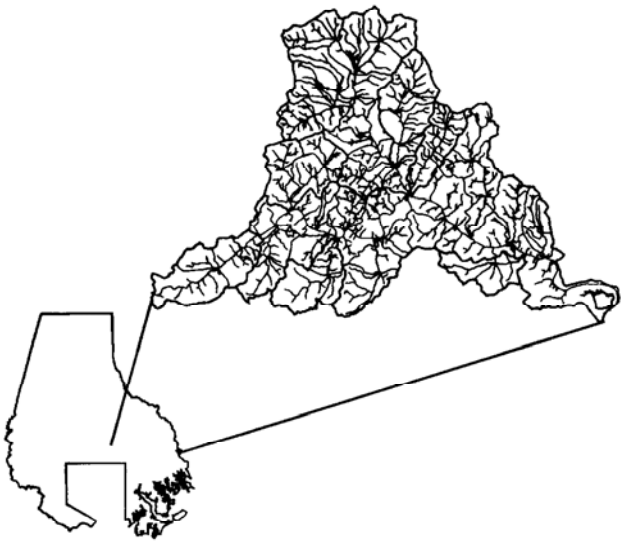
LOWER GUNPOWDER FALLS
WATER QUALITY MANAGEMENT STUDY

Executive Summary



PREPARED FOR

BALTIMORE COUNTY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
AND RESOURCE MANAGEMENT

PREPARED BY

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BALTIMORE, MARYLAND

IN ASSOCIATION WITH

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EDGEWATER, MARYLAND

SEPTEMBER 1999

EXECUTIVE SUMMARY

STUDY OBJECTIVES

The purpose of this study is to develop a comprehensive water quality management plan for the Lower Gunpowder River Watershed. The purposes of the plan are to:

1. Identify and evaluate non-point source stormwater pollution and stream degradation in the Lower Gunpowder Falls Watershed;

2. Determine management measures for the reduction of non-point source pollution and re-establishment of stream stability; and

3. Provide a watershed restoration framework for the Baltimore County Department of Environmental Protection and Resource management (DEPRM) Capital Improvement Program.

The plan will be used as a component of Baltimore County's work to satisfy Federal mandates under the National Pollutant Discharge Elimination System (NPDES) - Municipal Stormwater Discharge Permit and obligations for the State of Maryland Tributary Strategies.

STUDY AREA

The Lower Gunpowder Falls Watershed is located in the central eastern portion of Baltimore County, Maryland (Figure E-1). The watershed consists of area draining into the Gunpowder Falls below the Loch Raven Dam. The Lower Gunpowder Falls Watershed drainage area is 46.0 square miles and includes approximately 210 miles of stream. From the Loch Raven Dam, the Gunpowder Falls flows generally towards the east in a meandering pattern. Gunpowder Falls discharges into Day's Cove and the Chesapeake Bay at the Harford County Line forming the Gunpowder River. Major tributaries in the watershed include Minebank Run, Long Green Creek, Sweathouse Run, Haystack Branch, Jennifer Branch, and Bean Run.

Land use in the Lower Gunpowder Falls Watershed is divided somewhat equally between urban, forested, and agricultural areas. Land use in the watershed is divided into three zones. Urbanized areas are located to the south and west of the Lower Gunpowder Falls Mainstem. Urban areas consist of older developed areas such as Towson, Carney, and Parkville, the commercial corridor along Joppa Road, and newer, rapidly developing areas such as Perry Hall. A portion of the proposed Honeygo Development is located in the watershed, in a subwatershed called Bean Run.

The valley forming the Lower Gunpowder Falls Mainstem forms a second zone. Slopes are steep on either side of the mainstem. Most of the valley occupied by the mainstem consists of lands that are part of the Gunpowder Falls State Park. The park lands are heavily forested.

