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Executive Summary

JONES FALLS WATERSHED
WATER QUALITY
MANAGEMENT PLAN

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EXECUTIVE SUMMARY

BACKGROUND

The Jones Falls watershed is located in west-central Baltimore County and the City of Baltimore (see Figure E-1). The drainage features of the watershed are dominated by Jones Falls which discharges to Lake Roland. The stream resumes flow at the base of the reservoir for approximately 4,000 feet to the Baltimore City line between Interstate 83 and Route 25. From the City line, the stream flows in a generally south-southeasterly direction through the City until it discharges to the Patapsco River at the Northwest Harbor. This plan only addresses the Baltimore County portion of the watershed.

The total watershed area in Baltimore County is approximately 26,000 acres or 40 square miles. The watershed generally extends from Reisterstown Road in the vicinity of Owings Mills to west; Greenspring Avenue to Broadway Road and Padonia Road to the north; Towson to the east; and the Baltimore City line to the south. For the purposes of this study the eight sub-watersheds were defined including the mainstem of Jones Falls above Lake Roland (Sub-watershed 1), North Branch (Sub-watershed 2), Dipping Pond Run (Sub-watershed 3), Deep Run (Sub-watershed 4), Roland Run (Sub-watershed 5), Towson Run (Sub-watershed 6), Lower Jones Falls (Sub-watershed 7) and Slaughterhouse/Moores Branch (Sub-watershed 8) (see Figure E-2).

Historically, the Jones Falls watershed, as well as many other watersheds in the County, have been adversely impacted by land development, nonpoint source pollution, mining and agricultural activities. These impacts have included loss and degradation of natural habitat, stream channel erosion, and increased sediment, nutrient and other pollutant loads. The purpose of this plan is to assist Baltimore County in the identification and evaluation of nonpoint source pollution in the watershed and provide a watershed restoration framework for the Baltimore County Department of Environmental Protection and Resource Management's (DEPRM) Capital Improvement Program. The plan will also be used in part to comply with Federal mandates under the National Pollutant Discharge Elimination System - Municipal Stormwater Permit.

To assist in the preparation of the plan, several tasks were executed to identify the water quality and habitat problems and potential restoration measures in the watershed and its eight sub-watersheds. The tasks included:

- Review of existing data to determine watershed characteristics.

- Water quality modeling to determine existing and future nonpoint source pollutant loading characteristics.

