Simulating Ammonia Atmospheric Deposition Change

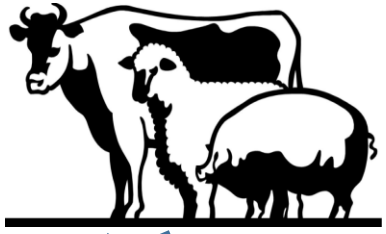
Matt Johnston

Lewis Linker

CBPO

Phase 6 Inputs Conceptual Model

Livestock Manure (and Biosolids)



Barnyard

Fertilizer

Nutrient Application Prescription

Pasture

Access Area

Crops

River

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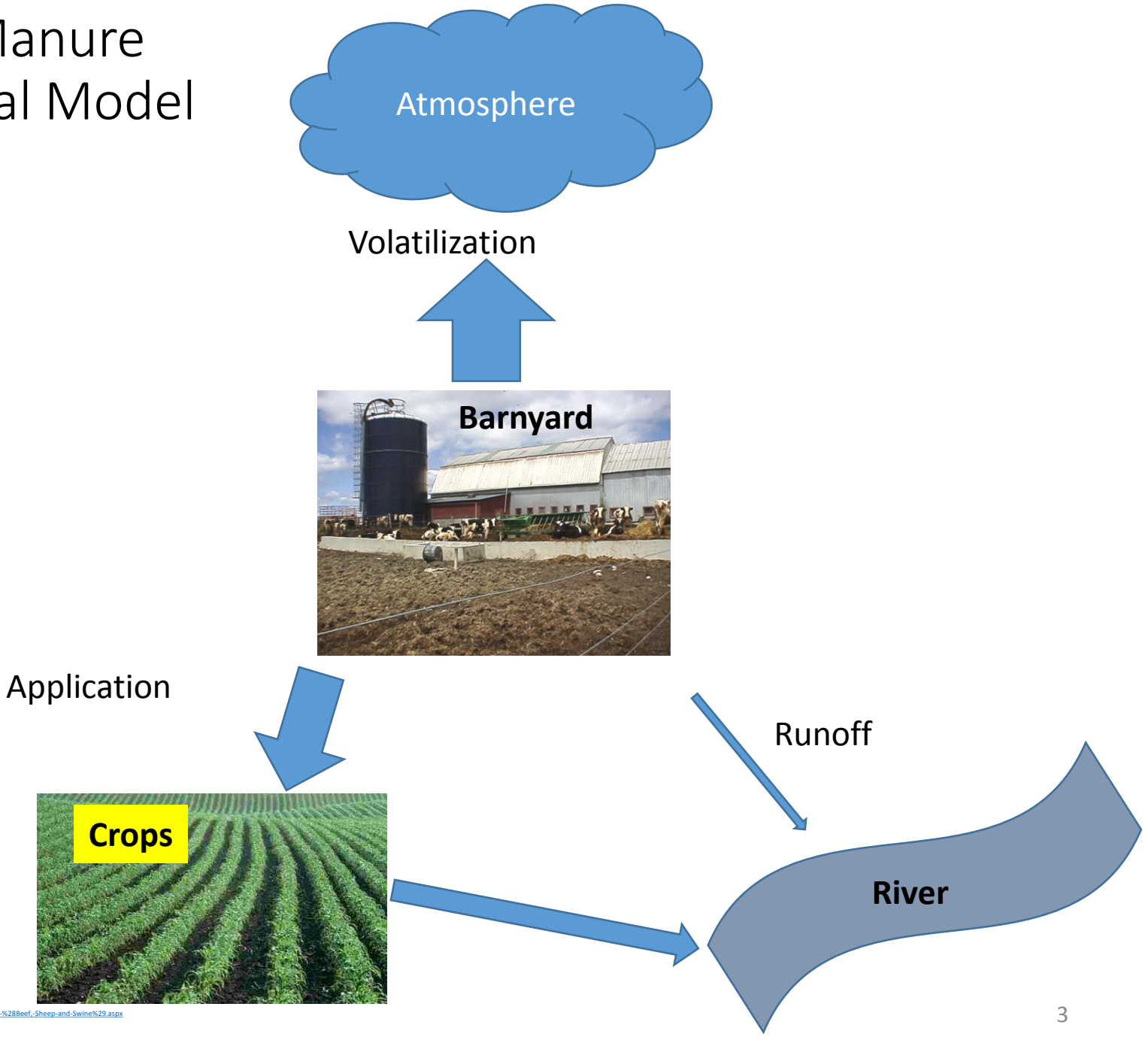
Phase 5 Manure Conceptual Model



