U.S. Fish & Wildlife Service

Oxon Run, Washington, D.C. Watershed and Stream Assessment

CBFO-S03-03

September 2003

OXON RUN, WASHINGTON, D.C.
WATERSHED AND STREAM ASSESSMENT

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Stream Habitat Assessment and Restoration Program
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office

CBFO-S03-03

Prepared in cooperation with:
District of Columbia, Department of Health, Watershed Protection Division

Annapolis, MD
2003

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EXECUTIVE SUMMARY

Oxon Run is a tributary of the Potomac River and secondary tributary to the Chesapeake Bay. Located in Washington, D.C. and Prince George's County, Maryland, in the Western Coastal Plain hydro-physiographic province, the watershed is highly urbanized. Approximately 33 percent of the land cover is impervious surface. Development has altered the rainfall-runoff regime, as runoff arrives at the stream quickly via storm drains, rather than slowly via groundwater recharge and overland flow. The stormwater influence, along with other modifications to the stream, such as channel straightening and piping, has destabilized Oxon Run. The U.S. Fish and Wildlife Service (Service), Chesapeake Bay Field Office, Stream Habitat Assessment and Restoration Program, and the District of Columbia Department of Health (DOH), Environmental Health Administration, Watershed Protection Division, have entered into a partnership to assess Oxon Run, develop restoration concepts, and restore Oxon Run to a stable natural channel. Assessment objectives include identifying causes of stream instability, identifying problem areas, prioritizing restoration reaches, and developing preliminary design criteria.

Based on topography and other survey work conducted in the Maryland Western Coastal Plain, Oxon Run was most likely a meandering riffle-pool sequence type stream, well-connected to its floodplain, with a gravel or sand bed (Rosgen type stream C4 or C5) prior to development in the watershed. Short reaches of the stream are still C4 streams, but have widened and/or incised. In response to changes in the watershed, the majority of the reaches have evolved to a different Rosgen type stream, either B4c or F4, both of which are straighter and more entrenched. Bankfull discharge, the channel forming flow, is between 250-400 cfs for the D.C. portion of Oxon Run. Both bankfull discharge and channel cross-sectional area are greater than expected based on a regional curve developed for the Maryland Coastal Plain, indicating channel enlargement in response to changes in the hydrological regime.

Virtually all of the streams in the Oxon Run watershed are unstable, and have poor potential for recovery without restoration. As the unstable reaches incise and migrate laterally, extensive streambank erosion occurs. Stream bank erosion produces an estimated 18,000 tons of sediment per year. Approximately 6 percent of this sediment comes from the portion of Oxon Run within D.C. jurisdiction. Aquatic habitat is poor, in large part due to marginal bed feature development, and the lack of defined pool-riffle sequences. In many locations, there are obstacles to fish passage, such as utility line crossings, pipes, and culverts. Streams in the watershed are rated as poor or very poor based on macroinvertebrate and fish rapid bioassessment procedures (RBPs) conducted by the Maryland Biological Stream Survey (MBSS) and other agencies. Water quality is poor, with degradation caused by pollutants from stormwater runoff, sanitary sewer leaks, and trash. Within D.C., specific contaminant sources include a decommissioned firing range and an unlined landfill.

Throughout D.C. jurisdiction, land on one or both streambanks is owned by the U.S. National Park Service (NPS) or D.C. Parks and Recreation, thus sufficient space exists to restore the stream to a stable, meandering C4 Rosgen type stream, providing high quality habitat for fish and other aquatic organisms. The Service recommends this type of restoration, in conjunction with both water quantity and water quality improvement, for the entire portion of Oxon Run within D.C. jurisdiction. To ensure success of the restoration, significant improvements in stormwater management, both in terms of water quantity and water quality must occur. Management practices that should be instituted include control of stormwater on-site, retrofit and repair of sanitary sewers to prevent leaks into the stream, and off-channel solutions for the stormwater outfalls.