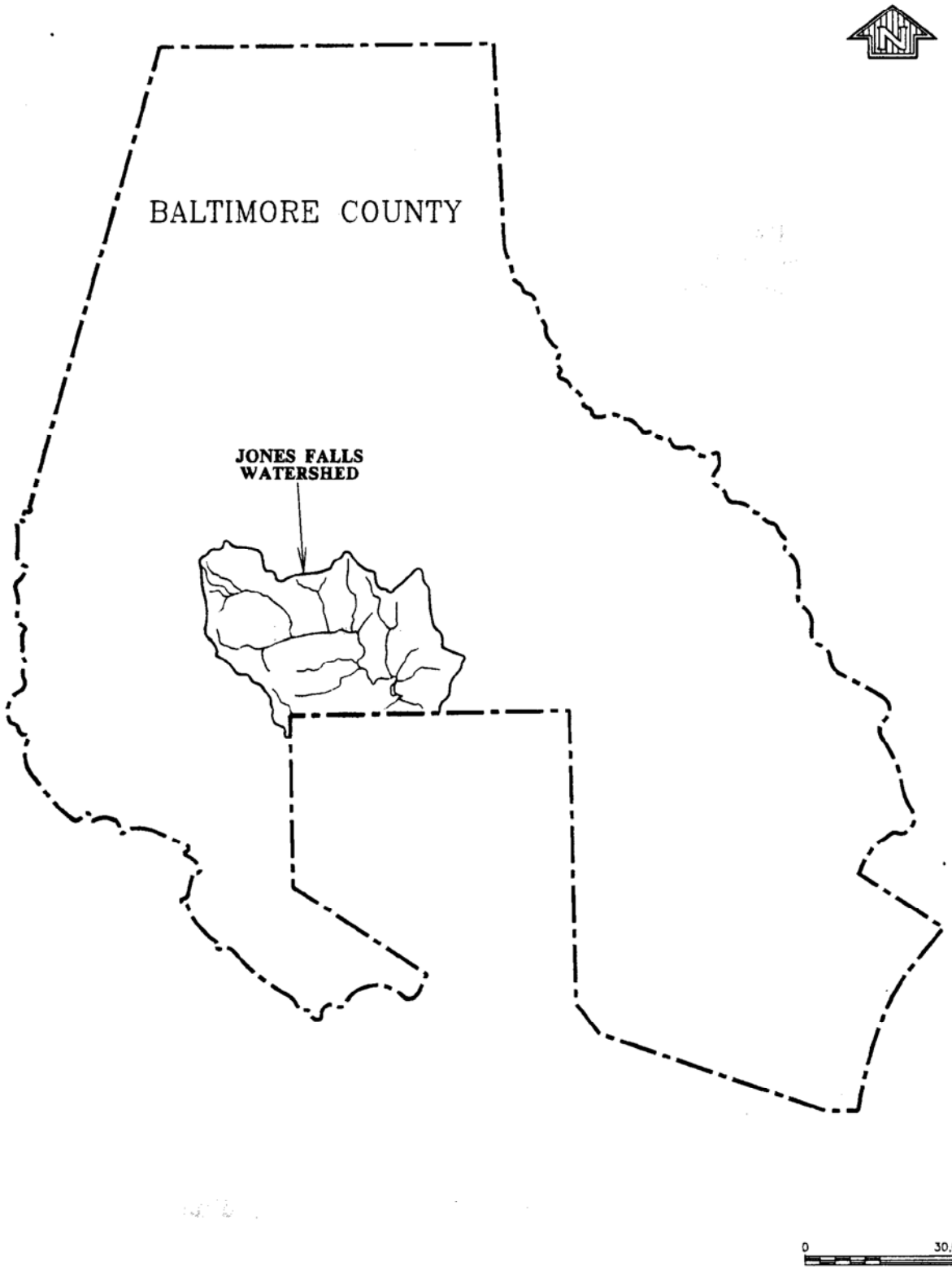

FIGURE E-1
REGIONAL LOCATION MAP FOR
JONES FALLS WATERSHED

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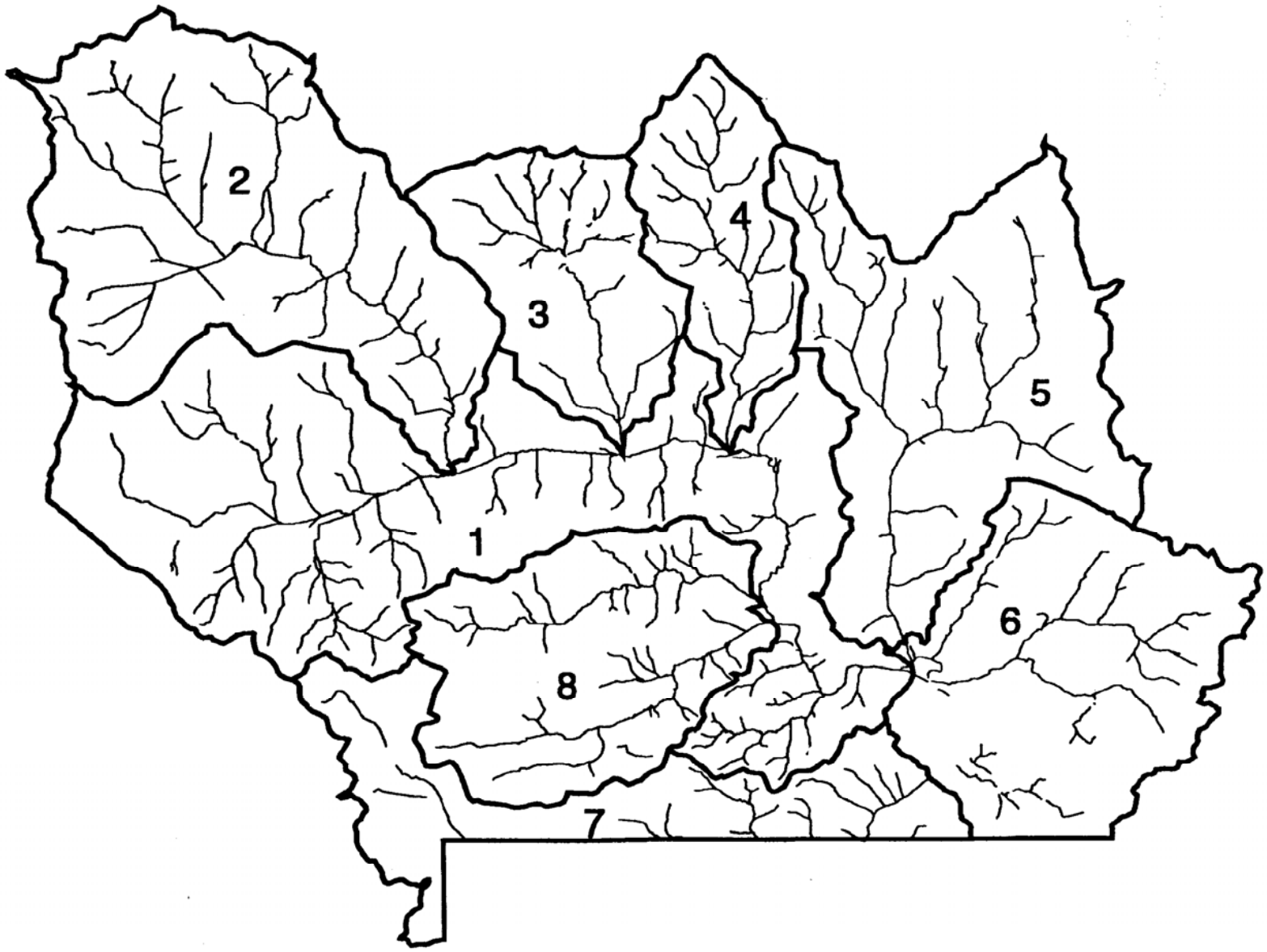

Figure E-2

Jones Falls Watershed

Sub-Watershed Map

Streams

Sub-Watershed Boundaries

1 Jones Falls
2 North Branch
3 Dipping Pond Run
4 Deep Run
5 Roland Run
6 Towson Run
7 Lower Jones Falls
8 Slaughterhouse/ Moores Branch

N

1 in. = 6000 ft.

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- Stream channel surveys to identify Level I Rosgen stream classifications for second order and higher stream channels (e.g., third and fourth order), unforested 100-foot riparian buffer, fish migration barriers, Level II Rosgen classifications on selected and stream segments, and other data.

- Summary and ranking of water quality and habitat problems.

- Evaluation and ranking of potential restoration measures.

Four principal goals were identified for the restoration of the Jones Falls watershed. These goals were identified following a review of the water quality and habitat problems and discussions with DEPRM staff:

- Reduce nonpoint source pollutant loads in the watershed.

- Reduce sediment inputs to Lake Roland.

- Protect and restore riparian and aquatic habitat in the watershed.

- Provide the framework for master plan, zoning, water and sewer extension and other growth management-related decisions in the watershed.

EXISTING WATERSHED CHARACTERISTICS

The Jones Falls watershed is located in the Piedmont Plateau physiographic province. The topography in this province can be characterized as rolling. Elevations range from approximately 220 feet above mean sea level where Jones Falls enters the City of Baltimore to approximately 700 feet in the far northwest corner of the watershed. The three principal areas of low relief in watershed include Green Spring Valley, in which the mainstem of Jones Falls is located, The Caves in the North Branch sub-watershed, and large portions of the Roland Run sub-watershed.

The watershed is generally underlain by crystalline rocks; primarily gneiss, quartzite, schist and marble. The overburden consists of disintegrated and decomposed rock, and the stream valleys typically consist of alluvium and colluvium. Three-fourths are classified as Group B soils which have moderate infiltration rates, and are moderately deep to deep and moderately well to well drained.

