eLINK Data Quality Control Analysis

A component of the ENTRF-funded project *Measuring Conservation Practice Outcomes*

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Introduction

eLINK is a central database housing pollution reduction outcomes for BWSR's grants to local government units (LGUs). Since 2003 eLINK has tracked BWSR grants and project outcomes including pollution reduction estimates. The database contains gaps in pollution reduction reporting. These gaps exist for various reasons including:

- Insufficient models to estimate pollution reductions for all practices
- Inadequate enforcement of reporting requirements
- Inability to demonstrate benefits of preventative practices, e.g., Well Sealing, Nutrient Management Planning and Use Exclusion.

In an era of accountability and reporting of environmental outcomes, it is essential that BWSR demonstrates the environmental benefits of BWSR-funded projects. The key to accountability and documenting outcomes is ensuring pollution reductions are 1) entered in the grant reporting process and 2) represent the best estimate for on the ground pollution reductions.

The Environment and Natural Resources Trust Fund provided funding as recommended by the Legislative-Citizen Commission on Minnesota Resources to address BWSR's need for improved measurement of conservation practice outcomes. As a part of the *Measuring Conservation Practice Outcomes* project, BWSR and the University of Minnesota developed new pollution reduction estimators aimed at filling eLINK's data gaps. Additionally, a quality control analysis was completed as a part of the *Measuring Conservation Practice Outcomes* project. The quality control analysis includes the following elements: 1) statistical analysis and interpretation of pollution reduction estimates derived from a newly developed estimator, 2) statistical analysis of reported pollution reduction from the most commonly-funded BMPs, 3) quality control recommendations, and 4) resources for internal quality control.

Data Analysis

Measuring the impact of deploying new pollution reduction estimators is accomplished by analyzing the estimated environmental outcomes before and after the estimator implementation. We expect improvement in data quality after a new pollution reduction estimator becomes available and LGUs are trained on proper use. In addition to looking at before/after scenarios, statistical analysis is also used for describing the business as usual scenario for BMPs without an associated pollution reduction estimator. Based on the data quality in the business as usual scenarios, quality control recommendations were developed for internal implementation aimed at improving eLINK data.

Data availability for the before/after analysis was limited by the timing of estimator development and grant reporting periods. A before/after analysis was feasible for only the Septic System Improvement BMP. The Milk House Waste Water Improvement estimator and Soil Hydrologic Group estimator were developed as a part of the project, but the eLINK database to date does not contain any pollution reduction estimates derived from these estimators. The eLINK database did not contain pollution reduction estimates using the Milk House Waste Water Improvement or Soil Hydrologic Group estimator because there has not been a reporting period since the estimator deployment. The Milk House Waste Water Improvement estimator and the Soil Hydrologic Group estimator were first made available to LGUs in June 2014. LGUs most frequently use estimators in December and January of each, the months immediately prior to grant reporting deadlines. We anticipate a rise in the use the estimators and outcome reporting by LGUs during the February 2015 reporting period.

New Estimators

Septic System Improvement Estimator

	Before	After
Data Completeness (%)	15%	84%
BOD_5 Mean (lbs/yr)	329.0	372.9
BOD_5 SD	301.3	129.8
Fecal Coliform Mean (CFU)	1.4×10^{13}	4.8×10^{13}
Fecal Coliform SD	2.6×10^{13}	2.4×10^{13}
Nitrogen Mean (lbs/yr)	49.8	19.0
Nitrogen SD	58.6	11.9
Phosphorus Mean (lbs/yr)	15.9	9.6
Phosphorus SD	40.4	3.8

Figure 1: Before and after descriptive statistics for the Septic System Improvement Estimator

The analysis shows dramatic improvements in data completeness from 15% to 84% for septic system improvement projects after Septic System Improvement Estimator deployment and LGU training. Another positive trend is the standard deviation for all environmental indicators (BOD5, Fecal Coliform, Nitrogen, and Phosphorus) decreased after estimator development and training. Lower standard deviations indicate pollution reduction estimates are tightening up and LGUs are using consistent, appropriate methods for modeling pollution reduction.

Milk House Waste Practices

	Before	After
Data Completeness (%)	42%	-
BOD_5 Mean (lbs/yr)	1212.1	-
BOD_5 SD	855.5	-
Nitrogen Mean (lbs/yr)	93.6	-
Nitrogen SD	57.7	-
Phosphorus Mean (lbs/yr)	65.9	-
Phosphorus SD	40.5	-

Figure 2: Descriptive Statistics for pollution reduction for Milk House Waste Improvements

eLINK data on milk house waste improvement practices was not available after LGU training, therefore the analysis focuses on the quality of data prior to the new estimator development. Prior to the deployment of the new Milk House Waste Estimator, BWSR did not have a recommended model for LGUs to use. Each LGU likely approached pollution reduction estimates using unique methodologies and assumptions. The large standard deviations indicate a wide range in estimates for a given indicator (BOD5, Nitrogen, and Phosphorus). We expect the data completeness to increase and the standard deviations to decrease after LGUs enter data for the February 2015 reporting period.

