

crossroads ventures llc

Total Phosphorus Loading Calculations and Comparisons

Between WinSLAMM and Other Stormwater Quality Methods

Prepared by:



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Table 1, “Comparison of WinSLAMM Data and Literature Estimate,” shows the results and sources of total phosphorous concentrations, or loading, for pre-development conditions. The units of measurement are expressed as either a concentration or an area load.

Table 1. Comparison of WinSLAMM Data and Literature Estimate for Phosphorus Loading

Location	Concentration mg/l	Load lbs/acres	Source
Big Indian (WinSLAMM)	0.23	0.23	DEIS Appendix 10A
Wildacres (WinSLAMM)	0.254	0.41	DEIS Appendix 10A
NURP	0.121		Haith 1993
Virginia Hardwood	0.15		Schueler 1987 NYCDEP 1997
Forest 1	0.010		USEPA
Wisconsin Forest		0.08-0.15	Panaska and Lilve 1995
Forest 2		0.1-3.3	WTM Carco 2003*
Forest 3		0.18	Olem 1990

* New source that was not reviewed during preparation of the DEIS

Location	Concentration mg/l	Load lbs/acres	Source
Giggle Hollow	0.02004		NYCDEP 2002 see pp 5 of 39

All of the above data is for the pre-development conditions. This data showed that WinSLAMM was predicting high values, which was considered acceptable since the post-development concentration was also being predicted by WinSLAMM.

A set of calculations were completed in April 2002 to determine the overall accuracy of the WinSLAMM predictions as it related to treatment removals (**see Appendix A, attached**). The calculations were based on a coefficient method, or direct calculation (land area x annual loading).

TP CALCULATIONS

Total Phosphorus Calculations for Selected Methods

The data from WinSLAMM analysis has been compared to other methods of runoff quality estimating including the 2000-2002 sample data collected by NYC DEP from predevelopment monitoring site Giggle Hollow.

There are three variations of the assumed loading rates for each of the estimates:

1. The impervious surface runoff concentration can be either 0.15 mg/l or 0.26 mg/l.
2. The golf course and landscape areas would have the same level of fertilizer applications.
3. The NYCDEP 1997 equation (modified simple equation) using a loading rate of 0.99 lbs/acre found in the Gleams Model.

Given the high demands placed on golf turf due to the number of rounds of play, it is necessary to fertilize and use comprehensive cultural practices to cause the turf to thrive. In landscape areas, the same inputs of fertilizers and other cultural practices are not necessary. Using the same loading rate is a prudent means of conservatively assessing runoff quality. Therefore, in the direct calculation method for Big Indian and Wildacres, show in **Tables 2 and 3**, the higher estimation of 0.99 lbs/acre was used.

TP CALCULATIONS

Several conversions were used throughout the calculations and are as follows:

Conversions

1 µg/l = 0.001 g/m³

1 lb = 0.4535 kg

1 acre = 4047 m²

1 inch = 0.0254 meters

0.9 = R, multiplier for annual rainfall

0.98 = R for impervious surfaces

0.64 = R for forest for Wild Acres[^] 0.60 = R for forest for Big Indian[^] [^] from p. 242 of the NYC DEP 2001 Watershed Protection Program Summary – <http://www.ci.nyc.ny.us/html/dep/html/fadplan.html>

Other Values

Annual Rainfall	= 50.4 inches	NYC DEP 1997
Impervious TP Concentration	= 0.26 mg/l for older urban areas = 0.15 mg/l for parking lot areas	NURP, Schueler 1987, NYC DEP 1997 NYC DEP 1997, Schueler 1987
Golf Turf TP Concentration	= 0.227 kg/acre/yr = 0.449 kg/acre/yr	NYC DEP 1997 DEIS
Landscaping TP Concentration	= 0.26 mg/l	NYC DEP 1997
Predevelopment Base Flow	= 0.15 mg/l	NYC DEP 1997
Event Monitoring TP Concentration	= 0.02005 mg/l	NYC DEP 2002

An annual rainfall of 50.4 inches per year was used in all of the calculations. This value was used based on regional rainfall collection values, shown in the NYC DEP 1997 *Guidance for Phosphorus Offset Pilot Program, Bureau of Water Supply Quality and Protection* report.