The existing land uses in the watershed are dominated by medium-density residential (25 percent), forest (24 percent) and low-density residential (21 percent) (see Table E-1). Cropland, open urban, high-density residential and commercial / industrial are also common in the watershed with acreages ranging from 2,922 to 1,006 acres, or 11 to 4 percent of the watershed. The most developed areas occur in the eastern and southern portions of the watershed. From a percent imperviousness basis, sub-watersheds 5, 6 and 7 are the most

Table E-1
Existing Land Use in the Jones Falls Watershed, Baltimore County
Aggregated Sub-watersheds and Land Uses
Maryland State Office of Planning 1990 Level II Land Use Data

	Aggregated Sub-watersheds								
Aggregated Land Use	1 - Jones Falls	2 - North Branch	3 - Dipping Pond Run	4 - Deep Run	5 - Roland Run	6 - Towson Run	7 - Lower Jones Falls	8 - Slaughterhouse and Moores Branches	Total (acres)
Low-density Residential	1,604	1,444	519	632	287	233	159	599	5,477
Medium-density Residential	884	3	50	86	2,036	1,826	719	808	6,412
High-density Residential	259	0	0	55	226	271	193	92	1,096
Commercial/Industrial	161	7	0	0	492	176	161	9	1,006
Open Urban	165	72	183	124	254	179	448	11	1,436
Pasture	355	75	228	38	29	1	32	98	856
Bare Ground	59	0	0	0	55	0	44	148	306
Cropland	904	1,182	289	179	200	0	0	168	2,922
Forest	2,144	1,762	490	323	242	362	255	737	6,315
Water/Wetlands	1	0	0	0	0	110	2	0	113
Totals (acres)*:	6,536	4,545	1,759	1,437	3,821	3,158	2,013	2,670	25,939

* Total values are approximate. Due to rounding or GIS adjustments, watershed and sub-watershed acreages may vary slightly from those reportedly elsewhere in this report.

Filename: landuse1.xls, sheet 4.

intensely developed with percents imperviousness of 30.2, 29.6 and 24.4, respectively. Sub-watersheds 8, 1 and 4 are moderately developed with percents imperviousness of 14.2, 13.0 and 11.6. respectively. Sub-watershed 3 and 2 are the least developed and have percents imperviousness of 7.1 and 6.4 respectively.

Under future land use conditions, the two most predominate land uses will be low-density residential (38 percent) and medium-density residential (24 percent) (see Table E-2). Forest (9 percent), open urban (6 percent), high-density residential (6 percent), cropland (6 percent) and commercial / industrial (5 percent) land uses will also be common. Sub-watersheds 5, 6 and 7 will remain the most developed in the watershed and will exhibit future percents imperviousness of 33.2, 37.7 and 29.6, respectively (see Table E-3). The remaining sub-watersheds will experience moderate increases in development and will exhibit percents imperviousness ranging from 9.8 percent in Sub-watershed 2 to 18.6 percent in Sub-watershed 8.

Based on limited water quality monitoring data from a station located on the mainstem of Jones Falls above Lake Roland, baseflow water quality is typically good and generally in compliance with Maryland Use designations except for water temperature. Jones Falls and its tributaries above Lake Roland are designated as Use III waters - reproducing trout. Instantaneous water temperature readings indicate that violations of the maximum water temperature limit for Use III waters occur regularly during the summer months. Jones Falls downstream of Lake Roland is designated as Use IV - recreational trout. Several small streams in Sub-watershed 7 that discharge to the mainstem of Jones Falls within the City of Baltimore are designated as Use I waters - water contact recreation and protection of aquatic life.

Stormwater runoff in developed areas of the watershed is conveyed by 61 major outfalls and 355 minor outfalls (see Table E-3). The majority of these outfalls convey stormwater runoff to the stream system without quantity or quality controls. Quantity and quality controls are currently provided by approximately 91 facilities. The majority of these stormwater management (SWM) facilities are detention ponds (39 ponds). The second most commonly utilized practice is underground detention (26 facilities). Collectively, all 91 facilities provide stormwater runoff or water quality control for approximately 1,221 acres or only 12 percent of the developed areas of the watershed. Much of the developed areas of the watershed, therefore, contribute uncontrolled stormwater runoff to the stream systems.

Ecological resources that were reviewed during the course of this study included wetlands, fisheries and benthic macroinvertebrates. National Wetland Inventory (NWI) mapping indicates that the majority of the stream channels in the watershed have been labeled as either forested, emergent, scrub-shrub or riverine wetlands. There are, however, more extensive stream valley wetlands in selected floodplain areas of all but sub-watersheds 4 and 8.

Table E-2
Future Land Use in the Jones Falls Watershed, Baltimore County
Aggregated Sub-watersheds and Land Uses
Baltimore County Zoning Category Land Use Data

Aggregated Land Use	Aggregated Sub-watersheds: 1 - Jones Falls	2 - North Branch	3 - Dipping Pond Run	4 - Deep Run	5 - Roland Run	6 - Towson Run	7 - Lower Jones Falls	8 - Slaughterhouse and Moores Branches	Total (acres)
Low-density Residential	2,937	2,491	957	965	531	421	263	1,229	9,794
Medium-density Residential	1,014	0	50	59	2,084	1,327	737	976	6,247
High-density Residential	317	0	0	54	236	727	189	93	1,616
Commercial/Industrial	257	10	0	39	569	266	254	9	1,404
Open Urban	220	215	183	124	254	179	447	11	1,633
Pasture	242	425	118	37	0	0	0	0	822
Bare Ground	59	0	0	0	55	0	44	149	307
Cropland	663	696	208	2	0	0	0	0	1,569
Forest	824	708	243	156	92	128	69	205	2,425
Water/Wetlands	1	0	0	0	0	111	1	0	113
Totals (acres)*:	6,534	4,545	1,759	1,436	3,821	3,159	2,004	2,672	25,930

* Total values are approximate. Due to rounding or GIS adjustments, watershed and sub-watershed acreages may vary slightly from those reported elsewhere in this report.

Filename: landuse1.xls, sheet 5.

