Land Use Loading Rates

Modeling Workgroup

September 30, 2014

Olivia H. Devereux

Outline

- Loading rate targets—what are they and how are they used?
- Data sources
- Synthesis
- Workgroup input
- Timeline

Loading Rates and Targets

- Loading rates from multiple models and literature are used to inform the targets

- Targets are specified loading rates used to calibrate the Phase 6 Watershed Model
  - Does not include BMPs
  - Show relative differences among land use loading rates
  - Subject to modification through calibration. Actual rate adjusted; relative differences maintained

Use of Targets

- Targets order the influence of different land uses in the same area
- Account for differences in loading among the same land uses in different areas.
- Calibration process balances loads spatially
- Phase 6 targets will not be the same everywhere
  - Targets may vary geographically based on nutrient balance and watershed characteristics. Loads will vary around the target based on the nutrients applied and management actions

Loads from Model Calibration

- Ultimately we will end up with N, P, and sediment loads from the CBP Partnership Watershed Model Phase 6.

- Loads will vary spatially and among scenarios
  - Initial conditions (animal numbers, septic systems, land use acres)
  - BMPs

- Objective is to isolate effect of BMPs for planning purposes

Phase 5 Average Targets

Land Use	TN Lbs/Acre	TP Lbs/Acre
Nursery	240	85
Crop	23	2-2.5
Harvested Forest	20	0.8
Extractive	12.5	3.5
Urban	9.3	1.5
Hay	6	0.4-0.8
Pasture	4.5	0.7
Forest	2	0.15

Data Sources for Establishing Loading Rate Targets

- Tetra Tech urban literature review (need to convert concentrations to loads)
- Tetra Tech agricultural, forest, and other land uses literature review
- Panel and workgroup documents and recommendations
- Collaborative work with USGS-Sparrow
- CBP Sensitivity Work using the multiple model framework
  - Sparrow
  - APLE
  - APEX
  - AgCHEM
  - RUSLE2 for sediment
- CWP small-scale sediment work
- Land data team riparian analyses
- Land data team impervious connectedness analysis
- STAC recommendations
- CBP Partnership Watershed Model Phase 5 background documentation, where relevant and reflects the latest science
- ICPRB calibration work

