Alexandria Supplement To Northern Virginia BMP Handbook

August 1, 1993

CHAPTER 1

CALCULATIONS PROCEDURES

City of Alexandria, Virginia
Department of
Transportation and Environmental Services
P.O. Box 178 - City Hall
Alexandria, Virginia 22313

ALL-AMERICA CITY
1984-85
1964

ALEXANDRIA SUPPLEMENT TO THE NORTHERN VIRGINIA BMP HANDBOOK

EDITOR'S NOTE ON REVISION 1

The primary reason for issuing Revision 1 to the Alexandria Supplement to the Northern Virginia BMP Handbook was to align the provisions of the Supplement with changes to the Alexandria City Code. Enactment of the Alexandria Zoning Ordinance in June of 1992 made significant changes to the development process in the City and recodified the Alexandria Chesapeake Bay Preservation Ordinance as Article XIII of the Alexandria Zoning Code. The Alexandria Erosion and Sediment Control Ordinance was also updated in June 1992.

City staff took this opportunity to make several additional changes to the manual to update the technical portions to the current "state of the art" and to make the Transportation and Environmental Services development review processes more "user friendly."

Changes are provided in the form of new substitute pages which are to replace the original pages with the same numbers. The changes made in the Supplement are summarized as follows:

Chapter 1 -- Calculations Procedures

Pages 1-1 through 1-10 were completely rewritten to reflect changes in the development process occasioned by the Alexandria Zoning Ordinance. The process for determining whether the pollutant removal requirements of the Virginia Chesapeake Bay Preservation Act or the Virginia Stormwater Management Act govern a particular site were also clarified.

Chapter 2 -- Unconventional BMP Facility Design Criteria

Portions dealing with Water Quality Inlets (Oil/Grit Separators) were deleted since this information is now contained in the basic Northern Virginia BMP Handbook. A new section on the theory and concept of "ultra-urban" BMPs was substituted in pages 2-1 through 2-12. A unified theoretical approach to designing sand filter BMPs was substituted for the previous methods obtained from originating jurisdictions (original methods were preserved in Appendix 2-1). Alexandria experience to date with sand filter BMPs was factored into the new procedure. Standard calculations sheets for each BMP were designed and are provided in Appendix 2-4. These sheets can be filled out and "sticky backed" directly onto the project Stormwater Management Plan, cutting down the amount of textual input required by developer's engineers. Construction and Maintenance requirements were also separated into Appendix 2-3 and formatted so that they may also be reproduced directly on Stormwater Management Plans.

The following BMPs have been added to the Supplement:

	BMP	Developed by:
o	Thin-Filter D.C. Underground Vault System	D.C.
o	Metal-Shell D.C. Underground Vault System	Alexandria
o	"Switch-Back" Sand Filter System	Alexandria
o	D.C. Manhole Filter System	D.C.
o	Roof Downspout System	Washington State
o	Vegetated Swale Criteria	Washington State

Standard procedures for outfitting BMPs for monitoring are provided as Appendix 2-8.

Chapter 3 -- Maintenance and Monitoring Agreements

The text was updated to agree with the Alexandria Zoning Ordinance. The procedure for preparing the agreement was modified. City staff will now prepare the agreement and forward it to the developer with the project bonding package. This is another "user friendly" modification to procedures.

Chapter 4 -- Submission Requirements

This entire chapter was rewritten to align it with the revised development processes contained in the Alexandria Zoning Ordinance. New Appendices 4-1 and 4-4 are the relevant portions of the Zoning Code. New Appendix 4-2 is the revised Site Plan Process and Checklist. New Appendix 4-5 provides the City's Floodplain Regulations. New Appendix 4-6 is the current Erosion and Sediment Control Ordinance.

Reproduction of all conditions of approval for a development project (both Site Plan and Special Use Permit) from the various City agencies (City Council, Planning Commission, Board of Architectural Review, Board of Zoning Appeals, etc.) on the initial sheets of the Site Plan is now required. This action makes the conditions conveniently available to all parties reviewing the project and preserves the conditions on the Site Plan sheets for future reference.

The following modifications to the Department of Transportation and Environmental Services have been made to facilitate processing of development proposals:

- T&ES has decreased the amount of detailed engineering data which is required for submission with a preliminary site plan application. Submission of the detailed stormwater management plan required by the Chesapeake Bay Preservation Act and the Stormwater Management Act have been delayed until after Planning Commission approval of the preliminary site plan. This precludes the developer from bearing these engineering costs for projects which do not achieve approval or from rework costs occasioned by major modifications imposed by the Planning Commission or City Council.

- T&ES now allows submission of the erosion and sediment control plan after approval of a project by the Planning Commission rather than with the Preliminary Site Plan. This action will allow developers to avoid the costs of preparation of this plan for projects which fail to achieve Planning Commission approval. They may also avoid rework costs for modifications brought about by additional conditions imposed by the Planning Commission.

Warren Bell, P.E.
City Engineer
Editor

City of Alexandria, Virginia

MEMORANDUM

MEMORANDUM TO INDUSTRY NO. 99-01

DATE: JULY 30, 1999

TO: DISTRIBUTION

FROM: WARREN BELL, P.E., DEPUTY DIRECTOR/ENGINEERING
TRANSPORTATION AND ENVIRONMENTAL SERVICES Warren Bell

SUBJECT: BMP EFFICIENCIES AND DESIGN STANDARDS AND SITE GRADING

BMP Efficiencies: The City's currently recognized efficiencies for the various stormwater BMPs are shown on the attached copy of the requisite page from the *Alexandria Supplement to the Northern Virginia BMP Handbook.* The efficiencies shown on this sheet should be used on all Site Plan submissions to the City.

Hydrodynamic BMP Design Flows: City staff has discovered that utilizing the manufacturer's recommended design procedures for some hydrodynamic BMPs will result in a structure that bypasses part of the first flush (defined in Virginia's Stormwater Management Regulations as the *first* ½ inch of runoff from the impervious areas on a site). This results in relatively polluted water being bypassed and relatively clean water from later in the storm being treated. Such a situation does not comply with Article XIII of the Alexandria Zoning Ordinance, which also requires that at least the *first* ½ inch of runoff must be treated for all sites which involve more that ½ acre of land disturbance. Accordingly, the City has revised its procedures for approving hydrodynamic BMPs. Henceforth, all hydrodynamic or other flow-through BMPs (*Bay Saver, CDS Technologies, Downstream Defender, Stormceptor, Vortex, V²B1, Stormfilter*) submitted for use on development projects within the City must be capable of processing the peak flow rate for the local three-month storm through the treatment portion of the device. The required peak flow rate may be computed using the Rational Method. Use a rainfall intensity of 1.75 inches/hour for a 5-minute time-of-concentration and a rainfall intensity of 1.45 inches/hour for a 10-minute time-of-concentration.

Virginia Stormwater Management Manual: The Department of Conservation and Recreation, Division of Soil and Water Conservation, has recently published a new *Stormwater Management Manual.* This manual contains the latest and most up-to-date criteria available for use in the design of sand filter and bioretention BMPs. Henceforth, all Bioretention BMPs proposed for use within Alexandria shall be designed according to the Virginia Stormwater Manual criteria. Consult with City staff about the latest modifications that may be advisable before proceeding to detailed engineering (bioretention is still a "work in progress). Use of the State's sand filter criteria is optional but highly recommended.

<u>Changes to Approved Grading Shown on Final Site Plans</u>: Developers and Engineers are reminded that the only way to obtain approval for other than very minor adjustments to the site grading shown on an approved Final Site Plan is to submit and gain approval of a formal revision to the Site Plan. Two recent incidents highlighted practices that are not approved methods in Alexandria. In one case, a builder who had purchased construction rights from the developer who had obtained City approval of a Special Use Permit attached unsigned grading drawings to a building permit plan. The builder later tried to assert that release of the building permit constituted City approval of the grading changes. The City rejected this assertion. All engineering firms dealing with the City should be aware that no one beneath the position of the Deputy Director/Engineering (City Engineer) has the authority to make changes to grading or public and private infrastructure on approved Final Site Plans. All parties should be aware that the City will also not entertain proposals for Site Plan changes from individual purchasing builders. All proposed Final Site Plan Revisions must be submitted by the developer who holds the Site Plan or SUP approval from the City and the revision must be submitted by the engineering firm that did the approved Final Site plan. Proposed revisions not meeting these conditions will be rejected out of hand. In the case in question, the developer was required to submit a formal request for a revision, which is pending. In the interim, T&ES has suspended all Certificate of Occupancy approvals on the project until the matter is resolved.

All engineering firms and developers should also be aware that the City requires that all proposed revisions be "red-lined" on the copies of the proposed revision submitted for review. City staff only reviews the "red-lined" revisions. Should other changes not "red-lined" be contained on revision drawings, the City reserves the right to require a return to the originally approved Final Site Plan conditions for such unmarked changes even if they are discovered after formal approval of the "red-lined" changes.

cc: Thomas F. O'Kane, Jr., Director, T&ES
M.M. Halim, Division Chief/Engineering & Design, T&ES
Geoff Byrd, Site Plan Coordinator, T&ES
Larry Gavan, Watershed Program Administrator, T&ES
Lalit Sharma, Site Plan Engineer, T&ES
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Dr. Terry Ryan, Executive Director, Engineers & Surveyors Institute

Alexandria Supplement
To The
Northern Virginia BMP Handbook

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RECORD OF REVISIONS

Revision No.	Description	Adoption Date	Approved By
1	Incorporate Alexandria Zoning Ordinance changes and update technology of Chapter 2.	8/1/93	Thomas F. O'Kane, Jr.

PREFACE

Section 13-104 of the Alexandria Zoning Ordinance (Chesapeake Bay Preservation Regulations) referred to in this manual as the Ordinance) charges the Director of Transportation and Environmental Services (referred to in this manual as the Director) with responsibility for establishing technical standards for compliance with the requirements of the Ordinance. This handbook supplement sets forth those standards and provides information on unconventional structural Best Management Practices (BMPs) which may used in the ultra-urbanized areas of the City where conventional BMPs are not feasible. It also provides standard maintenance and monitoring agreements for use with BMPs and stormwater detention facilities and sets forth plan of development submission requirements.

