

LIMESTONE BRANCH WATERSHED

2005 PROFILE

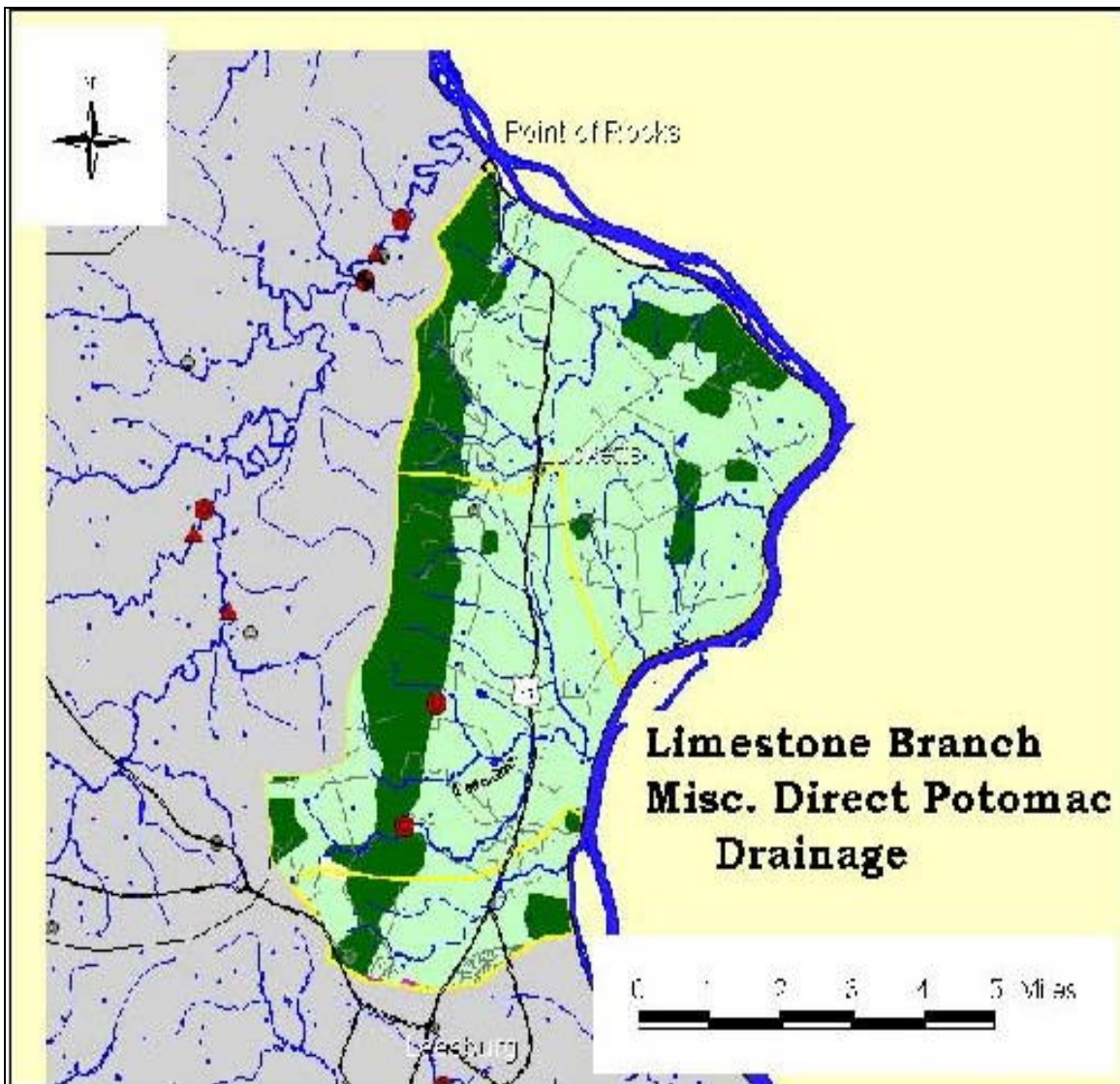


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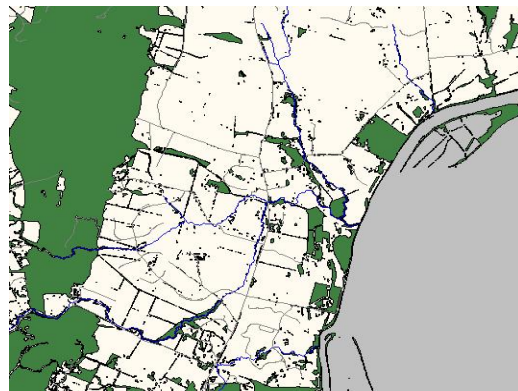
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Watershed Description

The Limestone Branch is a small watershed located in the eastern portion of the county north of Leesburg. The watershed runs from west to east, and is approximately 3.5 miles long and 7 miles wide covering an area of approximately 15.5 square miles. It drains less than 10,000 acres or 3% of the county. There are no major tributaries although three smaller unnamed drainages exist.