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I. INTRODUCTION

Oxon Run, a tributary of the Potomac River and secondary tributary to the Chesapeake Bay, is one of several streams flowing through Washington, D.C., for which the U.S. Fish and Wildlife Service is assessing baseline conditions and potential for restoration using a natural stream channel design approach. Oxon Run originates in Prince George's (PG) County, Maryland, and flows for approximately 4 miles before crossing into Washington, D.C., where it flows for approximately 3 miles. Near the township of Forest Heights, Oxon Run again flows through Prince George's County for approximately 1 mile to its confluence with the Potomac River. Approximately 0.3 miles of the downstream Prince George's County reach is tidal freshwater. Historically, these coastal plain streams supported populations of anadromous alewife *(Alosa pseudoharengus)* and blueback herring *(Alosa aestivalis),* as well as the catadromous American eel *(Anguilla rostrata*). Natural channel design, by restoring the profile and planview of a stable natural river, inherently creates high-quality habitat aquatic biota, including Service trust resources such as herring and eel. Restoration objectives include restoration of anadromous fish habitat, stream stabilization, reduction of sediment loading, elimination of fish passage barriers, improvements in water quality, and enhancement of the riparian buffer zone.

Urbanization, with its subsequent changes in runoff-stream flow regimes, is widely recognized as a major contributor to stream destabilization, aquatic and riparian habitat degradation, and increased sediment loading to coastal water bodies (Gregory 1987; Allan 1995). Historically, attempts to reduce flooding and control stormwater resulting from development have used "hard-engineered" structures such as concrete culverts and pipes. While these types of structures may resolve issues at the site of application, they often simply "move" the stormwater impacts to a location up- or downstream of the actual structure. Additionally, the loss of floodplains and wetlands reduces the natural filtering capability of the system, making pollutants associated with the runoff more available to organisms in the affected water body. Natural stream channel designs work with the central tendency of the river to move to an equilibrium state. Generally, natural channel designs are lower cost, easier to maintain, provide better quality habitat, and are more aesthetically pleasing than hardened structures.

The U.S. Fish and Wildlife Service (Service), Chesapeake Bay Field Office, Stream Habitat Assessment and Restoration Program, and the District of Columbia Department of Health (DOH), Environmental Health Administration, Watershed Protection Division, have entered into a partnership to assess Oxon Run, develop restoration concepts, and restore Oxon Run to a stable natural channel. The restoration of Oxon Run encompasses more than just the stream itself. A successful restoration for this stream must include improvements to the stream corridor area, including increased public access, environmental awareness programs, and recreational opportunities. This report addresses the watershed and stream assessment, and provides a preliminary design concept and projected construction costs.

II. ASSESSMENT OBJECTIVES

The watershed and stream assessment provides baseline information necessary for the restoration. Specific objectives for the assessment include:

- Determining the relationship between watershed landscape activities and stream processes,
- Documenting type streams and stability conditions,
- Prioritizing restoration reaches,
- Developing watershed restoration recommendations, and
- Developing preliminary design criteria for the restoration.

III. METHODOLOGY

The Service performed a detailed stream assessment of Oxon Run within D.C., using methods developed and refined by Rosgen (Rosgen 1996). This evaluation, a Rosgen Level I, II, and III assessment, determined important hydrological characteristics, such as Rosgen type stream, stream dimension, pattern and profile, bankfull discharge, and stream condition. Methods are described briefly. A more detailed description of the methods may be found in the Oxon Run Scope of Work, and in the report on Watts Branch (Eng 2002).

A. Watershed Assessment

The Service conducted a Rosgen Level I (Rosgen 1996) assessment for the reaches of Oxon Run, Barnaby Run, and their tributaries not contained within the District of Columbia. The Service analyzed land use/land cover patterns and development in the watershed, using historical maps and aerial photos, and reviewed water quality and biological assessments. Service personnel walked the streams, photo-documenting all reaches. Reaches of the streams were classified into Rosgen stream type (Rosgen 1994) based on visually identifiable features and measurements with a tape measure or pocket rod. The Service noted problem areas, such as stormwater outfalls and locations of obvious vertical or lateral instability. The watershed assessment included visual evaluation of stream geomorphic conditions, habitat quality, and riparian zone. The Service installed monumented cross sections in the main stem of Oxon Run upstream of the D.C. border, as well as in selected tributary locations. The Service will resurvey these cross sections to validate erosion rates.