ACKNOWLEDGEMENTS

This handbook supplement was prepared by the engineering staff of the Department of Transportation and Environmental Services (T&ES), and all members of the staff contributed significantly. The supplement would not have been possible, however, without substantial assistance from Best Management Practices professionals from several regions of the United States, who provided hours of consultation and forwarded materials on BMPs used within their jurisdictions. The City of Alexandria expresses special thanks to the following:

Kimberly V. Davis, Norman Goulet and David Bulova of the Northern Virginia Planning District Commission staff; Mark Graham of the Arlington County, Virginia, Department of Environmental Services; Leslie G. Tull, P.E., of the Austin, Texas, Environmental and Conservation Services Department; Hung V. Truong of the District of Columbia Environmental Regulation Administration; Earl Shaver of the Delaware Department of Natural Resources and Environmental Control; Thomas R. Schueler and John Galli of the Metropolitan Washington Council of Governments staff; and Gary Minton of Resource Planning Associates, a consultant to the City of Seattle, Washington.

Revision 1 additional acknowledgements:

To the above list must be added the names of Patrick D. Hartigan of the Washington State Department of Ecology and Eric H. Livingston of the State of Florida Department of Environmental Regulation.

The following were contributing authors and compilers of this manual:

Warren Bell, P.E.
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Printing and Production were by William K. Davison and JuWaume Q. Hayes.

in Chapter 5 of the NVBMPHB have clearly established that the concept will work for the site in question. If observation of the excavated area for the infiltration device casts doubts on the practicality of soil percolation ability, a successful full design volume exfiltration test of the excavation may be required before installation of the device is permitted to continue. If this test is a failure, another BMP solution will have to be adopted. Infiltration trenches and drywells will not be approved in strata above marine clays. However, see Chapter 2 for a discussion of infiltration wells which convey stormwater to strata below the marine clay layers.

Alexandria recognizes the phosphorous removal efficiencies shown in Table 1-1.

Table 1-1
BMP Removal Efficiencies Recognized by Alexandria (6/5/98)

BMP Facility	Removal Efficiency (%)
Extended Detention Pond Design (i) (Chart "A" of *NVBMPHB*)	40%
Regional Extended Detention Pond (Watershed ≥100 acres) (Chart "A" of *NVBMPHB*)	50%
Wet Pond Detention Design (i) (Permanent Pool = 2.5V*)	45%
Wet Pond Detention Design (ii) (Permanent Pool = 4.0 V*)	50%
Regional Wet Pond Detention (Watershed ≥ 100 acres) (Permanent Pool = 4.0 V*)	65%
Infiltration Trench Design (i) (0.5 in/imp. acre)	50%
Infiltration Trench Design (ii) (1.0 in/imp. acre)	65%
Infiltration Trench Design (iii) (2-yr.-Storm runoff)	70%
Intermittent Sand Filters (all variations) (0.5 in./imp. acre)	60%
Peat-Sand Filters (0.5 in./imp. acre)	70%
Alexandria Compound Filters (0.5 in./imp. acre)	70%
Bioretention Infiltration Basins (0.5 in./imp. acre)	50%
Bioretention Filters (0.5 in./imp. acre)	50%
Hydrodynamic BMPs**	15%***
Leaf Compost Media Filters	50%***

* Runoff volume produced by the mean annual storm
** Stormceptor, Vortechnics, BaySaver, Downstream Defender, etc.
*** Alexandria Provisional Rating

Chapter 1
Standard Calculations Procedures for the Alexandria Chesapeake Bay Preservation Ordinance

I. BACKGROUND

Article XIII of the Alexandria Zoning Ordinance comprises the City's current Chesapeake Bay Preservation Ordinance (hereinafter referred to as the Ordinance). Sections 13-104(C), 13-109 and 13-112 of the Ordinance that the Director of Transportation and Environmental Services (hereinafter referred to as the Director) shall establish procedures, consistent with good engineering practice, for calculating the stormwater pollutant removal requirements for development and redevelopment projects and for establishing Best Management Practices (BMP) removal efficiencies. This chapter establishes standard calculations procedures and worksheets and assigns removal efficiencies that Alexandria will recognize for both conventional and unconventional BMPs.

II. STORMWATER QUALITY MANAGEMENT PERFORMANCE REQUIREMENTS

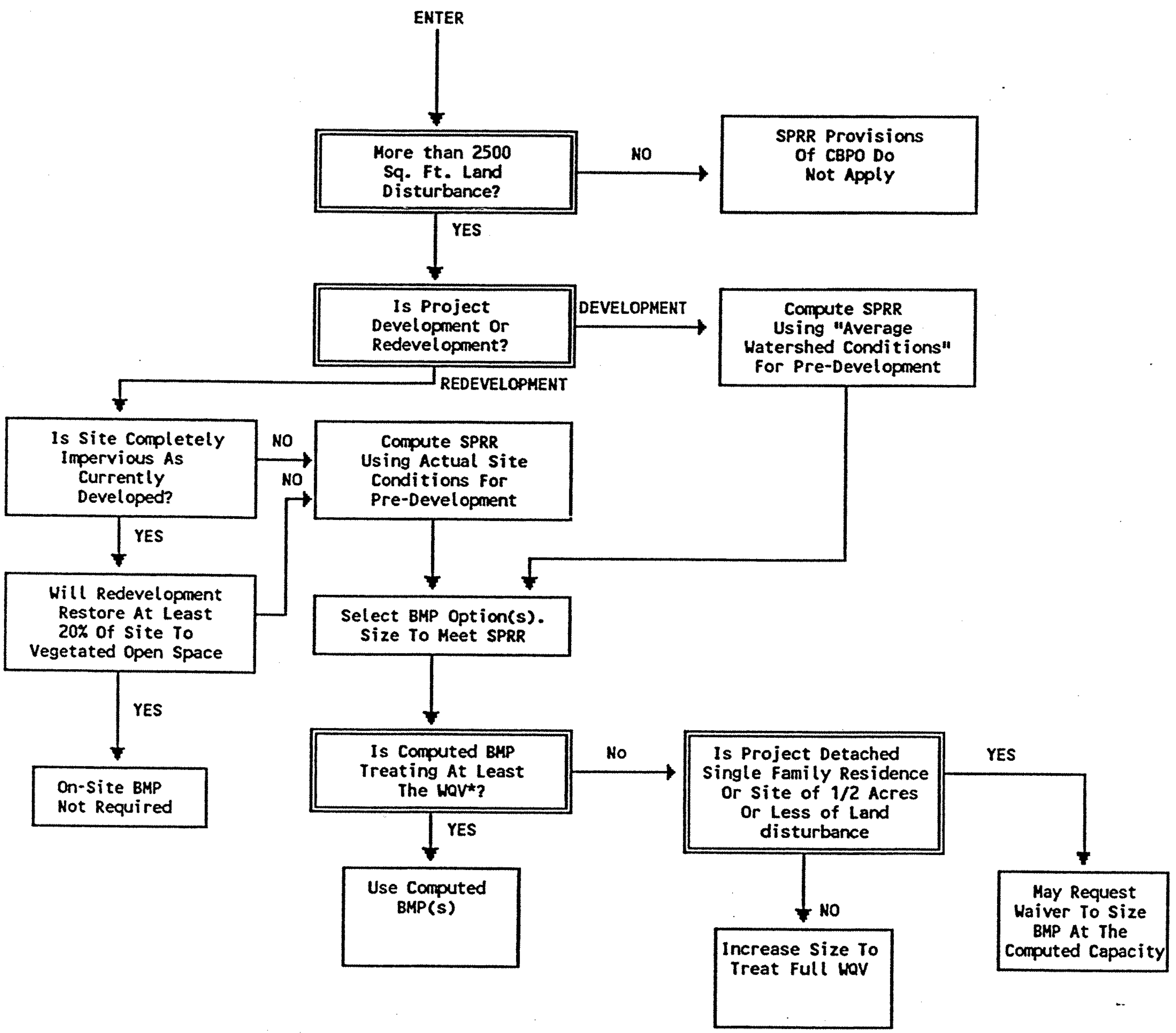
Sections 13-109, 13-110, 13-112, and 13-113 of the Ordinance require that new development projects exceeding 2,500 square feet of land disturbance meet a "no net increase" standard with respect to pollutants in stormwater runoff leaving the site and that redevelopment projects exceeding 2,500 square feet of site land disturbance must meet a "ten percent reduction" standard with respect to pollutants in stormwater runoff (see Chapter 4 of this manual for stormwater **quantity** management requirements).

See Section 13-103 of the Ordinance for specific definitions. Generally, if the site currently contains residential, commercial, industrial, institutional, transportation or utility facilities or structures, new work will be redevelopment. However, substantial alteration of residential, commercial, industrial institutional, transportation or utility facilities is considered development rather than redevelopment.

Section 13-117(B) of the Ordinance further requires that at least the Water Quality Volume (WQV), the first one-half inch of runoff from the impervious surfaces on the site, be treated in a Best Management Practice (BMP) approved by the Director (the WQV for one acre of impervious surface is 1816 cubic feet). This is a requirement of the Virginia Stormwater Management Act. The situation that occurs when this requirement prevails over the minimum pollutant removal standards of the Chesapeake Bay Preservation Act listed above shall be referred to the **WQV Default requirement.** For single family residences separately built and not part of a subdivision, including additions to existing sin-

FIGURE 1-1

ARTICLE XIII - ENVIRONMENTAL MANAGEMENT
STORMWATER POLLUTION REMOVAL REQUIREMENTS (SPRR)



* The first ½" of runoff from the impervious acreage on the site

gle-family detached residential structures, and for other sites not exceeding one-half acre of land disturbance, the Director may waive or modify this WQV Default requirement. Such waivers will normally be limited to adjusting the BMP size to the level required by Sections 13-109, 13-110, 13-112, or 13-113.

Sections 13-110 and 13-113 of the Ordinance allow the pollutant removal requirements and WQV Default requirements of a **redevelopment** site that is completely impervious as currently developed to be met by restoring a minimum of 20 percent of the site to vegetated open space.

Figure 1-1 is a decision chart to assist applicants in determining which standard governs for their particular projects.

III. Pollutant Loading Calculations Procedures

Alexandria's standard procedure for calculating compliance with the requirements of its Chesapeake Bay Preservation Ordinance are derived from the Guidance Calculations Procedures recommended in Appendix C of the Virginia Chesapeake Bay Local Assistance Department (CBLAD) Local Assistance Manual.[1]

A) KEYSTONE POLLUTANT

The Virginia Chesapeake Bay Preservation Act and the Alexandria Ordinance establish stormwater quality performance standards dealing with reductions in **pollutants** in post-development stormwater. CBLAD has designated total phosphorous as the "Keystone Pollutant" for determining conformance with the requirements of the Virginia Chesapeake Bay Preservation Act. The rationale for this selection is discussed in detail in Attachment A to Appendix C of the LOCAL ASSISTANCE MANUAL.[1] The selection criteria were:

1) The "Keystone Pollutant" must have a well-defined impact on the Chesapeake Bay.