Limestone Branch is located within the Piedmont, and topography varies only slightly. Elevations range from 200 ft to 800 ft above sea levels. In general, soils with high infiltration rates and low runoff potential are located in the low areas, and soils with low infiltration rates and high runoff potential tend to be found in the higher elevations. The average annual rainfall is 42 inches. There is no stream flow data for the Limestone Branch watershed.

Land Use -- Land use is predominately pasture (57%) and forest (39%). There are two major residential areas - Beacon Hill Estates and Golf Course, and Raspberry Falls Estates and Golf Course. The steeper slopes in the headwater portions of the watershed have remained forested, while the pasture land tends to be closer to the streams and in the lower elevations. Both residential developments and golf courses are located at the higher elevations where runoff potential is high. Riparian buffer zones are minimal to nonexistent in the residential-golf course sections of the stream, and marginal in many segments where the land is in pasture and crop use. Further conversion of agricultural land to residential use can be expected as residential communities in the nearby Leesburg continue to expand to accommodate Loudoun County's high rate of growth.



Limestone Branch watershed showing forest cover.

Impervious Surfaces -- Impervious surfaces include the roadways, driveways, rooftops and parking lots that do not allow infiltration of water from rainstorms and runoff. The Loudoun County Environmental Indicators Project (LEIP) includes mapping of impervious surfaces in the county using Lansat Imagery. They report that the amount of impervious surface in the Limestone Branch watershed is less than 1%. As a general rule, a watershed with less than 10% of its area in impervious surfaces will not experience a noticeable impact on the hydrological characteristics of the watershed. However, lawns in residential areas and golf course fairways located in soils with high runoff potential can be an exception to this rule. High flows that cause downstream streambank erosion and flooding are common in portions of the Limestone Branch watershed.



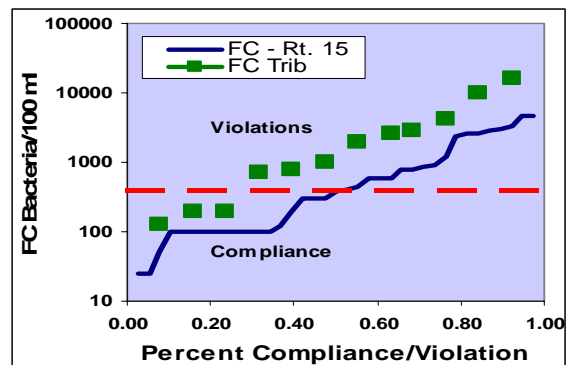
Turbid waters and streambank erosion downstream of residential-golf course development in Limestone Branch watershed

Water Quality Studies

Water Quality Standards – Water samples collected by DEQ at Rt. 15 since the early 1970’s show that water quality conditions in Limestone Branch are marginal. The state water quality standard for fecal coliform bacteria was being exceeded about 40% of the time. In 1998 DEQ listed 4.75 miles of Limestone Branch as “impaired.” The stream segment does not meeting state standards for recreational use because of fecal coliform bacteria pollution.

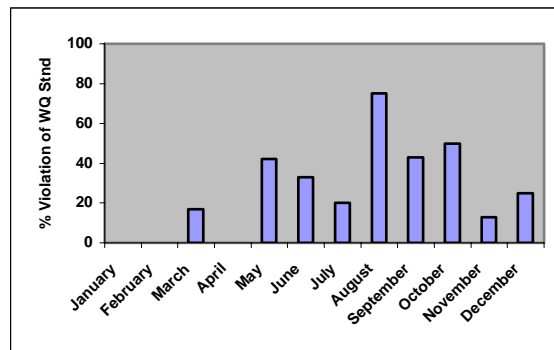
The 1995-2004 DEQ fecal coliform bacteria data, plotted as cumulative percentages to show the percent of samples that exceed the standard, are provided in **Figure 1**. The water quality at the Rt. 15 station does not meet state standards in that about 50 % of the samples are above 400 fecal coliform. MapTech also collected fecal coliform data at a station on the unnamed tributary at Rt. 661. Seventy-five percent of the samples at this station exceeded the state standard, as well. These data are also shown on **Figure 1**.