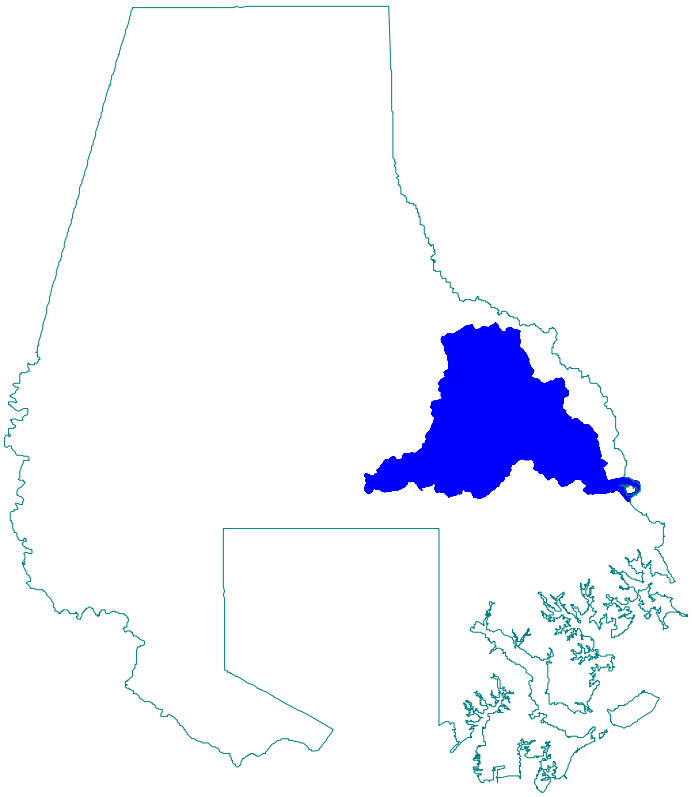

Figure E-1:
Location of Lower Gunpowder Falls Watershed Relative to Baltimore County

The third zone is the area of the watershed to the north and east of the Gunpowder Falls Mainstem. This area is predominantly rural in character. The area is primarily in agricultural land use, but there are significant areas of forests and light-density residential development. Agriculture is mixed between dairy farming, cattle, hay, corn, and row crops. Areas on ridgetops and steep slopes have been allowed to return to forested land uses. Low-density residential areas are scattered and consist of very old hamlets, homes built along major roads such as Belair and Harford Roads, and new subdivisions.

The watershed is divided into eight subwatersheds. The eight subwatersheds are depicted in Figure E-2. The Gunpowder Falls Mainstem is the largest subwatershed. Because it extends across the watershed and possess wide variation in land use, several of the tributaries and their are the Gunpowder Falls Mainstem is on occasion, further divided for

STUDY TASKS

Development of the Water Quality Management Plan for the Lower Gunpowder Falls Watershed consisted of five major work elements:

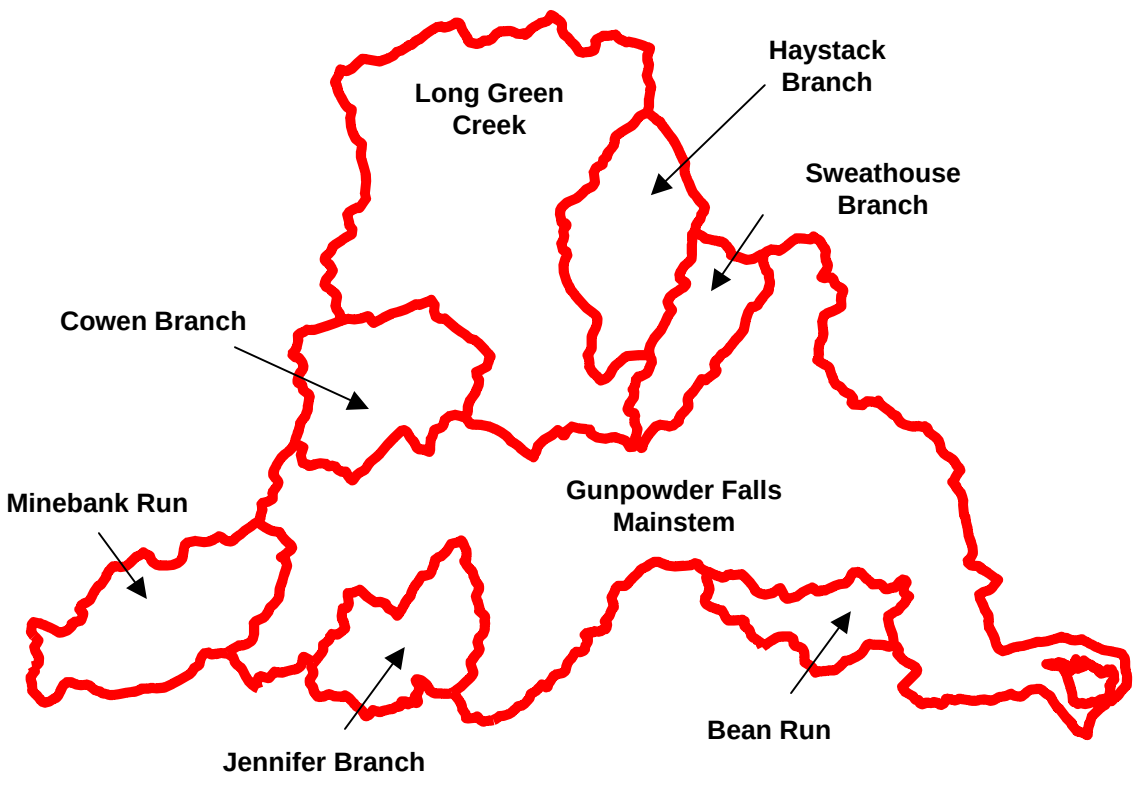

Figure E-2: Lower Gunpowder Falls Subwatersheds

I. **Watershed Characterization:** A review was made to identify principle features of the watershed and to collect available reference and mapping data.

II. **SWMM Modeling:** Hydrologic and non-point source pollutant modeling was performed with the EPA Storm Water Management Model (SWMM). The watershed was divided into 62 catchments. A continuous period simulation was performed for a 13-year period.

III. **Stream Stability Analysis:** The assessment includes Rosgen Level I assessment of all streams in the watershed, measurement and characterization of Rosgen Level II and Rosgen Level III geomorphic parameters, physical and hydraulic relationships, and ecological characteristics.

IV. **Water Quality Problems and Restoration Measures:** Watershed characteristics, SWMM modeling results and the stream stability assessment were integrated into a comprehensive evaluation of the existing and potential water quality problems in each subwatershed. Water quality problems were ranked on a comparative subwatershed basis as to their impacts and relative magnitude of contribution to the overall water quality deterioration in the entire watershed. Management measures, capital improvement projects, alternatives, controls, and strategies for reducing and preventing water quality problems in the watersheds and streams were developed.

V. **Prioritization**: Capital improvement projects were ranked in order of priority. Final management recommendations were made.

SWMM MODELING

Subwatersheds and Catchments

The eight subwatersheds were subdivided into 62 catchments. SWMM modeling was performed to develop a 13-year simulation of hydrologic and non-point source pollutants in each of the 62 catchments. Results include continuous streamflow and pollutant loading for ten non-point source pollutants from each of the catchments. Catchment modeling results were combined and routed to produce total stream flow and pollutant load at each junction point in the Lower Gunpowder Falls stream network. Modeling was performed for both existing conditions and ultimate development (proposed) conditions.

Land Use Changes

Ultimate development was based on buildout of current Baltimore County Zoning for the watershed. A comparison of the existing and ultimate land use is provided in Table E-1. In general terms, the rural/agricultural subwatersheds of Haystack Branch, Long Green Creek, and Sweathouse Branch will retain about the same balance of agriculture, forests, and low-density residential development due to agricultural preservation zoning. Jennifer Branch and Minebank Run are urbanized and will become further developed. Cowen Branch will increase in low-density residential development, but due to RC-5 zoning, will retain its rural character. Bean Run is projected to undergo intense development as part of the Honeygo Development.

Flow Modeling Results

Results of SWMM hydrologic modeling were analyzed to develop frequency relations for each catchment and node. Results of the Log Pearson III analysis are summarized in Tables E-2, E-3, and E-4. Table E-2 shows the discharge frequency relationship for the subwatersheds under existing conditions. Table E-3 shows the discharge frequency relationship for the subwatersheds under proposed conditions. Table E-4 compares the percent change. Analysis of the flow modeling results shows that:

- The urbanizing areas have the highest percent increase in discharge from existing to proposed conditions. Bean Run has the highest increases, followed by Minebank Run, Jennifer Branch, and the Pine Ridge Tributary to the Gunpowder Falls Mainstem.
- Long Green Creek, including Haystack Branch, and Sweathouse Branch have very low projected increases in discharge.