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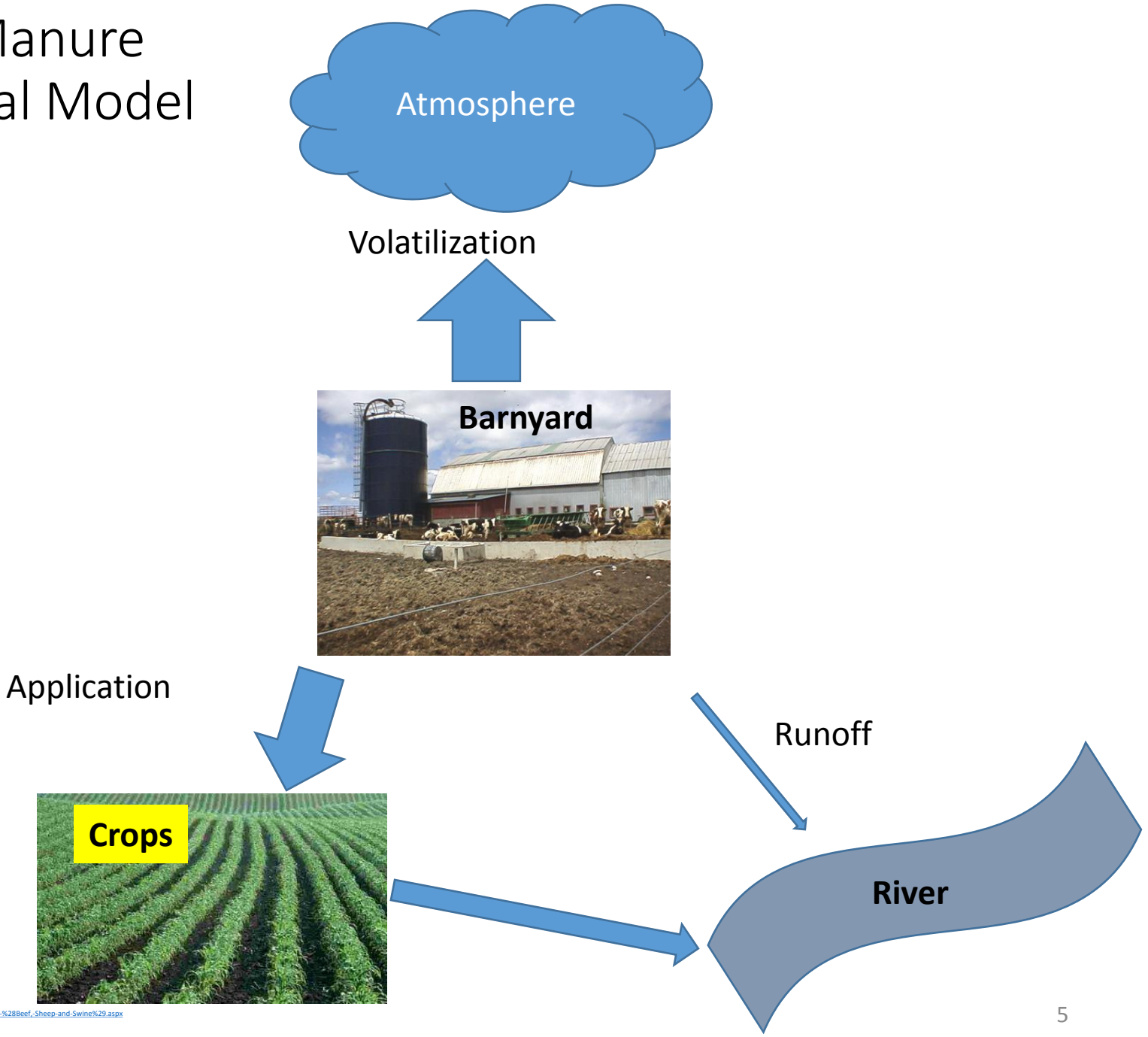
Manure Volatilization BMPs

- Lagoon Covers
  - all livestock
  - reduces NH3 volatilization within the barnyard by 15%.
- Alum
  - all poultry
  - reduces NH3 volatilization within the barnyard by 50%.