Table E-3

Summary of Water Quality-Related Problems

(Sheet 1 of 2)

FACTOR	SUB-WATERSHED								TOTALS
	1	2	3	4	5	6	7	8	
Sub-watershed Drainage Area (acres)	6,536	4,545	1,759	1,437	3,821	3,158	2,025	2,670	25,951
Total Length of Stream Channel (excluding 1st order)(feet)	89,230	54,910	20,590	18,480	46,990	34,850	10,560	32,740	308,350
Rosgen Level I Stream Classifications (feet)(a)									
"A" Class Channel	950	640	160	880	200	0	0	0	2,830
"B" Class Channel	6,300	7,840	160	2,320	3,750	500	200	1,940	23,010
"C" Class Channel	12,960	12,400	160	0	3,570	0	2,320	800	32,210
"D" Class Channel	1,700	0	0	0	400	0	0	0	2,100
"E" Class Channel	3840	800	880	0	4,920	0	800	0	11,240
"F" Class Channel	50,200	29,840	13,760	13,480	31,060	22,800	6,440	25,220	192,800
"G" Class Channel	6,300	120	5,560	1,760	3,950	6,500	1,280	3,280	28,750
Streambank Erosion (a)									
Length of Affected Streambank (feet)	9,900	3,040	1,840	1,040	4,650	7,000	880	5,520	33,870
Percent of Total Streambank (b)	6	3	4	3	5	12	4	9	6
Number of Debris Blockages (a)	5	3	1	0	7	0	0	0	16
Unforested 100-foot Riparian Buffer (a)									
Length of Affected Streambank (feet)	35,150	13,680	4,760	9,440	42,100	17,800	14,880	14,160	151,970
Percent of Streambank (b)	21	13	12	26	44	30	67	23	26
Magnitude of Mining Impacts (a)	None	None	None	None	None	None	None	Moderate	NA
Magnitude of Agricultural Impacts (a)	High	Moderate	Low	Moderate	Moderate	None	Low	Low	NA
Number of Man-made Fish Barriers (a)	6	2	7	2	9	7	2	1	36
Stormwater Management Facilities (c)									
Number of Facilities	27	7	2	6	22	15	5	7	91
Drainage Area Controlled (acres)	425	99	6	131	256	82	21	201	1221
Percent of Developed Drainage Area Controlled (d)	25	27	3	44	9	4	2	19	12
Stormwater Outfalls (c)									
Major Stormwater Outfalls	8	2	1	1	25	5	10	9	61
Minor Stormwater Outfalls	96	55	8	8	72	40	16	60	355
Numb[illegible]cit Discharges (a)	0		2	0	4	0	7	0	13

Tab

Summary of Water Quality-Related Problems

(Sheet 2 of 2)

FACTOR	SUB-WATERSHED 1	2	3	4	5	6	7	8	TOTALS(g)
Percent Imperviousness (e)									
Existing Conditions	13.0	6.4	7.1	11.6	30.2	29.6	24.4	14.2	20.5
Future Conditions	17.9	9.8	10.2	16.4	33.2	37.7	29.3	18.6	25.4
13-year Average Pollutant Loads (lb/acre/year)(f)									
Existing Total Suspended Solids	141	101	104	146	163	149	152	163	109
Future Total Suspended Solids	164	145	145	163	164	151	152	184	128
Percent Change TSS	16	43	39	12	1	1	0	13	17
Existing Total Nitrogen	5.7	4.1	4.2	5.8	6.5	6.0	5.9	5.9	2.9
Future Total Nitrogen	6.4	5.8	5.7	6.2	6.5	6.2	6.0	6.3	3.4
Percent Change TN	12	41	36	7	0	3	2	7	7
Existing Total Phosporus	0.41	0.36	0.37	0.44	0.56	0.50	0.47	0.40	0.24
Future Total Phosphorus	0.51	0.49	0.47	0.48	0.58	0.54	0.53	0.50	0.30
Percent Change TP	24	36	27	9	4	8	13	25	25
Existing Biochemical Oxygen Demand - 5 Day	13	9	10	11	22	17	16	11	8
Future Biochemical Oxygen Demand - 5 Day	14	12	11	10	23	20	20	9	9
Percent Change BOD	8	33	10	-9	5	18	25	-18	12
Existing Zinc	0.12	0.04	0.05	0.11	0.29	0.46	0.26	0.12	0.08
Future Zinc	0.16	0.06	0.06	0.13	0.32	0.50	0.31	0.15	0.10
Percent Change Zinc	33	50	20	18	10	9.00	19	25	25.00

(a) Data summaries and percentages only apply to the stream sections that were evaluated during the overview assessment. These data summarizes and percentages may not be representative of non-surveyed channels (i.e., first order streams). Modified as appropriate based on Chapter 5's Level II findings.

(b) Total streambank length is equal to twice the length of the stream channel.

(c) Developed from Baltimore County GIS database.

(d) For discussion purposes, developed areas are defined as commercial/industrial, high-density residential, medium-density residential and 25% of low-density residential. The removal of 75% of the low-density residential area was selected to represent the land uses exempt from County stormwater management quantity and quality controls (i.e., residential developments with lots 2 acres or more in size). The existing land use data base does not differentiate lot size. Therefore, the 75% removal value was selected on the basis of general field observations.

(e) Developed from Tables 2-6, 2-7 and 3-9.

(f) Developed from Tables 3-22 and 3-24.

(g) Pollutant load totals represent conditions at Lake Roland dam.

The Maryland Department of Natural Resources (MDNR) describes Jones Falls as a high quality stream that supports a healthy, self-sustaining brown trout population from its headwaters to Lake Roland. Upstream of Stevenson Road, Jones Falls and its tributaries are managed by MDNR as a trout fishing area limited to persons under 16 years of age and above 65 years of age. Downstream of Stevenson Road, Jones Falls and its tributaries are under a state-wide two fish per person limit. Although designated as Use III waters, the trout fishery in sub-watersheds 5 and 6 have likely been severely damaged or destroyed due to the high levels of development that exist in those sub-watersheds. Watersheds with imperviousness values greater than 11 to 14 percent are considered unable to support reproducing trout populations because of devastating thermal impacts that are associated with urban runoff.