In general, it can be concluded that the urban subwatersheds south and east of the Gunpowder Falls Mainstem will experience sharp rises in stormflow peaks if ultimate development occurs. The rural and agricultural subwatersheds are projected to experience only modest increases in stormflow peaks. The increases in Bean Run are a

Table E-1: Subwatershed Land Use					
Sub-watershed	Condition	Percent of Subwatershed			
		Residential	Commercial	Forest	Agriculture
Bean Run	Existing	41	5	29	25
	Proposed	89	11	0	0
Cowen Branch	Existing	34	0	36	30
	Proposed	56	0	28	16
Haystack Branch	Existing	15	0	30	55
	Proposed	17	0	23	60
Jennifer Branch	Existing	71	2	26	1
	Proposed	97	3	0	0
Long Green Creek	Existing	16	1	23	60
	Proposed	19	1	19	61
Minebank Run	Existing	44	15	28	13
	Proposed	83	17	0	0
Sweathouse Branch	Existing	26	0	46	28
	Proposed	33	0	38	29
Gunpowder Falls Mainstem	Existing	25	2	53	20
	Proposed	47	5	42	6

TableE-2: Existing Log Pearson III Discharges						
Subwatershed	Return Period (years) Discharge (cfs)					
	2	5	10	25	50	100
Minebank Run	308	579	827	1,232	1,612	2,067
Mainstem - Pine Ridge Tributary	159	282	395	583	763	984
Cowen Branch	172	369	564	906	1,245	1,669
Jennifer Branch	196	342	474	692	897	1,147
Mainstem - Perry Hall Tributary	291	503	685	969	1,225	1,523
Long Green Creek (above Haystack Branch)	624	1,423	2,205	3,540	4,821	6,377
Haystack Branch	23	53	85	143	203	278
Long Green Creek (at Gunpowder Falls)	657	1,538	2,423	3,960	5,461	7,309
Sweathouse Run	131	279	419	655	879	1,149
Mainstem - Kingsville Tributary	156	349	540	868	1,188	1,580
Bean Run	151	250	331	452	557	674
Bradshaw Tributary	90	151	199	270	330	397
Gunpowder Falls at Chesapeake Bay	2,032	4,376	6,692	10,720	14,682	19,616

Table E-3: Log Pearson III Discharges – Proposed Conditions						
Subwatershed	Return Period (years) Discharge (cfs)					
	2	5	10	25	50	100
Minebank Run	384	703	1,029	1,630	2,262	3,103
Mainstem - Pine Ridge Tributary	188	334	480	742	1,013	1,366
Cowen Branch	191	389	597	988	1,405	1,963
Jennifer Branch	239	419	597	916	1,244	1,673
Mainstem - Perry Hall Tributary	314	545	756	1,107	1,442	1,851
Long Green Creek (above Haystack Branch)	638	1,446	2,244	3,618	4,949	6,582
Haystack Branch	23	55	89	151	215	299
Long Green Creek (at Gunpowder Falls)	672	1,565	2,467	4,052	5,615	7,559
Sweathouse Run	139	294	446	710	968	1,290
Mainstem - Kingsville Tributary	183	370	570	954	1,372	1,944
Bean Run	200	326	444	647	846	1,098
Bradshaw Tributary	95	158	210	291	363	445
Gunpowder Falls at Chesapeake Bay	2,190	4,716	7,348	12,188	17,219	23,801

Table E-4 : Percent Increase in Discharges						
Subwatershed	% Increase in Return Period Discharge - Existing to Proposed					
	2	5	10	25	50	100
Minebank Run	24.8%	21.4%	24.5%	32.3%	40.4%	50.1%
Mainstem - Pine Ridge Tributary	18.2%	18.7%	21.6%	27.3%	32.7%	38.8%
Cowen Branch	11.0%	5.5%	5.9%	9.1%	12.9%	17.6%
Jennifer Branch	22.0%	22.5%	25.9%	32.5%	38.7%	45.9%
Mainstem - Perry Hall Tributary	7.7%	8.3%	10.4%	14.2%	17.7%	21.5%
Long Green Creek (above Haystack Branch)	2.3%	1.7%	1.8%	2.2%	2.7%	3.2%
Haystack Branch	3.7%	3.6%	4.1%	5.2%	6.2%	7.3%
Long Green Creek (at Gunpowder Falls)	2.3%	1.7%	1.8%	2.3%	2.8%	3.4%
Sweathouse Run	6.2%	5.6%	6.4%	8.3%	10.1%	12.2%
Mainstem - Kingsville Tributary	17.7%	5.9%	5.6%	9.8%	15.5%	23.0%
Bean Run	32.7%	30.2%	34.1%	43.0%	52.0%	62.9%
Bradshaw Tributary	5.8%	4.7%	5.6%	7.7%	9.7%	12.1%
Gunpowder Falls at Chesapeake Bay	7.8%	7.8%	9.8%	13.7%	17.3%	21.3%

major concern as the stream stability analysis shows that the streams in the Bean run subwatershed are particularly susceptible to increases in stormflow.