Literature Review—Urban

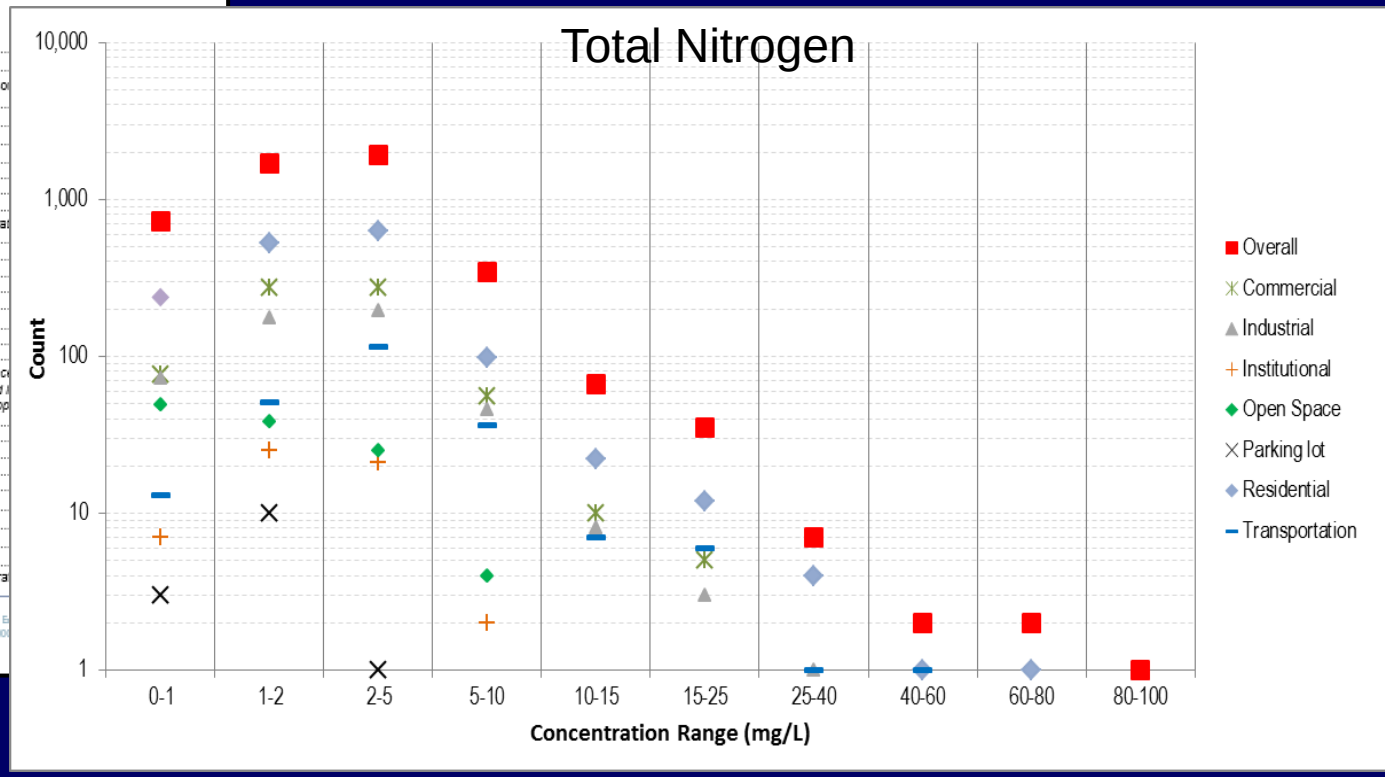
TETRA TECH

MEMO

To:	Gary Shenk, EPA; Peter Claggett, USGS
Cc:	Tom Schueler, CSN
From:	Mark Sievers, Tetra Tech Inc.
Date:	March 31, 2014
Subject:	Land Use Loading Literature Review Task Summary and Results

The memo is separated into the following sections (click for hyperlink):

- 1.0 Project Background and Purpose
- 2.0 Literature Search for Potentially Relevant Studies
- 3.0 Literature Review and Data Entry for Relevant Loading Rate and Co
- 4.0 Search, Review, and Data Entry of TMDL Model Reports
- 5.0 Quality Assurance/Quality Control
- 6.0 Data Standardization/Processing
- 7.0 Analysis and Results
  - 7.1 Analysis – Box Plots
    - *7.1.1 Concentration Data Analysis Summary (NSQD and literature)*
    - *7.1.2 Seasonal Variation Analysis Summary (NSQD and literature)*
    - *7.1.3 Loading Rate Data Analysis Summary (TMDL reports and litera*
  - 7.2 Analysis – Histograms
  - 7.3 Analysis – Impervious Regression
  - 7.4 Analysis – Wilcoxon Rank-Sum Test
    - *7.4.1 Hypothesis Testing*
    - *7.4.2 Wilcoxon Rank-Sum Statistic*
- 8.0 Summary/Conclusion/Recommendations
  - 8.1 Summary
  - 8.2 Objective Conclusions
    - *8.2.1 Do land use concentration/loading rates differ from overall conc*
    - *8.2.2 If so, can the land use be accurately mapped and incorporated*
    - *8.2.3 If so, would the land use respond in a unique manner to the app urban BMP?*
  - 8.3 Conclusion
    - *8.3.1 Data Limitations and Precautions with Interpretation*
    - *8.3.2 Preliminary Recommendations*
  - 8.4 Potential Future Efforts
- 9.0 References
- Attachment A: Parameter Standardization
- Attachment B: Land Use Standardization
- Attachment C: Box Plots
  - Attachment C.1: Concentration Statistics/Box Plots from NSQD and Litera