- Total Possible Effect = 36 Million lbs of volatilization reduction
- Average effect for 1 acre barnyard ~ 1500 lbs/year of volatilization

Phase 5 Manure Conceptual Model



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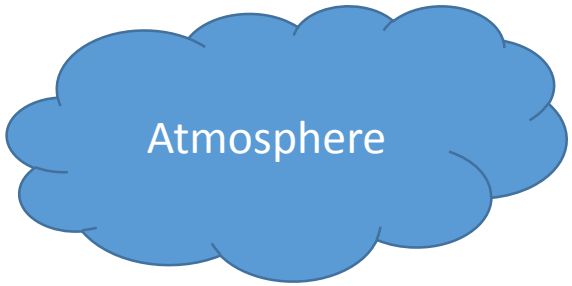
Phase 5 Manure Conceptual Model



Volatilization

Add volatilization practices

Effect exaggerated

Application

Runoff

River

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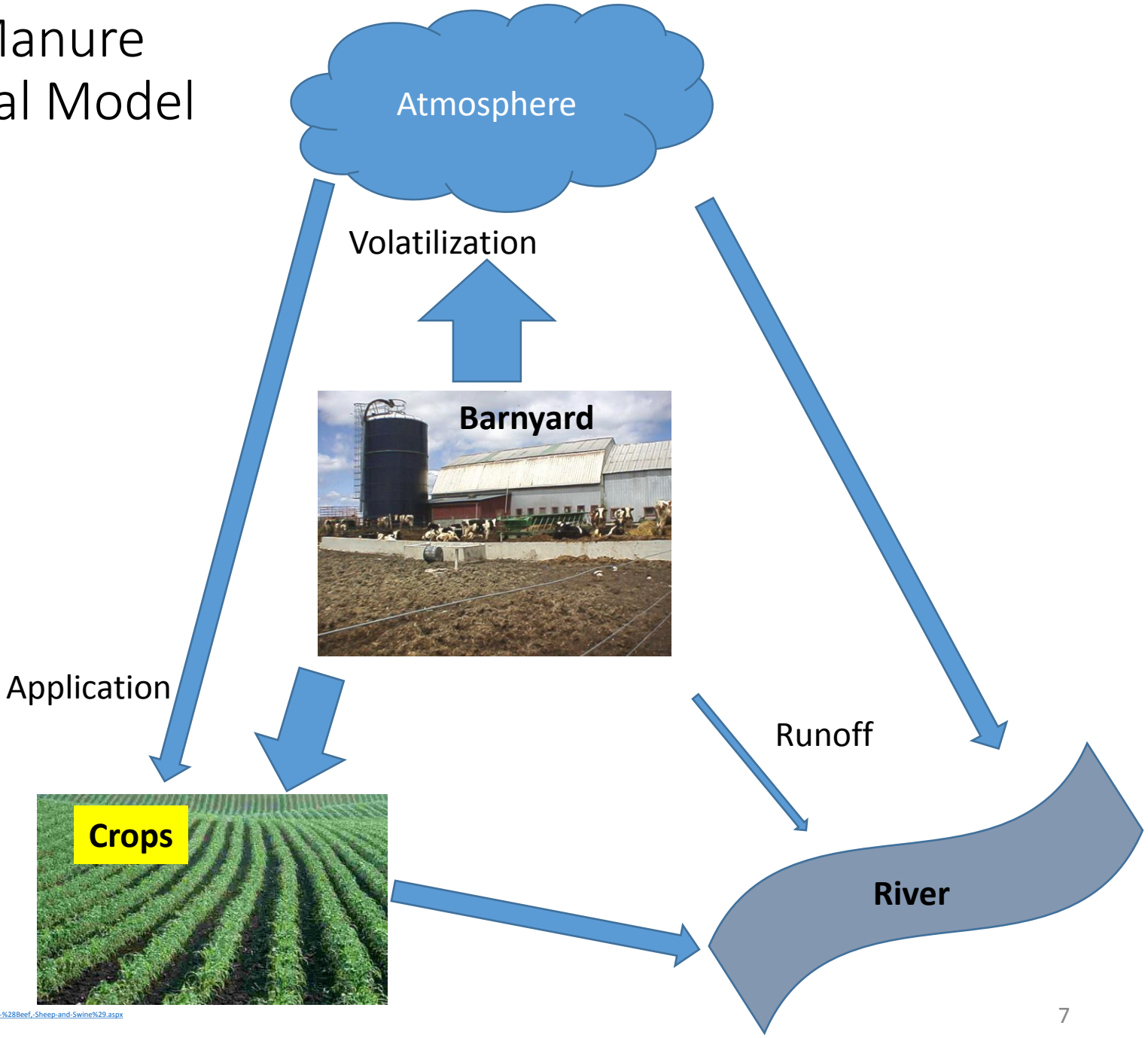
Phase 6 Manure Conceptual Model