Nine benthic macroinvertebrate monitoring stations have been established in the Jones Falls watershed by Save Our Streams (SOS). Only one station on the mainstem of Jones Falls above Lake Roland and individual stations on North Branch and Dipping Pond Run have favorable ratings of good/fair based on a recent four-year monitoring period. Other ratings in the watershed include fair (mainstem of Jones Falls upstream of Lake Roland), fair/poor (mainstem of Jones Falls upstream and downstream of Lake Roland) and poor (Roland Run, Towson Run and Moores Branch).

WATER QUALITY MODELING RESULTS

Surface loading, wash-off and stream transport of eleven pollutants were simulated for existing and future conditions using the Surface Water Management Model (SWMM), Version 4.30. The results of the modeling exercise confirmed that elevated pollutant loadings are occurring in the developed portions of the watershed and that these pollutant loadings will increase substantially in selected sub-watersheds under future land use conditions. A discussion of total phosphorus (TP) and total suspended solids (TSS) are provided below.

Using 13-year average values, TP loadings currently range from a low of 0.36 pounds per acre year (lb/ac/yr) or 1,636 pounds per year (lb/yr) in Sub-watershed 2 to a high of 0.56 lb/ac/yr or 2,140 lb/yr in Sub-watershed 5 (see Table E-3). Under future land use conditions, the TP loadings will increase from 4 to 36 percent. The largest increases will occur in the sub-watersheds that currently exhibit more rural characteristics, and therefore, provide greater opportunities for growth and development as permitted by zoning. These rural sub-watersheds include 1, 2, 3 and 8. TP loadings in these four sub-watersheds will increase from 24 to 36 percent.

Using 13-year average values, TSS loadings currently range from a low of 101 lb/ac/yr or 459,045 lb/yr in Sub-watershed 2 to a high of 163 lb/ac/yr or 622,823 lb/yr in Sub-watershed 5 (see Table E-3). Under future land use conditions, the TSS loadings will increase up to 43 percent. Like TP, the largest increases will occur in the sub-watersheds that currently exhibit more rural characteristics and provide greater opportunities for growth

and development. From a TSS loading perspective, the largest increases will occur in sub-watersheds 2 and 3 (i.e., 43 and 39 percent, respectively).

STREAM CHANNEL CHARACTERISTICS

Based on the Rosgen Level I classifications, the predominant channel types in the Jones Falls watershed are F class (71 percent), G class (10 percent), C class (9 percent) and B class (7 percent) (see Table E-3). Smaller sections of A, D and E class channels are also present. Approximately 33,870 linear feet of streambank erosion is present in the watershed. This represents approximately 6 percent of total streambank. Approximately 151,970 linear feet of unforested 100-foot riparian buffer is also present, which represents approximately 26 percent of total streambank. Approximately 36 man-made fish barriers are also present throughout the watershed.

RANKING OF WATER QUALITY AND HABITAT ISSUES

Tables E-4 and E-5 provide rankings water quality and habitat problems within the watershed and sub-watersheds, respectively. Based on the evaluations that were completed for this study, the general ranking of water quality and habitat problems in the watershed from highest to lowest is:

- Unstable stream channels,
- Elevated percent imperviousness,
- Elevated pollutant loads,
- Uncontrolled stormwater runoff,
- Unforested riparian buffer, and
- Fish Migration Barriers.

All of these problems are interrelated and the significance of each issue varies by sub-watershed. A principal factor that affects the ranking of these problems within sub-watersheds is water use designations. Sub-watersheds 1 through 6 and 8 are designated as Use III - reproducing trout waters. Sub-watersheds 5 and 6, however, have been intensely developed and likely no longer support viable trout populations. Sub-watershed 7 includes Use IV - recreational trout waters (mainstem of Jones Falls downstream of the Lake Roland Dam) and Use I - water contact recreation and aquatic life waters.

Unstable stream channels are considered significant because of the presence of D, F and G class channels in the watershed that are in disequilibrium. These channels commonly suffer from floodplain infringement; flashy, high-powered flows that incise and widen channels; and convey excessive bedloads. They are also sources of elevated pollutant loads and sediment, which is of particular significance to Lake Roland sedimentation rates, and often associated with unforested riparian buffers. From a stream channel stability perspective, the sub-watersheds are ranked from worst to best as 6, 3, 8, 4, 5, 1, 7 and 2. It is the top-ranked problem in sub-watersheds 3 and 6.

Table E-4
Ranking of Sub-watershed Water Quality and Habitat Problems
Jones Falls Watershed

Sub-watershed	Existing Water Quality and Habitat Problems (a)						Overall Sub-watershed Score (h)	Ranking within Watershed (i)
	Unstable Stream Channels (c)	Percent Impervious	Pollutant Loads (d)	Unforested Riparian Buffers (e)	Fish Migration Barriers (f)	Uncontrolled Stormwater Runoff (g)		
1	3	4	4	3	3	3	0.42	7
2	1	1	1	2	2	2	0.17	8
3	7	2	2	1	8	7	0.53	5
4	5	3	5	5	4	1	0.48	6
5	4	8	8	7	6	5	0.74	2
6	8	7	7	6	7	6	0.88	1
7	2	6	6	8	5	8	0.67	3
8	6	5	3	4	1	4	0.54	4
Weighting Factors (b)								
Group A	15	5	10	5	0	10		
Group B	15	15	10	10	5	10		

(a) Sub-watersheds are ranked from 1 to 8 for each of the six water quality and habitat problems. The sub-watershed having the worst conditions for a particular problem receives a rank of 8. The sub-watershed having the best conditions for a particular problem receives a score of 1.

(b) Weighting factors are assigned to each problem according to the importance of the problem to overall sub-watershed and watershed water quality and habitat conditions. The larger the weighting factor indicates the greater the signficance of the problem.

Group A - Applies to sub-watersheds 5, 6 and 7, which do not have viable reproducing trout populations.

Group B - Applies to sub-watersheds 1, 2, 3, 4, 8, which have viable reproducing trout populations.

(c) Based on Level I Rosgen classifications of D, F and G as percentages (see Table 6-1).

(d) Based on 13-year average for all land uses in pounds of total phosphorus per acre per year (see Table 6-1).

(e) Based on percent of total streambank of unforested riparian buffer (see Table 6-1).