2) The "Keystone Pollutant" should exist in a "composite "form, i.e.in a roughly equal spilt between particulate and soluble phases.

3) Enough research data must be available to provide a reasonable basis for estimating how "Keystone Pollutant" loads change in response to development and to current storm water control measures.

While the procedures in this chapter deal with phosphorous loadings, it is important to remember that the **objective** of the Ordinance is to **reduce all pollutants in the post-development stormwater** and that phosphorous is being used as a convenient indicator of the whole spectrum of pollutants.

B) THE SIMPLE METHOD

The method to calculate pre- and post-development phosphorous loadings recommended by CBLAD and adopted by Alexandria is the Simple Method derived by Thomas R. Schueler in the Metropolitan Washington Council of Governments (COG) handbook, CONTROLLING URBAN RUNOFF.[2] The Simple Method is intended for use on development sites of less than one square mile in area. For larger sites, the applicant may propose an analysis based on more sophisticated methods such as watershed and receiving water simulation models. The Simple Method is described as follows:[2]

$$L = P \times P_j \times R_v \times C \times A \times 2.72/12$$

where,

- L = phosphorous loadings (pounds/year--lb/yr).
- P = average annual rainfall depth (inches) = 40 inches per year for Alexandria.
- P_j = unitless correction factor for storms that produce no runoff = 0.9.
- R_v = runoff coefficient - expresses the fraction of rainfall converted to runoff.
- C = flow-weighted mean pollutant concentration (milligrams/liter--mg/l).
- A = area of development site (acres).

(2.72 and 12 are conversion constants.)

Further reducing the Alexandria constants in the formula yields:

$$L = 8.16 \times R_v \times C \times A$$

C) DERIVATION OF ALEXANDRIA PHOSPHOROUS LOADING FORMULAE

1) MEAN CONCENTRATION (C-VALUE)

Flow-weighed mean concentrations of phosphorous (C-values) were derived from runoff events monitored in the Washington, D.C. area as part of the National Urban Runoff study[2]. For use of the Simple Method in Virginia, CBLAD specifies:[1]

$$C = 0.26 \text{ mg/l when } I<20$$
$$C = 1.08 \text{ mg/l when } I\geq 20$$

where I = the % of site imperviousness in whole numbers.

2) **RUNOFF COEFFICIENT (R_v)**

The runoff coefficient describes the fraction of rainfall converted to runoff. While dependent on soil type, topography and cover, it is most influenced by watershed imperviousness. The Simple Method uses the following formula to compute R_v:

$$R_v = 0.05 + 0.009\ (I)$$

Structures, parking lots, roadways, sidewalks, paved patios (concrete, brick or asphalt), paved parking pads, etc., are considered impervious by definition. Other hard surfaces may be judged to be impervious if their ability to absorb rainfall is minimal.

3) **ALEXANDRIA WATERSHED RUNOFF COEFFICIENT**

For new development in Chesapeake Bay Preservation Areas, the Regulations allow the use of "average land cover conditions" in calculating pre-development pollutant loadings (post-development loadings must <u>always</u> be based on site-specific conditions). Since the entire City is served by storm sewers which discharge into a fairly short stretch of the Potomac River, the City has been designated a single watershed for purposes of this calculation. The calculated **average imperviousness of the City is 41 percent.** The average City-wide runoff coefficient is therefore:

$$\mathbf{R_v = 0.05 + 0.009(41) = 0.42}$$

When calculating annual phosphorous loadings using the City-wide runoff coefficient, the Simple Method Formula reduces to:

$$\mathbf{L_{Pre} = 8.16 \times 0.42 \times C \times A = 3.42 \times 1.08 \times A}$$

$$\mathbf{= 3.69 \times A}$$

F) CALCULATIONS SHEETS

Step-by-step calculations sheets for use in applying the Simple Method to development in Alexandria are provided in the Appendix 1-2 to this chapter. Worksheet A is for use with new development projects. Worksheet B is for use with redevelopment. Worksheet C will be used to demonstrate compliance. The general calculations sequence is:

1) Compile site-specific data on imperviousness and compute post-development R_v. For redevelopment, also compute pre-development R_v.

2) Calculate the pre-development load (L_{pre}--lbs/yr).

3) Calculate the post-development load (L_{post}--lbs/yr).

4) Calculate the pollutant removal requirement (RR).

For new **development, RR = L_{post} - L_{pre}.**

For **redevelopment, RR = L_{post} - 0.9L_{pre}.**

If RR $\leq$ 0.00, the WQV Default requirement will prevail. Select and size a BMP to treat the WQV, or see section II. above for possibility of a waiver. If RR > 0.00, continue the analysis.

5) Calculate overall BMP efficiency required when selecting BMP options.

%RR = RR/L_{post} x 100

6) Select and size a suitable BMP option.

7) Check to assure that the WQV Default requirement is satisfied.

Figure 1-2 in Appendix 1-2 is a flow chart illustrating the BMP sizing determination.

Calculations must be performed and certified by a Professional Engineer or Class IIIB Surveyor licensed to practice in Virginia.

IV. TRADITIONAL BEST MANAGEMENT PRACTICES

The Northern Virginia BMP Handbook (NVBMPHB)[3] published by the Northern Virginia Planning District Commission (NV PDC) will be utilized when designing traditional BMPs (dry ponds, wet ponds, infiltration devices) for use in Alexandria. Traditional BMPs will normally be used unless the Director determines that the site contains insufficient space. **Applicants should resolve this question with the City staff before investing in the design of unconventional BMPs.** Chapter 3 of the NVBMPHB contains information on BMP screening. CONTROLLING URBAN RUNOFF[2] also contains a number of useful screening tools to employ in selecting a traditional BMP option.

Applicants are cautioned that most areas of Alexandria do not contain soils which are conducive to infiltration devises. Infiltration will be approved only where field tests specified in Chapter 5 of the <u>NVBMPHB</u> have clearly established that the concept will work for the site in question. **If observation of the excavated area for the infiltration device casts doubts on the practicality of soil percolation ability, a successful full design volume exfiltration test of the excavation may be required before installation of the device is permitted to continue.** If this test is a failure, another BMP solution will have to be adopted. Infiltration trenches and drywells will <u>not</u> be approved in strata above marine clays. However, see Chapter 2 for a discussion of infiltration wells which convey stormwater to strata below the marine clay layers.

Alexandria recognizes the phosphorous removal efficiencies shown in **Table 1-1.**

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V. <u>INNOVATIVE BMPS FOR THE ULTRA-URBAN ENVIRONMENT</u>

Many of the older sections of Alexandria contain areas in which buildings, parking facilities and urban streets and walkways cover almost 100 percent of the surface, creating heavy runoff but offering no room for structural stormwater quality management facilities such as extended dry detention or wet ponds. When redevelopment occurs within these areas, high land values may require similarly intense land usage in order to have an economically viable project. Soil conditions in most of the City also mitigate against the use of infiltration devices. In such situations, innovative BMP applications are required to meet the stormwater quality requirements of the Chesapeake Bay Preservation Ordinance. Chapter 7 of the <u>NVBMPHB</u> discusses unconventional and experimental BMPs. Chapter 2 of this manual supplement presents details on unconventional BMPs which may be considered for use within the City. Because of their unconventional nature, treatment of the entire Water Quality Volume will be normally required when these devices are employed. **Unless waived by the Director, all unconventional BMPs must be equipped with special catchments and/or manholes for chemical monitoring of inflows and outflows.** Developer/applicant participation in a monitoring program to establish the actual removal efficiency of the device may also be required if authoritative engineering references demonstrating the removal efficiency of the proposed BMP are not available. Such requirements will be made a part of the Maintenance/Monitoring agreements discussed in Chapter 3. Unconventional BMPs can also be used in conjunction with stormwater quantity management devices where peak flow rates from the site must be decreased.

A recent study addressing the use of intermittant sand filters in series suggests that the phosphorous removal efficiency of an intermittant sand filter system may be increased more than 50 percent by adding a second polishing filter to the system.[4] **If a developer is willing to proffer financial and/or equipment paricipation in a full monitoring program to establish the actual removal efficiency of this concept, Alexandria will recognize a 65 percent removal efficiency for the BMP for approval purposes.**

(For second stage polishing filters, use a coefficient of permiability (k) = 12 feet per day.)

VI. BMPs FOR THE WQV DEFAULT CONDITION

The Virginia Stormwater Management Regulations[5] establish the following conventional BMP standards for treating the WQV:

A) EXTENDED DETENTION DRY PONDS

The WQV shall be detained and released over 48 hours (this pond design may result in a detained volume less than the volume derived from Chart "A"). If this requirement would result in an outlet opening smaller than three inches in diameter or the equivalent cross-sectional area, the period of detention may be waived so that three inches will be the minimum opening used.

B) RETENTION BASINS (WET PONDS)

The volume of the permanent pool must be at least three times greater than the WQV.

C) INFILTRATION FACILITIES

The WQV must be completely infiltrated within 48 hours. In addition, (1) the invert of the infiltration facility must be at least four feet above the seasonal high groundwater elevation; (2) a detailed soils analysis and report is required; and (3) in order to avoid groundwater contamination, approvals will be on a case by case basis after technical review by the staff of the Director.

D) UNCONVENTIONAL BMPS

The BMPs discussed in the Virginia Stormwater Management Regulations have phosphorous removal efficiencies in the 40-50 percent efficiency range. Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990, which apply to Alexandria, further requires that runoff from land development be treated with best available technology.[6] Accordingly, unconventional BMPs proposed for satisfying the WQV

Default condition must have an efficiency of at least 40 percent. The lower performance BMPs allowed for WQV Default in the original publication of this Supplement no longer apply.

VI. REDUCED BUFFER EQUIVALENCY

Section 13-109 of the Ordinance provides that the buffer in a Resource Protection Area may be reduced to an absolute minimum of 50 feet if the Director determines that a combination of a smaller buffer and appropriate BMPs located landward of the buffer will achieve the required 75 percent reduction in sediments and 40 percent reduction in nutrients that a full buffer is presumed to achieve (the buffer shall in no case be less than 50 feet except within a designated Intensely Developed Area). Worksheet D: Buffer Equivalency, is provided for use in demonstrating compliance for proposed reduced buffers.