Literature Review—Agricultural

- Journal Title/Type of Study
- Brief Study Description
- LU(s)
- LU specifically described? (Y/N)
- State(s)
- Parameter(s)
- Sample Location
- Modeling or Monitoring Study?
- Results by Season?
- Dry/Storm/ Simulated?
- EoF or Watershed?
- Flow through BMP?
- Data Source
- Data Quality
- Study Scale
- Original Land Use
- Crop Rotation
- Years in Crop Rotation
- Crop 1
- Crop 1 Plant Date
- Crop 1 Harvest Date
- Yield Crop 1
- Yield Units Crop 1
- "Additional Yield Info"
- Original Parameter
- For N and P. "Reported As" Units.
- Pathway
- Load or Concentration?
- Study Load/ Concentration
- Study Unit
- Normalized Load or Concentration
- Normalized Units
- EoF or Delivered?
- Area and unit
- Corrected Area
- Standard Area Unit
- Flow and units
- Time Frame
- Sampled Flow
- Sample Size
- Sample Type
- Total Rainfall Amount (cm)
- Rainfall Total Type
- General Precipitation Conditions
- Simulation Method
- Rain Intensity (cm/hr)
- Number of Rainfall Events
- Description
- CAFO or AFO?
- Animal Type
- Animal Details
- % Imp
- Soil Type(s)
- Percent Slope
- Tillage
- Erosion Control Measures
- Crop1 Residue Cover (%)
- Crop1 Leaf Cover (%)
- Nutrient Management Measures
- Animal Stocking Density
- Grazing Management
- Irrigation Practices
- Drainage Management
- Other Relevant Measures
- Manure Type and form
- Manure Moisture Content (%)
- Rotation N Fert Form
- Rotation N Application Rate Basis
- Rotation FertN Rate and Units
- Rotation FertN Application Date
- Rotation FertN Method
- Rotation ManureN Rate, Units
- Rotation ManureN Application Date
- Rotation ManureN Method
- Rotation OtherN Rate, Units
- Rotation OtherN Application Date
- Rotation OtherN Method
- Rotation N_Other: Specify
- Crop 1 N Fert Form
- Crop1 N Application Rate Basis
- Crop1 FertN Rate, Units
- Crop1 FertN Timing
- Crop1 FertN Method
- Crop1 ManureN Rate
- Crop1 ManureN Units
- Crop1 ManureN Timing
- Crop1 ManureN Method
- Crop1 OtherN Rate, Units
- Crop1 OtherN Timing
- Crop1 OtherN Method
- Crop-Specific N_Other: Specify
- Rotation P Fert Form
- Rotation P Application Rate Basis
- Rotation FertP Rate, Units
- Rotation FertP Application Date
- Rotation FertP Method
- Rotation ManureP Rate, Units
- Rotation ManureP Application Date
- Rotation ManureP Method
- Rotation OtherP Rate and Units
- Rotation OtherP Application Date
- Rotation OtherP Method
- Rotation P_Other: Specify
- Crop 1 P Fert Form
- Crop1 P Application Rate Basis
- Crop1 FertP Rate, Units
- Crop1 FertP Timing
- Crop1 FertP Method
- Crop1 ManureP Rate, Units
- Crop1 ManureP Timing
- Crop1 ManureP Method
- Crop1 OtherP Rate and Units
- Crop1 OtherP Timing
- Crop1 OtherP Method
- Crop-Specific P_Other: Specify

Agricultural Literature Review

Tetra Tech searched Web of Science and AGRICOLA for any combination of the keywords in the four groups below. Primary consideration was given to in-watershed resources published after 1990.

Group I	Group II	Group III	Group IV
Phosphorus	Loading coefficient	Land use	Chesapeake Bay
Nitrogen	Export coefficient	Land cover	Delaware
Sediment	Export	Agriculture	Maryland
Nutrients	Load	Cropland	New York
Water quality	Loading rate	Corn silage	Pennsylvania
Pollutant	Areal load	Soybean	Virginia
Eutrophication	Loss	Small grain	West Virginia
	Runoff	Forage	
		Hay	
		Pasture	
		Vegetables	
		Nursery	
		Orchard	
		Farmstead	

Agricultural Literature Review
Status as of 9/19/2014

- Keyword search results reviewed: 5,224
- Abstracts reviewed: 400+
- Full text articles identified for review: 240
- Articles yielding useful data, to date: 21 articles with 500+ data records
- Geographic scale of data entered, to date: Two of the articles yielding useful data to date are based in the Chesapeake Bay watershed. The data entered are from AL, GA, IN, IA, MD, MO, NE, NY (Lake Ontario area), NC, OH, OK, PA, SD, TX, and WI.
- Land uses represented in data entered to date include:
  - Mixed agriculture (row crops, pasture, hay, poultry houses)
  - Corn-soybean, corn-wheat, corn-oats, wheat-sorghum, and other rotations with/without cover crops
  - Apple orchard, sorghum, pasture, hay, native grass, peanuts, cotton, fallow
  - Continuous corn (silage)

Forest, Barren, Stream Corridor Literature Review

- Number of papers to review = 62

- Number of articles reviewed to date = 42
  - 25 papers contained useful information.
  - Mainly watershed scale. 2 catchment scale and a few unknown.
  - Mix of dry weather and storm data.
  - Few studies have flow, soil, or precipitation data.
  - Types of information found: mostly nitrogen and phosphorus loads, concentrations, and EMCs for general forest. Have found two studies with upland forest and another of harvested.

- Not pulling information on urban breakdowns that were reviewed before.

Wetland Literature Review

- Number of papers to review = 184
- Number of articles reviewed to date = 0
- This is in part for the Wetland Expert Panel
  - Review for wetland efficiency
  - Review for loading rates
  - Panel has not met. Under this task, Tetra Tech will probably review to pull information so as not to delay deliverables for this task.