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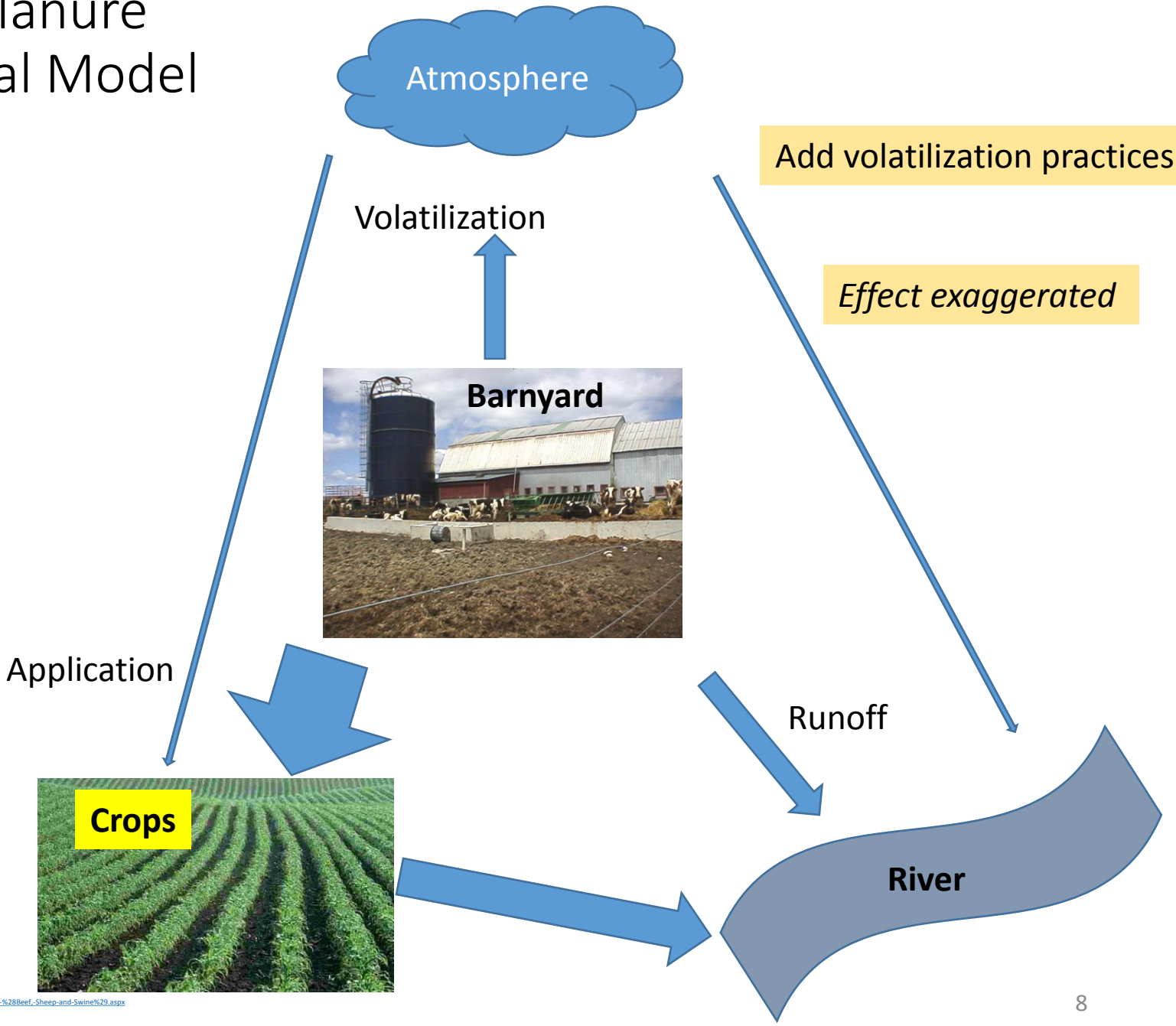
Phase 6 Manure Conceptual Model



