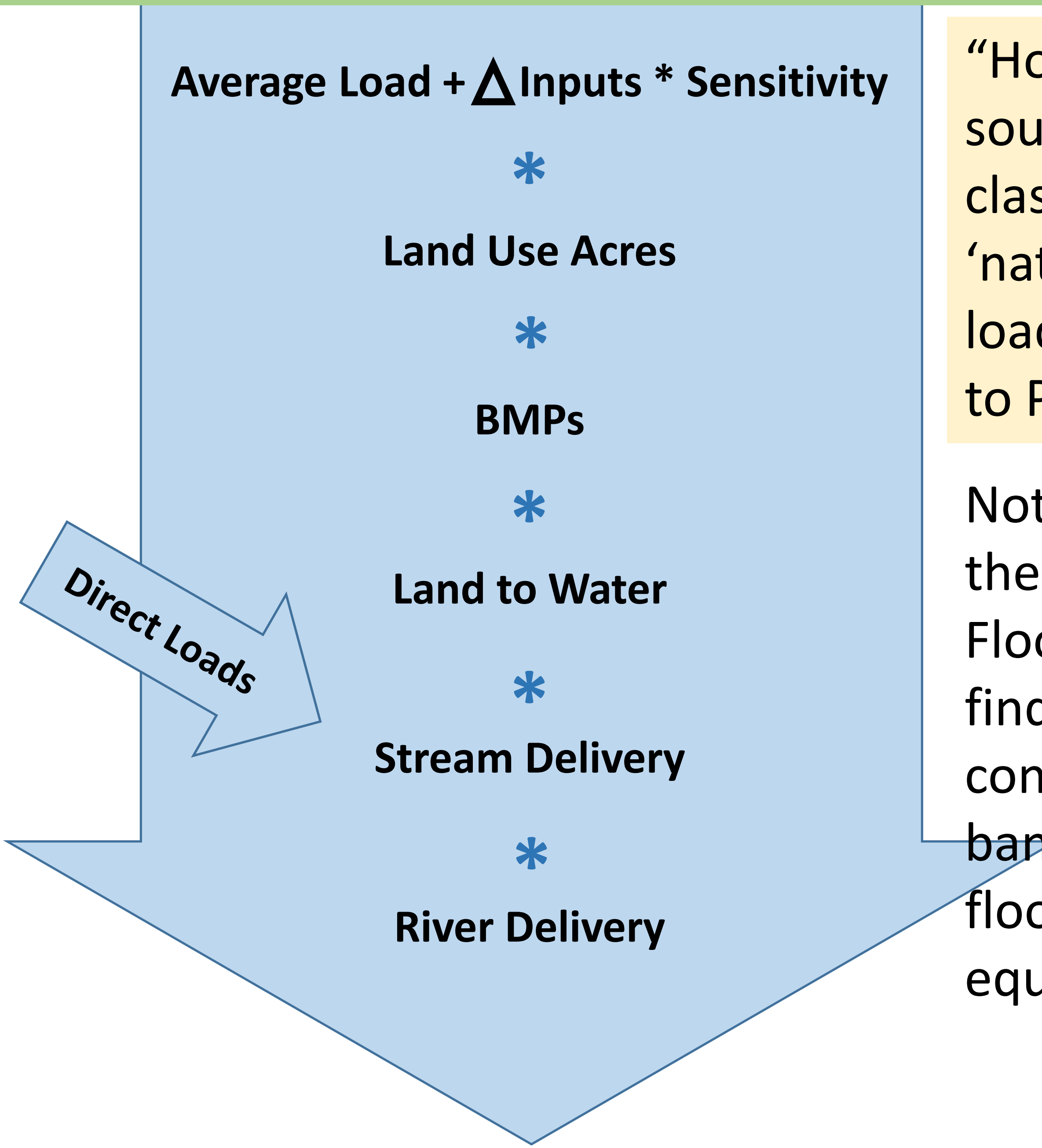
- **Land to Water**
- Request 7: Please explain the influence of Land to Water factors to estimate loads delivered to a stream. How do the SPARROW nitrogen coefficients interconnect with inputs reductions and increased bmps? (Reference: Table 7-2: Estimated Coefficients and Statistics from SPARROW Nitrogen Model of the Chesapeake Bay Watershed, Version 4)

Phase 6 Model Structure



L2W multiplies all model components. A BMP in an area with a L2W factor of 2 will receive four times the credit as a BMP in an area with a L2W factor of 0.5

Phase 6 Model Structure



"How do the in-stream sources of sediment, classified in Phase 6 as 'natural,' change the ag loads from Phase 5.3.2 to Phase 6?" - **CBC**

Not much – Following the Chesapeake Floodplain Network finding of no net contribution, stream bank erosion and floodplain deposition are equal and opposite

Calibration 1 – Perdue

- Documentation in Section 10 is confusing and graphs of the correlation of the initial model outputs to the actual observed data are not presented. Figures 10-11, 10-12 and 10-14 show the sites and relative number of observations, but there is no documentation of the correlation of the data from the model and the data from the observed points prior to model adjustment and following model adjustment. The narrative then graphs Phase 5.3.2 vs. Phase 6 and discusses its correlation with WRTDS. As described in the documentation neither model has an uncertainty analysis completed. So the model may be precise (Phase 6 correlates to WRTDS after model adjustment), but there is no verification that the model output is accurate or to what degree it is accurate. **It is suggested that the initial calibration run be graphed against observed data and the calibrated model be graphed against observed data and presented.**

Calibration 1

- Calibration is performed largely against observed data. There is also some adjustment to WRTDS at the RIM stations only. Other comparisons to WRTDS are used solely as a validation of the calibration which was performed on data.
- Graphics of the calibration relative to data are available on the MWG site
- The initial model run prior to calibration has arbitrary parameters and so is not relevant to show

Calibration 2 – Perdue

- There is no documentation of what input parameters and model parameters were modified to get Phase 6 to correlate with the observed data. For transparency reasons this information should be included in the documentation.