The general equation used to determine the annual loadings based on various TP concentrations is:

$$(\text{TP concentration}) * (\text{area}) * (\text{annual rainfall} * 0.9) = \text{Annual TP concentration for site}$$

A revised set of estimates for total phosphorus loading from the Big Indian and Wildacres Resort are presented on the following pages.

TP CALCULATIONS

Simple Method as described in the NYS DEC Stormwater Design Manual Post Development Pre-treatment

$$L = 0.226(R)(C)(A)$$

Where:

L = Annual load (lbs)

R = Annual Runoff (inches)

C = Pollutant Concentration (mg/l)

A = Area (acres)

0.226 = Unit Conversion factor

Where $R = (P)(P_j)(R_v)$:

P = Annual Rainfall (inches)

P_j = Fraction of rainfall producing Runoff = 0.9

R_v = Runoff Coefficient where $R_v = 0.05 + 0.9(I_a)$

Where I_a = Impervious fraction

TP CALCULATIONS

The method labeled “Direct Calculation/Giggle Hollow” is a direct calculation which utilizes an existing conditions (forest) concentration for runoff of 20.05 µg/l of phosphorus. The 2000-2001 non-precipitation runoff value was reported in NYC DEP (2002) as 15.47 µg/l (8/2000-12/31/2001). To create a year-round average that included precipitation events, two methods were utilized. The first estimate was formed by calculating averages for the precipitation events in 2002 when the fully automated samplers were operating, and calculating an overall average for events and adding the non-event mean from 2000-2001 NYC DEP TP baseflow monitoring. Below is the Giggle Hollow 2002 NYC DEP sample data that was utilized to estimate stormwater total phosphorus concentration.

The first estimate resulted in an average TP concentration of **20.05 µg/l**.

Giggle Hollow 2002 NYC DEP Sample Data

Event Start Date	Time	Event Stop Date	Time	Event Σ TP µg/l	Number of Samples	Equation	Event Average TP
March 26, 2002	9:50	March 27, 2002	9:44	281	25	(281)/(25) =	11.24
July 23, 2002	11:45	July 23, 2002	17:07	371	9	(371)/(9) =	41.22
September 15, 2002	8:15	September 26, 2002	5:05	606	22	(606)/(22) =	27.55
September 22, 2002	4:15	September 24, 2002	10:20	583	25	(583)/(25) =	23.32
September 26, 2002	19:45	September 28, 2002	9:10	843	38	(843)/(38) =	22.18
October 15, 2002	10:50	October 17, 2002	9:50	512	23	(512)/(23) =	22.26
Total Event Averages							147.77

Total Event Averages/Number of Events = Average TP Concentration in µg/l	147.77/6 =	24.63
2000/2001 NYC DEP TP baseflow in µg/l	=	15.47
(Average TP + NYC DEP TP)/2 = Average TP Concentration in µg/l	(24.63+15.47)/2 =	20.05

A second estimate of average TP loading was prepared by using the entire 2002 data set alone. This average value was 21.6 µg/l based on the 161 measurements made in 2002. The 20.05 µg/l was used in the calculation since the non-event estimate from 8/2000-12/2001 was based on a larger data set than the 2002 data.

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Land Use Type					
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Predevelopment						
WinSLAMM DEIS	149	NA	NA	NA	NA	149

WinSLAMM is a computer program that provides the user with an estimate of runoff quality developed by R. Pitt and J. Voorhees, 2000. The program is derived from empirical (real world) data collected during the National Urban Runoff Program. The above data is the result of the computer simulation.

See Appendix 10A of the DEIS.