Business as usual

Critical Area Planting

Data Completeness (%)	42%
Phosphorus reduction mean (lbs/yr)	88.8
Phosphorus reduction SD	246.6
Sediment reduction mean (Tons/yr)	93.7
Sediment reduction SD	234.3
Soil loss reduction mean (Tons/yr)	125.2
Soil loss reduction SD	432.1

Grade Stabilization

Data Completeness (%)	52%
Phosphorus reduction mean (lbs/yr)	75.1
Phosphorus reduction SD	246.5
Sediment reduction mean (Tons/yr)	84.9
Sediment reduction SD	303.1
Soil loss reduction mean (Tons/yr)	98.2
Soil loss reduction SD	346.0

Streambank and Shoreline Protection

Data Completeness (%)	63%
Phosphorus reduction mean (lbs/yr)	184.3
Phosphorus reduction SD	1992.0
Sediment reduction mean (Tons/yr)	216.4

Sediment reduction SD	2354.5
Soil loss reduction mean (Tons/yr)	230.1
Soil loss reduction SD	2503.7

Terrace

Data Completeness (%)	70%
Phosphorus reduction mean (lbs/yr)	59.5
Phosphorus reduction SD	513.8
Sediment reduction mean (Tons/yr)	53.0
Sediment reduction SD	454.0
Soil loss reduction mean (Tons/yr)	138.0
Soil loss reduction SD	1595.2

WASCOB

Data Completeness (%)	56%
Phosphorus reduction mean (lbs/yr)	57.5
Phosphorus reduction SD	238.0
Sediment reduction mean (Tons/yr)	55.6
Sediment reduction SD	292.5
Soil loss reduction mean (Tons/yr)	48.2
Soil loss reduction SD	126.2

Bioretention Basin

Data Completeness (%)	52%
Phosphorus reduction mean (lbs/yr)	5.8
Phosphorus reduction SD	17.3
Sediment reduction mean (Tons/yr)	32.1
Sediment reduction SD	164.2
Volume reduction mean (Tons/yr)	1.8
Volume reduction SD	4.3

Quality Control Recommendations

Quality control measures for improving eLINK data fall into two general categories: 1) education and outreach to LGUs and 2) internal mechanisms for BWSR staff. Education and outreach involves many elements with a unifying theme of clear and frequent communication between LGU staff and BWSR grants and Board Conservationist staff. Internal mechanisms are tools for BWSR staff, particularly Board Conservationists, which help identify potentially inaccurate pollution reduction estimates given the site specific details of the project.

Recommended actions for improving eLINK data:

Education and Outreach

- Continued training on new and existing pollution reduction estimators
- Update reporting guidance and specify pollution reduction indicators required for individual BMPs

Internal Mechanisms

- Develop lookup references for Board Conservationists use in the grant review process
- Training for Board Conservationists on BMPs and expected pollution reduction

Resources for Internal Quality Control

Three resources were developed to help Board Conservations review pollution reduction values. Board Conservationists can choose the resource that best fits the BMP and project they are reviewing. The first is a BMP effectiveness look up table reporting percent removal efficiencies for agricultural and stormwater practices. This lookup table is based on the literature cited in the Minnesota Department of Agriculture AgBMP handbook and the Minnesota Pollution Control Agency Stormwater Manual. The second resource identifies potential outliers for the most common BMPs reported in eLINK. It is important to note that the outlier ranges were calculated based on the data available in eLINK, not an independent dataset. The third resource outlines a Unit Area Loading methodology to estimate pollution reduction. Note the Unit Area Loading method estimates reductions reaching a water body, not edge of field calculations.

All internal control resources are found in Appendices A through D.

Documentation

Quality Control Analysis documentation notes:

Removed all 2003 and 2004 data per the recommendation eLINK database manager.

This analysis included data in “Nitrogen” column and ignored “Nitrogen_calc_est” and “Nitrogen_Final”. “Nitrogen” is user entered and “Nitrogen_calc_est” is estimated by N = 2 x Phosphorus. “Nitrogen_Final” aggregates the data in both “Nitrogen” and “Nitrogen_calc_est”. If “Nitrogen” has a value, than that value is used in “Nitrogen_calc_est”. If not, the value in “Nitrogen_calc_est” is used.

