

Potential Stormwater Volume Control Measures

- Nonpoint sources of urban & residential bacteria loads can be controlled through septic system installation/repair and pet litter control measures.
- Green infrastructure can be used to reduce stormwater volumes, and associated CSO occurrences.
- Table 1 shows the amount of specific impervious surface types within the City of Lynchburg, distributed by impairment.

Table 1. Impervious surfaces within the City of Lynchburg, distributed by impairment.

Impairment	Parking				Buildings (ac (%))	Buildings (>10,000 ft ²)	Buildings (800-3,600 ft ²)
	Driveways ac (%)	Lots ac (%)	Roads ac (%)	Sidewalks ac (%)		ac (%)	ac (%)
Ivy Creek	135 (18%)	148 (20%)	233 (31%)	15 (2%)	215 (29%)	47 (6%)	132 (18%)
Blackwater Creek (Including Burton & Tomahawk)	279 (9%)	1,026 (33%)	859 (27%)	101 (3%)	871 (28%)	305 (10%)	409 (13%)
Fishing Creek	47 (4%)	433 (38%)	291 (26%)	29 (3%)	331 (29%)	170 (15%)	118 (10%)
James River (Including Judith)	127 (14%)	169 (19%)	318 (37%)	39 (4%)	235 (26%)	61 (7%)	128 (14%)

- **Green Roofs**
 - Considered all buildings greater than 10,000 ft².
 - Assumed 80% of building footprint was available for green roof application.
 - Assumed 3-4 inch deep extensive green roof capable of retaining 1 inch of rainfall.
- **Rain Barrels**
 - Considered all buildings with 800 – 3,600 ft² footprint.
 - Assumed that rain barrels drain completely each day.
 - Assumed 4 barrels for every 1,000 ft² of roof space.
 - 50 gallon barrels.
- **Bioretention Basin**
 - Considered all parking lots.
 - Assumed 0.75 inches of rainfall retention.
 - Assumed bioretention basin drains completely each day.

Table 2. Stormwater BMP cost and volume retention/detention.

BMP	Unit	Cost/Unit	Cost/ ft ² -treated	Rainfall Retention/ Detention	Rainfall Volume Removal Efficiency
Green Roof	ft ²	\$10 – 20	\$10 – 20	1”	49%
Roof Runoff Detention	50-gal. barrel	\$100 – 150	\$0.40 – 0.60	0.32”	51%
Bioretention	acre-treated	\$5,000 – 10,000	\$0.11 – 0.23	0.75”	79%

Table 3. Stormwater BMP site-specific volume removal, as a percentage of rainfall on all impervious surfaces in the watershed.

BMP	<i>100% Implementation Average Rainfall Removal</i>			
	Ivy	Blackwater (Including Burton & Tomahawk)	Fishing	James (Including Judith)
Green Roof	2.5%	3.8%	5.9%	2.7%
Roof Runoff Detention	9.0%	6.7%	5.4%	7.3%
Bioretention	16%	26%	30%	15%

Potential Bacteria Reduction Control Measures**Table 4. Potential control measure efficiencies in removing *E. coli*.**

Control Measure	Bacteria Removal Efficiency
<i>Direct Reduction Efficiency</i>	
Streamside Fencing	100%
Corrected Straight-pipe	100%
Repaired Septic System	100%
Pet Waste Education Program	75%
Pet Waste Composters	100%
<i>Buffer Efficiency*</i>	
Vegetated Buffer	50%
<i>Runoff Treatment Efficiency</i>	
Improved Pasture Management	50%
Loafing Lot Management.	40%
Manure Incorporation	90%
Retention Ponds	80%

*Buffer efficiencies shown here are applied to runoff from twice the buffer area upstream of the buffer. Additional reductions result from the conversion of land from its existing condition to the buffer area.

Table 5. Estimation of streamside fence and number of full exclusion systems required in each impairment.

Impairment	Adjoining Pasture/Hay (Feet)	Livestock Exclusion Systems
Judith Creek	17,635	9
Blackwater - Inclusive*	103,239	52
Fishing Creek	0	0
Beaver Creek	64,415	33
James River	146,656	74
Totals	331,945	289

* "Blackwater – Inclusive" includes all upstream tributaries (Burton Creek, Tomahawk Creek, and Ivy Creek).

- Based on 2001 land use map and perennial streams.
- Need to account for existing systems.
- The typical livestock exclusion system includes streamside fencing, cross fencing, and an alternative watering system.

Table 6. Agricultural land-based BMPs.

Control Measure	Unit	Judith Creek	Blackwater - Inclusive*	Fishing Creek	Beaver Creek	James River
Improved Pasture Management	Acres	1,211	18,980	70	6,666	10,173
Loafing Lot Management	System	N/A	2	N/A	0	N/A
Manure Incorporation - Crop	Acre	N/A	210	N/A	40	125
Retention Ponds – Pasture/Crop	Acre - Treated	550 / 0	8,700 / 160	15 / 0	4,500 / 188	3,000 / 0
Vegetated Buffers – Cropland	Acres	N/A	0	N/A	0	0

* “Blackwater – Inclusive” includes all upstream tributaries (Burton Creek, Tomahawk Creek, and Ivy Creek).

- Areas available based on 2001 land use map.
- Need to account for existing systems, and significant changes in livestock numbers.
- If the changes in land use reflect a decrease in livestock numbers in Fishing Creek, then no agricultural BMPs are needed in the Fishing Creek watershed.

Table 7. Agricultural control measure costs.

Agricultural Control Measure	Unit	Cost per Unit
Grazing Land Protection System (SL-6)	System	\$20,000
Stream Protection System (WP-2T)	System	\$8,000
Streamside Fence Maintenance	Foot	\$3.50
Improved Pasture Management	Acres	\$154
Loafing Lot Management	System	\$10,000
Manure Incorporation	Acres	\$18
Vegetated Buffers - Cropland	Acres	\$360
Retention Ponds – Pasture	Acres – Treated	\$138

Table 8. Estimated residential waste treatment systems in each impaired watershed.

Impairment	Houses with Standard Septic Systems	Potential Failing Septic Systems	Potential Straight Pipes
Judith Creek	624	73	14
Blackwater – Inclusive*	8,150	1,018	50
Fishing Creek	87	13	0
Beaver Creek	2,158	295	27
James River	5,542	727	14
Total	16,561	2,126	105

* “Blackwater – Inclusive” includes all upstream tributaries (Burton Creek, Tomahawk Creek, and Ivy Creek).

In addition all impaired areas will need a pet waste education program, and pet waste composters for up to 25% of pet owners.

Table 9. Residential control measure costs.

Residential and Urban Control Measure	Unit	Cost per Unit
Septic Systems Pump-outs (RB-1)	System	\$220
Septic System Repair (RB-3)	System	\$3,500
Septic System Installation/Replacement (RB-4)	System	\$4,000
Alternative Waste Treatment System Installation (RB-5)	System	\$15,000
Pet Waste Education Program	System	\$3,750
Pet Waste Composters	Composters	\$50

Potential Funding Sources

- 319 Funds – Direct result of TMDL IP development.
- Amhearst County Drinking Water Protection
- State Agricultural BMP Cost-Share
- USDA-NRCS Programs
 - EQIP
 - CREP
- SE-RCAP: South East – Rural Cooperative Assistance Program
- IPR: Indoor Plumbing Rehabilitation