Chapter 3
Meeting the Project's Phosphorus Budget

A site's phosphorus export must be calculated and compared to the Project Phosphorus Budget (PPB) to determine the extent of phosphorus reductions needed and the best method for achieving these reductions.

3.1 Estimating Stormwater Phosphorus Export from the Project

To determine if a project meets or exceeds its PPB, the project's phosphorus export (PPE) needs to be estimated. This section outlines the procedure for estimating the pre-treatment PPE (Pre-PPE), that is, the phosphorus export from the project before passing through a stormwater management practice designed to remove phosphorus (i.e. buffers, wet ponds). Estimating post treatment phosphorus export will be discussed in the next section.

PPE = Project Phosphorus Export = amount of phosphorus that will reach the lake from a new development.

Pre-treatment PPE = Raw Phosphorus that the new development will create.

Post-treatment PPE = Phosphorus that will be discharged after treatment by all stormwater management treatment practices.

The amount of phosphorus exported from a project site will depend on the land use and soil type, with greatest exports from impervious surfaces as the one shown here.

Chapter Contents:

For all project development and subdivisions projects where the land use and impact has been determined and lot development will be restricted, the pre-treatment export is estimated by:

1. dividing the project into various land use types (i.e. parking, roads, roofs, lawns by soil type),
2. determining the area within each land use in acres and to the second decimal place,
3. multiplying that area by the appropriate phosphorus export factor from Table 3.1 or Table 3.2 as is appropriate, and
4. summing the resulting phosphorus exports to get the Pre-PPE.

Use the first four columns in Worksheet 2 in Appendix D to calculate the Pre-PPE.

Table 3.1 gives pre-treatment phosphorus export for new commercial/industrial development and for roads in residential subdivision projects. Table 3.2 should be used for lots in residential subdivisions unless the dimensions and locations of buildings, driveways and lawns have been pre-determined, specifically restricted, and all construction and landscaping on the lot will be done by the developer, in which case the High Export Option from Table 3.1 may be used.

Table 3.1
Algal Available Phosphorus Export (pre-treatment) for Commercial Development and Subdivisions

		Low Export Option	High Export Option
Land Use	Hydrologic Soil Group	P Fertilizers restricted, roads and drives paved and constructed with stable swales (lb/acre/yr)	No restrictions on fertilizer use, road surface or ditch design and construction (lb/acre/yr)
Landscaped Areas, Lawns & Ditches	A	0.1	0.2
	B	0.2	0.4
	C	0.3	0.6
	D	0.4	0.8
Roads/Driveways	N/A	1.25	1.75
Parking	N/A	1.25	1.25
Roofs/Other	N/A	0.5	0.5

The Low Export Option factors may be selected for commercial/industrial development and roads if all of the following are incorporated in the project:

- A deed restriction prohibiting the use of fertilizers containing phosphorus except when establishing new turf or vegetation on bare soil will be established for all lots. It is recommended that the use of fertilizer containing phosphorus always be limited.
- All roads, driveways and parking areas are paved.

- All ditches and drainage ways are designed, constructed and maintained as stable vegetated swales in accordance with the specifications in Volume III, Chapter 8.1, or as riprapped swales where required by steep slopes. The algal available phosphorus export for ditches and swales is based on soil type and is the same as the export of a lawn

If all of these elements are not clearly and permanently incorporated in the project design, use the High Export Option factors of Table 3.1.

Example 2: Pre-treatment PPE Calculation for Commercial Development

Problem:
'Good Intention Business Mall' is proposing a business mall on 6 acres. The development will consist of 3.5 acres of paved parking, a 0.5 acre paved access road, 1.5 acres of buildings and 0.5 acre of lawn. A deed restriction is proposed, prohibiting the use of fertilizers containing phosphorus. Soils on the site are classified as Hydrologic Soil Group C. Calculate the Pre-treatment PPE for the proposed project.

Solution:

Use Table 3.1 and Worksheet 2 to calculate the pre-treatment Algal Average Phosphorus Export.