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Calculation Method	Total Phosphorus Load (kg/year)					Total
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Predevelopment						
Direct Calculation/Giggle Hollow ^a	76.79	NA	NA	NA	NA	76.79

Below is the equation used to determine the predevelopment TP concentration.

$$(0.00002005 \text{ kg/m}^3)(1242 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.60) = \mathbf{76.79 \text{ kg/yr}}$$

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report

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Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Predevelopment							
Direct Calculation EPA ^b	57.45	NA	NA	NA	NA		57.45

Below is the equation used to determine the predevelopment TP concentration.

$$\begin{aligned}
 &(\text{TP concentration}) * (\text{area}) * (\text{annual rainfall} * 0.9) = \text{Annual TP concentration for site} \\
 &(0.00001 \text{ kg/m}^3)(1242 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = \mathbf{57.45 \text{ kg/yr}}
 \end{aligned}$$

^b Forest runoff = 0.010 mg/l (USEPA)

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Predevelopment							
Modified Simple Method* <small>*NYC DEP 1997</small>	86.17	NA	NA	NA	NA		86.17

Below is the equation used to determine the predevelopment TP concentration.

$$\begin{aligned}
 &(\text{TP concentration}) * (\text{area}) * (\text{annual rainfall} * 0.9) = \text{Annual TP concentration for site} \\
 &(0.000015 \text{ kg/m}^3)(1242 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = \mathbf{86.17 \text{ kg/yr}}
 \end{aligned}$$

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Land Use Type					
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Post Development (Pre-treatment)						
WinSLAMM DEIS	NA	NA	NA	NA	NA	252.30

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See Appendix 10A of the DEIS.

**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Post Development (Pre-treatment)							
Direct Calculation/Giggle Hollow ^a	56.33	68.62	NA	NA		125.09	250.04

Below is the equation used to determine the post development pretreatment TP concentration.

$$\begin{aligned}
 \text{Impervious concentration} & \quad (0.00026 \text{ kg/m}^3)(52.4 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.98) = 68.62 \text{ kg/yr} \\
 \text{Golf course and landscape concentration} & \quad (0.449 \text{ kg/ac/yr})(278.6 \text{ acres}) = 125.09 \text{ kg/yr} \\
 \text{Forest concentration} & \quad (0.00002005 \text{ kg/m}^3)(911 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.60) = \underline{56.33 \text{ kg/yr}} \\
 \text{Total Loading} & \quad \mathbf{250.04 \text{ kg/yr}}
 \end{aligned}$$

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report and Appendix 18 of the DEIS water quality data.

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**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Post Development (Pre-treatment)							
Direct Calculation EPA ^b	42.14	63.02	NA	NA	125.09		230.25

Below is the equation used to determine the post development pretreatment TP concentration.

Impervious concentration	$(0.00026 \text{ kg/m}^3)(52.4 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) =$	63.02 kg/yr
Golf course and landscape concentration	$(0.449 \text{ kg/ac/yr})(278.6 \text{ acres}) =$	125.09 kg/yr
Forest concentration	$(0.00001 \text{ kg/m}^3)(911 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) =$	<u>42.14 kg/yr</u>
	Total Loading	230.25 kg/yr

^b Pavement = 0.26 mg/l, Golf Course and Landscape combined runoff = 0.449 kg/ac and Forest runoff = 0.010 mg/l

**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Post Development (Pre-treatment)						
Modified Simple Method* ^c <small>*NYC DEP 1997</small>	84.49	44.37		44.90	NA	173.76

The equation below represents post development pretreatment TP loadings based on 99 lbs/yr loading for a 100 acres golf course.

$$\begin{aligned}
 &(\text{Simple Method Pretreatment Value}) + (99 \text{ lbs/year TP for 100 acre golf course}) + (\text{Remainder of site as Forested}) = \text{Post-Development Pre-Treatment} \\
 &(44.37 \text{ kg/yr}) + (44.90 \text{ kg/yr}) + (84.49 \text{ kg/yr}) = \mathbf{173.76 \text{ kg/yr}}
 \end{aligned}$$

^c Golf course runoff at 0.99 lbs/acre and forest runoff for rest of each site at 0.02005 mg/l added to developed site

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
WinSLAMM DEIS	NA	NA	NA	NA	NA	197	60	257

WinSLAMM is a computer program that provides the user with an estimate of runoff quality developed by R. Pitt and J. Voorhees, 2000. The program is derived from empirical (real world) data collected during the National Urban Runoff Program. The above data is the result of the computer simulation.

See Appendix 10A of the DEIS.

**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

BIG INDIAN

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
Direct Calculation/Giggle Hollow ^a	56.33	41.17	NA	NA	75.05	172.55	60	232.55

Treatment results in 40% removal of TP.

Below is the equation used to determine the post development post-treatment TP concentration.