B. Stream Assessment

The Service uses the Rosgen Level II stream assessment to describe stream characteristics. The Rosgen stream classification system uses physical features of a stream, such as width, depth, pattern, and bed material, to group streams into a "type," denoted by alphanumeric codes (Rosgen 1994). In an unaltered watershed, basin relief, geology, and soils determine type stream. In the Maryland Eastern Coastal Plain region, the Rosgen stream types most commonly found are C and E type streams (McCandless 2003), although in the Maryland Western Coastal Plain, which has more basin relief, A and B type streams also occur (Starr *et al.,* 2001). The C type streams are meandering riffle/pool channels with well-developed floodplains, moderate width/depth ratios, and obvious point bars (Rosgen 1996). The E type streams are also meandering riffle/pool channels, but have very low width/depth ratios and a more U-shaped cross section than the C type streams. Based on topography, Oxon Run was most likely a C type stream prior to development of the watershed.

The Service walked the D.C. portion of Oxon Run, and sketched a detailed geomorphic map, showing the streambed, banks, and area immediately adjacent to the stream. Sewer lines and stormwater outfalls were noted on the geomorphic map. The Service partitioned the main stem of Oxon Run, extending from the border of Washington, D.C, at Southern Avenue to just above the confluence of Oxon Run and Barnaby Run into 12 reaches, based on Rosgen type stream and condition. We selected several reaches to represent "typical" conditions in the stream. The Service conducted detailed surveys, consisting of a longitudinal profile, at least two cross sections (riffle and pool), and a pebble count (Rosgen 2002b), in five reaches (Reaches 2, 4, 8, 10, and 12). The Service surveyed 27 cross sections. Fifteen of the cross sections were monumented for further resurveying. Modified Wolman pebble counts in riffles were used to determine size distribution of the bed material and to calculate roughness. Due to concerns about degraded water quality and personnel safety, pebble count procedures for reach characterization were modified slightly, with bulk samples collected and later sieved in the laboratory. Two reaches surveyed (4 and 12) represent straight reaches and both are essentially a single riffle, thus no pool was surveyed. For five of the remaining seven reaches, the Service performed at least one cross-sectional survey, and installed one or more monumented cross sections to quantify erosion rates. Reach 1 (just downstream of the Southern Avenue bridge) and Reach 3 (near the upstream border of Oxon Run Park) are short transitional reaches, and were not surveyed. The Service determined stream geometry (sinuosity, belt width, and meander length) from aerial photographs. Reaches 1 through 8 are grouped into the Upper Reach, running from Southern Avenue to the head of the concrete-lined channel in Oxon Run Park. Reach 9 is the concrete-lined channel, and is referred to as Oxon Run Park in the report. Reaches 10 through12 are grouped into the Lower Reach.

A crucial component of stream assessment is identification of bankfull, the discharge primarily responsible for channel morphology. In unstable streams, field identification of bankfull can be difficult, as there may be multiple indicators, reflecting the bankfull discharge at different times in the evolution of the stream. In addition to field indicators, two other methods exist for estimating bankfull discharge: comparison with a gaged site, and approximation of discharge based on a regional curve. As no active U.S. Geological Survey (USGS) gage stations exist on Oxon Run or its tributaries, the Service used the gage on Watts Branch (Gage #01651800). Watts Branch is nearby and in the same hydro-physiographic region (coastal plain). Topography, soils, and land use in the two watersheds are similar. Typically, bankfull recurrence interval is somewhere between 1 and 2 years (Dunne and Leopold 1978). In the Maryland-Delaware Coastal Plain, recurrence intervals ranged from 1.04-1.37 years (McCandless 2003). In urban situations with a great deal of impervious surface bankfull can occur more often, at intervals of less than a year (Bruner 1999). Based on data from the Watts Branch gage, the bankfull recurrence interval is less than a year. The Service used regional curve data for the Maryland Coastal Plain to estimate discharge and cross-sectional area based on drainage area (McCandless 2003). The regional curve was derived from watersheds selected to have less than 20 percent impervious surface, thus it may not be directly applicable to highly urbanized watersheds. Although the specific effect of urbanization on bankfull discharge is not well defined, impervious surface has been documented to increase peak flows (Dunne and Leopold 1978).