Role of Sparrow

- Sparrow's strengths are indicating the differences among land use categories

- Sparrow provides data that may be used to inform scaling factors in the CBP Partnership Watershed Model
  - Edge of field (EOF) export rates
  - Land to water factors for soil parameters and slopes, and more

- Sparrow generates uncertainty estimates

Scale

- Goal is to have targets at the smallest scale that also is best informed by data

  - Field (EOF)
  - Hillslope
  - EOS
  - Small Watersheds or Small Stream Networks
  - Large Rivers

Land Uses—Developed

All are also divided by federal, MS4-regulated, and Combined Stormwater Sewer (CSS)

Phase 6 Proposed

- Impervious
  - Roads
  - Buildings, parking lots, etc.
  - Tree canopy over impervious
- Pervious
  - Turf
  - Tree canopy
  - Open space
- Construction
- Extractive

Phase 5

- Impervious developed
- Pervious developed
- Construction
- Extractive

Land Uses—Agricultural (slide 1 of 2)

Categories developed using nutrient use intensities, management strategies, and bare soil

Phase 6 Proposed

- Commodity crops
  - Corn
    - Grain, fall fallow
    - Grain fall small grain (double cropped)
    - Silage, fall fallow
    - Silage fall small grain (double cropped)
  - Soybeans
    - Fall fallow
    - Fall small grain (double cropped)
  - Small grains (Wheat, Bar, Canola, Rye, Triticale, Oats, Spelt, Emmer)
    - Fall fallow
    - Forage
    - Double crop beans
- Hay and legume and forage
  - Alfalfa and other legumes
  - Non-legume forage
  - Pasture and pastured cropland

Phase 5

- Hightill with manure
- Hightill without manure
- Lowtill with manure
- Nutrient management hightill with manure
- Nutrient management hightill without manure
- Nutrient management lowtill

- Alfalfa
- Hay with nutrients
- Hay without nutrients
- Nutrient management alfalfa
- Nutrient management hay
- Pasture
- Nutrient management pasture

Land Uses—Agricultural (slide 2 of 2)

Phase 6 Proposed

- Specialty and other crops (9 separate land uses)
  - Vines
    - High, medium, low input
  - Low cover
    - High, medium, low input
  - High cover
    - High, medium, low input
- Farmsteads (4 separate land uses)
  - Animal Impervious
    - AFO (nonregulated)
    - CAFO (regulated)
  - Non-animal
    - Impervious
    - Pervious
- Other land use (cropland idle or used for cover crops or soil improvement but not harvested and not pastured or grazed)
- Degraded riparian pasture (TRP): To be determined

Phase 5

- Nursery
- Animal feeding operations
- Concentrated animal feeding operations
- Degraded riparian pasture

Land Uses (Cont.)

Phase 6 Proposed

- Natural
  - Forests
    - Riparian/floodplain
    - Upland
    - Harvested
    - Disturbed (e.g.: insect, fire)
  - Wetlands
    - Tidal emergent
    - Fresh emergent
    - Palustrine
- Barren
  - Extractive (e.g.: active mines)
- Stream corridors
  - Urban
  - Suburban/rural
- Scrub, shrub, grass (Mixed open)
- Water

Phase 5

- Forest (included wetlands)
- Harvested forest
- Water

Land Use Summary

Urban is also divided by federal, MS4-regulated, and Combined Stormwater Sewer (CSS)