Impervious concentration	$[(0.00026 \text{ kg/m}^3)(52.4 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.98)][1-0.40]$	=	41.17 kg/yr
Golf course and landscape concentration	$[(0.449 \text{ kg/ac/yr})(278.6 \text{ acres})][1-0.40]$	=	75.05 kg/yr
Forest concentration	$(0.00002005 \text{ kg/m}^3)(911 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.60)$	=	56.33 kg/yr
Total Post Development Post Treatment Loading			172.55 kg/yr

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report and Appendix 18 of the DEIS water quality data.

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**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

BIG INDIAN

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
Direct Calculation EPA ^b	42.14	31.43	NA	NA	62.54	136.11	60	196.11

Treatment results in 50% removal of TP.

Below is the equation used to determine the post development post treatment TP concentration.

Impervious concentration	$[(0.00026 \text{ kg/m}^3)(52.4 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9)]/2 =$	31.43 kg/yr
Golf course and landscape concentration	$[(0.449 \text{ kg/ac/yr})(278.6 \text{ acres})]/2 =$	62.54 kg/yr
Forest concentration	$(0.00001 \text{ kg/m}^3)(911 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) =$	42.14 kg/yr
Total Post Development Post Treatment Loading		136.11 kg/yr

^b Pavement = 0.26 mg/l, Golf Course and Landscape combined runoff = 0.449 kg/ac and Forest runoff = 0.010 mg/l

**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

BIG INDIAN

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
Modified Simple Method* ^c <small>*NYC DEP 1997</small>	84.49	22.18		22.45	NA	128.12	60	189.12

Post-Development

(Simple Method Post-treatment Value) + [(Post-Development Post-treatment 99 lbs/year TP for 100 acre golf course)] + (Remainder of site as Forested) = Post-Treatment

(22.18 kg/yr) + (22.45 kg/yr) + (84.49 kg/yr) = **128.12 kg/yr**

^c Golf course runoff at 0.99 lbs/acre and forest runoff for rest of each site at 0.02005 mg/l added to developed site

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Land Use Type					
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Predevelopment						
WinSLAMM DEIS	124	NA	NA	NA	NA	124

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See Appendix 10A of the DEIS.

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Land Use Type					
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Predevelopment						
Direct Calculation/Giggle Hollow ^a	47.35	NA	NA	NA	NA	47.35

Below is the equation used to determine the predevelopment TP concentration.

$$(0.00002005 \text{ kg/m}^3)(718 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.64) = \mathbf{47.35 \text{ kg/yr}}$$

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report

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Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Predevelopment							
Direct Calculation EPA ^b	33.21	NA	NA	NA	NA		33.21

Below is the equation used to determine the predevelopment TP concentration.

$$\begin{aligned}
 &(\text{TP concentration}) * (\text{area}) * (\text{annual rainfall} * 0.9) = \text{Annual TP concentration for site} \\
 &(0.00001 \text{ kg/m}^3)(718 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = \mathbf{33.21 \text{ kg/yr}}
 \end{aligned}$$

^b Forest runoff = 0.010 mg/l (USEPA)

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Predevelopment							
Modified Simple Method* <small>*NYC DEP 1997</small>	49.81	NA	NA	NA	NA		49.81

Below is the equation used to determine the predevelopment TP concentration.

$$\begin{aligned}
 &(\text{TP concentration}) * (\text{area}) * (\text{annual rainfall} * 0.9) = \text{Annual TP concentration for site} \\
 &(0.000015 \text{ kg/m}^3)(718 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = \mathbf{49.81 \text{ kg/yr}}
 \end{aligned}$$

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Land Use Type					
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Post Development (Pre-treatment)						
WinSLAMM DEIS	NA	NA	NA	NA	NA	217.6

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See Appendix 10A of the DEIS.

