COUNTY OF ROANOKE

STORMWATER MANAGEMENT DESIGN MANUAL

SEPTEMBER 11, 2007

Department of Community Development
5204 Bernard Drive
Roanoke, Virginia 24018

COUNTY OF ROANOKE

STORMWATER MANAGEMENT DESIGN MANUAL

Chapter 1 – Introduction

1.1 Stormwater Management Goals 1-1
1.2 Contents of the Manual 1-1
1.3 Authority 1-3
1.4 Applicability 1-3
1.5 Administration 1-4
1.5.1 General 1-4
1.5.2 Manual Amendments 1-4
1.5.3 Variances 1-5
1.5.4 Appeal of Decisions 1-5
1.6 Erosion and Sediment Control 1-5
1.7 Approval and Permits 1-5
1.7.1 Local Approvals and Permits 1-5
1.7.2 VSMP Permit 1-5
1.7.3 Joint Permit Application 1-6
1.8 Reference Documents 1-6
1.9 Acronyms and Abbreviations 1-7

Chapter 2 Stormwater Management Plan Review and Approval

2.1 Overview of the Review and Approval Process 2-1
2.2 Concept Stormwater Management Plan Submittal 2-1
2.3 Final Stormwater Management Plan Submittal 2-2
2.4 Submittal of Stormwater Calculations 2-2
2.5 Changes and Modifications to an Approved Plan 2-3

Chapter 3 Easements

3.1 General **3-1**
3.2 Drainage Easements **3-1**
3.2.1 Culverts and Storm Drains 3-2
3.2.2 Open Channels 3-3
3.2.3 Stormwater Management Facilities 3-3
3.3 Access Easements **3-4**
3.4 Maintenance of Easements **3-4**

Appendix 3A – Standard Easement Agreements

Chapter 4 Stormwater Hydrology

4.1 References **4-1**
4.2 Design Frequencies **4-1**
4.2.1 General 4-1
4.2.2 Storm Drainage Systems 4-1
4.2.3 Stormwater Management Facilities 4-2
4.3 Time of Concentration (t_c) and Travel Time (T_t) **4-3**
4.3.1 General 4-3
4.3.2 Overland Flow 4-4
4.3.3 Shallow Concentrated Flow 4-4
4.3.4 Channelized Flow 4-5
4.3.5 Pipe Flow 4-5
4.4 Selection of Methodologies **4-5**
4.4.1 General 4-5
4.4.2 Peak Discharge Methods for Design of Storm Drainage Systems 4-5
4.4.3 Hydrograph Methods for Design of Stormwater Management Facilities 4-6
4.5 Methodologies **4-6**
4.5.1 Rational Method 4-6
4.5.2 Modified Rational Method 4-8
4.5.3 Anderson Method 4-9
4.5.4 SCS Method 4-9
4.6 Pre Development Conditions **4-11**
4.6.1 Site Development 4-11
4.6.2 Redevelopment 4-12
4.7 Drainage Area Analysis **4-12**

Appendix 4A – Design Aids, From Chapter 6, VDOT Drainage Manual
Appendix 4B – Design Aids, From Chapter 4, VA SWM Handbook
Appendix 4C – Information from VDOT Hydraulic Design Advisories

Chapter 5 Open Channels

5.1 References 5-1
5.2 Design Methodology and Criteria 5-1
5.2.1 Major and Minor Channels 5-1
5.2.2 Design Flow 5-1
5.2.3 Hydrology 5-2
5.2.4 Channel Hydraulics 5-2
5.2.5 Channel Velocity 5-2
5.2.6 Channel Slope 5-3
5.2.7 Cross Sectional Area 5-4
5.2.8 Channel Lining 5-5
5.2.9 Freeboard Requirements 5-7
5.2.10 Calculation of Depth of Flow at Bends and Curves 5-7
5.2.11 Channel Location and Width Restrictions on Residential Lots 5-7
5.3 Adequate Channels 5-8
5.4 Environmental Considerations and Fishery Protection 5-9
5.5 Maintenance Requirements 5-9
5.6 Floodplain Studies 5-9

