ATTACHMENT 3: WATER QUALITY MODELING DOCUMENTATION

PLET MODEL INPUTS

PLET MODEL OUTPUTS

PLET BMP SCENARIO

IN-LAKE MODELING INPUTS AND OUTPUTS

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PLET Model Inputs

1. Watershed Land Use Area (ac) and Precipitation (in)

HSG	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Total	Feedlots Percent Paved	Annual Rainfall	Rain Days	Average Rain/Event
C	1847.469	899.09	75.43606	5.909513	0	0	2827.904573	1	27.35439363	87.27586207	0.649897804

2. Agricultural Animals (Animal Count)

Beef Cattle	Young Beef	Dairy Cattle	Young Dairy Stock	Swine (Hog)	Feeder Pig	Sheep	Horse	Chicken	Turkey	Duck	# Of Months Manure Applied to Cropland	# Of Months Manure Applied to Pastureland
0	0	0	0	69	0	7	5	7	1	0	1	0

3. Septic & Illegal Wastewater Discharge

Number of Septic Systems	Population Per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # Of People	Direct Discharge Reduction, %
0	2	0.27	0	0

4. Percent Nutrient in Soil

Soil N conc. %	Soil P conc. %	Soil BOD conc. %
0.08	0.0308	0.16

5. Universal Soil Loss Equation

Cropland					Pastureland					Forest					User Defined				
R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P
133	0.3208	0.27	0.2	1	150	0.3208	0.3746	0.04	1	150	0.3208	0.3746	0.003	1	150	0.3208	0.3746	0.15542	1

6. Reference Runoff Curve Number

SHG	A	B	C	D
Urban	83.00	89.00	92.00	93.00
Cropland	67.00	78.00	85.00	89.00
Pastureland	49.00	69.00	79.00	84.00
Forest	39.00	60.00	73.00	79.00
User Defined	0.00	0.00	0.00	0.00

6a. Detailed Urban Reference Runoff Curve Number

SHG	A	B	C	D
Commercial	89.00	92.00	94.00	95.00
Industrial	81.00	88.00	91.00	93.00
Institutional	81.00	88.00	91.00	93.00
Transportation	98.00	98.00	98.00	98.00
Multi-Family	77.00	85.00	90.00	92.00
Single-Family	57.00	72.00	81.00	86.00
Urban Cultivated	67.00	78.00	85.00	89.00
Vacant-Developed	77.00	85.00	90.00	92.00
Open Space	49.00	69.00	79.00	84.00

7. Nutrient Concentration in Runoff (mg/L)

Landuse	Landuse Description	N	N Description	P	BOD
1. L-Cropland	1. L-Cropland: The study area has low livestock density (<=1500 lb/ac live animal weight)	1.9	Area with low livestock density: N, P, and BOD conc. in cropland runoff (mg/l)	0.3	4
1a. w/ manure		8.1	Manured L-cropland: N, P, and BOD conc. in manured cropland runoff (mg/l)	2	12.3
2. M-Cropland	2. M-Cropland: The study area has medium livestock density (>1500 and <2500 lb/ac live animal weight)	2.9	Area with medium livestock density: N, P, and BOD conc. in cropland runoff (mg/l)	0.4	6.1
2a. w/ manure		12.2	Manured M-cropland: N, P, and BOD conc. in manured cropland runoff (mg/l)	3	18.5
3. H-Cropland	3. H-Cropland: The study area has high livestock density (>=2500 lb/ac live animal weight)	4.4	Area with high livestock density: N, P, and BOD conc. in cropland runoff (mg/l)	0.5	9.2
3a. w/ manure		18.3	Manured H-cropland: N, P, and BOD conc. in manured cropland runoff (mg/l)	4	24.6
4. L-Pastureland	1. L-Pastureland: The study area has low livestock density (<=1500 lb/ac live animal weight)	4	Area with low livestock density: N, P, and BOD conc. in pastureland runoff (mg/l)	0.3	13
4a. w/ manure		4	Manured L-cropland: N, P, and BOD conc. in manured pastureland runoff (mg/l)	0.3	13
5. M-Pastureland	2. M-Pastureland: The study area has medium livestock density (>1500 and <2500 lb/ac live animal weight)	4	Area with medium livestock density: N, P, and BOD conc. in pastureland runoff (mg/l)	0.3	13
5a. w/ manure		4	Manured M-cropland: N, P, and BOD conc. in manured pastureland runoff (mg/l)	0.3	13
6. H-Pastureland	3. H-Pastureland: The study area has high livestock density (>=2500 lb/ac live animal weight)	4	Area with high livestock density: N, P, and BOD conc. in pastureland runoff (mg/l)	0.3	13
6a. w/ manure		4	Manured H-cropland: N, P, and BOD conc. in manured pastureland runoff (mg/l)	0.3	13
7. Forest		0.2		0.1	0.5
8. User Defined		0		0	0