This analysis included data in the “Phosphorus” column and ignored “Phos_calc_all”. “Phosphorus” is a user entered value and “Phos_calc_all” is populated using assumptions similar to those outlined above for Nitrogen.

For the septic system improvement estimator, this analysis assumed data from the “E_coli” indicator entered after October 2013 is actually “Fecal Coliform”.

For the milkhouse waste practices estimator, Total Suspended Solids is not an indicator in eLINK. The database manager was made aware of the issue and it was added. Data for Total Suspended Solids was not available because of the database omission and therefore was not used in the statistical analysis.

Effectiveness Summary

The BMP effectiveness table for agricultural BMPs was populated using the following rules of precedence. 1) Data from the AgBMP handbook pertaining to Minnesota and the upper Midwest, 2) To fill the data gaps, data from the AgBMP appendix B (national sources) was included, 3) In cases where both the upper Midwest and national data existed, the Minnesota/upper Midwest data trumped national values.

Data from the Georgia manual (cited in the AgBMP handbook) was not included because it provided little in the way of references.

Outliers

The Grubb's test could not be used for outlier identification because the data for individual BMP pollutant reductions are not normally distributed. The Inter Quartile Method was used instead because it does not require normal distributions. Also, the Inter Quartile Method is median based and is less subject to the problem of masking where a single outlier can inflate the standard deviation thus masking itself.

Appendix A

BMP Effectiveness Summary - Agricultural

BMP effectiveness estimate - % reduction

BMP	Turbidity/ Sediment	Total Phosphorus	Soluble Phosphorus	Total Nitrogen	Nitrate Nitrogen	Ammonia Nitrogen	Pesticides	Herbicides	Bacteria	Dissolved Oxygen
Alternative Tile Intakes										
Perforated Riser	90% - 95%	0.659								
Gravel (rock) inlet	70% - 90%	81.6% - 88.1%								
Dense Pattern Tile	1									
Conservation Cover (327)										
Conservation Crop Rotation (328)	0.66	0.53	30% - 75%	59%-62%						
Conservation Tillage (329, 345 and 346)	0.96	66% - 91%	0.57	0.53	10% - 68%	-43% - 93%				
Constructed (Treatment) Wetlands	0.75	20% - 90%	49% - 56%		40% - 90%					70% - 92%
Contour Buffer Strips (332)	83% - 91%	49% - 80%	20% - 50%	27% - 50%				67% - 77%	43% - 74% (fecal coliform)	
Contour Farming (330)	28% - 67%	10% - 62%		25% - 68%						
Contour Stripcropping (585)	43% - 95%	8% - 93%	20% - 93%	20% - 55%						
Controlled Drainage (554)		0.5			20% - 61%					
Cover Crops (340)	32% - 92%	54% - 94%	7% - 63%		13% - 64%	35% - 41%				
Culvert Sizing/Road Retention/Culvert Downsizing										

BMP Effectiveness Summary - Agricultural

BMP effectiveness estimate - % reduction

	Turbidity/ Sediment	Total Phosphorus	Soluble Phosphorus	Total Nitrogen	Nitrate Nitrogen	Ammonia Nitrogen	Pesticides	Herbicides	Bacteria	Dissolved Oxygen
Feedlot/Wastewater Filter Strip (635) and Clean Runoff Water Diversion (362)	0.79	0.83	10% - 45%	0.84	0.93					
Filter Strips (393) and Field Boarders (386)	86% - 91%	65% - 96%	24% - 39%	0.27	-158% - 85%	-35% - 98%	51% - 80%	49% - 78%		
Forest Buffer	40% - 60%	30% - 45%	19% - 65%							
Grade Stabilization (410)	0.99									
Grassed Waterways	94% - 98%							70% - 96%		
Livestock Exclusion/Fencing (382/472)	82% - 84%	0.76		-0.78	0.32					
Nutrient Management (590)			0.5	18% - 36%	10% - 45%					
Pest Management (595)								17% -43%		
Riparian and Channel Vegetation (332/390)	53% - 99.7%	41% - 93%		57.9% - 92.1%						
Rotational Grazing	0.49	0.75		0.62						
Sediment Basin (350)	0.84	0.5	0.8	0.3	0.82				0.7	
Streambank and Shoreline Protection (580)	4% - 8%									
Terrace (600)	80% - 95%	70% - 85%		20% - 55%						
Tile System Design					0.47					
Waste Storage Facility (313)		0.58		0.52						

BMP Effectiveness Summary - Agricultural

BMP effectiveness estimate - % reduction

	Turbidity/ Sediment	Total Phosphorus	Soluble Phosphorus	Total Nitrogen	Nitrate Nitrogen	Ammonia Nitrogen	Pesticides	Herbicides	Bacteria	Dissolved Oxygen
Water and Sediment Control Basin (638)	79% - 99%	12% - 526%		7% - 25%						
Wetland Restoration (651)	> 75%	0% - 50%		0.64	68% - >85%	0.63				
Woodchip Bioreactor					30% - 40%					

