Analysis and Results

The analysis of the Paint Branch watershed has involved the input of the Paint Branch Technical Work Group consisting of representatives of State and county environmental regulatory and resource management agencies. These agencies include the Maryland Department of Natural Resources (DNR), Maryland Department of the Environment (MDE), Metropolitan Washington Council of Governments (MWCOG), Interstate Commission on the Potomac River Basin (ICPRB), M-NCPPC Montgomery County Planning Department and Department of Parks, Montgomery County Department of Environmental Protection (DEP), and Montgomery County Office of Planning and Implementation.

A. Past and Present Conditions

1. Conditions of the Natural Resources in Paint Branch

Data on past and present conditions in various parts of Paint Branch are summarized in Table 2. Figure 4 shows the general location of seeps and springs in Paint Branch which were largely characterized through field observations by members of the Potomac-Patuxent Chapter of Trout Unlimited in May, 1979; the information in Figure 4 has also been supplemented by the extensive field knowledge of John Galli of MWCOG and Charles Gougeon of the DNR Freshwater Fisheries Division, as well as field observations through regulatory review work by the M-NCPPC Environmental Planning Division. Additional information documenting Paint Branch's health has been extensively collected in the form of data on the fish community, in particular, the brown trout population. This data has been collected for over 20 years by the DNR Freshwater Fisheries Division and are summarized in Tables 3 and 4.

Other data that have been collected and documented on the condition of the natural resources in Paint Branch, but that have not been summarized in the above tables and figures include:

- Some limited field surveys of the streams in upper Paint Branch were conducted by CH2M Hill as part of their April 1980 study to characterize the physical features of these streams. The report also references some limited macroinvertebrate studies in Good Hope and Gum Springs Tributary that were conducted in the 1970's outside of DNR's monitoring program.

- A limited field survey of Good Hope Tributary was conducted in November, 1979 to estimate stream baseflows (Galli, 1983).

- M-NCPPC Department of Parks 1980 and 1993 stream channel cross-section analysis for upper Good Hope Tributary (AWRC, 1994).

- Inventory and assessment of the Paint Branch as part of an assessment of possible effects of the Intercounty Connector (Aquatic Resource Consulting, 1986).

- MWCOG Rapid Stream Assessment Technique survey for the Good Hope Tributary (AWRC, 1994).

- Monitoring program initiated by DEP in 1994 for fish, macroinvertebrates, and physical and habitat conditions in Paint Branch. This is part of a County-wide baseline monitoring program to assess the biological, physical/chemical, and habitat conditions in all County streams.

- MWCOG Rapid Stream Assessment Technique survey for the Right Fork Tributary on June 16, 1995 (Galli, 1995).

- A cursory assessment of specific spring and seep areas in upper Paint Branch by a hydrogeologic consultant for the M-NCPPC Environmental Planning Division (Hau, 1995).

As can be seen from these sources summarized and referenced above, the data include a wide range of parameters and vary in coverage over time and geographic location , depending on the monitoring program. These data show the generally high quality conditions in upper Paint Branch over time. In contrast, stream conditions within the mainstem are more variable, and stream quality tends to be lower in the lower sections than in the upper sections.

From the various data sources, other points can be made regarding the conditions of the various Paint Branch streams:

- The large concentration of seeps and springs in upper Paint Branch, compared to the lower Paint Branch, highlights the importance of cold, clean groundwater flow contribution to the quality of upper Paint Branch.

- Good Hope Tributary —

  The upper headwaters of the stream just south of Briggs Chaney Road and east of New Hampshire Avenue appear to derive their baseflow from a bedrock fracture that lies directly under the stream channel.

  A large spring, which contributes significant cold baseflow to the upper stream reaches, exists at the rear of Parcel 471, south of Good Hope Road. Cursory evaluation of the geology of the area by Hau (1995) indicates that the groundwater feeding the spring may be recharging from land in three general areas: land between Good Hope Road and Piping Rock Drive between the two branches of Good Hope Tributary, land to the west of the left branch, and land to the east of the right branch.

  The stream has undergone some degradation since the early 1980's:

  - There is a general trend towards channel widening in upper Good Hope Tributary.
  - Existing embeddedness (sand-silt deposition in riffle areas) are very high throughout the stream.
  - The number of larger adult trout (defined as adult trout at least 26 cm., or approximately 10 inches, in length) has, since about 1989, significantly declined.

- Gum Springs Tributary —

  The stream appears to derive much of its baseflow from a bedrock fracture that lies directly under the stream channel. It is also likely that several fractures lying perpendicular and oblique to the Gum Springs channel are also providing groundwater recharge to the stream.