Worksheet 2
Pre-PPE Calculations

Project Name: Good Intention Business Mall	Development Type:Commercial		
Land Surface Type of Lot #(s) with description	**Acres or # of lots**	**Export Coefficient from Table 3.1**	**Pre-treatment Algal Av. P Export (lbs P/year)**
Parking (pavement)	3.50	1.25	4.375
Access Road (low export)	0.50	1.25	0.625
Buildings	1.50	0.5	0.75
Lawn (HSG C)	0.50	0.3	0.15
		Pre-PPE (lbs P/year)	5.9

Based on these calculations, the Pre-treatment PPE is 5.9 lbs P/year.

Table 3.2 gives pre-treatment phosphorus export for single family residential lots. In most cases, the specific area of the development on a lot (houses, garages, driveways, lawns) within the subdivision is usually not known. Table 3.2 must be used to determine the export from each lot unless the developer:

- Has pre-determined the area of each land use on each lot
- Will be constructing the buildings and driveways and landscaping the lots, and
- Will be restricting any further expansion of these land uses
- A deed restriction will be required for each lot that incorporates an area restriction.

Table 3.2
Algal Available Phosphorus Export from Single Family Residential Lots (pre-treatment)

Hydrologic Soil Group	With Area Restrictions		Without Area Restrictions	
	Cleared Area ≤ 12,000 sq ft Driveway/Park ≤ 1,750 sq ft (lb/lot/year)		No Restriction on cleared area or driveway/parking area (lb/lot/year)	
	w/ 75% drive/park area to buffer	w/o 75% drive/park area to buffer	w/ 75% drive/park area to buffer	w/o 75% drive/park area to buffer
A	0.09	0.14	0.12	0.18
B	0.12	0.17	0.17	0.24
C	0.15	0.2	0.22	0.29
D	1.08	0.23	0.27	0.34

Note: Driveways and parking are considered to be draining directly to a buffer if the flow path to the buffer is 50 feet or less and if the runoff reaches the buffer in well distributed overland flow.

Note: The phosphorus export values in this table assume a driveway of 150 feet in length, or less. If driveways will likely exceed 150 feet, the excess driveway length should be considered a road and its export calculated using Worksheet 2 and Table 3.1.

Example 3: Pre-PPE Calculation for Subdivision Development

Problem:
The 'Homesweet Home Subdivision' in Example 1 involves the development of 12 lots and 0.5 acres of road. Four lots will be constructed on HSG B soils with no restrictions on cleared area or driveway/parking area. Eight of the lots will be constructed on HSG C soils and will have restrictions to minimize site clearing to <12,000 square feet each and to minimize driveway/parking areas to <1,750 square feet. Six of the restricted lots will not direct 75% of the driveway and parking area runoff to a buffer. Two of the restricted lots will direct the stormwater runoff from 75% or more of the driveways and parking areas to a buffer. Driveways from two of the lots will exceed 150 feet in length, with an anticipated 0.056 acres of driveway over the 150 length. The proposed road will be paved. Calculate the Pre-treatment PPE for the proposed subdivision.

Solution:
Use Tables 3.1 and 3.2 and Worksheet 2 to calculate the pre-treatment Algal Average Phosphorus Export.

Worksheet 2
Pre-PPE Calculations

Project Name: Homesweet Home Subdivision	Development Type:Residential		
Land Surface Type of Lot #(s) with description	**Acres or # of lots**	**Export Coefficient from Table 3.1**	**Pre-treatment Algal Av. P Export (lbs P/year)**
Lots 1-4 (HSG B) no restriction, w/o 75% to buffer	4	0.24	0.96
Lots 5-10 (HSG C) <12,000 sqft clearing, w/o 75% to buffer	6	0.20	1.2
Lots 11 & 12 (HSG C) <12,000 sqft clearing, w/ 75% to buffer	2	0.15	0.30
Lots 2 & 3 driveway access > 150 feet	0.056	1.25	0.07
Subdivision Road (low export)	0.5	1.25	0.625
		Pre-PPE (lbs P/year)	3.155

Since two of the driveways exceeded 150 feet in length, the excess driveway length was considered a road and its export calculated as such.

Based on these calculations, the Pre-treatment PPE is 3.155 lbs P/year.