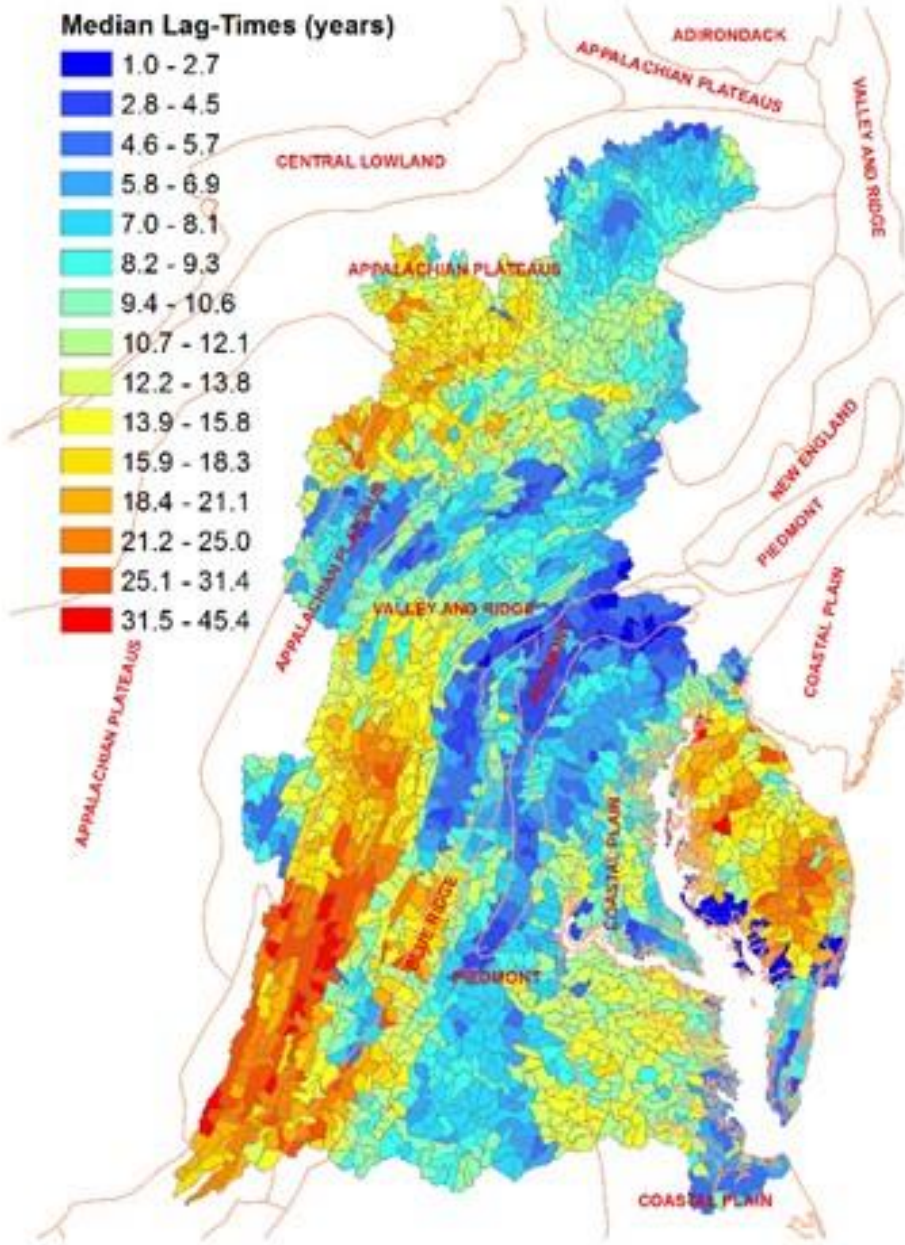
- Input parameters were not modified
- Calibration parameters are discussed in section 10.6.3.2 and appendix 10.A.
- The calibration method is similar to Phase 5.3 and the 5.3 documentation has a larger discussion

Calibration 3 – Perdue

- Is nitrogen and phosphorus emanating from groundwater included in nitrogen and phosphorus estimates in the Phase 6 Model output? If not and the calibration is adjusting water quality output to observed water quality input, then the calibration is placing large quantities of nutrients back on the current activities that are unrelated to actual nutrients applied and nutrients making it to the water resource from those applied today. So, current model estimates are assuming much larger quantities of nutrients from today's activities going to the bay based on farming activities that took place 10-30 years ago.

Calibration 3

- Groundwater is simulated, as it always has been
- Groundwater lag is simulated for the first time and was a major effort in Phase 6



AgWG Comments

Gary Shenk, Matt Johnston, and Andrew Sommerlot

CBPO

8/3/2017