  The stream varies in quality. The upper section, roughly northeast of Twig Road, exhibits very good conditions. This section, with the exception of years when human activities have caused recruitment failure, is consistently successful in producing young-of-year trout; it also continues to provide limited habitat for adult trout. In contrast, the lower section is currently more degraded because of greater subdivision-related impacts. However, both sections of the stream serve as potential holding areas for young-of-year and adult trout.

- Right Fork Tributary —

  The very abundant and diverse macroinvertebrate community consistently shows this stream to be of very high water quality. The stream has the highest water quality of all the streams in the Paint Branch system.

(Continued on page 30)

Summary of Studies Characterizing Stream Conditions in the Paint Branch Watershed in Eastern Mont. County

Table 2

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds: Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
Macro-invertebrates	1979-1980	MD. DNR (Hughes, 1980)	Not given in source.	Macro-invertebrate Diversity Index	3.00 - 4.00 = Excellent 2.00 - 3.00 = Good 1.00 - 2.00 = Fair 0.00 - 1.00 = Poor	Range = 1.88 - 2.16 (FAIR TO GOOD) Mean = 2.00	Range = 2.27 - 3.77 (GOOD TO EXCEL) Mean = 3.14	Range = 2.42 - 3.01 (GOOD TO EXCEL) Mean = 2.80			•Briggs Chaney Rd: Range= 2.00 - 2.43 (GOOD) Mean = 2.16 •Fairland Rd: Range= 1.65 - 2.65 (FAIR TO GOOD) Mean = 2.21 •Rt. 29: Range= 1.38 - 2.25 (FAIR TO GOOD) Mean = 1.90
	1980-1984	MD. DNR (Gougeon, 1985)	Not given in source.	Macro-invertebrate Diversity Index	3.00 - 4.00 Excellent 2.00 - 3.00 = Good 1.00 - 2.00 = Fair 0.00 - 1.00 = Poor	Range = 1.83 - 2.83 (FAIR TO GOOD)	Range = 1.69 - 3.56 (FAIR TO EXCEL)	•Upper: Range = 1.83 - 3.56 (FAIR TO EXCEL) •Lower: Range = 1.41 - 3.13 (FAIR TO EXCEL)	Range = 1.61 - 3.62 (FAIR TO EXCEL)		•Briggs Chaney Rd: Range= 1.36- 3.03, for 1980 to 3/82 only (FAIR TO EXCEL) •Fairland Rd: Range= 1.17 - 2.86 (FAIR TO GOOD) •Rt. 29: Range= 0.71 - 2.40 (FAIR TO GOOD)
	1989	MWCOG (Kumble, 1990)	Surber, 2 sq. ft.	Modified RBP III; 6 metrics[1]	Good/Fair/Poor						•Fairland Rd (GOOD) •Rt. 29 (GOOD)
	1989	ICPRB (Stribling et.al., 1990)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Rt. 29 (GOOD)
	1990	ICPRB (Cummins et.al., 1991)	Surber, 2 sq. ft.	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Randolph Rd (EXCEL)
	1990	MD. DNR (1990)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (GOOD)	•Upper (EXCEL)	•Upper (GOOD) •Lower (GOOD)	•Lower (FAIR)		•Fairland Rd (GOOD) •Rt. 29 (FAIR)
	1991	MD. DNR (1991)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (EXCEL)	•Upper (EXCEL)	•Upper (EXCEL) •Lower (EXCEL)	•Lower (GOOD)		•Fairland Rd (EXCEL) •Rt. 29 (FAIR)
	1992	MD. DNR (1992)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (EXCEL)	•Upper (EXCEL)	•Upper (EXCEL) •Lower (EXCEL)	•Lower (GOOD)		•Fairland Rd (EXCEL) •Rt. 29 (GOOD)

Summary of Studies Characterizing Stream Conditions (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds: Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
	1993	MD. DNR (1993)	D-net, 90 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor	•Lower (FAIR)	•Upper (EXCEL)	•Upper (GOOD) •Lower (GOOD)	•Lower (FAIR)		•Fairland Rd (GOOD) •Rt. 29 (POOR)
	1993	M-NCPPC EPD (1993)	D-net, 300 seconds	RBP II; 7 metrics. EPD analysis[2]	Excellent/Good/ Fair/Poor						•Above Randolph Rd (FAIR) •Below Randolph Rd (FAIR)
Fish - (excludes MD. DNR data)	1988	MWCOG (Herson et.al, 1989) ICPRB (Cummins, 1989)	Seine hauls	Fish diversity comparisons. MWCOG ratings[3]	Excellent=15-25 species Good=10-15 species Fair = 5-10 species Poor = 0-5 species						•Rt. 29: 5-10 species (FAIR)
	1983, 1986, 1988	MWCOG (Kumble et.al., 1990)	Not given in source	Abundance of sensitive species	No rating provided			7 sensitive species out of 12 species collected, at 10% impervious-ness		1 sensitive species out of 6 sps. collected at 25% imperv.	
	1990	ICPRB (Cummins et.al., 1991)	Electro-shock	RBP V; IBI, 8 metrics[4]	Excellent/Good/ Fair/Poor						•Below Randolph Rd (GOOD)
Chemical and Physical Water Quality	1972	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Powdermill Rd (EXCEL)
	1973	MCDEP (1974)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor						•Fairland Rd (GOOD) •Powdermill Rd (GOOD)
	1974-1975	MCDEP (1976)	Grab samples	9 parameters[5]	Excellent/Good/ Fair/Poor						•Fairland Rd (EXCEL) •Powdermill Rd (EXCEL)
	1976	MCDEP (1977)	Grab samples	9 parameters[6]	Excellent/Good/ Fair/Poor						•Fairland Rd (GOOD) •White Oak NSWC (GOOD) •Powdermill Rd (GOOD)