3.2 Redevelopment or Expansion of Existing Uses

Phosphorus export need not be estimated for any land uses that were in existence prior to 1997 (prior to 1980 for projects that require a Site Location of Development Act (SLODA) Permit from the DEP). For any proposed project that will be built within a parcel having existing development (built before 1997 or 1980 for SLODA projects) that will be enlarged, upgraded or expanded, the phosphorus export should only be estimated for the net increase. This would apply to the redevelopment or expansion of any existing buildings, parking, roads and lawns. Any existing development or land disturbance that was created after 1997 (1980 for SLODA Projects) must be included as a new phosphorus export. This includes logging roads, new access roads, and all other projects created from an undisturbed condition that did not require a phosphorus design and permit at the time of construction.

For example, if a proposed subdivision is served by an existing 2000 foot gravel road, which was built before 1997, and will be upgraded and expanded from a width of 14 feet to a width, with shoulders, of 24 feet, the phosphorus export should only be estimated for the net increase in road area, or 10 feet x 2000 feet = 20,000 square feet.

3.3 Reduction of Phosphorus Export

Most projects will generate more phosphorus than the project's phosphorus budget (PPB) will allow. In order to meet the budget, the excess phosphorus export must be reduced. Comparison of the pre-treatment PPE with the PPB will determine how much export will need to be reduced. This section describes options for reducing phosphorus export and how to estimate phosphorus export after treatment.

There are two basic options for reducing long term phosphorus export.

Option 1. Redesign to Reduce Phosphorus Export: The first option is to redesign the project so that initial phosphorus export is minimized. This can be accomplished by:

- Limiting the size or intensity of the project (i.e. reducing the number of lots, the length of roads, the size of a parking area),
- Locating the developed portion of the project on the best soils and shallowest slopes, and
- Incorporating such measures as clearing restrictions and limitations on the use of phosphorus fertilizers.

These reductions in phosphorus export will be reflected in the calculation of pre-treatment PPE described in the previous section.

Option 2. Implement Best Management Practices (BMPs): The second option for reducing a project's stormwater phosphorus export is to incorporate stormwater best management practices (BMPs) to remove phosphorus from the stormwater before it leaves the site. Some examples of BMPs are vegetated buffer areas, wet ponds, soil filters and infiltration beds. Volume III presents detailed design standards for a number of commonly used BMPs.

All BMPs are not created equal. Some BMPs do a better job of removing phosphorus from stormwater than others. Also, within a given type of BMP, differing designs or locations may result in different levels of effectiveness in removing phosphorus. For example, a broad, wooded buffer on permeable soils with a shallow

slope will retain much more phosphorus than a narrow, field buffer on tight soils and steeper slopes. For stormwater treatment ponds, such as wetponds, the size of the pond relative to its contributing watershed, its depth and its shape determine its effectiveness.

In this Volume, a BMP's effectiveness in treating stormwater runoff is described in terms of a "treatment factor". The Treatment Factor (TF) indicates the fraction of stormwater phosphorus that will pass through the BMP and not be retained. A simple way of estimating treatment factors for a variety of BMPs based on an adjustment of the standard sizing specifications for BMPs described in Volume III of this manual is presented in Chapter 4 of this volume.

RE = Removal efficiency = The fraction of stormwater phosphorus that will be removed by the BMP. The higher the removal efficiency, the more effective it will be at retaining phosphorus from reaching the resource.

TF= Treatment factor = (1.0 - RE) = The fraction of the stormwater phosphorus that will pass through a BMP and not be retained. The lower the treatment factor, the more effective the BMP.

When phosphorus from a project draining to a BMP is multiplied by that BMP's Treatment factor (1.0 - RE), the resulting product is the amount of phosphorus that, after treatment, will still be exported to the lake.

For example, if a wooded buffer was projected to retain 60% and discharges 40% of the inflow phosphorus, it would have a removal efficiency of 0.6 and a treatment factor of 0.4.