7a. Nutrient Concentration in Shallow Groundwater (mg/L)

Landuse	N	P	BOD
Urban	1.5	0.063	0
Cropland	1.44	0.063	0
Pastureland	1.44	0.063	0
Forest	0.11	0.009	0
Feedlots	6	0.07	0
User Defined	0	0	0

8. Urban Land Use Distribution

Urban Area (ac)	Commercial %	Industrial %	Institutional %	Transportation %	Multi Family %	Single Family %	Urban Cultivated %	Vacant (developed) %	Open Space %	Total
1847.469	10.93	0.34	26.41	11.37	0.03	44.73	0	0	6.18	99.99

9. Input Irrigation Area (ac) and Irrigation Amount (in)

Total Cropland (ac)	Cropland Acres Irrigated	Water Depth (in) per Irrigation Before BMP	Water Depth (in) per Irrigation After BMP	Irrigation Frequency (#/Year)
899.09	359.52	1	1	8

10. Wildlife density in cropland (# of animals / sq. mile)

Raccoon	Other	Goose	Deer	Beaver
0	0	0	0	0

BMPs and Efficiencies

Input BMP ID	FK Input ID	Input Type	N	P	BOD	Sediment	BMP Name	% Area BMP Applied
18867	31660	Cropland	.61	.911	0	.911	Combined BMPs-Calculated (Simple Cropland)	100

Animal Weight (lb)

Beef Cattle	Dairy Cattle	Hog	Sheep	Horse	Chicken	Turkey	Duck	Goose	Deer	Beaver	Raccoon	Other
1000	1400	200	100	1000	4	10	4	6	40	15	7	0

Soil Infiltration

A	B	C	D	SHG
0.36	0.24	0.12	0.06	Urban
0.45	0.3	0.15	0.075	Cropland
0.45	0.3	0.15	0.075	Pastureland
0.45	0.3	0.15	0.075	Forest
0.45	0.3	0.15	0.075	User Defined

Feedlots Reference (ratio of nutrients produced by animals relative to 1000 lb of slaughter steer)

Animal	N	P	BOD
1. Slaughter Steer	1	1	1
2. Young Beef	0.5	0.51	0.5
3. Dairy Cow	1.853	0.92	1.4
4. Young Dairy Stock	0.662	0.33	0.5
5. Swine	0.306	0.27	0.388
6. Feeder Pig	0.076	0.07	0.097
7. Sheep	0.124	0.06	0.075
8. Horse	0.882	0.42	1.063
9. Chicken	0.01	0.01	0.008
01. Turkey	0.018	0.03	0.013
02. Duck	0.018	0.01	0.011

Assume the average concentrations reaching the stream (from septic overcharge) are:

Parameter	Average Concentration	Remarks
Total Nitrogen	60	mg/L (range of 20 to 100)
Total Phosphorus	23.5	mg/L (range of 18 to 29)
Organics (BOD)	245	mg/L (range of 200 to 290)
E. coli	0	MPN/100ml
Typical septic overcharge flow rate	70	gal/day/person(range of 45 to 100)

Wastewater per capita

Parameter	Wastewater	Remarks
Total Nitrogen	40	mg/L (range of 20 to 85)
Total Phosphorus	8	mg/L (range of 4 to 15)
Organics (BOD)	220	mg/L (range of 110 to 400)
E. coli	0	MPN/100ml
Typical septic overcharge flow rate	75	gal/day/person(range of 75 to 125)

Gullies

No gullies were identified in the watershed.