Summary of Studies Characterizing Stream Conditions (cont.)

Parameters Studied	Year of Data Collection	Agency (Source)	Sampling Method	Analysis Method	Stream Condition Characterization	Paint Branch Subwatersheds					
						Left Fork Trib.	Right Fork Trib.	Good Hope Trib.	Gum Springs Trib.	Hollywood Branch	Mainstem
	1977	MCDEP (1978)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1978	MCDEP (1979)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1979	MCDEP (1980)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1980	MCDEP (1981)	Grab samples	9 parameters[6]	Excellent/Good/Fair/Poor						•Fairland Rd (FAIR) •White Oak NSWC (FAIR) •Powdermill Rd (FAIR)
	1985	MWCOG (1987)	Grab samples	4 parameters[7]	Good/Fair/Poor						•Powdermill Rd (GOOD)
	1988	ICPRB (Cummins, 1989)	Grab samples	4 parameters[8]	No rating provided						•Rt. 29[8]
	1989	ICPRB (Stribling et.al., 1990)	Grab samples	10 parameters[9]	Good/Fair/Poor						•Fairland Rd (GOOD) •Rt. 29 (FAIR)
	1990	ICPRB (Cummins et.al., 1991)	Grab samples	6 parameters[10]	No rating provided						•Randolph Rd[10]

Summary of Studies Characterizing Stream Conditions (cont.)

1. RBP III (EPA's Rapid Bioassessment Protocol, level III) is a genus level study on the benthic macroinvertebrate (aquatic insect) community, which entails scoring 6 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent assessment of all sites in the study. MWCOG examined the RBP III data collected and analyzed by ICPRB in 1989 and then developed the stream condition characterization breakdown.

2. RBP II (EPA's Rapid Bioassessment Protocol, level II) is a family level study on the benthic macroinvertebrate (aquatic insect) community. The Environmental Planning Division analyzed data from the source indicated, which involved transposing a mix of genus and family level macroinvertebrate data into a consistent set of family level data for all the sites and then performing a RBP II (family level) analysis. The RBP II analysis entails scoring 7 different macroinvertebrate community attributes (metrics) at each site and comparing those scores to a reference (best condition) site to get a consistent assessment of all sites throughout the study.

3. Fish diversity comparisons involved comparing the diversity of fish communities from different stream sites throughout the Anacostia River basin. Ratings are based on a MWCOG breakdown: 0 - 5 fish species = POOR, 5 - 10 species = FAIR, 10 - 15 species = GOOD, 15 - 25 species = EXCELLENT.

4. RBP V is a species level analysis on the fish community. An Index of Biological Integrity (IBI) is an analysis procedure, similar to RBP II & III, which involves assigning values for 8 different fish community attributes (metrics) for each site, and then comparing those values to a reference (best condition) site to get a consistent and standardized assessment for all sites throughout the study.

5. The 9 parameters assessed by MCDEP in the years 1972 through 1975 included; mean water temperature, mean dissolved oxygen, mean pH, mean biochemical oxygen demand (BOD), mean turbidity, mean total coliform, mean fecal coliform, mean total nitrate/nitrite, and mean total phosphates. Stream condition characterization for 1972 through 1975 was based on a combination of assessments and comparisons of the average values of the 9 water quality parameters for all the sites on each stream, which included; assessing violations of State water quality criteria, assessing sites which exhibited poor water quality, comparisons of the various parameters between streams, and professional judgement of DEP staff.

6. The 9 parameters assessed by MCDEP in the years 1976 through 1980 included; mean water temperatures, mean dissolved oxygen, mean pH, mean BOD, mean total phosphates, mean nitrate/nitrite, mean turbidity, mean total suspended solids, and mean fecal coliform bacteria concentrations. Stream condition characterization for 1976 through 1980 was based on a Water Quality Index (for further information and explanation see the MCDEP Environmental Reports for those years or see the EPA publication: EPA-907/9-74-001, Feb 1974).