Appendix 5A – Aids for Open Channel Design, From Chapter 7, VDOT Drainage Manual

Chapter 6 Culverts

6.1 References 6-1
6.2 Design Methodology and Criteria 6-2
6.2.1 Computation Methods 6-2
6.2.2 Hydrology 6-2
6.2.3 Culvert Hydraulics 6-2
6.2.4 Structural Design 6-6
6.2.5 Materials 6-6
6.2.6 Culvert Sizes 6-7
6.2.7 End Conditions 6-7
6.2.8 Multiple Barrel Culverts 6-8
6.2.9 Culvert Skew 6-8
6.2.10 Buoyancy 6-8
6.2.11 Debris and Trash Racks 6-9
6.3 Installation 6-9
6.3.1 Bedding Material 6-9
6.3.2 Backfill 6-9
6.4 Environmental Considerations and Fishery Protection 6-9
6.5 Maintenance Requirements 6-10

Appendix 6A – Aids for Stormwater Culvert Design, From Chapter 8, VDOT Drainage Manual

Chapter 7 Storm Drains

7.1 References 7-1
7.2 Design Methodology and Criteria 7-1
7.2.1 Computation Methods 7-1
7.2.2 Hydrology 7-2
7.2.3 Design Flows 7-2
7.2.4 Measures to Convey Stormwater Runoff to Inlets 7-3
7.2.5 Storm Drain Inlets 7-4
7.2.6 Storm Drain Pipes 7-6
7.2.7 Determination of Hydraulic Grade Line 7-7
7.2.8 100-Year Conditions 7-10
7.2.9 Materials 7-10
7.2.10 Structural Design 7-11
7.3 Installation 7-11
7.3.1 Bedding Material 7-11
7.3.2 Backfill 7-11
7.3.3 Separation of Utilities 7-12
7.4 Environmental Impacts 7-12
7.5 Erosion Protection at Outfalls 7-12
7.6 Maintenance Requirements 7-12

Appendix 7A – Aids for Storm Drain System Design, From Chapter 9, VDOT Drainage Manual

Appendix 7B – Installation Procedures

Chapter 8 Residential Lot Drainage (RESERVED)

Chapter 9 Stormwater Detention

9.1 References 9-2
9.2 Design Methodology and Criteria 9-2
9.2.1 Hydrology 9-2
9.2.2 Design Flows and Storage Volumes 9-2
9.2.3 Minimum Contributing Drainage Area 9-2
9.2.4 Detention Facility Locations 9-2
9.2.5 Basin Grading 9-3
9.2.6 Embankments and Emergency Spillways 9-4
9.2.7 Outlet Structures and Release Rates 9-4
9.2.9 Water Quality 9-6
9.2.10 Landscaping 9-6
9.2.11 Underground Detention 9-6
9.2.12 Trash Racks 9-7

9.3 Environmental Impacts 9-7
9.4 Maintenance Requirements 9-7

Chapter 10 Energy Dissipation

10.1 References 10-1
10.2 Design Methodology and Criteria 10-2
10.2.1 Outlet Velocity 10-2
10.2.2 Erosion Control Stone 10-2
10.2.3 Riprap Outlet Basins 10-2
10.2.4 Baffled Outlets 10-3
10.2.5 Energy Dissipator for Paved Areas 10-4
10.2.6 Additional Energy Dissipators 10-4
10.3 Installation Requirements 10-5
10.4 Easements 10-5
10.5 Environmental Impacts 10-5
10.6 Maintenance Requirements 10-5

Appendix 10A – Aids for Energy Dissipation Design, From VDOT Drainage Manual

Appendix 10B – Aids for Energy Dissipation Design, From VDOT Road and Bridge Standards