Water Quality Modeling Results

Water quality modeling was performed for ten non-point source pollutants for both existing and proposed conditions. Under the loading and washoff parameters used in the SWMM modeling, all land uses generate non-point source pollutants. Airfall creates deposition of pollutants on even pristine lands. Generally, the least contributory land uses are water, wetlands, and forests. Agricultural lands tend to be high in nutrients. Developed areas tend to be high in metals. As land uses switch from rural to urban, there can be some reduction in nutrients, but this is offset by an increase in metals. Based on the model loading parameters, the worst increases are associated with the conversion of forested land to development.

The water quality model results indicate follow changes in land use closely. The urban subwatersheds south and east of the Gunpowder Falls Mainstem are the most developed, so are highest in pollutant loads. The urban subwatersheds are projected to increase in development intensity so the pollutant loads will increase as well. The rural and agricultural areas north and east of the Gunpowder Falls Mainstem will see only slight increases in development, so will only see slight increases in non-source pollutants.

ASSESSMENT OF STREAM STABILITY

The assessment of stream stability covered all stream reaches in the watershed, but not all stream reaches were surveyed to the same level of detail. After initial watershed characterization, a Rosgen Level I assessment was performed on all streams using maps, aerial photos, site visits, and geologic studies. Then, detailed field investigations were performed for selected Representative Reaches throughout the watershed. Representative Reaches included at least one reach from each of the major Rosgen Stream Classification Types identified in the watershed during Level I classification. A second set of reaches representing about a third of the watershed were the subject of a series of less intensive and more rapid field measurements. These reaches are referred to as Extrapolated Reaches. Using the field measurements made of Representative Reaches and Extrapolated Reaches, the remaining reaches were classified using aerial photos. These reaches are referred to as Remotely Sensed Reaches. The primary results of the detailed stream assessments are classifications of all the stream reaches within the watershed. A breakdown of the distribution of Level II reach classifications is presented in Table E-5. Equally important results of the stream stability analysis are the insights into the controls and processes that generate the range, location, and types of streams found in the watershed; and an evaluation of the range and type of stream stability problems.

The Role of Geologic Controls

Underlying geology controls much of the development of stream types in the Lower Gunpowder Falls Watershed. In many places on the uplands, and especially on steep slopes, the depth to bedrock is very shallow. The bedrock itself is very resistant to

erosion. As a result, downcutting of stream channels is restricted in many locations. Widespread degradation of channels draining the urban uplands has not occurred because the underlying bedrock resists downcutting and forms natural grade controls.

Many of the wide agricultural valleys are filled with alluvial sediment and do not possess similar grade control. Stream channels in these valleys frequently possess vertical banks composed of uniform fine-grained sediment. There is very little rooting depth to the vegetation. Many of the channels now classified as Type C or Type E could, with very little disturbance, quickly evolve into Type F channels.

Controls of Channel Entrenchment

Significant channel entrenchment is not common. Although the channels appear deep, bankfull flows are much higher than anticipated. This is also borne out by the SWMM modeling that has shown that the watershed is much flashier than originally suspected. Again, geology plays a role as the bedrock also resists downcutting.

Baseflow

Perennial baseflow is prevalent in many stream reaches, even those draining the developed areas. Baseflow was observed even after three years of below normal rainfall. The geologic and topographic characteristics of the watershed are influential in generating perennial baseflow. Also, the alluvial valleys are capable of storing large amounts of water. Alluvial fill generates significant baseflow even during dry periods.

Stream Stability Needs

The location and causes of stream instabilities were identified during Level II field classifications. Much of the stream instability have local causes and require local remedies. Local causes include unprotected cattle crossings, poor riparian buffers, debris jams, etc. There are also systematic causes of stream instability that require changes in regulatory and management policies. Because of the bedrock controls, most streams are generally stable except for localized problems except for two subwatersheds. The Bean Run Subwatershed is expected to undergo development as part of the Honeygo development. Because its streams are more typical of the Coastal Plain, it is expected that the streams will be destabilized by development unless preventative management measures are undertaken prior to development. The Long Green Creek Subwatershed is experiencing stream impacts from both agricultural use and low-density development. Many of the streams in the valleys could evolve into unstable streams unless preventative management measures are undertaken.