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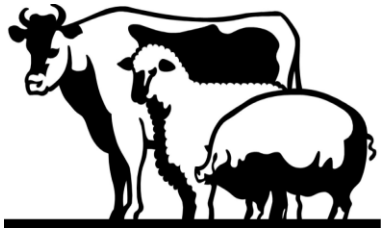
Manure Treatment Technologies



Reactive N

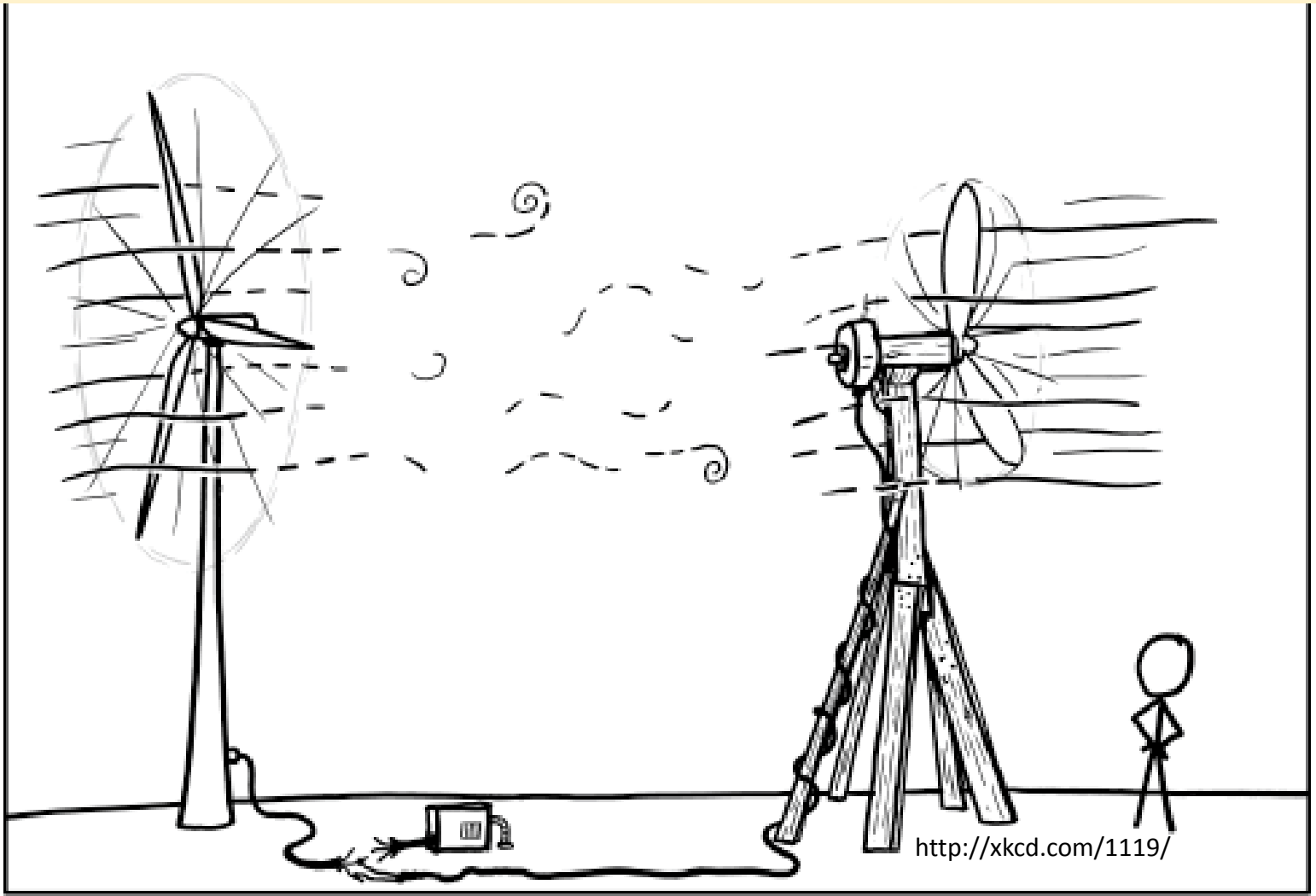
Non-Reactive N

Compost
Gasification
Pyrolysis

Modeling Workgroup 8/9
Finding: Small effect
Recommendations:

Simple solution for a pound change based on transport

Applied to increases and decreases



http://xkcd.com/1119/

Simple Method of Credit

- Calculate how much deposition changed
- Calculate how much would have made it to the bay and apply as a credit or load to the land use with the BMP

The Aggregate State Transfer Functions at the Watershed Level can be Parsed to the Watershed Area within each State