VII. ACCESS AND MAINTENANCE EASEMENTS

When utilizing conventional BMPs, access and maintenance easements conforming to the requirements of Chapter 6 of the <u>NVBMPHB</u> shall be provided (this is not to imply public maintenance of the BMP--maintenance will be by the owner). When using unconventional BMPs, such easements shall conform to the requirements of Chapter 2 of this manual.

APPENDIX 1-1 -- TECHNICAL NOTES

I. Sample Calculation to Determine Stormwater Pollution Removal Requirements for a New Residence:

A recent building plan on Branch Road called for the construction of a new 2,178 square foot residence on an undeveloped parcel. The total area of the lot was 11,761 square feet. Since almost 8,000 square feet of land disturbance is involved, a formal plan of development, including an erosion and sediment control plan is required. Compilation of the impervious areas of the roof, driveway, etc., resulted in a total of 0.07 acres, or 26 percent impervious cover. Since this is less than the City-wide average impervious cover of 41 percent, the project would be exempt from pollutant removal requirements, and a single-family residence waiver may be obtained for the WQV Default. However, an erosion and sediment control plan is required. See Plot Plans and sample calculations sheets at the end of this appendix.

II. Sample Calculation to Determine Stormwater Pollutant Removal Requirements for an Addition to an Existing Residence:

A homeowner on Fairmont Road proposed constructing a 3,050 square foot addition to an existing 2,730 square foot residence. The area of the site was 10,018 square feet. Since clearing the site and construction activity would result in over 2,500 square feet of land disturbance, an erosion and sediment control plan is required. Total post-development impervious cover would be 0.08 acres, or 35 percent of the site. Since this is less than the City-wide average impervious cover of 41 percent, the project would be exempt from the pollutant removal requirements, and a single family residence waiver may be obtained for the WQV Default. See Plot Plans and sample calculations sheets at the end of this appendix.

III. Sample Calculation to Determine Stormwater Pollutant Removal Requirements for Redevelopment of a Parking Lot:

A developer is proposing to construct an underground parking garage and mixed use development on the site of an existing parking lot in Old Town. Total area of the site is 31,363 square feet. The existing site is completely covered with asphalt paving. Since over 2,500 square feet of land disturbance is involved, a full plan of development is required. The stormwater pollutant removal requirements could have been met by restoring at least 20 percent of the site to such pervious cover as landscaping beds. However, because of space constraints and high land values, the parking garage is planned for lot-line to lot-line dimensions, precluding pervious vegetated open space on the site. Calculations establish a removal requirement of ten percent of the pollutants in the post-development stormwater runoff (see site plan and sample calculations sheets at the end of this appendix). A stormwater pollutant removal facility must be provided. Since the site is in a combined sewer watershed, the first half-inch of runoff from the roof, driveways and exposed upper parking level must be collected and held in a Water Quality Volume Storage Tank until it can be released without contributing to a combined sewer overflow into the Potomac River (see Chapter 2 for details of this BMP). A holding capacity of 1308 cubic feet (equivalent to (eight feet by eight feet by 21 feet). The tank will be placed in the lower level of the parking facility.

IV. Sample Calculations to Determine Pollutant Removal Require ments for a New Shopping Center:

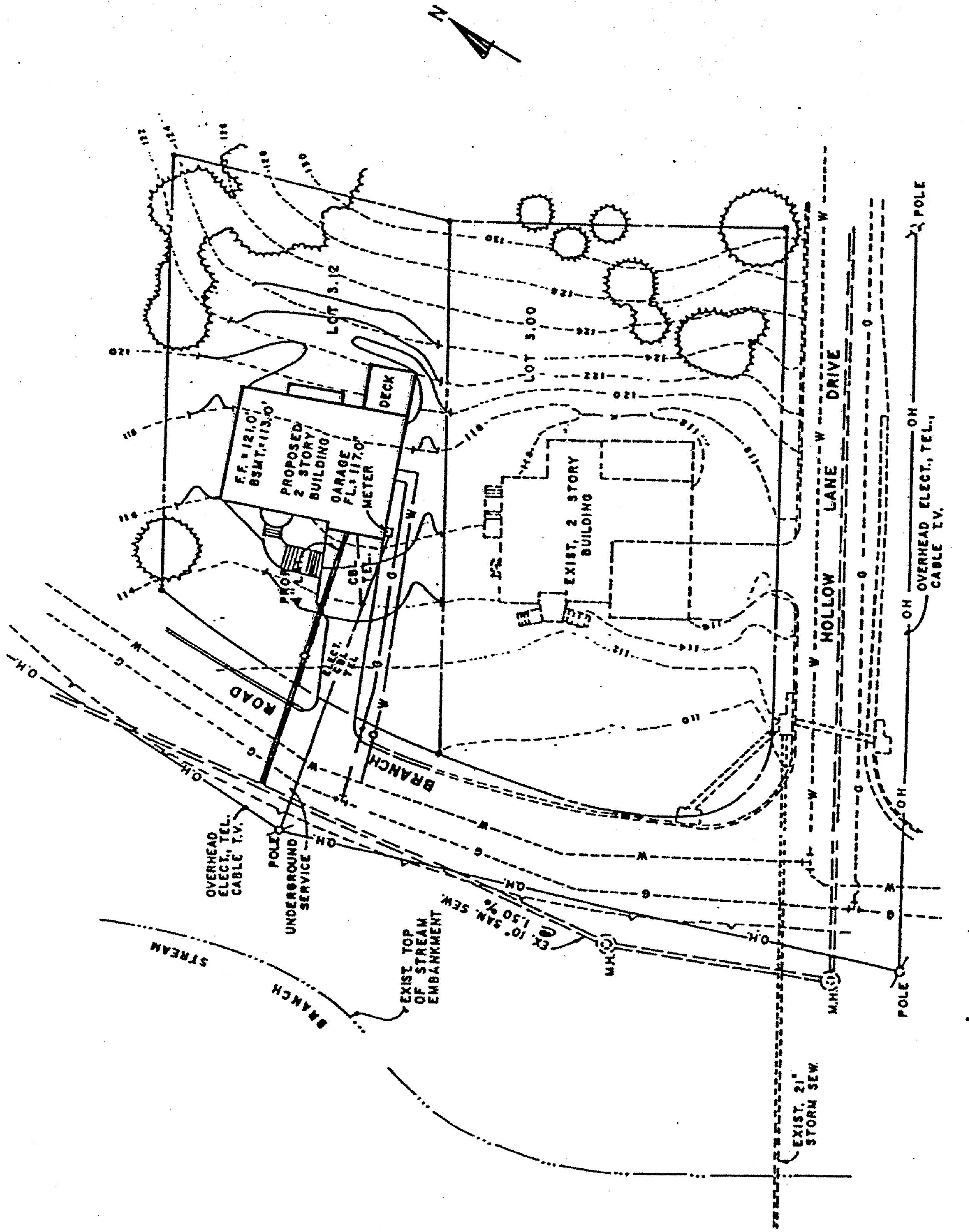
A developer is exploring development possibilities for a 3.4-acre undeveloped parcel in the West End. The stormwater pollutant removal requirements for this site would require a very efficient BMP. Figure 1-1 graphs the maximum site imperviousness allowed for several conventional BMPs with varying site coverage taking into account Alexandria's "average watershed conditions" of 41 percent impervious cover. If 100 percent of the site in question was served by a small wet pond, some 88 percent of the site could be covered with impervious materials. The site would require a pond of 16,600 cubic feet capacity. With an average depth of six (6) feet, this would have a surface area of approximately 2,800 square feet (about 53 feet by 53 feet). A combination of infiltration wells for roof water and sand filtration systems for parking lot runoff would be an alternate solution to handle this high pollutant removal requirement (see Chapter 2 for details of these BMPs).

V. Sample Calculations to Determine Stormwater Pollutant Removal Requirements for Redevelopment of a Marina:

The City wishes to develop the 1.14-acre Old Town Yacht Basin property as a new marina, which is water-dependent construction. The current level of impervious cover is 100 percent. The development plan calls for restoring 23 percent of the site to such vegetated areas as landscaping planting beds. Since this is more than the minimum 20 percent pervious cover standard in Section 7-409 in the ordinance, the project meets the pollutant removal standards without having to construct a BMP. However, the WQV Default condition would prevail. Runoff from the impervious areas (parking lot, etc.) will be treated in a half-sized Delaware Sand Filter (see Chapter 2 for details of this BMP). An erosion and sediment control plan will also be required.

VI. Sample Calculations to Determine Stormwater Pollutant Removal Requirements for Redevelopment of an Existing Shopping Center:

A developer proposes to redevelop an existing 15-acre shopping center by adding buildings and reconfiguring the parking lot. Under current conditions, 12.05 acres, or 80 percent of the site, is covered with impervious surface. The proposed redevelopment will result in 12.52 acres, or 83 percent of the site, with impervious cover. Calculations result in a removal requirement of 13.4 percent of the pollutants in the post-development stormwater runoff (see site plans and sample calculations sheets at the end of this appendix). A Delaware Sand Filter sized to treat the Water Quality Volume would satisfy this requirement (see Chapter 2 for details on this BMP). Since over 2,500 square feet of land disturbance is involved, an erosion and sediment control plan is also required.



BRANCH ROAD EXISTING PLOT PLAN

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WORKSHEET A: Example NEW DEVELOPMENT New Single family residence W/RPA (Branch Road plot plan)

1. Compile site-specific data and determine site imperviousness (I_{site}).

POST-DEVELOPMENT

A*	= 0.27 acres	
I_a** structures	= 0.05 acres	
parking lot	= ______ acres	
roadway	= 0.02 acres	
other	= ______ acres	
	= ______ acres	
	= ______ acres	
Total I_a	= 0.07 acres	

$R_{v\text{-post}} = 0.05 + 0.009\ (I_{site})$

$= 0.05 + 0.009$ (______________)

= __________

$R_{watershed}$ is embedded in the formula in Step 4.

I_{site} = (Total I_a/A) x 100
= 26 (percent expressed in whole numbers)

*A is the total area of the site
** I_a is the total amount of impervious cover.