**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

WILDACRES

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Post Development (Pre-treatment)							
Direct Calculation/Giggle Hollow ^a	31.39	42.90	NA	NA		93.95	168.24

Below is the equation used to determine the post development pretreatment TP concentration.

$$\begin{aligned}
 \text{Impervious concentration} & \quad (0.00026 \text{ kg/m}^3)(32.76 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.98) = 42.90 \text{ kg/yr} \\
 \text{Golf course and landscape concentration} & \quad (0.227 \text{ kg/ac/yr})(209.24 \text{ acres}) = 93.95 \text{ kg/yr} \\
 \text{Forest concentration} & \quad (0.00002005 \text{ kg/m}^3)(476 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.64) = \underline{31.39 \text{ kg/yr}} \\
 \text{Total Loading} & \quad \mathbf{168.24 \text{ kg/yr}}
 \end{aligned}$$

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report and Appendix 18 of the DEIS water quality data.

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**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

Calculation Method	Total Phosphorus Load (kg/year)					Composite golf course and landscape loading	Total
	Forest	Impervious	Landscape	Golf Course	Land Use Type		
Post Development (Pre-treatment)							
Direct Calculation EPA ^b	22.01	39.40	NA	NA		93.94	155.35

Below is the equation used to determine the post development pretreatment TP concentration.

Impervious concentration $(0.00026 \text{ kg/m}^3)(32.76 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = 39.40 \text{ kg/yr}$
 Golf course and landscape concentration $(0.449 \text{ kg/ac/yr})(209.24 \text{ acres}) = 93.94 \text{ kg/yr}$
 Forest concentration $(0.00001 \text{ kg/m}^3)(476 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9) = \underline{22.01 \text{ kg/yr}}$
Total Loading 155.35 kg/yr

^b Pavement = 0.26 mg/l, Golf Course and Landscape combined runoff = 0.449 kg/ac and Forest runoff = 0.010 mg/l

**TP CALCULATIONS
POST DEVELOPMENT PRE TREATMENT**

Calculation Method	Total Phosphorus Load (kg/year)					Total
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	
Post Development (Pre-treatment)						
Modified Simple Method* ^c <small>*NYC DEP 1997</small>	44.14	28.94		44.9	NA	117.98

The equation below represents post development pretreatment TP loadings based on 99 lbs/yr loading for a 100 acres golf course.

$$\begin{aligned}
 &(\text{Simple Method Pretreatment Value}) + (99 \text{ lbs/year TP for 100 acre golf course}) + (\text{Remainder of site as Forested}) = \text{Post-Development Pre-Treatment} \\
 &(28.94 \text{ kg/yr}) + (44.90 \text{ kg/yr}) + (44.14 \text{ kg/yr}) = \mathbf{117.98 \text{ kg/yr}}
 \end{aligned}$$

^c Golf course runoff at 0.99 lbs/acre and forest runoff for rest of each site at 0.02005 mg/l added to developed site

**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

WILDACRES

Calculation Method	Land Use Type					Total Phosphorus Load (kg/year)		Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	Total			
Post Development (Post-treatment)									
WinSLAMM DEIS	NA	NA	NA	NA	NA	146	78	224	

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See Appendix 10A of the DEIS.

**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

WILDACRES

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
Direct Calculation/Giggle Hollow ^a	31.39	25.74	NA	NA	56.37	113.50	78	191.50

Treatment results in 40% removal of TP.

Below is the equation used to determine the post development post-treatment TP concentration.

Impervious concentration $[(0.00026 \text{ kg/m}^3)(32.76 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.98)][1-0.40] = 25.74 \text{ kg/yr}$

Golf course and landscape concentration $[(0.449 \text{ kg/ac/yr})(209.24 \text{ acres})][1-0.40] = 56.37 \text{ kg/yr}$

Forest concentration $(0.0002005 \text{ kg/m}^3)(476 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.64) = 31.39 \text{ kg/yr}$

Total Post Development Post Treatment Loading 113.50 kg/yr

^a Forest runoff = 0.02005 mg/l based on NYC DEP 2002 data report and Appendix 18 of the DEIS water quality data.

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**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

WILDACRES

Calculation Method	Land Use Type					Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading			
Post Development (Post-treatment)								
Direct Calculation EPA ^b	22.01	19.65	NA	NA	46.97	88.63	78	166.63

Treatment results in 50% removal of TP.