WATER QUALITY PROBLEMS AND RESTORATION MEASURES

Subwatershed Characterization

Watershed characteristics, SWMM modeling results and the stream stability assessment were integrated into a comprehensive evaluation of the existing and potential water quality problems in each subwatershed. Key findings in each subwatershed are as follows:

- **Cowen Branch:** The Cowen Branch Subwatershed does not possess any systematic stream stability problems. There are a series of minor stream instabilities generated by local instabilities such as stream crossings, losses of stream buffer, or localized geomorphic controls. The subwatershed is expected to lose forest and agricultural areas to new residential development. If the current patterns of development continue, development impacts will be minimal. The total directly connected impervious area will stay low. Increases in stormflow peaks will be minimal.

  Water pollutant loads will remain within a range close to the average for the watershed as a whole. Agricultural areas in the watershed are not subject to the intense uses that are common in the Long Green Creek subwatershed. Agricultural land management appears to be good.

  It is expected that current development patterns will persist maintaining a lightly developed watershed with stable streams. The existing stream stability in the Cowen Branch watershed can be maintained by wide ranging protective actions including education, public involvement, and maintenance and inspection of existing stormwater management facilities.

- **Long Green Creek:** Along with the typical range of localized problems, the stream stability of Long Green Creek Subwatershed is impacted by existing agricultural practices and from new low-density development. Poor agricultural practices are seen throughout the Long Green Valley. Many of the instances of poor sediment control can be corrected through use of standard agricultural BMPs. Long-term solutions for agricultural impacts require that individual farmers engage in better land management practices.

  The use of riparian buffers is extremely critical in this subwatershed. Streams on the valley floors traverse areas of deep, stratified soil deposits. Banks without buffers typically are filled with slumps and entrenched. Flood flows are kept within the banks causing high shear along unstable banks.

  In addition to agriculture, there are potential impacts from low-density development. Portions of the upper reaches of the subwatershed are zoned RC5, which allows low-density development. Much of this development can occur without stormwater controls if lot sizes exceed two acres. Stream surveys downstream of these developments have revealed channel degradation is occurring.

  There are several potential restoration projects that reflect the need for a variety of management measures required in the Long Green Creek Subwatershed. Long term solutions to the agricultural impacts require a comprehensive management strategy that involves education and funding of cooperative extension efforts using available Federal and State funding. Strategies are discussed further in the report.

- **Haystack Branch:** Very few problems were noted in this subwatershed with the majority of potential restoration projects consisting of minor channel restoration and off-line improvements to riparian conditions. Stream instability problems appear to be mostly localized and self-healing. Agricultural land management in Haystack Branch is generally very good. Grazing is within limits to maintain good pastures. Tilled land for crops appears to be limited to the valley floor, where slopes are shallow. Land use in the subwatershed is projected to change very little.

- **Sweathouse Branch:** The Sweathouse Branch Subwatershed does not possess any systematic stream stability problems. There are a series of minor stream instabilities that are identified in the report. These problems are generated by local instabilities such as poor land management practices, unprotected cattle crossings, and medium-density developments.

  Sweathouse Branch has been designated as Maryland State Wildlands. The stream is a popular hiking destination in the Gunpowder Falls State Park. Additional protection can be afforded this high quality stream system by increasing stream valley protection efforts to provide a larger riparian buffer.

- **Bean Run:** Major development is projected for the Bean Run Subwatershed. Without changes in current land development and management practices, the streams in the Bean Run Subwatershed will severely degrade. Stormflow increases will cause the channels to widen because the existing banks have very limited capabilities to resist the increased stress. Stream habitat will be lost as baseflow depths drop, water temperatures increase, and substrate becomes embedded with sediment. Widening will continue because stormflows will be held within the channel banks.

  Baltimore County is in a position to take preventative action to maintain stream channels before development occurs. Development regulations for the Honeygo Development are under development. A series of stormwater management regulations have been specifically designed in the report to prevent development impacts on streams in Bean Run. It is stressed that the failure to take preventive measures now will have serious consequences to the streams in Bean Run..

- **Minebank Run:** Much of the development in Minebank Run predates the establishment of stormwater management regulations. In addition, new development is often the result of small infill projects that fall below the threshold for stormwater management. Uncontrolled runoff entering the stream is the major water quality problem in the watershed. Because of the steep slopes and high stormflow peaks, constructed drainage channels frequently fail and are sources of erosion. Bank erosion along the mainstem of Minebank Run is also common, because the flood flows are contained within the channel.