2. Determine need to continue.

I_{site} = 26 % (from Step 1)
$I_{watershed}$ = 41%

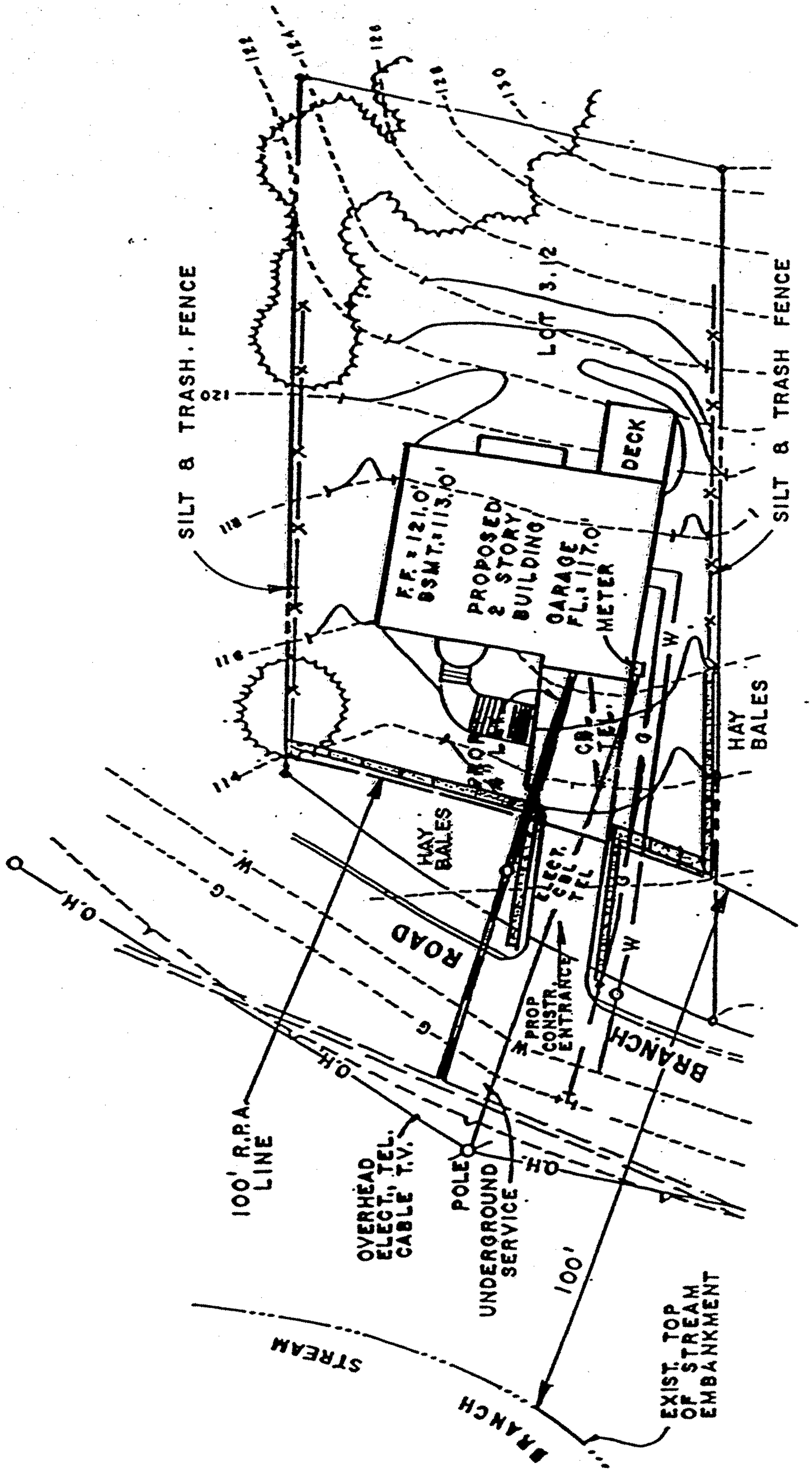
If $I_{site} \leq I_{watershed}$ ✓ STOP and submit analysis to this point. WQV Default prevails. See p. 1-8 of the Alexandria Supplement.

If $I_{site} > I_{watershed}$ CONTINUE.

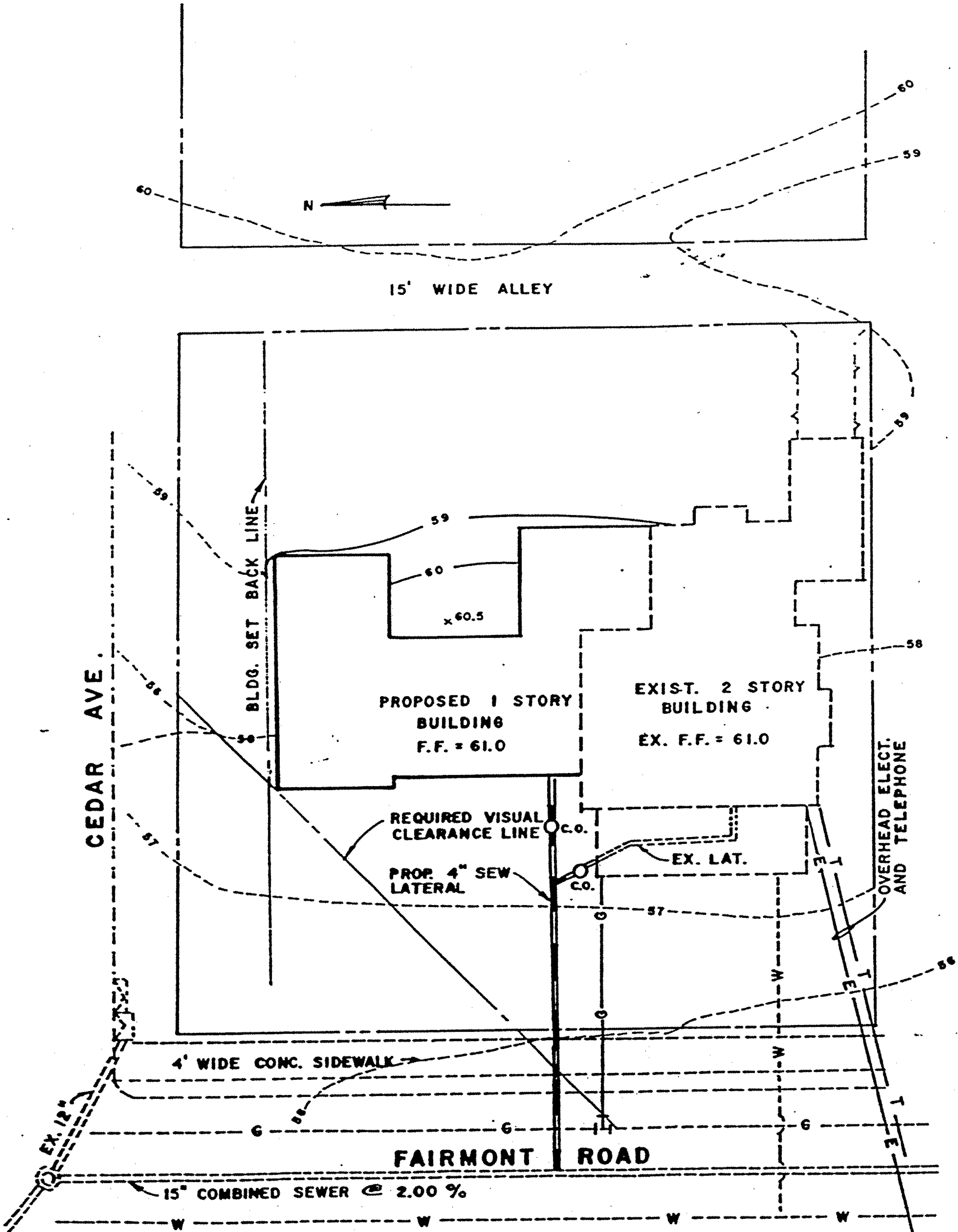
3. Select C-values (C_{pre} and $_{post}$).

C = 0.26 mg/l when I < 20
= 1.08 mg/l when I ≥ 20

Since $I_{watershed}$ is > 20%, C_{pre} = 1.08 mg/l



BRANCH ROAD CBPO PLAN OF DEVELOPMENT



FAIRMONT ROAD PLOT PLAN

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LOADING COMPUTATIONS

WORKSHEET A: Example NEW DEVELOPMENT Addition to a single family residence (Fairmont Road plot plan)

1. Compile site-specific data and determine site imperviousness (I_{site}).

POST-DEVELOPMENT

A*	= 0.23 acres	$R_{v\text{-}post}$ = 0.05 + 0.009 (I_{site})
I_a** structures	= 0.07 acres	
parking lot	= ______ acres	= 0.05 + 0.009 (______)
roadway	= 0.01 acres	= ______
other	= ______ acres	
	= ______ acres	$R_{watershed}$ is embedded in the formula in Step 4.
	= ______ acres	
Total I_a	= 0.08 acres	

I_{site} = (Total I_a/A) x 100
= 35 (percent expressed in whole numbers)

*A is the total area of the site
** I_a is the total amount of impervious cover.