Figure 1. Fecal Coliform Bacteria Levels in Limestone Branch, 1995-2004.



DEQ also analyzed the water quality data to determine whether there is a seasonal pattern in violations. These results are shown in **Figure 2**. The violation rate is highest from May to October when water flow is likely lowest and livestock have the greatest access to streams.

Figure 2. Seasonal Distribution of Violations of the 1998 Fecal Coliform Standard in Limestone Branch at Rt. 15.



TMDL Study -- In 2002-2003 DEQ conducted a Total Maximum Daily Load or TMDL study and published the results in a 2004 report titled, “*Bacteria TMDL for Limestone Branch, Loudoun County, Virginia.*” During the study MapTech, under contract with the Virginia Department of Conservation and Recreation (DCR), collected 24 water quality samples at two sites on a monthly basis from August 2002 through July 2003. The samples were analyzed for fecal coliform, *E. coli* bacteria, and their antibiotic resistance characteristics (a form of BST analysis). The latter analysis provides the identity of the species of warm blood animal in whose wastes the fecal coliform bacteria were deposited in the stream. There were four categories of sources identified: human, livestock, pet, and wildlife.

Assessment of Fecal Coliform Bacteria Sources – The TMDL study determined the relative contribution of bacteria by human, pet, livestock, and wildlife sources of fecal bacteria into the stream at two sampling stations. The results of these analyses are shown in **Table 1**. Human sources are relatively small in the watershed, pet and livestock are about equal contributors in the mainstem of Limestone Branch, and livestock is the main contributor in the unnamed tributary, with pets and wildlife a close second.

Table 1. Bacteria Source Tracking Results for Limestone Branch Watershed.

Fecal Coliform cfu/100 ml (median)	E. coli cfu/100 ml (median)	Bacteria Source Tracking Distribution (average)			
		Human	Pet	Livestock	Wildlife
Limestone Branch at Rt. 15					
445	165	8%	32%	34%	26%
Unnamed Tributary at Rt. 661					
1500	450	8%	28%	37%	28%

The study also estimated the quantity or what they called “loading” of each of the four sources in the watershed. The load estimates were divided into point sources and nonpoint sources of pollution. Point sources of pollution are those discharges that come out of a pipe. Nonpoint sources of pollution are wastes that are discharged into streams in a diffused manner or flow over the land into streams in runoff from a rainfall.

- **Point Sources of Pollution** – Limestone Branch watershed has six small sewage treatment plants that have been issued state discharge permits for their treated effluent. The plants and their permitted discharges are listed on Table 2. The

permitted discharge loads are two to three orders of magnitude (10^{12} compared to 10^{14} or 10^{15}) less than the estimated loads from human, pet, livestock and wildlife sources in the stream, and, therefore, are not a significant contributor. This remains true even in the event that the discharges increase to 4-times the current volume.

Table 2. Annual Fecal Coliform Bacteria Discharges from the Permitted Waste Water Treatment Plants Discharging in the Limestone Branch Watershed.

Facility Name	Receiving Stream	Design Flow (MGD)	Fecal Coliform Discharge Limit (cfu/100ml)	Annual Fecal Coliform Discharge (Max permitted)
Lucketts Elem. School	Tributary to Limestone Br.	0.0063	126	1.10×10^{10}
Piedmont Behavioral Health Center	Tributary to Limestone Br.	0.0100	126	1.74×10^{10}
Hiway Mobile Home Community	Tributary to Limestone Br.	0.0120	126	2.09×10^{10}
Raspberry Falls	Limestone Br.	0.1000	126	1.74×10^{11}
Selma Plantation	Tributary to Limestone Br.	0.0150	126	1.83×10^{11}
Oakwoods	Tributary to Limestone Br.	0.0900	126	1.57×10^{11}
Existing Permitted Fecal Coliform Discharge				5.63×10^{11}
2 x Expansion				1.13×10^{12}
4 x Expansion				2.82×10^{12}

- **Human Non-Point Sources From Straight Pipes** – In 2000 Limestone Branch watershed had a population of approximately 1,600 people living in 531 households. Some of these properties have no known septic systems. The Virginia Department of Health (VDH) estimates that there are nine households located adjacent to perennial streams that have straight discharges of untreated sewage (straight pipes).
- **Human Non-Point Sources From Malfunctioning Septic Systems** – VDH estimated the number of households with malfunctioning septic systems based on the known drain field locations and age of the systems. They estimate there are potentially 64 failing septic tanks systems in the Limestone Branch watershed that are discharging partially treated or untreated wastes in perennial streams.