C. Problem Identification and Prioritization

In addition to the morphological assessment, the Service performed a stability and condition assessment (Rosgen Level III) for all reaches within the D.C. jurisdiction (Rosgen 2002a) to identify specific problems, and determine restoration priorities. A Rosgen Level III assessment compares the stream of interest to a stable (reference) stream of the expected type (determination based on valley type and slope), and quantifies the deviation from the optimum condition (of the stable stream). The assessment incorporates a number of metrics for assessing stream condition and stability. Although the Service expended considerable effort to locate a reference reach within the Oxon Run watershed and neighboring watersheds, no streams in the watershed or nearby watersheds were suitable for a reference reach. Thus, where reference dimensions were required for comparisons, we used data for a C4 stream from Rosgen (Rosgen 2002c) and for C4 and C5 streams from the coastal plain (McCandless 2003).

Specific assessment protocols are described in detail in Rosgen (Rosgen 2002c), but generally, the method consists of using physical features such as bank heights, depositional patterns, width/depth ratios, stream geometry, and entrainment (the size of particle moved by a particular discharge) calculations to predict erosion and evaluate stability. Although currently no erosion potential relationship exists for Maryland, quantification of sediment loading was performed using erosion potential relationships developed from Yellowstone data (Rosgen 1996; Rosgen 2002b). While only an approximation, this provides a means for reach-to-reach comparisons within Oxon Run, and an estimate of total sediment input on an annual basis. The Level III assessment is a prediction and provides no information regarding actual rates of incision, bank erosion, or lateral migration. Obtaining rates requires a time-trend analysis. To validate the predictions, the Service will resurvey monumented cross sections.

IV. EXISTING CONDITIONS

The Service assessed the condition of the watershed based on a combination of fieldwork and a review of existing maps, photos, and other documentation. Geology, soils, land use, and land cover digital data were provided by D.C. (DCWPD 2001).

A. Watershed Characterization

The Oxon Run watershed is a sub-watershed of the Potomac River, and is comprised of the Oxon Run main stem and tributaries, Barnaby Run and its tributaries, and an unnamed tributary that joins Oxon Run downstream of the town of Forest Heights. The watershed is approximately 14 square miles (mi^2), and is largely within Prince George's County, Maryland (Figure 1). The watershed is in the coastal plain hydrologic region (Schmidt, Jr. 1993). Overall valley slope ranges from 0.6 to 0.7 percent, and basin relief (measured from the highest point in the watershed) is 1.5 percent.

1. Historical Overview

To track trends in the watershed, and determine specific factors that affect stream stability, the Service obtained maps and aerial photos from the USGS. The earliest map is 1880, and the most recent aerial photograph is 2000. The best topographical information regarding the original orientation of the stream is from a 1938 topographical map, and this was used to derive the Strahler stream order (Allan 1995) and calculate the original number of tributaries and stream miles.

The earliest maps (1880 and 1888) show the Oxon Run watershed lightly settled, with small farms scattered throughout the watershed and some of the land cleared for agricultural production and orchards (not shown). By 1900 (Figure 2), several major roads were already in place, including a "ridge road" along the northern watershed divide that approximates the current-day South Martin Luther King Avenue-Alabama Avenue-Bowen Road-Marlboro Pike route. At this point, the streams appear relatively unaltered, although small agricultural diversions or ditches do not show up in a map of this scale. By 1938, the watershed was still largely rural, although there were discernable town centers in Silver Hill, Suitland, and Dupont Heights (Figure 3). There were 25.1 miles of perennial streams, including the main stem of Oxon Run, 18 first order tributaries, two second order tributaries, and a single third order tributary (Barnaby Run). A rifle range, later part of Camp Simms, was located on the main stem of Oxon Run. Reach 4 may have been straightened in this period to accommodate the firing range backstops in Camp Simms. In several locations, near the confluence with the Potomac River, as well as near Cedar Hill and Lincoln Memorial Park cemeteries, reaches of the streams have been channelized. Other streams appear relatively unaltered. A 1943 map (not shown) shows substantial development in the upper portion of the watershed, between Suitland Road and Marlboro Pike. The town of Forest Heights was built in this period.