7. The 4 parameters assessed by MWCOG in 1985 included; mean total suspended solids, mean fecal coliforms, mean nitrate, mean total phosphorous concentrations. Stream condition characterization was based on professional judgement.

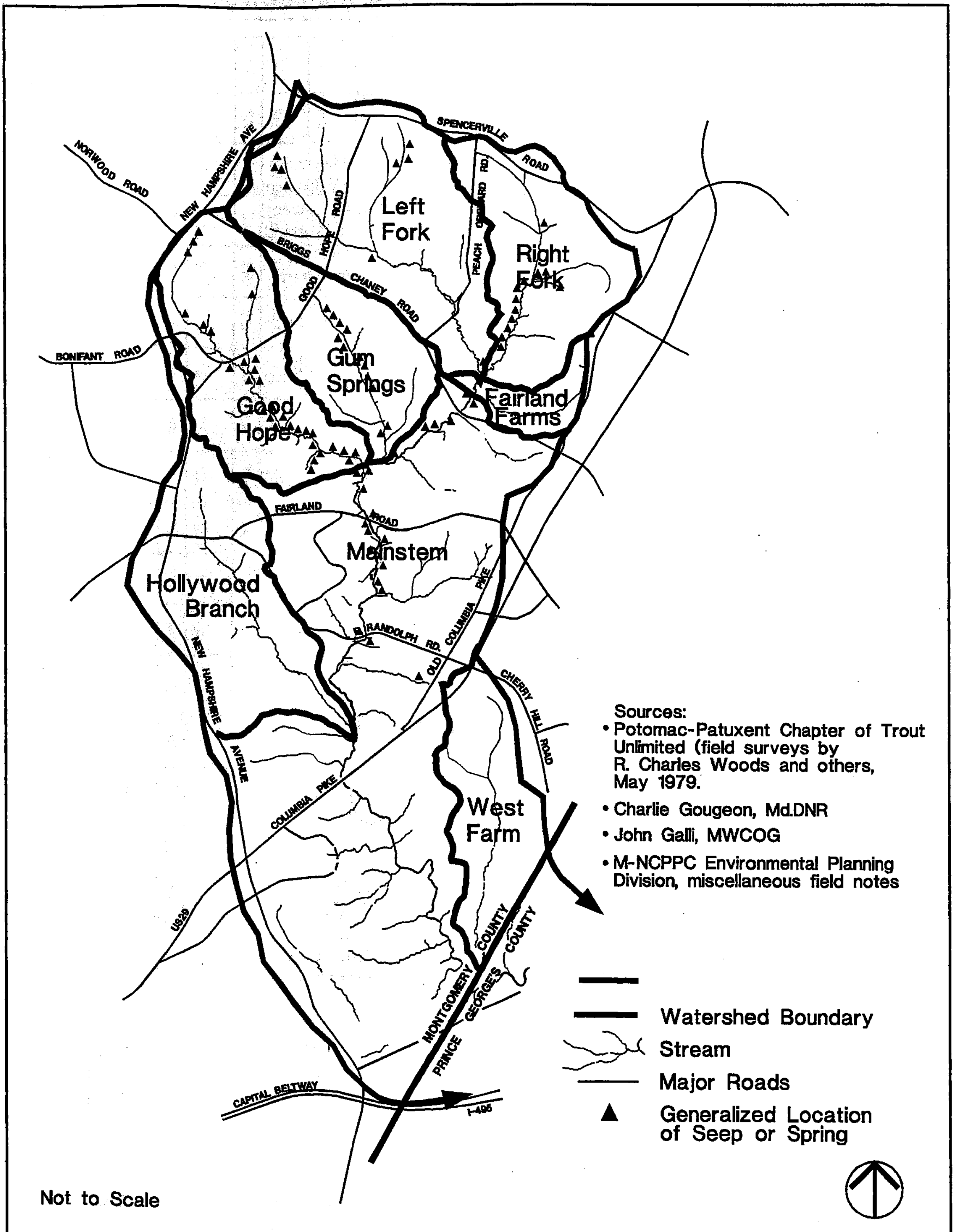
8. The 4 parameters collected by ICPRB in 1988 included; water temperatures, pH, dissolved oxygen, and conductivity. No stream rating or characterization was furnished in the study report, however a discussion of the relative significance of the values of the 4 parameters was provided in the report and is summarized in the following: the Rt 29 site had temperatures, pH, and conductivity levels which were normal in spring, summer, and fall, but the dissolved oxygen level was low in summer while normal in spring and fall.

9. The 10 parameters assessed by ICPRB in 1989 included; mean water temperature, mean dissolved oxygen, mean pH, mean turbidity, mean total suspended solids, mean total dissolved solids, mean ammonia, mean conductivity, mean total coliforms, and mean fecal coliform. Stream condition characterization was based on professional judgement.