EPA United States Environmental Protection Agency

State Level Transfer Coefficients to State Watershed Area

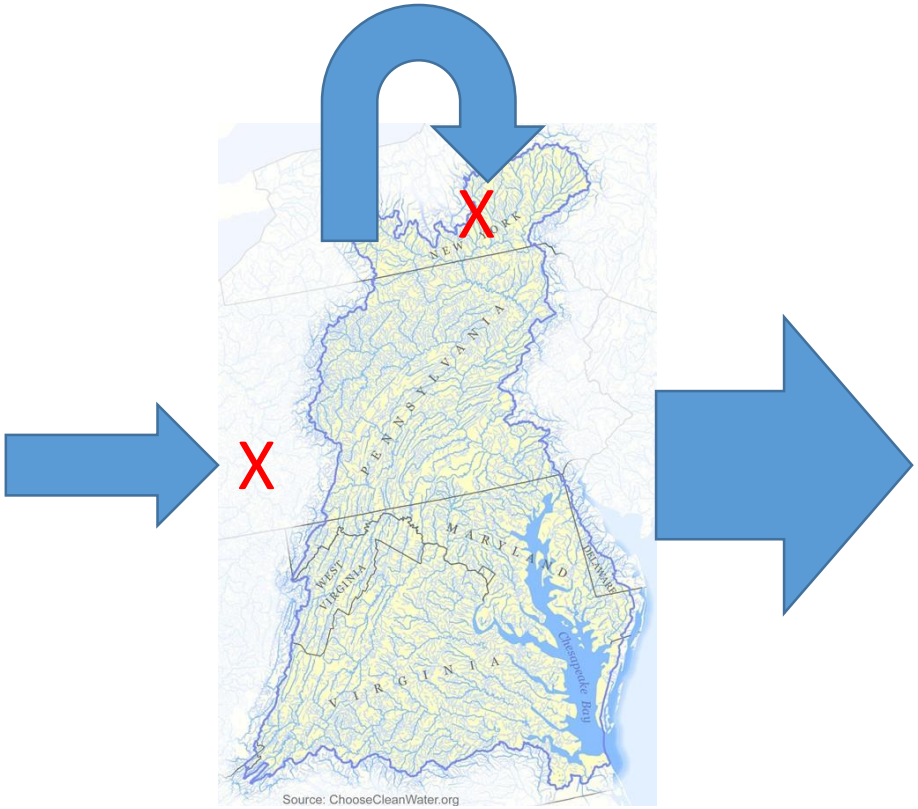
Emitter → / Receptor ↓	Delaware	Maryland	New York	Pennsylvania	Virginia	W. Virginia
	kg-N/ton-N	kg-N/ton-N	kg-N/ton-N	kg-N/ton-N	kg-N/ton-N	kg-N/ton-N
Delaware	5.40	2.31	0.44	0.87	1.10	0.44
Maryland	19.46	57.16	5.30	14.33	20.95	10.60
New York	5.31	7.25	11.50	10.47	4.76	4.73
Pennsylvania	23.86	49.09	16.37	62.28	24.79	28.11
Virginia	19.55	43.34	7.84	20.59	85.05	27.70
W. Virginia	1.88	6.04	1.03	3.73	5.50	9.88
WaterSHED Aggregate	75.46	165.19	42.49	112.27	142.15	81.47