When planning the project, the project designer should look for opportunities to locate the most effective BMPs (those with the highest removal efficiency) to collect runoff from the portions of the project which produce the most phosphorus export (i.e. roads, parking areas, driveways, house lots). If the project site is large enough, the preferred BMP is a natural wooded buffer area located immediately down hill of the stormwater source area. Buffers are preferred because they are natural and they require little, if any, maintenance (just don't cut the trees or disturb the ground cover). The critical element in siting buffers is to insure that the stormwater runoff enters the buffer in overland, non-channelized flow, that will not concentrate into a channelized flow within the buffer. By comparison, other BMPs require site specific design and careful construction as well as regular inspection and maintenance.

3.4 Estimating Project Phosphorus Export after Treatment (Post-PPE)

In order to determine if the BMPs incorporated into the project are adequate to meet the PPB (Project Phosphorus Budget), the pre-treatment PPE must be revised to reflect the treatment capabilities of those BMPs. This is accomplished by multiplying the phosphorus export from each source area (i.e. a parking lot, a house lot, a segment of road) by the treatment factor (1.0 - RE) of the BMP to which it drains. See Section 4.1 BMP Rules of Thumb, if the individual source areas (or subcatchments) drain cumulatively to more than one BMP. The export values for all source areas, both treated and untreated, are then added together to get the total phosphorus export for the project using Worksheet 2.

For large projects or projects where the natural topography divides the site drainage into a number of sub-drainage areas, this process may not be as straight forward. For instance, often the entire length of a road will not drain to the same BMP. The local topography will result in one segment of road being treated by one BMP, other segments by other BMPs, and still other segments receiving no treatment at all. In the case of a crowned road, the uphill side of the road might drain to a road ditch that flows to a wet pond, while sheet runoff from the downhill side of the road may drain to a wooded buffer, which for part of the road length is 75 feet wide, meadow and on shallow slopes and for the remaining length is only 50 feet wide, wooded on steep slopes. Since all three BMPs, the wet pond and the two buffers, have different treatment factors, it is necessary to break the road surface area into three discreet subcatchments based on the BMP(s) to which each road segment drains to calculate treated phosphorus export from the road. This is true not only for roads but for all other types of development as well.

Summarize the project's phosphorus export and treatment as follows:

1. Indicate, on a topographic site plan of the project, all the BMPs that will be incorporated into the project.
2. Delineate all subcatchments for which each BMP is providing treatment.
3. Identify all portions of the developed area (i.e. buildings, road segments, parking lots or portions there of, lawns, house lots) which are being treated by a given BMP or combination of BMPs on Worksheet 2.
4. List each subcatchment and export area, along with the appropriate pre-treatment phosphorus export factor from Table 3.1 or Table 3.2 and the appropriate treatment factor(s) for the BMP(s) to which the area drains on the worksheet. If there is no BMP treating runoff from a catchment enter 1.0 in the treatment factor column.
5. BMP removal efficiencies and treatment factors can be calculated from Chapter 4 of this volume and Volume III. Enter these values on the worksheet.
6. Multiply each export area by its associated export factor and treatment factor to obtain the released phosphorus export value from each area and BMP. For areas receiving no treatment, multiply by 1.0.
7. See Section 4.1., BMP Rules of Thumb, if the source area drains to more than one BMP.
8. Sum the export from all treated and untreated areas to obtain the total post treatment phosphorus export (Post-PPE) from the project.

Example 4: Post-PPE Calculation for Subdivision Development

Problem:
The 'Homesweet Home Subdivision' project described in Example 1 and 3 is proposing to treat a portion of the stormwater runoff from the subdivision through the use of buffers. Lots 1-4 will not receive any treatment. Lots 5 through 12, the excess driveway lengths from Lots 2 and 3, and the access road is superelevated and will be directed to a downgradient buffer sized in accordance with Chapter 5 of Volume III of this manual. Calculate the Post-treatment PPE for the proposed subdivision.

Solution:
The Pre-treatment PPE was calculated in Example 3. A forested buffer treating stormwater runoff that meets the standard sizing as provided in Chapter 5 of Volume III will achieve a Removal Efficiency of 0.6. Thus, the corresponding Treatment Factor is 0.4, which should be entered into Worksheet 2 as shown below. Note that 1.0 has been entered into the treatment factor column for lots 1 through 4 for which no BMPS are providing stormwater treatment.