(f) Based on number of barriers per mile of stream channel (developed from Table 6-1).

(g) Based on percent of developed areas that are potentially subject to SWM regulations and are presently controlled by SWM facilities (see Table 6-1).

(h) Overall sub-watershed scores were obtained by multipying individual problem rankings within a sub-watershed by their respective weighting factors, and then summing the products for each sub-watershed. This product was then divided by the highest possible score for the group in which the sub-watershed is located in. The highest possible scores are 360 for Group A and 520 for Group B. The higher the resulting value the greater the sub-watershed rank.

(i) ings are directly proportional to overall score; thus, the sub-watershed th est score (i.e., the most significant problems) receives a rank of 1.

Table E-5
Ranking of Water Quality and Habitat Problems within Sub-watersheds
Jones Falls Watershed

Sub-watershed	Unstable Stream Channel Conditions	Percent Imperviousness	Pollutant Loads	Unforested Riparian Buffer	Uncontrolled Stormwater Runoff	Fish Migration Barriers (a)
1 - Jones Falls	3	1	4	2	5	6
2 - North Branch	3	4	5	1	2	6
3 - Dipping Pond Run	1	4	3	5	2	6
4 - Deep Run	4	1	3	2	5	6
5 - Roland Run	3	5	1	4	2	6
6 - Towson Run	1	5	2	4	3	6
7 - Lower Jones Falls	4	5	2	3	1	6
8 - Slaughterhouse/Moores Br.	2	1	5	3	4	6

(a) Although migration barriers can have long-term impacts on the quality and extent of a trout fishery, in the short-term it was considered more important to maintain or improve the quality of the habitat for the existing fishery. Therefore, fish migration barriers were ranked sixth in all sub-watersheds.

Elevated percent imperviousness is considered significant because of correlations with thermal enhancement of stormwater runoff, which is of concern to the Use III sub-watersheds. Percent imperviousness is also correlated with pollutant loads and runoff volumes. From a percent imperviousness perspective, the sub-watersheds are currently ranked from worst to best as 5, 6, 7, 8, 1, 4, 3 and 2. It is the top-ranked current problem in sub-watersheds 1, 4 and 8. Under future land use conditions, percent imperviousness will reach critical levels in sub-watersheds 1, 4 and 8.

Elevated pollutant loads are considered significant because of water quality and habitat degradation. Elevated pollutant loads are correlated with percent imperviousness, stream channel stability and level of controls provided by stormwater management facilities. From a pollutant load perspective, the sub-watersheds are currently ranked from worst to best as 5, 6, 7, 4, 1, 8, 3 and 2. It is the top-ranked current problem in Sub-watershed 5. Under future land use conditions, nonpoint source pollutant loads will increase significantly if left uncontrolled.

Uncontrolled stormwater runoff is considered significant because of associated pollutant loads and runoff volumes and peaks. The uncontrolled runoff contributes to water quality, stream channel and habitat degradation. From a uncontrolled runoff perspective, the sub-watersheds are ranked from worst to best as 7, 3, 6, 5, 8, 1, 2 and 4. It is the top-ranked problem in Sub-watershed 7.

Unforested riparian buffers are considered significant because of the pollutant removal, stream channel shading, streambank stabilization and habitat benefits that they would provide if present. The stream shading benefits are of particular importance for the Use III waters. From an unforested riparian buffer perspective, the sub-watersheds are ranked from worst to best as 7, 5, 6, 4, 8, 1, 2 and 3. It is the top-ranked problem in Sub-watershed 2.

Fish migration barriers impede the migration and movement of fish within a stream system. From a fish migration barrier perspective, the sub-watersheds are ranked from worst to best as 3, 6, 5, 7, 4, 1, 2 and 8. Although migration barriers can have long-term impacts on the quality and extent of a trout fishery, in the short-term it was considered more important to maintain or improve the quality of the habitat for the existing fishery. Therefore, fish migration barriers were ranked sixth in all sub-watersheds.

RECOMMENDED RESTORATION MEASURES

Watershed and sub-watershed restoration measures were evaluated after the water quality and habitat problems had been defined, summarized and ranked. This evaluation considered the four principal goals that were established for watershed restoration. Initially four case study areas in the watershed were evaluated as part of the study. The case study areas were selected as being generally representative of water quality and habitat problems in the watershed. The case study areas included:

- Roland Run beginning at Business Park Drive and continuing downstream for approximately 2,000 feet.

- Towson Run beginning at the upstream end of Towsontown Boulevard road crossing and continuing upstream for approximately 2,000 feet.

- Unnamed stream in Sub-watershed 7 beginning near the intersection of Wallis and Park Heights avenues and continuing upstream for approximately 2,000 feet.

- Mainstem of Jones Falls beginning at Old Valley Road and continuing upstream for approximately 2,000 feet.

Since these case studies encompassed the majority of the problems in the watershed, restoration options that were developed and evaluated for them were used to prepare integrated restoration plan for each of the eight sub-watersheds. The options were presented as source-based controls (e.g., new and retrofitted ponds, outfall BMPs, reforested buffers and agricultural BMPs) and stream-based controls (e.g., re-establishment of a stable channel using methodology developed by Rosgen).

The recommended source-based controls include:

- Retrofits of three existing dry ponds to extended detention wet ponds.

- Construction of BMPs to control runoff conveyed by 32 major outfalls and 141 minor outfalls. These BMPs would use dry pond technology in sub-watersheds 1, 2, 3, 4 and 8 to minimize potential thermal impacts. The BMPs in sub-watersheds 5, 6 and 7 would use wet pond technology.

- Installation of up to 96 Stormceptor Units to control runoff from existing uncontrolled high-density residential and commercial / industrial land use areas. Widespread application of this relatively new technology would not occur until and unless current County test applications of the units support widespread use. Alternatively, water quality inlets with sand filters are recommended.

- Reforestation of stream buffers along 26,680 linear feet of streambank in agricultural areas and 26,249 linear feet of streambank in low-density residential areas.

- Use of conservation tillage on 381 acres of cropland that is currently managed with conventional tillage.