Below is the equation used to determine the post development post treatment TP concentration.

$$\begin{aligned} \text{Impervious concentration} &= \frac{[(0.00026 \text{ kg/m}^3)(32.76 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9)]}{2} = 19.65 \text{ kg/yr} \\ \text{Golf course and landscape concentration} &= \frac{[(0.449 \text{ kg/ac/yr})(209.24 \text{ acres})]}{2} = 46.97 \text{ kg/yr} \\ \text{Forest concentration} &= \frac{(0.00001 \text{ kg/m}^3)(476 \text{ acres} * 4047 \text{ m}^2)(1.27 \text{ m} * 0.9)}{2} = 22.01 \text{ kg/yr} \\ \text{Total Post Development Post Treatment Loading} &= \mathbf{88.63 \text{ kg/yr}} \end{aligned}$$

^b Pavement = 0.26 mg/l, Golf Course and Landscape combined runoff = 0.449 kg/ac and Forest runoff = 0.010 mg/l

**TP CALCULATIONS
POST DEVELOPMENT POST TREATMENT**

WILDACRES

Calculation Method	Land Use Type					Total Phosphorus Load (kg/year)		
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	Total	Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
Post Development (Post-treatment)								
Modified Simple Method* ^c <small>*NYC DEP 1997</small>	44.14	14.51		22.45	NA	81.10	78	159.10

(Simple Method Post-treatment Value) + [(Post-Development Post-treatment 99 lbs/year TP for 100 acre golf course)] + (Remainder of site as Forested) = Post-Treatment
 (14.51 kg/yr) + (22.45 kg/yr) + (44.14 kg/yr) = **81.10 kg/yr**

^c Golf course runoff at 0.99 lbs/acre and forest runoff for rest of each site at 0.02005 mg/l added to developed site

TP LOADING CALCULATION COMPARISONS

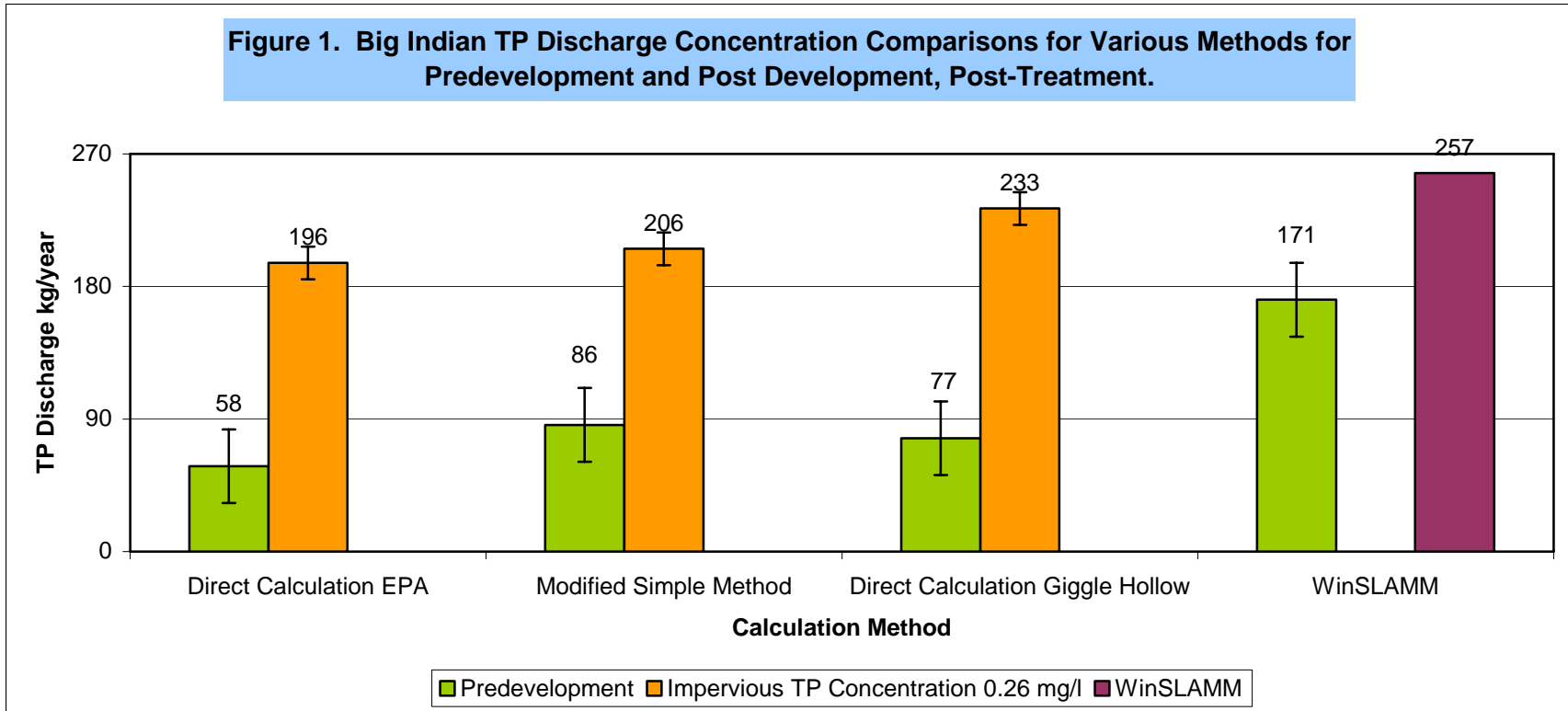
Tables 2 and 3 show a comparison of the selected methods (WinSLAMM, Direct Calculation EPA, Direct Calculation NYC DEP and Modified Simple Method) using impervious concentrations of 0.26 mg/l and 0.15 mg/l. For each method there is a relatively small variation in results between the two impervious concentrations as shown in **Figures 1 and 2**. **Figures 1 and 2** show the variation in the annual loading as calculated by the various selected methods based on the results in **Tables 2 and 3**. These figures are for total point and non-point source loading. The first observation based on the data is that values derived from the direct calculation, the NYC DEP 1997 Modified Simple Method, and the NYC DEP 2000 result in similar loadings. Use of the Simple Method results in the lowest loading estimate due to the small amount of impervious surfaces associated with the project. The originators of the Simple Method recommend that values for subcatchments with less than 5% impervious be considered cautiously. The highest value results from the WinSLAMM computer model.