Robin Dennis – presentation to Modeling Workgroup 1/8/13

5% to 20% of NOx Deposited in Watershed

	Emitter	Emitter	Emitter	Emitter	Emitter	Emitter
Receptor	DE	MD	NY	PA	VA	WV
DE	0.6%	0.3%	0.0%	0.1%	0.1%	0.0%
MD	2.1%	6.3%	0.6%	1.6%	2.3%	1.2%
NY	0.6%	0.8%	1.3%	1.2%	0.5%	0.5%
PA	2.6%	5.4%	1.8%	6.9%	2.7%	3.1%
VA	2.2%	4.8%	0.9%	2.3%	9.4%	3.1%
WV	0.2%	0.7%	0.1%	0.4%	0.6%	1.1%
Total	8.3%	18.2%	4.7%	12.4%	15.7%	9.0%

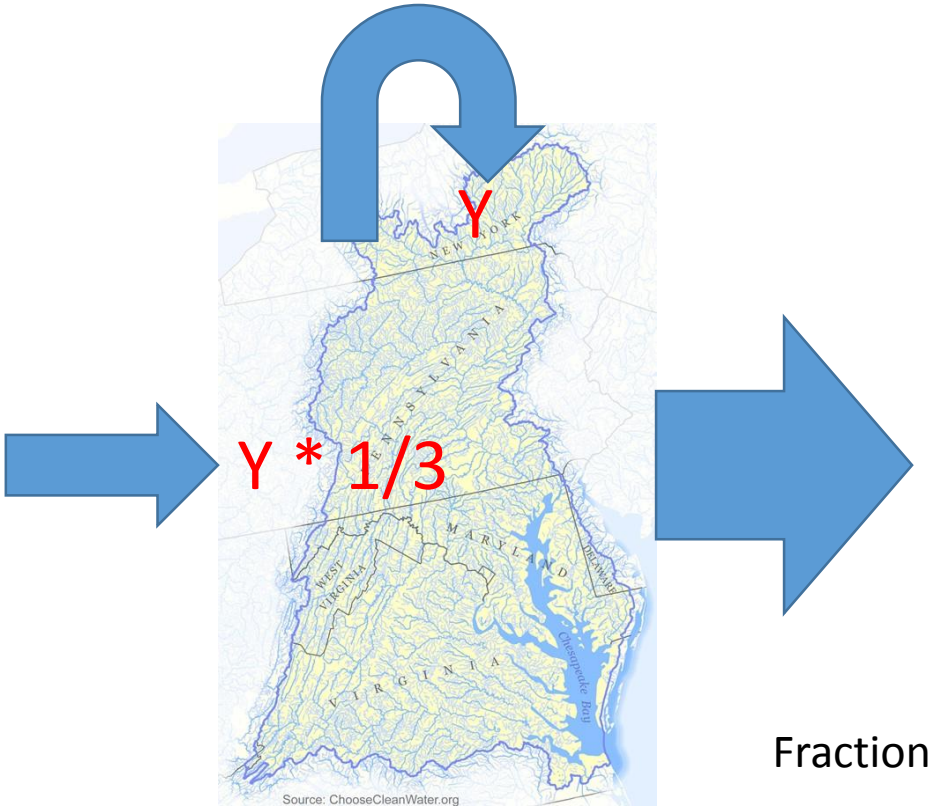
50% of NOx from outside of CB Watershed



At most, 20% of emissions are deposited

25% of NH3 from outside of CB Watershed

Assume that transport out is related to transport in.