Worksheet 2
Pre-PPE and Post-PPE Calculations

Project Name: Homesweet Home Subdivision			Development Type:Residential			Sheet #___
Land Surface Type of Lot #(s) with description	**Acres or # of lots**	**Export Coefficient from Table 3.1 Table 3.2**	**Pre-treatment Algal Av. P Export (lbs P/year)**	**Treatment Factor for BMP(s) from Chapter 6**	**Post-treatment Algal Av. P Export (lbs P/year)**	**Description of BMPs**
Lots 1-4 (HSG B) no restriction, w/o 75% to buffer	4.00	0.24	0.96	1.0	0.96	No treatment provided
Lots 5-10 (HSG C) <12,000 sqft clearing, w/o 75% to buffer	6.00	0.20	1.2	0.4	0.48	75 ft forest buffer
Lots 11 & 12 (HSG C) <12,000 sqft clearing, w/ 75% to buffer	2.00	0.15	0.30	0.4	0.012	75 ft forest buffer
Lots 2 & 3 driveway access > 150 feet	0.056	1.25	0.07	0.4	0.028	
Access Road (low export)	0.50	1.25	0.625	0.4	0.25	55 ft roadside forest buffer
		Pre-PPE (lbs P/year)	3.155	Post-PPE (lbs P/year)	1.838	

Based on these calculations, the Post-treatment PPE is 1.838 lbs P/year.

3.5 Evaluating Project Overall Phosphorus Export

For an acceptable site development, the Post-PPE needs to be smaller than the PPB for the parcel. The calculations can be summarized in Worksheet 4. If the resulting project phosphorus export (Post-PPE) is less than or equal to the project phosphorus budget (PPB) from Worksheet 1 than the project meets its budget. If not, further reductions in stormwater phosphorus are required. Credits for mitigation of existing sources may be another option for reducing the net project phosphorus export (Post-PPE) or paying a compensation fee may be an option (See Chapter 5, Credits for Mitigation and Compensation Fee for guidance).

Using Worksheet 4, summarize the Net Project Phosphorus Export as follows:

1. Bring in the Project Phosphorus Budget (PPB) from Worksheet 1
2. Bring in any Mitigation Credits from Worksheet 3
3. Bring in the total Pre-Treatment Phosphorus Export (Pre-PPE) as calculated on Worksheet 2
4. Bring in the total Post-Treatment Phosphorus Export (Post-PPE) as calculated on Worksheet 2
5. If the Post PPE is less than or equal to the site's PPB, the project meets its phosphorus budget.
6. If the Post-PPE is larger than the site's PPB but the Post-PPE is less than or equal to 0.4 times the Pre-PPE, then paying a compensation fee may be an option in certain lake watersheds. That list is available in Appendix F.
7. If the Post-PPE is larger than the site's PPB and the Post-PPE is more than 0.4 times the Pre-PPE, then more phosphorus treatment needs to be provided or less development must occur.

Example 5: Project Phosphorus Export Summary for Subdivision Development

Problem:

Summarize the Project Phosphorus Export for the 'Homesweet Home Subdivision' project described in Example 1, 3 and 4. Determine whether the project as proposed meets its phosphorus budget.

Solution:

Use Worksheet 4 to summarize the Project Phosphorus Export as shown below.

Worksheet 4
Project Phosphorus Export Summary

Summarizing the project's algal available phosphorus export (PPE)			
Project name: Homesweet Home Subdivision			
Project Phosphorus Budget	PPB	1.995	lbs P/year
Mitigation Credit - Source Elimination Credit	SEC	0.00	lbs P/year
Source Treatment Credit	STC	0.00	lbs P/year
Total Phosphorus Mitigation Credit (SWC+STC)	TMC	0.00	lbs P/year
Total Pre-treatment Phosphorus Export Worksheet 2	Pre-PPE	3.155	lbs P/year
Total Post-treatment Phosphorus Export Worksheet 2	Post-PPE	1.838	lbs P/year
Project Phosphorus Export (Post-PPE - TMC)	PPE	1.838	lbs P/year

Since the calculated PPE of 1.838 lbs P/year is less than the PPB of 1.995 lbs P/year, the project meets its phosphorus budget and no further treatment or reduction actions are necessary.