- **Livestock** – DEQ used 1997 agriculture date for Loudoun County to estimate the number of livestock. The Limestone Branch watershed contains approximately 3% of the total pastureland in the county. Wastes from livestock are deposited directly to the stream where livestock have stream access, and are deposited on the land where it is available for transport to streams in surface runoff. DEQ estimates there are approximately 1,200 cows, cattle and calves; and 100 horses in the watershed.



Livestock with stream access deposit wastes and erode stream banks.

- **Wildlife** – Wildlife most likely to contribute significant amounts of fecal coliform bacteria in wastes are deer and raccoons. The Virginia Department of Game and Inland Fisheries estimates there are approximately 1,650 deer and 230 raccoon in the watershed based on available habitat types.
- **Fecal Coliform Bacteria Loads from Non-Point Sources of Pollution** – DEQ used the estimated populations of human and animal sources to develop estimated fecal coliform bacteria loading from non-point sources in the Limestone Branch watershed. The population figurers were multiplied by the typical waste production rates and typical fecal coliform bacteria densities in the waste products of the different sources to get the estimated source loads. The annual fecal coliform loads from major sources are listed on **Table 3**.

Table 3. Estimated Fecal Coliform Production from Point and Nonpoint Pollution Sources in the Limestone Branch Watershed.

Source of Pollution	Population in Limestone Br	Waste Production (average)	Annual Fecal Bacteria Load (cfu/yr)
Human – straight pipes	27 people	7.3×10^{11} cfu/yr/person	1.97×10^{13}
Human – failing septic systems	192 people	1.04×10^6 100 mL/yr/person	2.07×10^{14}
Livestock	49,317 cattle/cows + 15,800 horses + other livestock	47.5 lbs/animal/yr	1.02×10^{15}
Wildlife	1651 deer + 233 raccoon + other wildlife	1.3×10^6 g/deer/yr & 1.05×10^5 g/raccoon/yr	2.58×10^{14}
Total			1.5×10^{15}

Stream Monitoring

Stream Quality and Habitat Monitoring – Virginia Department of Environmental Quality (DEQ) monitors water quality at one location, and Loudoun Wildlife Conservancy (LWC) monitors stream habitat and aquatic life at two locations in the Limestone Branch watershed. DEQ has collected chemical and bacteriological data at their station on the main stem at Rt. 15 dating back to 1974. LWC has collected habitat and aquatic insect data from a tributary station at Rt. 661 dating from 1997 and a tributary station at Rt. 740 dating from 2001. A summary of the available data is provided in **Table 4**.

DEQ has designated Limestone Branch at Rt. 15 as a trend station which means it is sampled several times a year. In addition, MapTech collected 12 extra samples in 2003 during the TMDL special study under contract with the Virginia Department of Conservation and Recreation (DCR).

Table 4. Stream Monitoring Data for the Limestone Branch Watershed.

Monitoring Sites	Water Flow	Chemical	Bacterial	Habitat	Aquatic Insects
Rt. 15		DEQ 1974-2004	DEQ 1974-2004		
RT. 661				LWC 1997-2004	LWC 1997-2004
Rt. 740				LWC 2001-2004	LWC 2001-2004

Water Chemistry Conditions

The chemical quality of a stream is an important indicator to determine whether the stream is fit for recreational use. DEQ has collected chemical water quality data at one station on Limestone Branch since the 1970's. These data show that chemical parameters meet state standards and national guidelines. These key chemical parameters for the period 1996-2004 are summarized in **Table 5**.

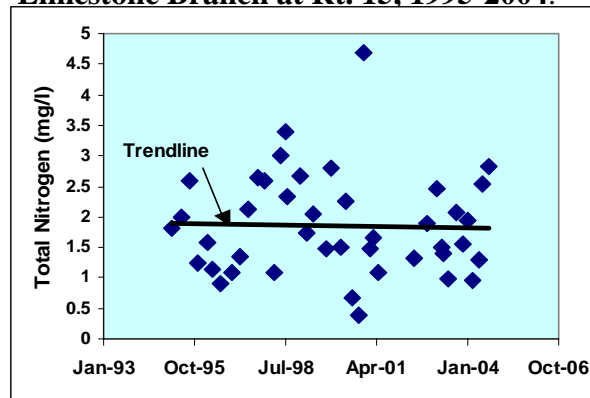
Table 5. Summary of Key Chemical Parameters Based Upon DEQ Data from the Limestone Branch Watershed Between 1996 and 2001.