2. Determine need to continue.

I_{site} = 35 % (from Step 1)
$I_{watershed}$ = 41%

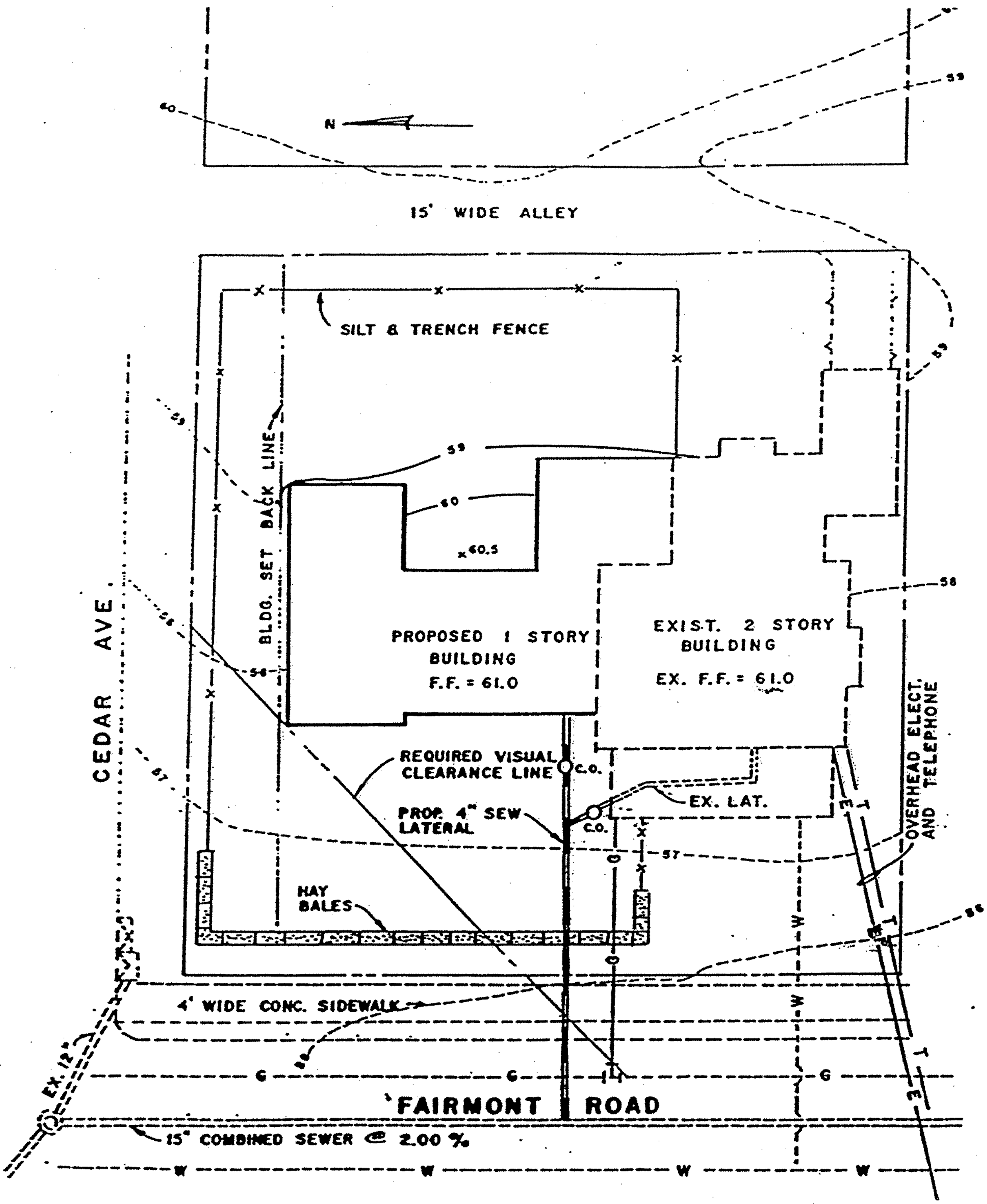
If $I_{site} \leq I_{watershed}$ STOP and submit analysis to this point. WQV Default prevails. See p. 1-8 of the Alexandria Supplement.

If $I_{site} > I_{watershed}$ CONTINUE.

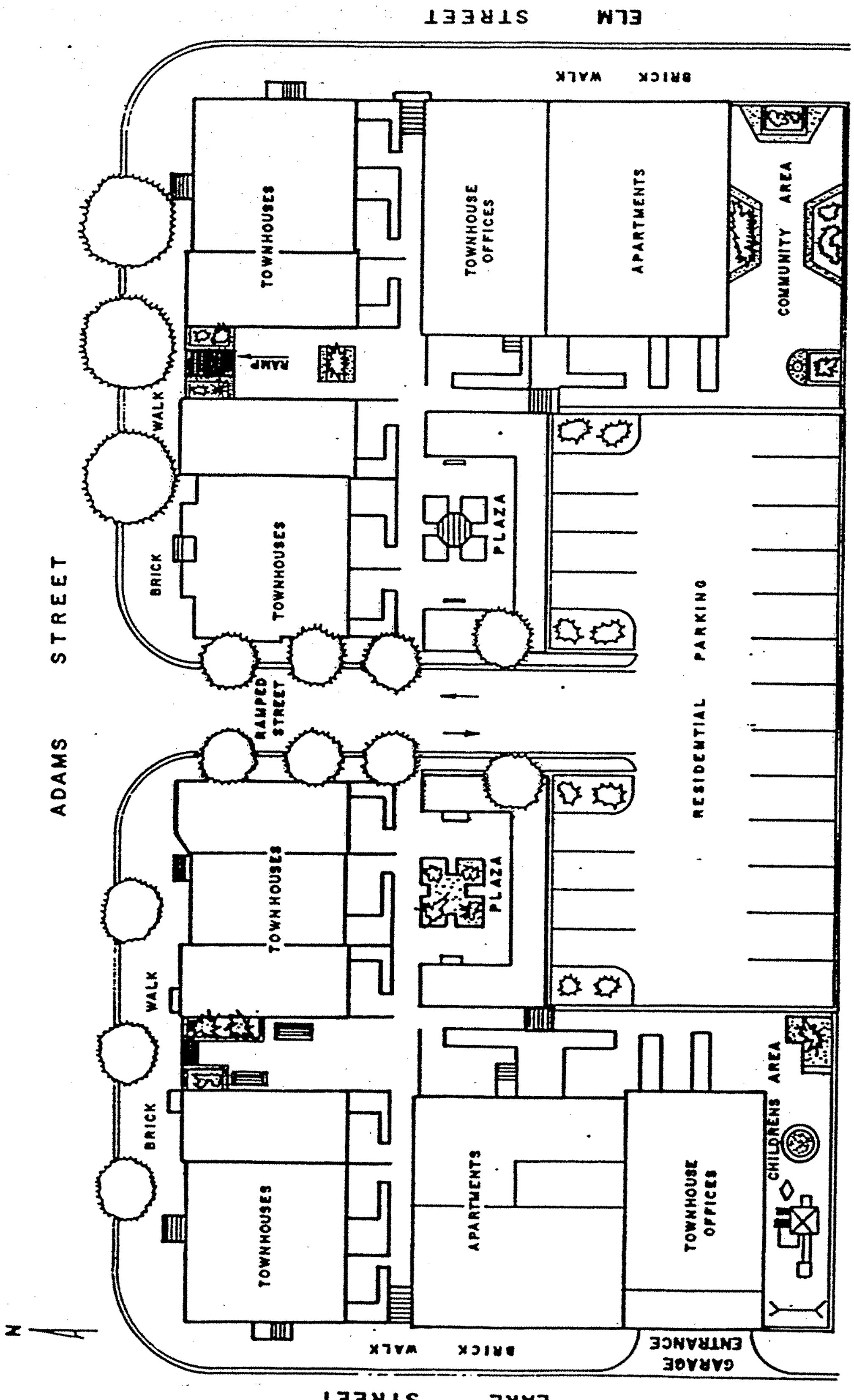
3. Select C-values (C_{pre} and $_{post}$).

C = 0.26 mg/l when I < 20
= 1.08 mg/l when I $\geq$ 20

Since $I_{watershed}$ is > 20%, C_{pre} = 1.08 mg/l



FAIRMONT CBPO PLAN OF DEVELOPMENT



MIXED DEVELOPMENT PLAN

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LOADING COMPUTATIONS

WORKSHEET B: Parking facility redevelopment REDEVELOPMENT (Adams Street mixed development plan)

1. Compile site-specific data.

		PRE-DEVELOPMENT	POST-DEVELOPMENT
A*		= 0.72 acres	= 0.72 acres
I_a	structures	= ϕ acres	= 0.26 acres
	parking lot	= 0.72 acres	= 0.16 acres
	roadway	= ____ acres	= 0.05 acres
	other	= ____ acres	= 0.25 acres
		= ____ acres	= ____ acres
		= ____ acres	= ____ acres
	Total I_a	= 0.72 acres	= 0.72 acres

$I = (\text{total } I_{a/A}) \times 100$

PRE-DEVELOPMENT	POST-DEVELOPMENT
= 100 percent expressed in whole numbers	= 100 percent expressed in whole numbers

$R_v = 0.05 + (0.009 \times I)$

PRE-DEVELOPMENT	POST-DEVELOPMENT
= 0.95 unitless	= 0.95 unitless

C: $I \geq 20 = 1.08$mg/l
$I < 20 = 0.26$mg/l

PRE-DEVELOPMENT	POST-DEVELOPMENT
= 1.08 mg/l	= 1.08 mg/l

*A is the total area of the site
** I_a is the total impervious cover on the site