Sources
AgBMP handbook - values specific to MN and upper Midwest
AgBMP handbook - values from other National sources

Appendix B

BMP Effectiveness Summary - Stormwater

BMP effectiveness estimate - % reduction

BMP	TSS	Total Phosphorus	Total Nitrogen	Metals	Bacteria	Hydrocarbon	Data source
Bioretention/raingarden	85% - 90%	50% - 100%	0.5%	0.95%	0.35%	0.8%	a,b
Sand or other media filter	75% - 90%	30% - 55%	10% - 60%	0.8%	0.35%	0.8%	a,b,e
Grass filter or dry swale	40% - 87%	0% - 55%	0.35%	0.8%	0.35%	0.8%	a
Stormwater pond	60% - 90%	34% - 73%	30% - 55%	0.6%	0.7%	0.8%	a,e
Pervious pavement	0.9%	65% - 80%	0.6%				b,e
Infiltration Trench	85% - 100%	25% - 100%	0.55%				b,e
Wet swale	69-87%	20-50%					b
Water and Sediment Control Basin / dry pond	0.53%	15% - 45%					c
Vegetated Filter Strips	0.75%	45% - 80%	0.4%				c,e
Forested Buffers	40% - 60%	30% - 45%					d
Stormwater Wetlands	0.8%	0.45%	0.55%				e
Tree Box Filter	0.99%						e

Sources

a MPCA Stormwater Manual

b MIDS work group

c Weiss et al. 2005. The Cost and Effectiveness of Stormwater Mangament Practices. Prepared for the Minnesota Department of Transportation

d Chesapeake Bay Program, Phase 5.3 Watershed Model. Section 6: Best Management Practices for Nutrients and Sediment

e New Hampshire Department of Environmental Services 2008, New Hampshire Stormwater Manual, Volume 2 appendix B, BMP Pollutant Removal Efficiency

Appendix C

This table includes outlier ranges for common BMPs in eLINK. The outlier ranges identified below are provided for the express use as a method of flagging possible outliers in eLINK grant reporting. A value exceeding the outlier range does not automatically mean the reported value is erroneous. Projects reporting pollution reduction values exceeding the ranges should be looked at closer to identify site and project specific details explaining the estimate. Also, pollution reduction values not exceeding the ranges below may in fact be an outlier. Use best professional judgment.

Outliers – InterQuartile Method

	Phosphorus (lbs.yr)	Sediment (Tons/yr)	Soil Loss (Tons/yr)	BOD_5 (lbs/yr)	Nitrogen (lbs/yr)
Alternative Tile Intake – gravel	>1.5	>1.7	>2	-	-
Bioretention Basin	>4.4	>1.5	NA	-	-
Cover Crop	>13.2	-	-	-	-
Critical Area Planting	>168	>201	>145	-	-
Filter Strip	>130	>50.8	>76.7	-	-
Grade Stabilization Structure	>118.2	>132.4	>122.3	-	-
Grassed Waterway and Swales	>140	>142.4	>163	-	-
Septic System Improvement	>17	-	-	<81 or >665	>43.8
Streambank and Shoreline Protection	>88.5	>89.9	>112.0	-	-
Terrace	>68.7	>58.9	>79.7	-	-
WASCOB	>81.9	>80.1	>88.3	-	-

The InterQuartile Method

Values are declared outlier if:

Value < 1st quartile – 1.5 x InterQuartile Range

Value > 3rd quartile + 1.5 x Interquartile Range

Appendix D

Unit Area Load Calculations

The Unit Area Load approach is used to estimate phosphorus and total suspended sediment export to receiving water bodies.

Load (lb/yr) = area (acres) x UAL (lb/acre-year)

Land Use	Total Phosphorus UAL (lb/acre-year)	TSS UAL (T/acre-year)
Cropland	0.4	1.7-2.6
Forest/Grassland	0.08	0.1
Urban – high density	0.11	0.21
Urban – low density	0.80	0.1

Example: The Lake Wobegon Watershed District converted 147 acres of cropland to native grasses. Estimate the sediment and phosphorus reductions for this project.

Total Phosporus = 147 x 0.4 = 58.8 lb/yr, grassland = 147 x 0.08 = 11.8 lb/yr
Reduction = 58.8 – 11.8 = 47 lbs/yr

Total Suspended Sediment = 147 x 2 = 294 T/yr, grassland = 147 x 0.1 = 14.7 T/yr
Reduction = 294 – 15 = 279 T/yr