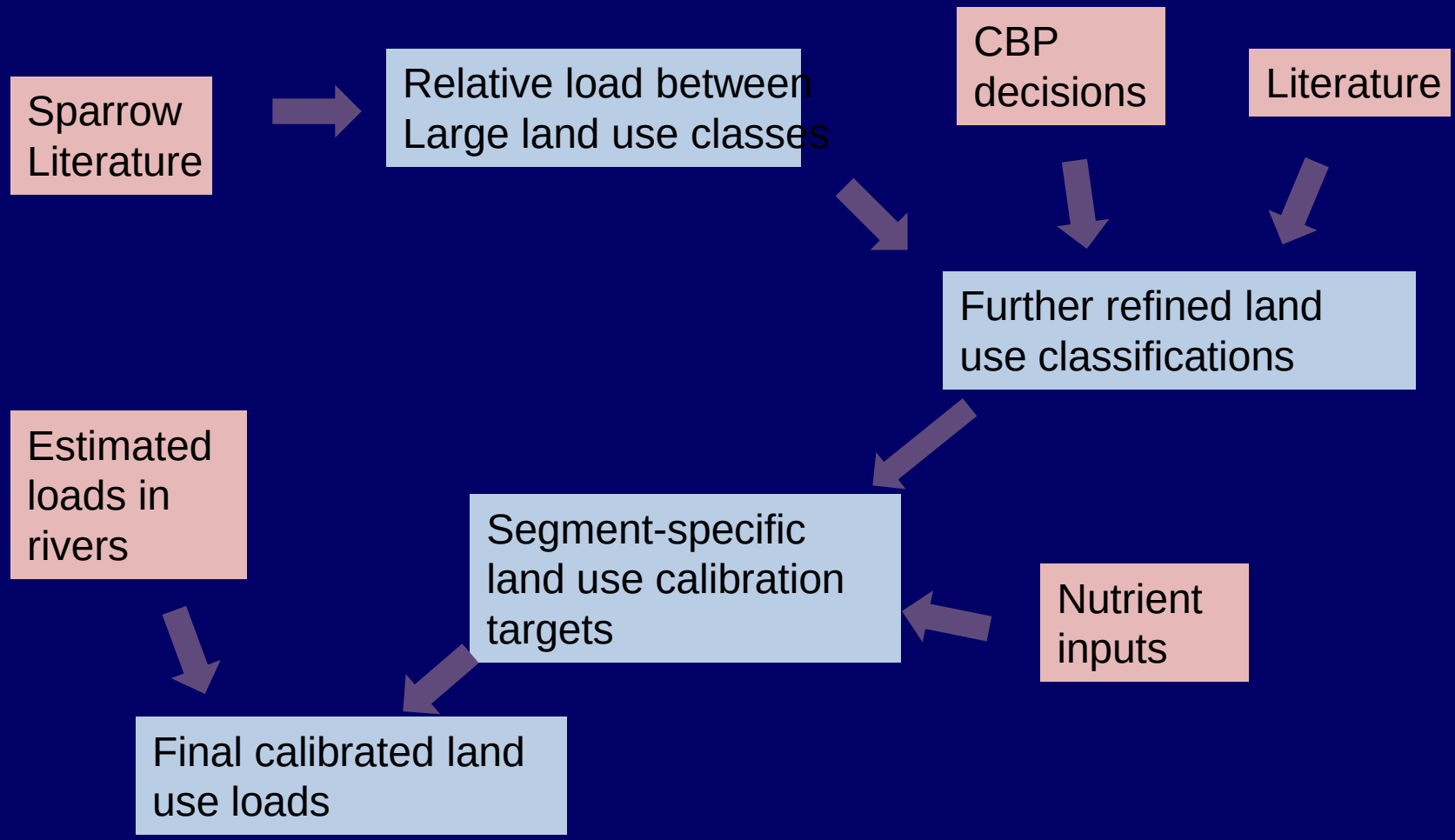
- Phase 6 proposed land uses = 47
  - Urban 8
  - Agricultural 27
  - Other 12
- Phase 5 land uses = 23
  - Urban 4
  - Agricultural 16
  - Other 3

It may be that the loading rate data do not support differentiation among some land uses

Reasons to differentiate land uses

- Distinct land use loading rates from literature, models, other data sources
- BMPs are exclusive to one type of land use (e.g.: stream corridor buffers or fencing)
- Helps jurisdictions for planning and reporting purposes. In this case, there would not be a different loading rate.

Land Use Load Decisions – Phase 6



Role of Workgroups

- Provide critical pieces of information in addition to the full literature review that is already underway.
- Panel, workgroup documents and recommendations, and available literature are critical sources of data for developing the loading rate targets.
- Modeling workgroup approves the final Phase 6 model

Timeline

- December 31, 2014 - Sparrow and literature review results for draft land uses
- February 28, 2015 - draft targets for draft land uses
- April 30, 2015 - final targets approved by Modeling Workgroup for draft land uses
- Oct 1, 2015 - Once the final land uses are approved, we will finalize targets using a Sparrow update, final sensitivities, and other information.

Keeping Up To Date – Webpages

- Land Use Loading Rates https://www.chesapeakebay.net/about/wmp_for_mpa_effort/land_use_loading_rates

- Additional information on component efforts http://www.chesapeakebay.net/groups/group/water_quality_goal_implementation_team/wmp_for_the_mpa

Communication

- Presenting at:
  - Modeling Team 9/15.
  - Agricultural Modeling Subcommittee 9/16
  - *Agricultural Workgroup, as Mark Dubin determines*
  - Urban Stormwater Workgroup 9/23
  - Land Use Workgroup 9/25
  - Modeling Quarterly Review 9/30-10/1
  - Forestry Workgroup 10/1
  - Watershed Technical Workgroup 10/2
  - Wetland Expert Panel November
  - Also available to any other Workgroup

- Will present multiple times.