2. Calculate the pre-development load (L_{pre})

$L_{pre} = 8.16 \times R_{v\text{-}pre} \times C \times A$

$= 8.16 \times \underline{0.95} \times \underline{1.08} \times \underline{0.72}$

$= \underline{6.03}$ pounds per year

WORKSHEET B: REDEVELOPMENT

3. Calculate the post-development load (L_{post})

$L_{post} = 8.16 \times R_{v\text{-}post} \times C \times A$

$= 8.16 \times$ 0.95 $\times$ 1.08 $\times$ 0.72

$=$ 6.03 pounds per year

4. Calculate the pollutant removal requirement (RR).

$RR = L_{post} - (0.9 \times L_{pre})$

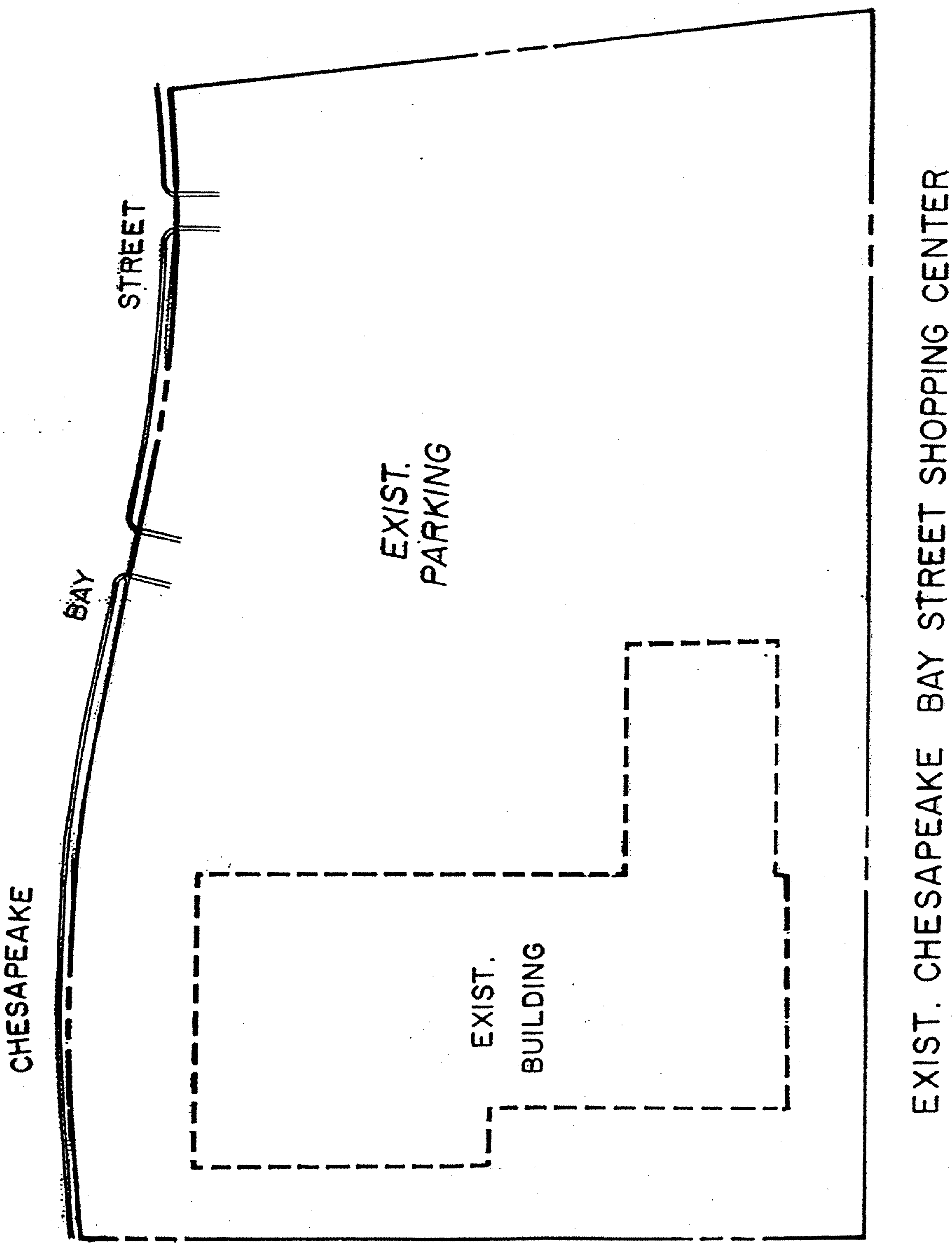
$=$ 6.03 $- (0.9 \times$ 6.03$)$

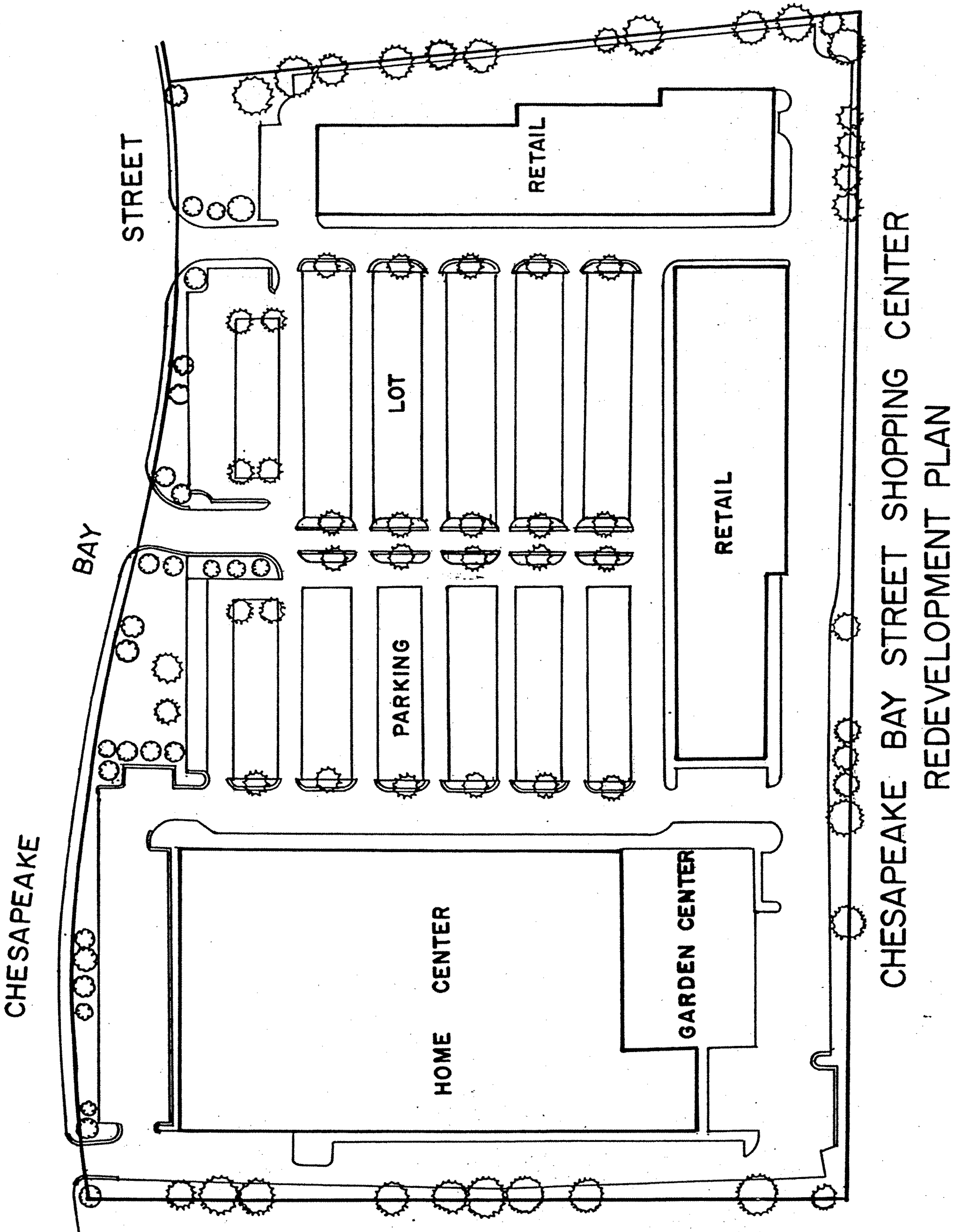
$=$ 0.6 pounds per year

$\%RR = (RR/L_{post}) \times 100$

$= ($0.6 / 6.03$) \times 100$

$=$ 10 %


CHESAPEAKE
BAY
STREET
EXIST.
PARKING
EXIST.
BUILDING
EXIST. CHESAPEAKE BAY STREET SHOPPING CENTER


CHESAPEAKE BAY STREET SHOPPING CENTER
REDEVELOPMENT PLAN
CHESAPEAKE
BAY
STREET
RETAIL
LOT
PARKING
RETAIL
HOME CENTER
GARDEN CENTER

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WORKSHEET B: Example REDEVELOPMENT Shopping Center Redevelopment (Chesapeake Bay Street Shopping Center Redevelopment Plan)

1. Compile site-specific data.

		PRE-DEVELOPMENT	POST-DEVELOPMENT
A*		= 15.00 acres	= 15.00 acres
I_a	structures	= 3.25 acres	= 4.62 acres
	parking lot	= 6.60 acres	= 5.40 acres
	roadway	= 2.20 acres	= 2.50 acres
	other	= ______ acres	= ______ acres
		= ______ acres	= ______ acres
		= ______ acres	= ______ acres
	Total I_a	= 12.05 acres	= 12.52 acres

$I = (\text{total } I_{a/A}) \times 100$

	PRE-DEVELOPMENT	POST-DEVELOPMENT
	= 80 percent expressed in whole numbers	= 83 percent expressed in whole numbers
$R_v = 0.05 + (0.009 \times I)$	= 0.77 unitless	0.80 = unitless
C: $I \geq 20$ = 1.08mg/l; $I < 20$ = 0.26mg/l	= 1.08 mg/l	= 1.08 mg/l

*A is the total area of the site
** I_a is the total impervious cover on the site

2. Calculate the pre-development load (L_{pre})

$L_{pre} = 8.16 \times R_{v\text{-}pre} \times C \times A$

= 8.16 x 0.77 x 1.08 x 15.0

= 101.8 pounds per year

WORKSHEET B: REDEVELOPMENT

3. Calculate the post-development load (L_{post})

$L_{post} = 8.16 \times R_{v\text{-}post} \times C \times A$

$= 8.16 \times$ 0.80 $\times$ 1.08 $\times$ 15.0

= 105.8 pounds per year

4. Calculate the pollutant removal requirement (RR).

$RR = L_{post} - (0.9 \times L_{pre})$

= 105.8 - (0.9 x 101.8)