Gully Name	Top Width	Bottom Width	Depth	Length	Years to Form	BMP Efficiency	Soil Class	Soil Weight	Nutrient Correction Factor	Annual Load	Load Reduction	FK Model ID	Annual Load NCF	Load Reduction NCF

Streambanks

Streambank Name	Length	Height	Lateral Recession	Rate Range	Rate	BMP Efficiency	Soil Class	Soil Weight	Nutrient Correction Factor	Annual Load	Load Reduction	FK Model ID	Annual Load NCF	Load Reduction NCF
Bank 2	3356	3	Moderate	0.06 - 0.2	0.13	0.9	Silt Loam	0.0425	1	55.6257	50.06313	26273	55.6257	50.06313
Bank 1	3356	3	Moderate	0.06 - 0.2	0.13	0.9	Silt Loam	0.0425	1	55.6257	50.06313	26273	55.6257	50.06313

Urban pollutant concentration in runoff (mg/L)

Commercial	Industrial	Institutional	Transport	Multi Family	Single Family	Urban Cultivated	Vacant	Open Space	Pollutant
2	2.5	1.8	3	2.2	2.2	1.9	1.5	1.5	TN
.2	.4	.3	.5	.4	.4	.3	.15	.15	TP
9.3	9	7.8	9.3	10	10	4	4	4	BOD
75	120	67	150	100	100	150	70	70	TSS

Selected Urban BMPs

Commercial	Industrial	Institutional	Transport	Multi Family	Single Family	Urban Cultivated	Vacant	Open Space
Combined BMPs - Calculated	Combined BMPs - Calculated	Combined BMPs - Calculated	Combined BMPs - Calculated	Combined BMPs - Calculated	Combined BMPs - Calculated	-	-	Combined BMPs - Calculated

Combined BMPs-Calculated Efficiency Values

N Removal Efficiency	P Removal Efficiency	BOD Removal Efficiency	Sediment Removal Efficiency
0.4	0.43	0	0.78

Urban Landuse Distribution (ac)

Commercial	Industrial	Institutional	Transportation	Multi Family	Single Family	Urban Cultivated	Vacant	Open Space
201.9283617	6.2813946	487.9166	210.057225	0.5542407	826.3729	0	0	114.1735842

Effective Urban BMP Application Area (ac)

Commercial	Industrial	Institutional	Transport	Multi Family	Single Family	Urban Cultivated	Vacant	Open Space
201.928	6.2813	487.9165	210.057	0.55424	826.3728			114.1735

Model Info

HUC 12	State	County	Station ID	Watershed	Model ID
102702030302	NE	ADAMS	NE253660	102702030302 - Headwaters West Fork Big Blue River	26273

PLET Model Outputs

Total load by subwatershed

Watershed	N Load (No BMP) (lbs/year)	P Load (No BMP) (lbs/year)	BOD Load (No BMP) (lbs/year)	Sediment Load (No BMP) (tons/year)	N Reduction (lbs/year)	P Reduction (lbs/year)	BOD Reduction (lbs/year)	Sediment Reduction (tons/year)
102702030302 - Headwaters West Fork Big Blue River	13636.07	2607.93	43253.44	742.06	6911.26	1728.74	2913.19	641.25
TOTAL	13636.07	2607.93	43253.44	742.06	6911.26	1728.74	2913.19	641.25

Watershed	N Load (With BMP) (lbs/year)	P Load (With BMP) (lbs/year)	BOD Load (With BMP) (lbs/year)	Sediment Load (With BMP) (tons/year)	% N Reduction	% P Reduction	% BOD Reduction	% Sediment Reduction
102702030302 - Headwaters West Fork Big Blue River	6724.81	879.19	40340.25	100.81	50.68	66.29	6.74	86.42
TOTAL	6724.81	879.19	40340.25	100.81	50.68	66.29	6.74	86.42

Total load by land uses pre-BMPs

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (ton/yr)
Urban	7940.08	1269.82	31678.79	174.36
Cropland	5158.5	1230.56	10098.03	444.7
Pastureland	358.31	38.46	1117.79	11.68
Forest	1.18	0.56	2.83	0.07
Feedlots	0	0	0	0
User Defined	0	0	0	0
Septic	0	0	0	0
Gully	0	0	0	0
Streambank	178	68.53	356	111.25
Groundwater	0	0	0	0
TOTAL	13636.07	2607.93	43253.44	742.06