Fraction deposited $\frac{Y}{Y + 4Y/3}$ = 40%

Ammonia Deposition

Following the logic of the previous slide

	Emitter	Emitter	Emitter	Emitter	Emitter	Emitter
Receptor	DE	MD	NY	PA	VA	WV
DE	1.76%	0.76%	0.15%	0.29%	0.36%	0.15%
MD	6.17%	16.79%	1.73%	4.59%	6.62%	3.43%
NY	1.74%	2.36%	3.71%	3.38%	1.56%	1.55%
PA	7.50%	14.65%	5.22%	18.11%	7.77%	8.75%
VA	6.20%	13.08%	2.55%	6.51%	23.68%	8.63%
WV	0.62%	1.97%	0.34%	1.22%	1.80%	3.20%
Total	23.98%	49.61%	13.70%	34.11%	41.80%	25.70%

What about direct deposition to the Bay?

- Area of Bay = 4479 square miles
- Area of VA, MD, and DE in Bay Watershed = 31362 square miles
- Bay receives 14.28% of the deposition to the States

Ammonia Deposition

	Emitter	Emitter	Emitter	Emitter	Emitter	Emitter
Receptor	DE	MD	NY	PA	VA	WV
DE	1.76%	0.76%	0.15%	0.29%	0.36%	0.15%
MD	6.17%	16.79%	1.73%	4.59%	6.62%	3.43%
NY	1.74%	2.36%	3.71%	3.38%	1.56%	1.55%
PA	7.50%	14.65%	5.22%	18.11%	7.77%	8.75%
VA	6.20%	13.08%	2.55%	6.51%	23.68%	8.63%
WV	0.62%	1.97%	0.34%	1.22%	1.80%	3.20%
Bay	2.02%	4.37%	0.63%	1.63%	4.38%	1.74%
Total	26.00%	53.98%	14.33%	35.74%	46.18%	27.45%

How Much of that Makes it to the Bay – watershed model run -

Lands in:	Delivered
DE	11.84%
MD	15.48%
NY	8.06%
PA	19.28%
VA	7.33%
WV	6.91%
Bay	100.00%

	Emitter	Emitter	Emitter	Emitter	Emitter	Emitter
Receptor	DE	MD	NY	PA	VA	WV
DE	0.21%	0.09%	0.02%	0.03%	0.04%	0.02%
MD	0.96%	2.60%	0.27%	0.71%	1.03%	0.53%
NY	0.14%	0.19%	0.30%	0.27%	0.13%	0.12%
PA	1.45%	2.82%	1.01%	3.49%	1.50%	1.69%
VA	0.45%	0.96%	0.19%	0.48%	1.74%	0.63%
WV	0.04%	0.14%	0.02%	0.08%	0.12%	0.22%
Bay	2.02%	4.37%	0.63%	1.63%	4.38%	1.74%
Total	5.27%	11.17%	2.43%	6.70%	8.93%	4.96%

Final Recommendation

	Emitter DE	Emitter MD	Emitter NY	Emitter PA	Emitter VA	Emitter WV
To Watershed	24.0%	49.6%	13.7%	34.1%	41.8%	25.7%
Delivered	3.2%	6.8%	1.8%	5.1%	4.6%	3.2%
To Bay	2.0%	4.4%	0.6%	1.6%	4.4%	1.7%
Total Delivered	5.3%	11.2%	2.4%	6.7%	8.9%	5.0%

- For any change in NH3 deposition based on a BMP, apply the 'Total Delivered' percentage as a pound increase or decrease to the most relevant land use