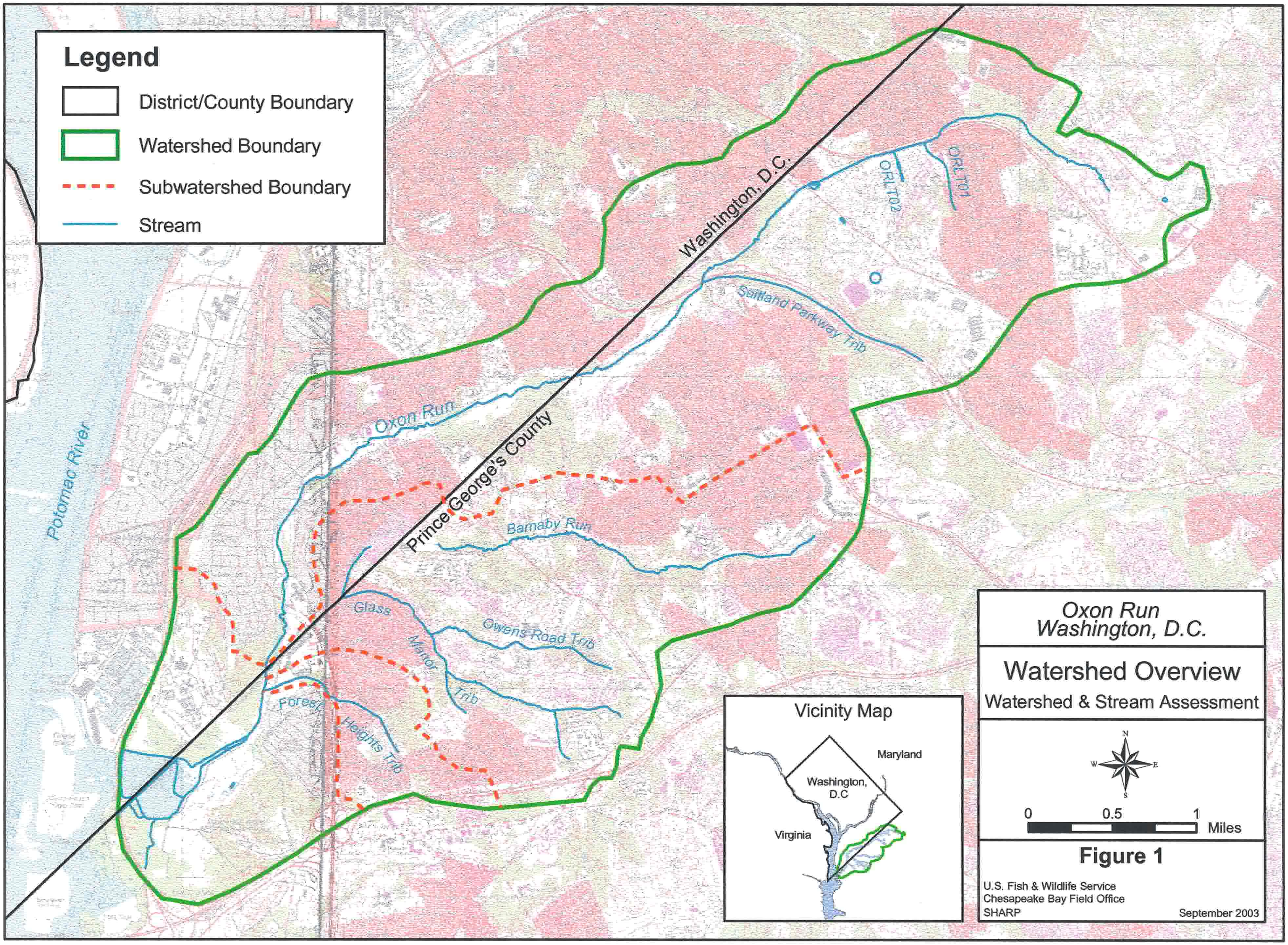
Legend
District/County Boundary
Watershed Boundary
Subwatershed Boundary
Stream
Washington, D.C.
Prince George's County
Potomac River
Oxon Run
ORLT01
ORLT02
Suitland Parkway Trib
Barnaby Run
Glass
Manor
Trib
Owens Road Trib
Forest