  Drainage channels from developed areas entering Minebank Run require stabilization and retrofit. Stormwater retrofits are required to install stormwater treatment where space allows. Bank stabilization is required in selected reaches along the Minebank Run Mainstem.

  As with Long Green Creek, non-invasive stormwater development regulations are recommended for individual houses or subdivisions that fall below the threshold for mandatory stormwater management.

- **Jennifer Branch:** Surveys revealed little riparian buffer, steep cut banks, and debris in many portions of Jennifer Branch. Indications are that there is some downcutting occurring downstream of culverts and sewer crossings. The amount of debris suggests that stormflow velocities are high, causing scour and erosion. Conditions are typical of older residential neighborhoods.

  A series of stormwater retrofits have been identified to stabilize channel grade and banks in several locations. Water quality is poor and likely to degrade; however,

space for stormwater management facilities is unavailable. Further development is likely to occur as larger lots are subdivided. It is recommended that County incorporate mandatory stormwater management practices into construction permit reviews so that impacts associated with infill development are treated or minimized.

- **Gunpowder Falls Mainstem**: It is difficult to present a general summary of the Lower Gunpowder Falls Mainstem because the subwatershed is large and traverses the entire watershed from Piedmont to Coastal Plain. The subwatershed does not possess any systematic stability problems. There are a number of individual tributary streams to the mainstem that are severely degraded along their entire length. Generally, the cause of degraded tributary streams can be attributed to poor land management practices in the headwater streams.

  The local catchments draining into the Gunpowder Falls Mainstem possess the largest potential for sediment-related water quality problems among the subwatersheds in the Gunpowder Fall Watershed. Land use, soil conditions, and topography combine to create unstable streams in the headwaters. Problems can be resolved by installing protected cattle crossings, cattle exclusions, and reestablishing riparian buffers. The local Mainstem Catchments are also the single greatest source of sediment among all the subwatersheds. Future development is unlikely to increase the sediment production from the unstable Mainstem tributaries.

  A series of stream restoration projects and stormwater management retrofits have been identified to rehabilitate problem tributaries. Stormwater quality treatment facilities that are being constructed in some of the larger new development that is occurring in the Perry Hall area are important for reducing water quality impacts from non-point source pollution. Frequent inspection is recommended to ensure that these facilities are maintained and function properly

General trends in water quality, watershed wide are summarized by subwatershed in Table IV-6.

Table E-6: Summary of Subwatershed Water Quality Problems				
Subwatershed	Relative Severity of Water Quality Problems within Subwatershed			
	Stream Stability and Sediment Supply		Non-Point Source	
	Existing Conditions	Proposed Conditions	Existing Conditions	Proposed Conditions
Bean Run	Poor	Severe: Potential to worsen with Proposed Development	Fair	Some degradation with proposed Development
Cowen Branch	Good – except one bad reach	No Change	Low	Small Increase
Haystack Branch	Good	No Change	Low – Nutrients a question	No Change
Jennifer Branch	Fair for Urban Channels	Could worsen	Poor	Degrade with development
Long Green Creek	Poor	No Change	Low – Nutrients a question	No Change
Minebank Run	Poor	Worsen with Development	Poor	Degrade with development
Sweathouse Branch	Good	No Change	Low	No Change
Pine Ridge Tributary	Some bad sections	No Change	Poor	Degrade with development
Perry Hall Tributary	Fair – natural grade controls forming	No Change	Severe	Severe
Kingsville Branch	Good	May degrade, but has natural stability.	Good	Degrade slightly with development
Bradshaw Branch	Severe	No Change	Fair	No Change
Local Mainstem Catchments	Severe Problems on several tribs.	No worsening with future development	Poor due to urban tributaries.	No Change

Management Measures

Specific management measures have been developed for both rural and urban water quality problems in the Lower Gunpowder Falls Watershed. A problem common to both land uses is that smaller developments and infilling can be constructed without stormwater management controls. In the rural areas, this can cause loss of stream stability. In urban areas, non-point source pollutant problems are exacerbated. To remedy this problem, it is recommended that the County implement mandatory stormwater management regulations for subthreshold development. These regulations can be enforced through the County's Building Permit system. Proposed measures are not burdensome; they require redirection of stormwater runoff into areas where infiltration can take place. Small measures can have a major impact on reducing development impacts across each subwatershed.