= 14.2 pounds per year

$\%RR = (RR/L_{post}) \times 100$

= (14.2 / 105.8) x 100

= 13.4 %

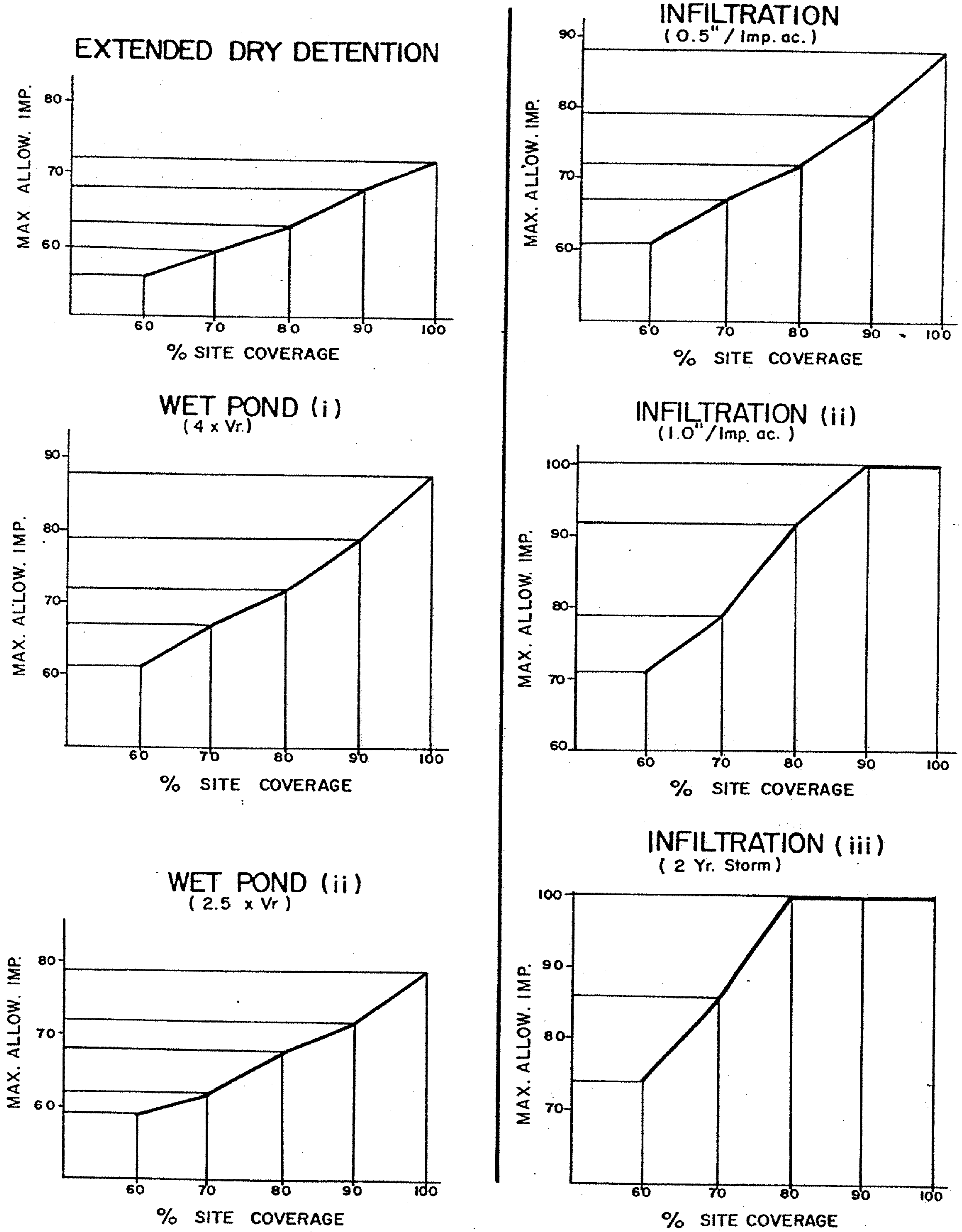

FIGURE: 1 - 1 BMP SITE COVERAGE vs. ALLOWABLE IMPERVIOUSNESS GRAPHS FOR TRADITIONAL BMP'S.

APPENDIX 1-2 -- CALCULATIONS WORKSHEETS

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WORKSHEET A: NEW DEVELOPMENT

1. Compile site-specific data and determine site imperviousness (I_{site}).

POST-DEVELOPMENT

A* = _______acres
I_a** structures = _______acres
parking lot = _______acres
roadway = _______acres
other = _______acres
= _______acres

= _______acres

Total I_a = _______acres

$R_{v\text{-}post} = 0.05 + 0.009\ (I_{site})$
$= 0.05 + 0.009$ (_______________)
= ___________

$R_{watershed}$ is embedded in the formula in Step 4.

I_{site} = (Total I_a/A) x 100
= _______(percent expressed in whole numbers)

*A is the total area of the site
** I_a is the total amount of impervious cover.

2. Determine need to continue.

I_{site} = _______% (from Step 1)
$I_{watershed}$ = 41%

If $I_{site} \le I_{watershed}$ STOP and submit analysis to this point. WQV Default prevails. See p. 1-8 of the Alexandria Supplement.

If $I_{site} > I_{watershed}$ CONTINUE.

3. Select C-values (C_{pre} and $_{post}$).

$C = 0.26$ mg/l when $I < 20$
$= 1.08$ mg/l when $I \ge 20$

Since $I_{watershed}$ is > 20%, $C_{pre} = 1.08$ mg/l

WORKSHEET A: NEW DEVELOPMENT

4. **Calculate the pre-development load (L_{pre}).**

$L_{Pre} = 3.69 \times A$

$= 3.69 \times$ ________ Acres

$=$ ________ pounds per year

5. **Calculate the post-development load (L_{post}).**

$L_{post} = 8.16 \times R_v \times C \times A$

$= 8.16 \times$ ______ x ______ x ______

$=$ ______ pounds per year

6. **Calculate the pollutant removal requirement (RR).**

$RR = L_{post} - L_{pre}$

= ______ - ______

= ______ pounds per year

To determine the overall BMP efficiency required (%RR) when selecting BMP options:

$\%RR = RR/L_{post} \times 100$

= (_____/_____) x 100

= ______%

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LOADING COMPUTATIONS

WORKSHEET B: REDEVELOPMENT

1. Compile site-specific data.

		PRE-DEVELOPMENT	POST-DEVELOPMENT
A*		= _______ acres	= _______ acres
I_a	structures	= _______ acres	= _______ acres
	parking lot	= _______ acres	= _______ acres
	roadway	= _______ acres	= _______ acres
	other	= _______ acres	= _______ acres
		= _______ acres	= _______ acres
		= _______ acres	= _______ acres
	Total I_a	= _______ acres	= _______ acres

$I = (\text{total } I_{a/A}) \times 100$

	PRE-DEVELOPMENT	POST-DEVELOPMENT
I	= _______ percent expressed in whole numbers	= _______ percent expressed in whole numbers

$R_v = 0.05 + (0.009 \times I)$

	PRE-DEVELOPMENT	POST-DEVELOPMENT
R_v	= _______ unitless	= _______ unitless

C: $I \geq 20 = 1.08\text{mg/l}$
$I < 20 = 0.26\text{mg/l}$

	PRE-DEVELOPMENT	POST-DEVELOPMENT
C	= _______ mg/l	= _______ mg/l

*A is the total area of the site
** I_a is the total impervious cover on the site

2. Calculate the pre-development load (L_{pre})

$L_{pre} = 8.16 \times R_{v\text{-}pre} \times C \times A$

= 8.16 x _______ x _______ x _______

= _______ pounds per year

WORKSHEET B: REDEVELOPMENT

3. Calculate the post-development load (L_{post})

L_{post} = 8.16 x $R_{v\text{-}post}$ x C x A

= 8.16 x _______ x _______ x _______

= _______ pounds per year

4. Calculate the pollutant removal requirement (RR).

RR = L_{post} - (0.9 x L_{pre})

= _______ - (0.9 x _______)

= _______ pounds per year

%RR = (RR/L_{post}) x 100

=(_______/_______) x 100

= _______%

WORKSHEET C: COMPLIANCE

Select BMP options using screening tools and list them below. Then calculate the load removed for each option. DO NOT LIST BMPs IN SERIES HERE.

Selected Option	Removal* Efficiency x (% 100)	Fraction of CBPA Drainage Area Served (expressed in decimal form)	x	L_{post} (lbs/yr)	=	Load Removed (lbs/yr)
________	________	________		________		________
________	________	________		________		________
________	________	________		________		________
________	________	________		________		________

*For conventional BMPs, see Section IIa of the Northern Virginia BMP Handbook (NVBMPHB) published by the Northern Virginia Planning District Commission or Chapter 1 of the Alexandria Supplement to the NVBMPHB. For non-conventional BMPs, see Section IV, Chapter 1 of the Alexandria Supplement.

WORKSHEET D: BUFFER EQUIVALENCY

1. **Calculate the drainage area (A_d) served by the buffer.**

Assume a maximum of 200 feet of overland flow can be handled by the buffer (the 200 foot maximum is required by the new ESC regulations (VR 625-02-00) and is suggested policy by both VDOT and ASCS-SCS). Average the width (W_{avg}) of the site along the inland side of the proposed reduced buffer.

$A_d = 200' \times W_{avg}$

$A_d = 200 \times$ _______ = _______ sqft

2. **Compile site-specific data and determine imperviousness (I) of the buffer drainage area (A_d).**

I_a: structures	=	_______sqft
parking lot	=	_______sqft
roadway	=	_______sqft
other	=	_______sqft
	=	_______sqft
	=	_______sqft
Total I_a	=	_______sqft

I = (Total I_a/A) x 100 = _______percent expressed in whole numbers

$R_{v-d} = 0.05 + (0.009 \times I) = 0.05 \times (0.009 \times$ _______)

= _______unitless

C: = 1.08 mg/l if $I \geq 20$
= 0.26 mg/l if $I < 20$

3. **Calculate the pollutant load (L_d) generated by the drainage area of the buffer.**

$L_d = 8.16 \times R_d d \times C \times A_d$

= 8.16 x _______ x _______ x _______

= _______lb/yr.

WORKSHEET D: BUFFER EQUIVALENCY

4. **Determine the maximum load capable of being removed by the full buffer.**

Multiply the load generated (from Step 3) by 0.40 (the removal rate dictated by the Regulations for a full 100-foot buffer).

$R_{fb} = 0.40 \times L_d = 0.40 \times$ _______ = ______ lbs/yr.

5. **Determine the load removed by the remaining, undisturbed buffer.**

Total Buffer Length	Removal Efficiency
100 (no encroachment)	.40
90 (10' encroachment)	.37
80 (20' encroachment)	.35
70 (30' encroachment)	.32
60 (40" encroachment)	.30
50 (max. encroachment)	.25

Multiply the load generated (from Step 3) by the appropriate removal rate shown above.

R_{rb} = Removal efficiency x L_d

= _______ x _______ = _______lbs/yr.

6. **Determine the load removal requirement of an "equivalent" BMP.**

$RR_{bmp} - R_{fb} - R_{rb}$ = _______ - _______

= _______lbs/yr.

7. **Determine available BMP options.**

Sometimes an additional (relocated) buffer width may be appropriate.

Provide adequate BMP design.

CHAPTER 1 END NOTES

1. Virginia Chesapeake Bay Local Assistance Department, Local Assistence Manual, Appendix C: Guidance Calculation Procedure, Richmond, Virginia, November, 1989.

2. Metropolitan Washington Council of Governments, 1987, Controlling Urban Runoff, A Practical Manual for Planning and Designing Urban BMPs, Department of Environmental Programs, MWCOG, Washington D.C., 276 pp.

3. Northern Virginia Planning District Commission, Northern Virginia BMP Handbook, Annandale, Virginia, 1992.

4. Piluk, Richard J. and Hao, Oliver J., "Evaluation of On-Site Waste Disposal Syatem for Nitrogen Reduction," Journal of Environmental Engineering, Vol. 115, No. 4, American Society of Civil Engineers, August, 1989, 16 pp.

5. U.S. Environmental Protection Agency, Office of Water, Coastal Nonpoint Pollution Control Program, Program Development and Approval Guidance, Washington, D.C., 1993.