Appendix 10C – Energy Dissipation Design Schematics

Chapter 11 Stormwater Pollutant Removal Practices

11.1 References 11-1
11.2 Stormwater Quality Requirements 11-1
11.3 Stormwater Quality Calculations 11-2
11.3.1 BMP Selection Using Performance-Based Criteria 11-2
11.3.2 BMP Selection Using Technology-Based Criteria 11-5
11.3.3 Water Quality Volume (WQV) 11-5
11.4 Non Structural BMPs 11-5
11.5 Structural BMPs 11-6
11.5.1 General Selection Criteria Information 11-6
11.5.2 Vegetated Filter Strip 11-7
11.5.3 Grassed Swale 11-9
11.5.4 Constructed Wetlands 11-12
11.5.5 Extended Detention and Enhanced Extended Detention Ponds 11-15
11.5.6 Retention Ponds 11-18
11.5.7 Bioretention Filter 11-21

11.5.8 Infiltration Devices 11-24
11.5.9 Sand Filter 11-29
11.5.10 Oil Water Separator 11-31
11.5.11 Permeable Pavement 11-33
11.5.12 Manufactured BMP Systems 11-36

Appendix 11A – Aids for Simple Method Calculations, From VA SWM Handbook, Chapter 5 and Appendix 5D

Chapter 12 Environmentally Sensitive Areas

12.1 References 12-1
12.2 Floodplains 12-2
12.2.1 Applicant Flood Study Requirements 12-3
12.2.2 Floodplain Delineation 12-5
12.3 Steep Slopes 12-5
12.3.1 Development Restrictions 12-5
~~12.3.2 Design Standards ..... 12-5~~
12.4 Stream Buffers 12-6
12.5 Critical Erosion Areas 12-6
12.6 Karst Geology 12-7
12.7 Stormwater Hot Spots 12-8
12.7.1 Design Restrictions 12-9
12.7.2 Golf Course Development 12-9

Appendix 12A – Design Aids, From Local Assistance Manual, Chesapeake Bay Local Assistance Department

Chapter 13 Geotechnical Studies (RESERVED)

Chapter 14 Maintenance of Stormwater Management Facilities

14.1 Responsibility for Maintenance 14-1
14.2 Maintenance Agreements 14-2
14.3 Maintenance Program 14-2
14.3.1 Earthen Embankments 14-6
14.3.2 Principal Spillways 14-7
14.3.3 Emergency Spillway 14-8
14.3.4 Sediment Forebay 14-9
14.3.5 Landscaping 14-10
14.3.6 Stormwater Detention and Retention Basins 14-11
14.3.7 Constructed Wetlands 14-12
14.3.8 Infiltration Practices 14-13

14.3.9 Bioretention Filter 14-16
14.3.10 Sand Filters 14-17
14.3.11 Grassed Swale 14-18
14.3.12 Vegetated Filter Strip 14-19
14.3.13 Manufactured BMP System 14-20
14.3.14 Conservation Areas 14-21
14.3.15 Underwater Detention Facilities 14-22
14.3.16 Oil Water Separator 14-23
14.4 Additional Maintenance and Repair 14-24
14.5 Inspection and Maintenance Records 14-24
14.6 References 14-24

Appendix 14A – Maintenance Agreements
Appendix 14B – Maintaining Your BMP, A Guidebook for Private Owners and Operators in Northern Virginia

Chapter 15 Inspection and Enforcement

15.1 Construction Inspections 15-1
15.1.1 Notifications to the County of Roanoke 15-1
15.1.2 Periodic Inspections 15-2
15.1.3 Final Inspection and As-Built Documentation 15-3
15.2 Post-Construction Inspections and Maintenance 15-4
15.3 Records 15-4
15.4 Enforcement 15-5
15.4.1 Notice of Violation 15-5
15.4.2 Stop Work Orders 15-5
15.4.3 Penalties 15-6
15.4.4 Restoration of Land 15-6

Appendix 15A – Inspection Forms