10. The 6 parameters assessed by ICPRB in 1990 included; water temperature, pH, total dissolved solids, turbidity, dissolved oxygen, and coliform bacteria concentrations. No stream rating or characterization was furnished as part of the study report, however a discussion of the relative significance of the values was provided in the report and is summarized in the following; the Randolph Rd site had pH levels which were mostly normal throughout the year but high in July, the Total Dissolved Solid levels were normal all year, the turbidity levels were normal all year, the dissolved oxygen levels were normal all year, the temperature levels were normal all year, the coliform concentrations chronically met or exceeded the recommended limit set in State water quality standards.

Generalized Locations of Large Seeps and Springs

Figure 4



Sources:
- Potomac-Patuxent Chapter of Trout Unlimited (field surveys by R. Charles Woods and others, May 1979.
- Charlie Gougeon, Md.DNR
- John Galli, MWCOG
- M-NCPPC Environmental Planning Division, miscellaneous field notes

Fish Species Collected by Maryland DNR in Paint Branch, Montgomery and Prince George's Counties, 1974-1994

Table 3

Salmonidae	
Brown trout	*Salmo trutta* Linnaeus
Cyprinidae	
Blacknose Dace	*Rhinichthys atratulus* (Hermann)
Longnose dace	*Rhinichthys cataractae* (Valenciennes)
Cutlips minnow	*Exoglossum maxillingua* (Lesueur)
Creek chub	*Semotilus atromaculatus* (Mitchill)
Fallfish	*Semotilus corporalis* (Mitchill)
Rosyside dace	*Clinostomus funduloides* Girard
Common shiner	*Notropis cornutus* (Mitchill)
Bluntnose minnow	*Pimephales notatus* (Rafinesque)
Carp	*Cyprinus carpio* Linnaeus
Satinfin shiner	*Notropis analostanus* (Girard)
Spottail shiner	*Notropis hudsonius* (Clinton)
Swallowtail shiner	*Notropis procne* (Cope)
Spotfin shiner	*Notropis spilopterus* (Cope)
Goldfish	*Carassius auratus* (Mitchill)
Golden shiner	*Notemigonus crysoleucae* (Mitchill)
Catostomidae	
Northern hogsucker	*Hypentelium nigricans* (Lesueur)
White sucker	*Catostomus commersoni* (Lacepede)
Ictaluridae	
Margined madtom	*Noturus insignis* (Richardson)
Brown bullhead	*Ictalurus nebulosus* (Lesueur)
Cottidae	
Mottled sculpin	*Cottus bairdi* Girard
Percidae	
Tessellated darter	*Etheostoma olmstedi* Storer
Shield darter	*Percina peltata* (Stauffer)
Centrarchidae	
Bluegill sunfish	*Lepomis macrochirus* (Rafinesque)
Largemouth bass	*Micropterus salmoides* (Lacepede)
Redbreast sunfish	*Lepomis auritus* (Linnaeus)
Green sunfish	*Lepomis cyanellus* Rafinesque
Pumpkinseed sunfish	*Lepomis gibbosus* (Linnaeus)
Anguillidae	
American eel	*Anguilla rostrata* (Lesueur)

Source: Gougeon, 1985 and 1995

Note: DEP's monitoring of fish species initiated in 1994 included many of the above species. In addition, lamprey (*Lampetra* species) was also collected.

Relative Abundance of Brown Trout (Adult and Young-of-Year) in Paint Branch

Table 4

TABLE 4. RELATIVE ABUNDANCE OF BROWN TROUT (ADULT AND YOUNG-OF-YEAR) IN PAINT BRANCH

Stream Section	1974	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Above Capital Beltway (Rt. 495) to lower boundary of Naval Surface Warfare Center (NSWC)	O	NS	NS	NS	NS	NS	VS	NS	NS	NS	NS	NS	VS	NS	VS	NS	VS	
Within NSWC boundaries	O	NS	NS	VS	NS	VS	NS	NS	NS	NS	NS	NS	S	NS	NS	NS	S	
Upper boundary of NSWC to U.S. 29	S-C	O	VS	S	S	S	S	S	S	VS	VS	S	S	NS	VS	S	S	
U.S. 29 to Randolph Road	C	VS	S	S	S	S	S	S	VS	NS	VS	NS	NS	NS	VS	NS	VS	
Randolph Road to Fairland Road	NS	NS	NS	NS	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Fairland Road to Briggs Chaney Road	C	S	S-C	C	S-C	S-C	C	S	S	S	S-C	S	S	A	C	S-C	S-C	S
Mainstem Above Briggs Chaney Road and Right Fork Tributary	C-A	C	VS	S	S	S-C	S-C	NS	S	S	S-C	S	S	NS	S	S	S	
Left Fork Tributary	S-C	VS	O	NS	NS	VS	NS	C	VS	NS	S-C	C	S	NS	NS	NS	NS	
Good Hope Tributary	C-A	C	A	C-A	C	C	A	A	A	C	C-A	C	C-A	C	C	A	A	A
Gum Springs Tributary	C-A	C	A	C-A	NS	NS	C	S	S	NS	S	S-C	A	C	C	S-C	A	VS[1] O[2]