Parameter	Criteria	Observation	Condition
pH	Range of 6-9 units	Mean pH level is 7.3 and range from 4.4 to 8.5. Levels fell below 6 during one period which is toxic to aquatic life.	Criteria generally met
DO (Dissolved Oxygen)	Minimum of 4 mg/l	Mean DO level is 10.4 with a range of 6 to 14.2 mg/l. Levels are consistently between 8 and 12 mg/l which is very good for aquatic life.	Criteria consistently met
BOD (Biological Oxygen)	No DEQ standard - EPA guideline is a maximum of 7	Mean BOD level is 2.1 with a range of 0.4 to 5 mg/l. Levels are consistently less than 2 mg/l indicating low organic	Criteria consistently met

Parameter	Criteria	Observation	Condition
Demand)	mg/L	loads.	
Phosphorus	No DEQ standard - - EPA guideline is 1 mg/L for non- impaired waters	Mean level of 0.09 mg/l suggests there is not excessive run-off of fertilizers from agricultural and other operations affecting the watershed.	Criteria consistently met
Nitrogen (as Nitrate)	No DEQ or EPA guideline for nitrogen	Mean level of 0.5 with a range of 0.1 to 1 mg/l. These low levels of nitrogen in combination with low levels of phosphorus keep growth of aquatic plants in check.	Low levels

Chesapeake Bay Nutrient Reduction Goals -- Government and citizen groups in the Chesapeake Bay watershed have working since 1987 to reduce the amount of nutrients flowing into the Bay from tributaries such as the Potomac River and its tributaries including Limestone Branch. An analysis of DEQ's nitrogen data for 1995-2004 is provided in **Figure 3**. The trendline for these data show that nitrogen levels are not being reduced over this time period. It is critical to reduce nitrogen in order to raise the dissolved oxygen levels in Chesapeake Bay and eliminating the "dead zones" in the Bay where the lack of oxygen is killing fish, crabs, and shellfish.

Figure 3. Total Nitrogen Levels for Limestone Branch at Rt. 15, 1995-2004.



Stream Habitat Conditions

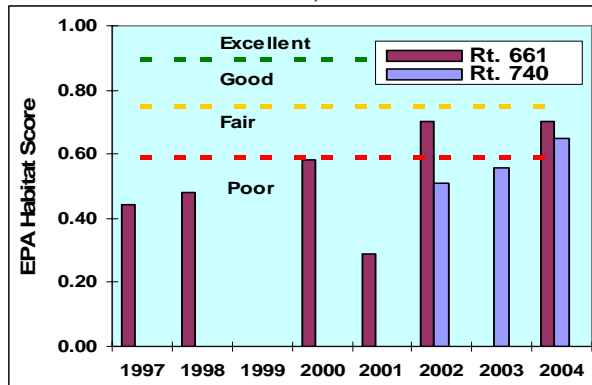
Loudoun Wildlife Conservancy – LWC has collected stream habitat data at two sites on tributaries in the watershed using the EPA RBPII protocol for several years. Monitoring at the Rt. 661 site was started in 1997, and monitoring at the Rt. 740 site started in 2001. The quality of the stream habitat is assessed using ten parameters that are combine into a "habitat condition score." The results are summarized in **Figure 4**.

These data show that the stream habitat condition is generally in the "poor" to "fair" range of conditions. This indicates that the streamside habitat is being degraded by human activities, and that the health of aquatic life can be impacted. The greatest problems are loss of riparian buffers and natural vegetation that stabilizes the streambank and help prevent erosion. As a result aquatic insects that live in the cobble and gravel in the stream substrate are smothered by sediments from erosion, and from shifting substrates caused by high stormwater flows.

Mowed grass and hilly terrain results in high stormwater runoff flows, downstream erosion, and flooding.



Figure 4. Stream Habitat Condition on Tributaries to Limestone Branch at Rt. 661 and Rt. 740, 1997-2004.



Aquatic Insect Populations

Loudoun Wildlife Conservancy – LWC has collected aquatic insect data at the Rt. 661 tributary site since 1997 and at the Rt. 740 tributary site since 2001. These data were analyzed using EPA metrics.