On a watershed-wide basis, these recommended source-based restoration measures would result in a 10 percent reduction in existing TP loads and a 12 percent reduction in TSS loads (see Table E-6). The TSS reductions, however, would have minimal impact on reducing the existing sedimentation rate of Lake Roland.

Potential stream-based controls based on Rosgen Level I classifications include the restoration of approximately 235,410 linear feet of stream channel (see Table E-7). Implementation of these stream-based controls would be expected to result in substantial reductions of pollutant load and Lake Roland sedimentation rates. These reductions, however, are not accurately quantifiable. Furthermore, Rosgen Level II classifications should be performed on stream channels to verify restoration needs and benefits.

The implementation of all recommended source-based measures would cost $13,136,879 for initial capital and design, or $11,771 per pound of TP removed per year and $31 per pound of TSS removed per year. The measures would cost $1,412,437 on an annualized total cost basis, or $1,266 per pound of TP removed per year and $3 per pound of TSS removed per year (see Table E-8). Implementation of all potential stream-based restoration options would cost $28,354,300 in initial capital and design and $1,798,918 on an annualized cost basis.

If funding limitations do not allow the implementation of all recommended measures at the same time, it is recommended that the following guidelines be considered in prioritizing restoration projects. The guidelines are subject to change based on County objectives, acquisition of new data (e.g., completion of Rosgen Level II classifications and BMP-specific studies on thermal impacts), funding limitations and citizen concerns.

1. It is recommended that the sub-watershed restoration generally occur in the following order: 6, 5, 7, 8, 3, 4, 1 and 2.

Restoration order may need to be adjusted to comply with regulatory requirements (e.g., the stormwater NPDES program), to preserve the existing quality of sub-watersheds 1, 2, 3, 4 and 8, or to satisfy other objectives.

2. It is recommended that restoration efforts within a sub-watershed focus on those measures that address each sub-watershed's priority water quality and habitat problems. For those sub-watersheds with a top priority of reducing pollutant loads, the restoration measures that remove the largest quantities of pollutants per year should be implemented first.

3. It is recommended that source-based BMPs in the upper sections of the watershed or sub-watersheds that have definite peak flow reduction capability be implemented before stream-based restoration. The basis for this recommendation is that restored stream channels should be designed for the bankfull flow that will exist after implementation of source-based controls.

Table E-6
Summary of Recommended Source-based Restoration Measures Benefits
Jones Falls Watershed

Factors	Sub-watershed 1	2	3	4	5	6	7	8	Totals
Total Phosphorus									
Existing Base TP Load (lb/yr)(a)	2,680	1,636	651	632	2,140	1,579	952	1,068	11,338
TP Removed by Existing BMPs (lb/yr)(b)	52	11	1	17	43	12	3	24	163
TP Removed by Existing BMPs (%)	2%	1%	0%	3%	2%	1%	0%	2%	1%
TP Removed by Proposed BMPs (lb/yr)(c)	221	146	25	21	360	105	147	91	1,116
TP Removed by Proposed BMPs (%)	8%	9%	4%	3%	17%	7%	15%	9%	10%
TP Removed by Existing & Proposed BMPs (lb/yr)	273	157	26	38	403	117	150	115	1,279
TP Removed by Existing & Proposed BMPs (%)	10%	10%	4%	6%	19%	7%	16%	11%	11%
Total Suspended Solids									
Existing Base TSS Load (lb/yr)(a)	921,576	459,045	182,936	209,802	622,823	470,542	307,800	435,210	3,609,734
TSS Removed by Existing BMPs (lb/yr)(b)	29,963	5,000	312	9,563	20,864	6,109	1,596	16,382	89,788
TSS Removed by Existing BMPs (%)	3%	1%	0%	5%	3%	1%	1%	4%	2%
TSS Removed by Proposed BMPs (lb/yr)(c)	93,951	53,838	8,328	8,043	124,863	41,548	56,261	40,997	427,829
TSS Removed by Proposed BMPs (%)	10%	12%	5%	4%	20%	9%	18%	9%	12%
TSS Removed by Existing & Proposed BMPs (lb/yr)	123,914	58,838	8,640	17,606	145,727	47,657	57,857	57,379	517,617
TSS Removed by Existing & Proposed BMPs (%)	13%	13%	5%	8%	23%	10%	19%	13%	14%
TSS Reduction to Lake Roland by Proposed BMPs (lb/yr)(d)	93,951	53,838	8,328	8,043	124,863	41,548	NA	40,997	371,568
TSS Reduction to Lake Roland by Proposed BMPs (cubic feet/yr)(e)	940	538	83	80	1,249	415		410	3,716
Total Reduction (cubic feet/yr):	3,716								
Total Reduction (% of annual delivery)(f):	1%								

(a) Based on sub-watershed acreages and 13-year average pollutant loadings (see Table 6-1).
(b) Based on existing drainage area controlled and 13-year average pollutant loadings (see Table 6-1). Assumed 30% TP removal and 50% TSS removal by existing BMPs.
(c) Summary of data in Tables 8-2 through 8-9.
(d) Considers only those sub-watersheds that convey flow to Lake Roland.
(e) Based on conversion of 100 lb sediment per cubic foot.
(f) Percentage of 1992 estimate of 23,000 cubic yard annual sediment load to Lake Roland (Phoenix Engineering, 1993).

Table E-7
Potential Stream-based Controls
Sub-watershed Restoration Options
Jones Falls Watershed

	Sub-watershed								
	1	2	3	4	5	6	7	8	Totals
Linear Feet of Unstable Channel (a)	58,200	29,960	19,320	15,240	35,410	29,300	7,720	28,500	223,650
Linear Feet of Best Probable Channel (b)	54,280	29,960	19,320	15,240	34,910	28,180	7,720	28,500	218,110
Cost Per Linear Foot of Restoration (c)	$130	$130	$130	$130	$130	$130	$130	$130	1,040
Capital and Design Cost Per Sub-watershed	$7,056,400	$3,894,800	$2,511,600	$1,981,200	$4,538,300	$3,663,400	$1,003,600	$3,705,000	$28,354,300
Annualized Total Cost (d)	$447,688	$247,103	$159,347	$125,696	$287,929	$232,422	$63,673	$235,061	$1,798,918

(a) Consists of D, F and G class channels.
(b) Consists of B, C and E class channels.
(c) Based on Bird River study (Dames & Moore, 1995).
(d) Annualized total cost based on 6 percent interest and 3 percent inflation, as appropriate.