NS - Not Sampled
A - Abundant
C-A - Common/Abundant
C - Common
S-C - Scarce/Common
S - Scarce
VS - Very Scarce
O - None Collected

Sources: Gougeon, 1985.
Maryland Department of Natural Resources, Freshwater Fisheries Division, 1995.

[1]Station from confluence with mainstem upstream to horse trail crossing.

[2]Bart Dr. Station - The absence of trout at this station is most likely a result of WSSC sewer overflow in spring 1995.

(Continued from page 22)

Bedrock fractures may be a source of some of the stream baseflow. However, it appears that the more significant source of stream baseflow is from shallow groundwater flows through soils on adjacent upland recharge areas.

A recent stream assessment conducted by MWCOG and DEP shows that the stream is in very good condition. The upstream section, roughly northeast of Locustwood Lane and draining land with less impervious cover, is of higher quality than the downstream section. Stream channel erosion greatly increases within the downstream section, compared to the upstream section.

- Left Fork Tributary —

  This stream is not a consistent reproduction area for trout. It continues to provide habitat for adult trout and seasonal refuge for young-of-year trout.

- Hollywood Branch —

  This is a small stream that drains to the mainstem below Fairland Rd. It is severely degraded. The unstable stream flow pattern has resulted in a less diverse and abundant fish community.

- Mainstem —

  Between 1982 and 1984, the mainstem between Fairland Road and Briggs Chaney Road was found to be used as a successful trout spawning and nursery area. This represented an improvement in the mainstem because prior to 1982, no evidence of successful trout reproduction existed for the same section of the mainstem (Gougeon, 1985).

  However, in recent DNR surveys, young-of-year trout have declined in density in the mainstem above Fairland Road since about 1985. There are currently very good numbers of young-of-year trout in this part of the mainstem; DNR believes these young-of-year are migrants from the nursery areas of Good Hope and Gum Springs tributaries (Gougeon, 1995).

  DNR has observed increases in sediment loads and silting over the years in the mainstem above Randolph Road. This section of the mainstem had supported limited trout spawning in the past (see above), but trout spawning in the mainstem has become very inconsistent (Gougeon, 1995).

  In July 1982, the Naval Surface Weapons Center discontinued the discharge of chlorinated water into the mainstem south of US 29. Trout, as well as other fish species, were able to repopulate the section of the mainstem below the discharge point after termination of the chlorine input.

2. Subwatershed Imperviousness

Table 5 shows the impervious cover for each of the subwatersheds in Paint Branch for 1990. It also shows the proportion of each subwatershed in forest and wetland cover. Table 6 compares impervious cover within the four main subwatersheds in upper Paint Branch between the early 1980's and early 1990's. It should be noted that the imperviousness estimates vary among the different sources for the same time period because different imperviousness factors were applied for some land use categories. From Table 6, it can be seen that impervious cover within the four main subwatersheds of upper Paint Branch has significantly increased since the early 1980's.

3. Relating Land Use Activities with Stream Conditions

The increases in impervious cover over time *is a general indicator* of a greater degree of stressful conditions placed on the streams due to increasing land-cover changes and more land disturbance activities within the drainage basins. These increases in stress are reflected in changing conditions of some of the streams and changing characteristics of part of the brown trout population that have been documented over time. Significant land use activities and land-cover changes and their effects on the receiving stream systems in upper Paint Branch are summarized below. Many of these changes have occurred since the adoption of the 1981 master plan:

- Good Hope Tributary —

  About 1980-present — Increased stormwater runoff into the Good Hope Tributary. This is due to land development occurring without SWM facilities in about three-fourths of the developed area in Good Hope Tributary (such development predated stormwater management requirements) and the relatively large number of individual single-family lots being constructed over about the last 10 years (no SWM controls are required for such individual lots). These land cover changes have resulted in channel widening and high sand-silt deposition in riffle areas caused by increased stream bank erosion. These changes translate to a degradation and loss of adult trout habitat, a decline in the general water quality and habitat conditions of the stream, and a stressed trout population in Good Hope Tributary, as exhibited in the dramatic decline in the number of larger-sized adult trout (AWRC, 1994).

  February and March 1981 — Logging operation in the upper third of Good Hope basin (on the Lanigan Property) created high sediment loads to the stream due to heavy equipment crossing and resulting stream bank erosion. About 0.5 km. of stream length was adversely affected. Poor trout hatch in Good Hope Tributary was documented in 1982 (Gougeon, 1985).