Additional management measures are discussed. It is recommended that the County undertake the following management measures:

1. Develop a rigorous program for inspecting stormwater management facilities in the urban portions (areas to the south and west of the Gunpowder Falls Mainstem) of the watershed.

2. Maintain diligent enforcement of current laws and regulations regarding forest conservation, maintenance of stream buffers, and sediment and erosion control.

3. Pursue federal and state funding for implementation of agricultural BMPs including installation of riparian buffers, filter strips, cattle exclusions, and protected cattle crossings.

4. Coordinate activities with the Baltimore Soil Conservation District to target remediation efforts for problems on agricultural lands identified in this study.

5. Institute a special set of stormwater management regulations for the portion of the Honeygo development located within the Bean Run subwatershed. The intention of the special regulations is to prevent stream stability impacts that are predicted to occur unless measures are taken to limit the impacts of proposed intense development of the subwatershed. The suggested measures include:

    a) Require that riparian buffers remain undisturbed.

    b) Require that riparian zones be dedicated to the County or to an individual homeowner after development.

    c) Require on-site retention of stormwater such that there is no increase in the 0.5 year, 1.0 year and 1.5 year return period stormflow peaks and volume.

    d) Require all stream crossings to span the 10-year floodplain without encroachment.

    e) Require developers to have a qualified sediment and erosion control specialist on-site for daily inspections.

f) Require developers to conduct pre- and post-construction monitoring for potential stream impacts.

6. Citizen-based volunteer programs to monitor water quality and construct water quality improvement projects should be encouraged. The County should take a more active role in encouraging the activities of these groups.

7. The County should implement an education program to inform landowners how they can help to protect their watershed. Specific programs should be aimed at rural and agricultural land-owners where individual actions produce large results.

8. Pursue Use III classification for Cowen Branch, the Kingsville Branch, and the unnamed tributary streams draining into the Gunpowder Falls Mainstem from the north and east.

Water Quality Enhancement Projects

The Lower Gunpowder Falls Watershed was surveyed for opportunities to implement Best Management Practices (BMPs) for the purpose of improving water quality in receiving streams flowing to the Gunpowder Falls and ultimately, the Chesapeake Bay. The Water Quality Enhancement (WQE) survey included the following tasks:

1. identify potential WQE sites and potential projects;

2. determine rough feasibility, estimate costs for construction and maintenance, potential for neighborhood acceptance, and pollutant removal capabilities of the BMP(s) identified; and

3. rank the WQE Retrofit sites based on cost effectiveness and potential for project success.

A final list of recommended projects is presented in Chapter V. General prioritization criteria involved ranking projects on their ability to reduce water quality problems, project feasibility, and ranking based on the relative benefits to costs. Additionally some projects were selected for the following reasons.

- Opportunities for new stormwater quality treatment facilities in existing developed areas are few. Because there are so few opportunities, it is important to implement the few opportunities available. All projects involving stormwater management in ponds in the Minebank Run, Jennifer Branch, Pine Ridge Tributary, Perry Hall Tributary, and Bean Run subwatersheds are recommended.
- Several projects were selected because they are known to be of great importance for resolving reach or catchment wide problems. In some cases, the ranking system did not give these projects the highest priority because there were less expensive projects with similar, but lesser benefits.

ACKNOWLEDGEMENTS

The assistance of the Baltimore County staff is greatly appreciated in preparing this study. In particular we wish to thank Ms. Nancy Pentz, the project manager for the Baltimore County Department of Environmental Management and Resource Protection (DEPRM). She was assisted and advised by Mr. Eldon Gemmill, Mr. Steve Stewart, Mr. Rocky Powell, and Mr. Chin Lien. Mr. Steve Stewart also provided assistance in downloading precipitation data from the NOAA Automated Flood Warning System.

A study of this magnitude requires the participation of many individuals. Conor Shea, Ph.D., P.E. was the overall project manager for Parsons Brinckerhoff, Inc. He was assisted by Daniel O'Leary, P.E., Seth Brown, Kelly Brennan, Jennifer Sampson, Eugene Bosley, Eric DeDominicis, and Steve Yochum. Mr. Chuck Weinkam of Coastal Resources, Inc. was responsible for directing stream stability assessments. He was assisted by Ricardo Gonzalez, Sarah Williamson, Betsy Weinkam, David Smith, Dave Durmowicz, Tracy Lauterborn, and Bridgette Grillo of Coastal Resources, Inc. and Mary Jo Kishter, Don Quattrochi, and Dan Rice of Loiderman Associates, Inc.