Total load by land uses with BMPs

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (ton/yr)
Urban	4764.05	723.8	31678.79	38.36
Cropland	1583.48	109.52	7505.25	39.58
Pastureland	358.31	38.46	1117.79	11.68
Forest	1.18	0.56	2.83	0.07
Feedlots	0	0	0	0
User Defined	0	0	0	0
Septic	0	0	0	0
Gully	0	0	0	0
Streambank	17.8	6.85	35.6	11.13
Groundwater	0	0	0	0
TOTAL	6724.81	879.19	40340.25	100.81

Nutrient and sediment load pre-BMPs (lb/yr)

Urban				Cropland				Pastureland			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
7940.08	1269.82	31678.79	348722.7	5158.5	1230.56	10098.03	889401.39	358.31	38.46	1117.79	23353.25

Forest				Feedlot				User Defined				Septic			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
1.18	0.56	2.83	137.21	0	0	0	0	0	0	0	0	0	0	0	0

Gully				Streambank			
N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	178	68.53	356	222502.8

Nutrient and sediment load with BMPs (lb/yr)

Urban				Cropland				Pastureland			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
4764.05	723.8	31678.79	76719.21	1583.48	109.52	7505.25	79156.72	358.31	38.46	1117.79	23353.25

Forest				Feedlot				User Defined				Septic			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
1.18	0.56	2.83	137.21	0	0	0	0	0	0	0	0	0	0	0	0

Gully				Streambank			
N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	17.8	6.85	35.6	22250.28

Load from groundwater pre-BMPs (lb/yr)

Urban				Cropland				Pastureland				Forest			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Feedlot				User Defined				Total			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	0	0	0	0	0	0	0	0

Load from groundwater with BMP (lb/yr)

Urban				Cropland				Pastureland				Forest			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

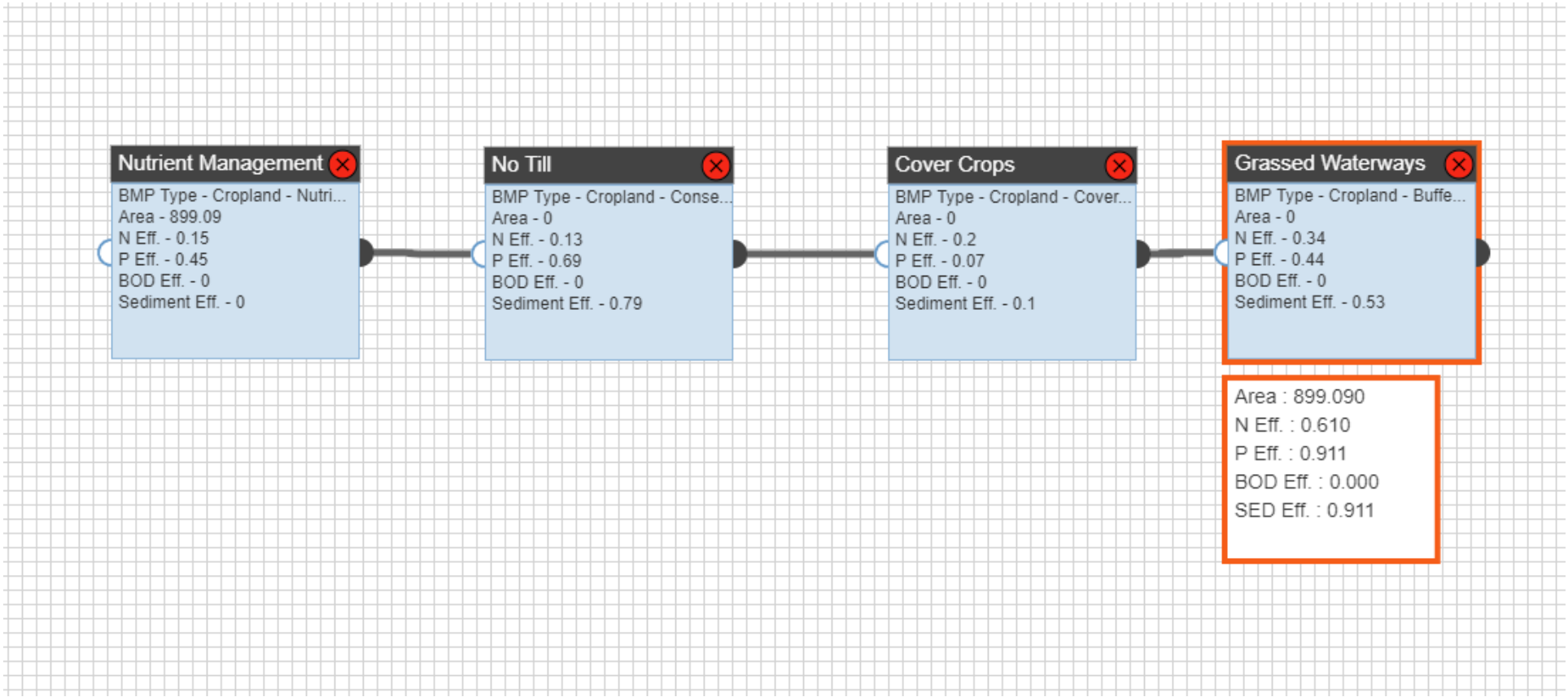
Feedlot				User Defined				Total			
N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
0	0	0	0	0	0	0	0	0	0	0	0