  July 1981 — Subdivision construction site (Landfare/Fairland Ridge subdivision) adjacent to Good Hope Tributary generated large sediment loads to about a 1.5 km. segment via an unnamed tributary. Trout fry hatch for 1982 was very poor. Macroinvertebrate numbers and diversity severely reduced (Gougeon, 1985).

  1986 to present — On-site stormwater management facility at the Fairland Ridge subdivision was designed and constructed to include redundant quality control measures and to prevent warm water discharges to the stream (i.e., state-of-the-art). However, because of lack of maintenance and localized soil conditions, some of the infiltration control features are not working as designed. In addition, as part of a study on thermal impacts of stormwater management facilities, MWCOG has documented that warm water discharges can occur from this type of facility (Galli, 1990); this conclusion is contrary to the long-held assumption that stormwater management facilities that include infiltration measures and that do not retain water on a permanent basis are thermally neutral.

- Gum Springs Tributary —

  Current conditions, as noted in the previous section, indicate that the lower section is more degraded than the upper section. Upper Gum Springs Tributary drains an area with about 12 percent imperviousness, in contrast to the 19 percent imperviousness of the land that drains to lower Gum Springs Tributary. The higher imperviousness of lower Gum Springs Tributary is a general indicator of the adverse impacts associated with the greater degree of land disturbance activities and land cover changes. The specific impacts on lower Gum Springs Tributary are summarized in the three events listed below:

  1980-1984 — Sediment originating from poorly maintained sediment traps at the Oak Springs subdivision construction site (near Good Hope Road) generated high sediment load that affected the entire Gum Springs Tributary. Sediment input occurred in fall of 1982; trout hatch of spring 1983 was very poor (Gougeon, 1985).

  August 10, 1986 — Heavy sediment inputs during construction of Oak Springs and Gum Springs Farm subdivisions have severely degraded the lower Gum Springs Tributary, including the loss of trout spawning habitat.

  The Oak Springs SWM facility, which contains a wet pool area, has degraded the lower Gum Springs Tributary. The initial

Summary of 1990 Subwatershed Impervious and Other Land Cover in Paint Branch

Table 5

Subwatershed	Size of Sub-watershed (Acres)	1990 % Imper-viousness	% Imper-viousness from Pipeline	1990 Existing + Pipeline % Imper-viousness	% Imper-viousness from Develop-able Land Under 1981 Zoning	Existing + Pipeline + Develop-able % Imper-viousness Under 1981 Master Planned Zoning	% Imper-viousness from Master Planned Roads[1]	1981 Master Plan Build-out % Imper-viousness	Percent of Subwatershed in: Develop-able Land	Forest Cover	Wetland Cover[2]
Left Fork	1,400	12.1	0.4	12.4	2.2	14.6	N/A	14.6	25.2	19.9	2.6
Right Fork	941	9.6	0.8	10.4	4.4	14.8	N/A	14.8	46.9	21.7	3.0
Good Hope	986	9.8	0.6	10.4	2.4	12.8	1.7	14.5	30.6	54.4	1.8
Gum Springs	624	15.6	1.9	17.5	0.2	17.7	0.6	18.3	3.8	24.6	0.4
Fairland Farms	198	11.8	0.8	12.6	2.5	15.1	N/A	15.1	15.0	15.2	1.3
Hollywood Branch	996	24.1	0.2	24.3	0.0	24.3	N/A	24.3	0.0	13.6	0.2
West Farm	727	17.9	17.7	35.6	16.9	52.5	N/A	52.5	23.8	20.5	0.3
Mainstem	3,828	21.0	0.5	21.5	1.1	22.6	0.3	22.9	3.5	29.2	2.3

Source: Data based on GIS analysis of 1990 conditions
N/A - Not applicable N/C - Not calculated

1. Master planned roads include only Briggs Chaney Road realignment at MD 650, MD 28-MD 198 connector, and a 6-lane ICC.

2. Wetlands coverage is based on MD DNR non-tidal wetlands data for 1988.

Estimated Impervious Cover Within the Major Subwatersheds of Upper Paint Branch

Table 6

Subwatershed	Estimated Percent Subwatershed Imperviousness	
	In Early 1980s	In Early 1990s
Good Hope Tributary	9.21% (Source: M-NCPPC, 1981) 5.81% (Source: CH_2M Hill, 1982) 7.28% (Source: Galli, 1983) 5.7% (Source: AWRC, 1994)	9.0% (Source: AWRC, 1994) 9.8% (Source: Table 4 of this study)
Gum Springs Tributary	10.75% (Source: M-NCPPC, 1981) 7.7% (Source: CH_2M Hill, 1982) 8.78% (Source: Galli, 1983)	15.6% (Source: Table 4 of this study)
Right Fork Tributary	8.90% (Source: M-NCPPC, 1981) 4.7% (Source: CH_2M Hill, 1982) 6.36% (Source: Galli, 1983)	9.6% (Source: Table 4 of this study)
Left Fork Tributary	7.2% (Source: CH_2M Hill, 1982)	12.1% (Source: Table 4 of this study)

construction of the facility resulted in stream bank erosion because of excessive stormwater discharges from the facility. This problem has since been corrected, but the facility continues to discharge warm waters to the stream during the warm summer months. Because of this degradation, the stream has suffered in its function as a major trout spawning and nursery area.