TP LOADING CALCULATION COMPARISONS

Table 2. BIG INDIAN

See corresponding Figure 1.

Calculation Method	Land Use Type					Total		
	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading		Wastewater Treatment Facility Effluent	Total Post-treatment Discharges
Total Phosphorus Load (kg/year)								
Post Development Pre-treatment								
Using an impervious concentration of 0.15 mg/l								
Direct Calculation/Giggle Hollow	56	40	NA	NA	125	221		
Direct Calculation EPA	42	36	NA	NA	125	203		
Modified Simple Method	85		44	45	NA	174		
Using an impervious concentration of 0.26 mg/l								
Direct Calculation/Giggle Hollow	56	69	NA	NA	125	250		
Direct Calculation EPA	42	63	NA	NA	125	230		
Modified Simple Method	85		77	45	NA	207		
Post Development Post-treatment								
Using an impervious concentration of 0.15 mg/l								
Direct Calculation/Giggle Hollow	56	24	NA	NA	75	155	60	215
Direct Calculation EPA	42	18	NA	NA	63	123	60	183
Modified Simple Method	85		22	22	NA	129	60	189
Using an impervious concentration of 0.26 mg/l								
Direct Calculation/Giggle Hollow	56	41	NA	NA	75	173	60	233
Direct Calculation EPA	42	31	NA	NA	63	136	60	196
Modified Simple Method	85		39	22	NA	146	60	206