Pollutant loads from urban (lb/yr)

Pre-BMP Load				Load Reduction				Load (with BMP)			
N	P	BOD	TSS	N	P	BOD	TSS	N	P	BOD	TSS
7940.08	1269.82	31678.79	348722.7	3176.03	546.02	0	272003.53	4764.05	723.8	31678.79	76719.21

PLET BMP Scenario

Cropland BMP Scenario



In-Lake Modeling Inputs and Outputs

Phosphorus In-Lake Model (Canfield & Bachmann, 1981)

Phosphorus Calibration Target	Input	Input	Calculated Input	Input	Calculated Input	Input (adjust Areal Loading to calibrate to target concentration/load)	Output	Output	Output
	Surface Area (ac)	Volume (ac-ft)	Mean Depth (m) **[z]**	Detention time (yrs)	Lake Flushing (yr^-1) **[p]**	Areal Loading **[L]**	Phosphorus Concentration (ug/L) **[TP]**	Annual Net Load (lb/yr)	Annual Gross Load (lb/yr)*
Median Sampled Concentration (165.6 ug/L)	67.35	390.35	1.767	1.313	0.761	2760	165.6	1659	2719
Water Quality Standard, Before Lake Renovation (50 ug/L)	67.35	390.35	1.767	0.491	2.036	439	50.0	264	433
Water Quality Standard, After Lake Renovation (50 ug/L)	67.70	428.44	1.929	0.539	1.855	452	50.0	273	448
Expected Load After BMPs (386 lb/yr)	67.70	428.44	1.929	0.539	1.855	390	45.4	236	386

**Gross load based on net load where net load is assumed to be 61% of total (gross) load entering the lake, per Cunha et al. (2014)*

Nitrogen In-Lake Model (Bachmann, 1980)

Nitrogen Calibration Target	Input	Input	Calculated Input	Input	Calculated Input	Input (adjust Areal Loading to calibrate to target concentration/load)	Output	Output	Output
	Surface Area (ac)	Volume (ac-ft)	Mean Depth (m) **[z]**	Detention time (yrs)	Lake Flushing (yr^-1) **[p]**	Areal Loading **[L]**	Nitrogen Concentration (ug/L) **[TN]**	Annual Net Load (lb/yr)	Annual Gross Load (lb/yr)*
Median Sampled Concentration (1,705.2 ug/L)	67.35	390.35	1.767	1.313	0.761	16753	1705.2	10069	16506
Water Quality Standard, Before Lake Renovation (1,000 ug/L)	67.35	390.35	1.767	0.491	2.036	12076	1000.0	7258	11898
Water Quality Standard, After Lake Renovation (1,000 ug/L)	67.70	428.44	1.929	0.539	1.855	12837	1000.0	7755	12713
Expected Load After BMPs (3,742 lb/yr)	67.70	428.44	1.929	0.539	1.855	3778	294.3	2282	3742

**Gross load based on net load where net load is assumed to be 61% of total (gross) load entering the lake, per Cunha et al. (2014)*