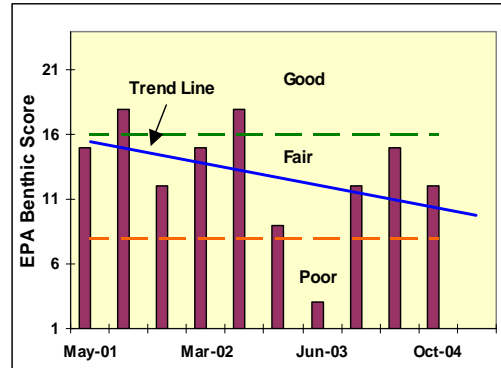
The results for the station off of Rt. 740, Tutt Lane, are shown in **Figure 5**. They indicate the conditions of the aquatic insect communities at this monitoring site are generally in “fair” range. There are a reduced number of different types of insects, fewer insects that are intolerant to pollution and sediments, and more insects, such as black flies, that are tolerant of pollution. The data also show that conditions are getting worse. This site is downstream of a large development that includes a golf course. There are few natural riparian buffers and high levels of runoff from the steep slopes on the golf course that contribute to streambank erosion problems downstream.

Aquatic life conditions in the other tributary at the Rt. 661 station where there is no large development and golf course in the headwaters are different as seen in **Figure 6**. The conditions are generally in the “fair” to “good” range that means there are greater species diversity, more insects intolerant to pollution and sediments, and fewer that are pollution tolerant. Conditions also seem to be improving as shown by the trendline. This monitoring site is downstream of a regional park, and park authorities have fenced off the stream from livestock, planted trees, and allowed the natural vegetation to grow in the riparian buffer. This is greatly improving the stream habitat and stream conditions upstream of the monitoring site, and it may account for the improving aquatic life conditions at the downstream site.

Steep banks with active erosion and undercutting of trees from high flows along Rt. 740.



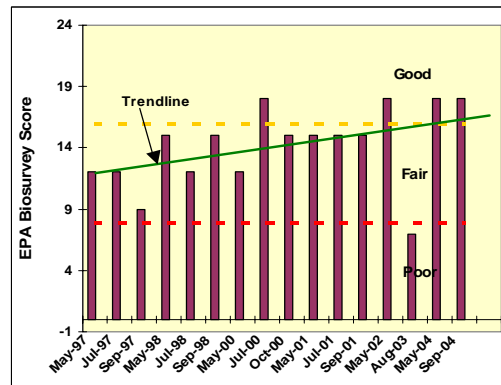
Figure 5. Aquatic Life Conditions in Tributary of Limestone Branch at Rt. Rt. 740, 1997-2004.



Conducting a habitat assessment at the Rt. 661 site where the riparian buffer is being restored.



Figure 6. Aquatic Life Conditions in Unnamed Tributary to Limestone Branch at Rt. 661, 1997-2004.



Overall Assessment of Stream Health

Water quality and stream habitat conditions are documented at one DEQ and two LWC monitoring sites in the Limestone Branch watershed. The data show that although the water chemistry is good, fecal contamination from nonpoint sources of pollution affect the entire watershed. These waters do not meet DEQ's water quality standards for recreational use and the main stem has been classified as "impaired." DEQ currently does not have sufficient water quality data for the two unnamed tributaries to classify these waters, although samples taken during the TMDL study show high levels of fecal bacteria.

Stream habitat conditions are monitored by LWC at their two monitoring sites. Conditions are generally "poor" to "fair" due to poor riparian buffers, limited natural vegetation along the streams, and high stream bank erosion that contributes sediments to the streams and covers stream-bottom cobble and gravel. These conditions impact the biological community.

The condition of aquatic insects at the two sites are generally in the “fair” range. However, in one tributary with a large development and golf course in the headwaters, aquatic insects show a downward trend. In the other tributary without a development and golf course in the headwaters, aquatic life conditions appear to be improving. Recent restoration of the riparian buffer upstream of the latter monitoring station has likely helped improve aquatic life conditions. The results of these measurements of the condition of the Limestone Branch watershed are summarized in **Table 6**.

Table 6. Summary of Limestone Branch Assessments that Measure Stream Health.

Monitoring Site	Environmental Parameters					
	Water Flow	Chemical Quality	Bacteria Quality	Habitat Assessment	Aquatic Insect Score	Impervious Surfaces
Rt. 15		Good	Impaired			Good
Rt. 661 Tributary				Poor -Fair	Fair	Moderate
Rt. 740 Tributary				Poor - Fair	Fair	Good

References:

Virginia Department of Environmental Quality. 2004. *Draft Bacteria TMDL for Limestone Branch, Loudoun County, Virginia*. March 2004.