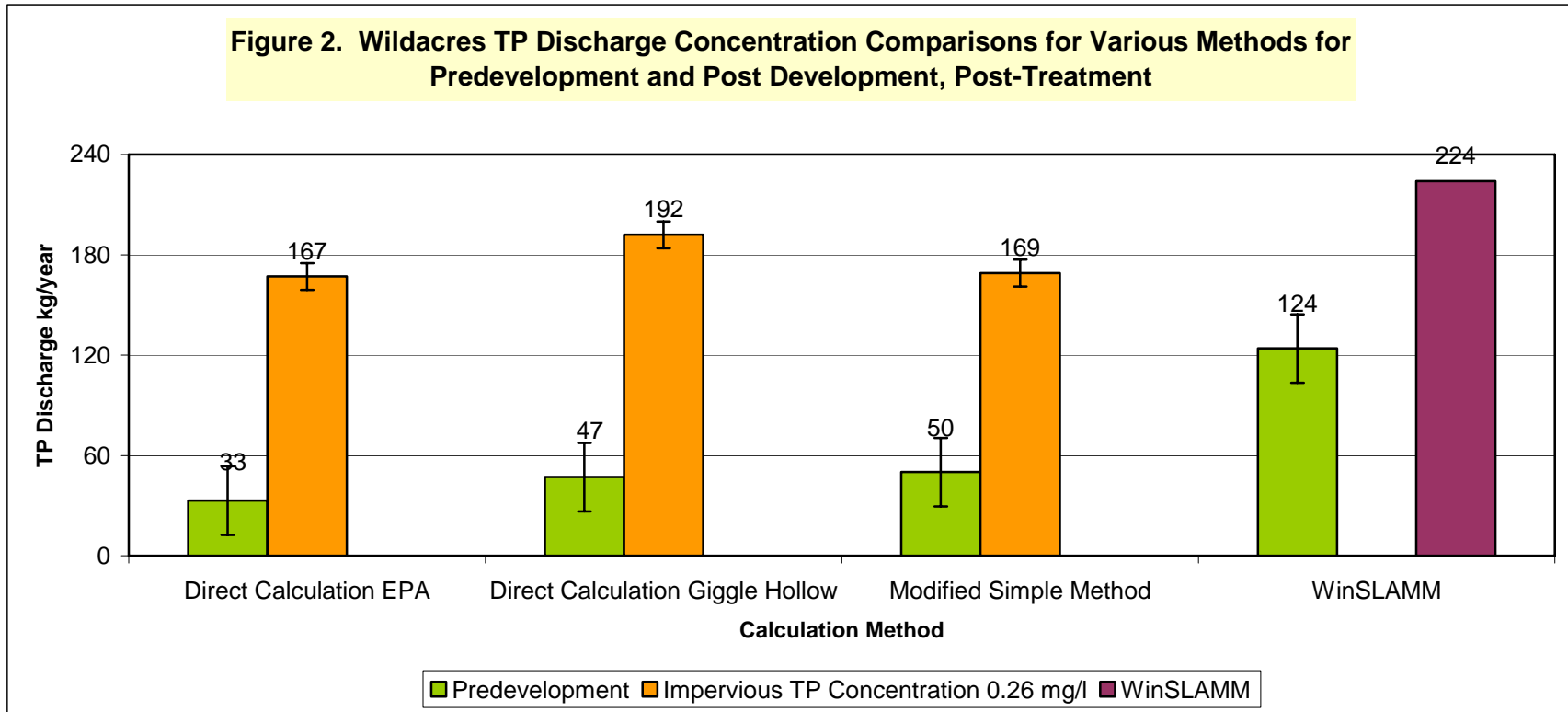
TP LOADING CALCULATION COMPARISONS

Table 3. WILDACRES

See corresponding Figure 2.

Total Phosphorus Load (kg/year)
Land Use Type

Calculation Method	Forest	Impervious	Landscape	Golf Course	Composite golf course and landscape loading	Total		
Post Development Pre-treatment								
Using an impervious concentration of 0.15 mg/l								
Direct Calculation/Giggle Hollow	31	25	NA	NA	94	150		
Direct Calculation EPA	22	23	NA	NA	94	139		
Modified Simple Method	44		29	45	NA	118		
Using an impervious concentration of 0.26 mg/l								
Direct Calculation/Giggle Hollow	31	43	NA	NA	94	168		
Direct Calculation EPA	22	39	NA	NA	94	155		
Modified Simple Method	44		50	45	NA	139		
Post Development Post-treatment								
Using an impervious concentration of 0.15 mg/l								
Direct Calculation/Giggle Hollow	31	15	NA	NA	56	102	78	180
Direct Calculation EPA	22	11	NA	NA	47	80	78	158
Modified Simple Method	44		15	22	NA	81	78	159
Using an impervious concentration of 0.26 mg/l								
Direct Calculation/Giggle Hollow	31	26	NA	NA	56	114	78	192
Direct Calculation EPA	22	20	NA	NA	47	89	78	167
Modified Simple Method	44		25	22	NA	91	78	169



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