Table E-8
Summary of Costs to Implement Source- and Stream-based Controls
Jones Falls Watershed

Sub-watershed	Source-based Controls Anualized Total Costs: Total Cost	$/lb TP Removed	$/lb/TSS Removed	Stream-based Controls Annualized Total Costs (a)
1 - Jones Falls	$265,915	$1,202	$3	$447,688
2 - North Branch	$112,926	$775	$2	$247,103
3 - Dipping Pond Run	$17,126	$693	$2	$159,347
4 - Deep Run	$25,084	$1,183	$3	$125,696
5 - Roland Run	$430,512	$1,196	$3	$287,929
6 - Towson Run	$159,394	$1,515	$4	$232,422
7 - Lower Jones Falls	$190,403	$1,298	$3	$63,673
8 - Slaughterhouse/Moores Br.	$108,048	$1,187	$3	$235,061
Totals:	$1,309,408	$1,173	$3	$1,798,919

(a) TP and TSS removals were not quantified for stream-based controls.

IMPLICATIONS UNDER FUTURE LAND USE CONDITIONS

If future growth and redevelopment in the Jones Falls watershed is permitted to proceed under current development patterns, it would result in increases in pollutant loads, percent imperviousness and the frequency of peak flows that exceed bankfull levels. These increases would likely have significant adverse impacts on water quality and habitat.

Under future conditions the total TP load for the Jones Falls watershed will increase by 1 percent. This increase assumes that all of recommended BMPs are implemented and that BMPs will be implemented for future development. Considered independently, this 1 percent increase is respectable based on the level of new development that is expected in portions of the watershed. However, if viewed from the perspective of reducing nutrient loads under the Chesapeake Bay initiative, the 1 percent increase may not be as acceptable. Furthermore, TP increases that range from 7 to 16 percent will occur in four of the five sub-watersheds that are designated as Use III waters and that currently support viable reproducing trout populations. These increases in TP and other nonpoint source pollutants would be expected to adversely impact the water quality and aquatic biology of the Use III stream systems. Therefore, current development patterns will need to be reevaluated and BMPs will need to be more aggressively pursued to reduce or prevent any additional increases in pollutant loads, particularly in sub-watersheds 1, 2, 3, 4 and 8; to reduce overall TP and other pollutant loads from current levels; and to achieve objectives under the Chesapeake Bay initiative.

The percent imperviousness will be at critical levels from a thermal impact concern in three of the five Use III designated sub-watersheds under future conditions (i.e., sub-watersheds 1, 4 and 8). If aggressive measures are not taken to reduce and mitigate impervious levels, these streams may be, at best, reduced to Use IV water conditions (i.e., recreational or put-and-take trout fishery).

An increased frequency in runoff events that equal or exceed bankfull levels are a principal cause of stream channel instability. The increases in these events are likely the result of several factors including the absence of stormwater management controls in areas that were developed prior to the implementation of stormwater management regulations, the approval of stormwater management waivers, and potentially ineffective control requirements under the existing program. With respect to this last point, when stormwater management is required, applicants must take measures necessary to maintain the post-development peak discharges for the 24-hour 2-, 10- and 100-year frequency storm events at a level equal to or less than the respective 24-hour, 2-, 10- and 100-year pre-development peak discharge rates. The control of only 2-year events does not typically result in the control of bankfull events.

To address the potentially significant water quality and habitat issues under future land use conditions, the following recommendations are offered:

- Although dry ponds are generally recommended for use in Sub-watersheds 1, 2, 3, 4 and 8, site-by-site reviews of wet pond technology should be conducted to determine its feasibility in these Use III waters. Site-specific designs may facilitate the use of wet pond technology and its greater pollutant removal efficiencies without thermal impacts.

- Infiltration practices should continue to be considered the preferred stormwater management technique if supported by site-specific soil, geologic and water table data. However, the use of proper construction, installation and maintenance techniques must be ensured to minimize facility clogging and failure.

- All BMPs must be diligently and regularly maintained to ensure that optimum pollutant removal efficiencies are maintained.

- Major and minor outfall retrofits should be aggressively pursued beyond the retrofit percentages assumed in this study (i.e., retrofit 50 percent of major outfalls and 40 percent of minor outfalls).

- Ban stormwater management waivers.

- Expand the stormwater management requirements to residential developments with lots greater than 2 acres.

- Persist in public/corporate education and awareness programs on the detrimental effects of nutrients and toxics from lawns, gardens, farms and golf courses.

- Implement stream-based controls where warranted.

- Downzone properties in future growth areas to the extent feasible. Potential areas to consider include:

  -Sub-watershed 1 areas west and southwest of Baronet Road, the vicinity of Greene Tree Road, and selected areas in Greenspring Valley downstream of Park Heights Avenue.
  -Sub-watershed 2 areas north and east of The Caves, and southwest of Greenspring Avenue.
  -Sub-watershed 3 areas west of Woodland Drive.

-Sub-watershed 4 areas north of Seminary Avenue and east of Mays Chapel Road, and north of Chestnut Ridge Drive / Chapel Ridge Road.

-Sub-watershed 5 areas north of Seminary Avenue and west of Jennifer Road / Marburg Manor Drive.

-Sub-watershed 8 areas north and east of Arundel Corporation, and north of Old Court Road and east of Old Crossing Drive.

- Aggressively reforest riparian buffers and protect existing forested buffers,

- Revisions to the stormwater management regulations should be studied and considered that would require applicants to maintain post-development peak discharges and frequencies at levels that are equal to or less than pre-development bankfull conditions.

- Use site planning techniques that reduce or mitigate for imperviousness (e.g., cluster development, reduced street widths, reduced diameters of cul-de-sac turnarounds, and use of grassed swales). To ensure widespread use of these practices, revisions may be required in subdivision regulations.

- Use a watershed- or sub-watershed-based comprehensive growth management approach to reduce the need for wider roads, and additional roads and infrastructure.