1993 — Construction of the WSSC water line along Briggs Chaney Road resulted in large sediment inputs via existing storm drain networks into Gum Springs Tributary. This severely reduced the young-of-year trout that had been produced in Gum Springs Tributary for that year (Gougeon, 1995).

- Right Fork Tributary —

  The stream's high water quality is most likely due to the subwatershed's currently low impervious cover, especially in its upper reaches. In the lower part of the subwatershed, where more subdivision activity has occurred, the stream is of slightly lower quality.

- Left Fork Tributary —

  This stream is not consistently successful in recruiting young-of-year trout. This is likely because the stream receives high storm flows from existing R-200 subdivisions. These storm flows create erosive conditions which result in a siltier stream. In addition, the stream receives periodic warm water discharges from old existing ponds (e.g., Twin Ponds near Rainbow Drive and ponds at the former Maydale Nature Center) which further reduce the suitability of the stream as a trout nursery area.

- Hollywood Branch —

  This stream, as noted in the previous section, is degraded. This is because its drainage basin has fairly high impervious cover (about 24 percent). Much of the development is composed of R-200 subdivisions which predate stormwater management control requirements.

- Mainstem —

  April 1980 — An extensive fish kill (all fish species) occurred in Left and Right Forks and the mainstem to about 183 km. below Briggs Chaney Road (total stream lengths affected about 4.8 km.). The fish kill was due to intentional dumping of swimming pool chlorine. The trout fishery was able to recover from this man-made "disaster." This is because there were other stream refugia in the system (Good Hope and Gum Springs tributaries) which were healthy and could provide enough young-of-year trout to repopulate the affected area. That is, the stream system had enough healthy areas to counter unforseen "disaster" events. If the healthy areas of the stream system were more confined or restricted, the system may not have responded as well to the "disaster" (Gougeon, 1985). **This event illustrates the importance of preserving healthy conditions in a system of streams, rather than just a limited number of streams, so that the aquatic system has redundancy and resiliency and can effectively counter significant stresses.**

  The mainstem downstream of Briggs Chaney Road (at least to about 300 feet downstream) was heavily silted due to inadequate erosion and sediment controls during a bridge and roadway improvement project at Briggs Chaney Road in the 1970's. This project resulted in a long-term loss of young-of-year and adult trout habitat and trout-spawning areas, as well as aquatic macroinvertebrate habitat.

- Of the 901.5 acres in stream valley park in the Paint Branch watershed, 370.8 acres were acquired or dedicated since the adoption of the 1981 master plan (Gries, 1995). Park ownership of near-stream areas per the 1981 master plan is a good tool for protecting and managing these areas, and it helps preserve wide, natural buffers for the stream. However, it cannot prevent in-stream problems (as illustrated in the example cited above), such as high water temperatures, erosive storm flows, reduced stream baseflows, and sediment input that are due to large impervious surfaces, land disturbance, or poor or inadequate BMP's that occur outside of parkland but drain to the stream.

B. Projected Conditions

Although the Paint Branch system continues to exhibit high quality conditions in general, especially above Fairland Road, it has been stressed by past and present development activities. The relatively small size of the streams that make up the system, especially above Fairland Road, and the incremental land use changes in the watershed make it difficult for the system to continue to "neutralize" the stressful conditions (i.e., to reach an equilibrium and stabilize). The stream system only has a limited and finite ability to absorb and withstand adverse conditions imposed on it before it irreversibly degrades and its unique trout resource, along with the high water quality conditions and other aquatic life, are lost.

As can be seen in Table 5, impervious cover is projected to increase significantly in most parts of the Paint Branch watershed, except for the subwatersheds of Hollywood Branch and the mainstem, given the 1981 master plan zoning. These increases are indicators of a large potential for adverse impacts to the streams that drain the land, if the subwatersheds develop according to the 1981 master plan.

The potential for significant adverse impacts is greatest to the streams in upper Paint Branch (i.e., north of Fairland Road). Stressed conditions have already been observed and documented in these streams, even with headwater subwatershed imperviousness falling within the generally accepted range of 10 to 15 percent (see Chapter 2, C. 2.) for preserving healthy streams.