Heights Trib
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Watershed Overview
Watershed & Stream Assessment
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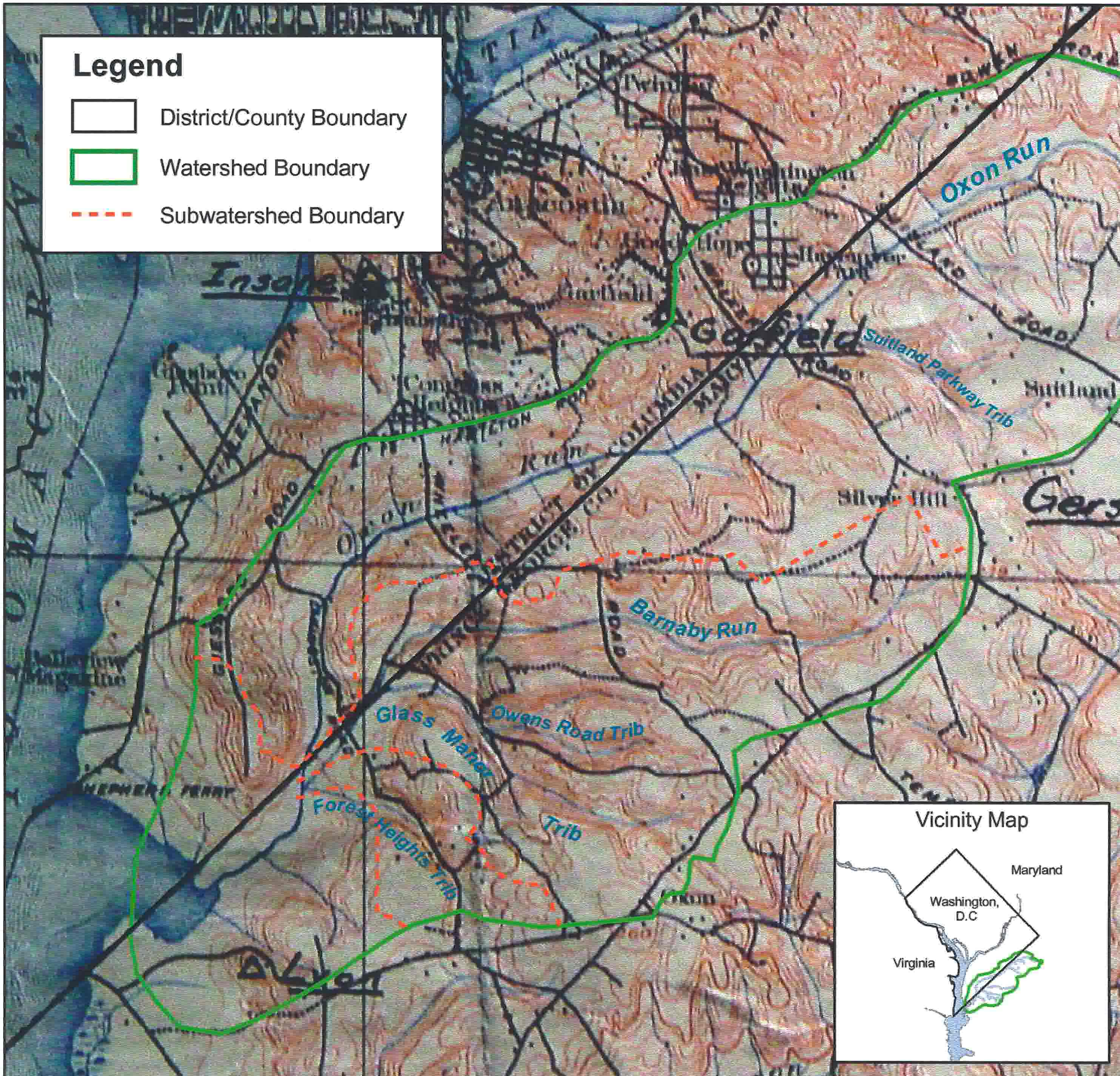
Figure 1
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003



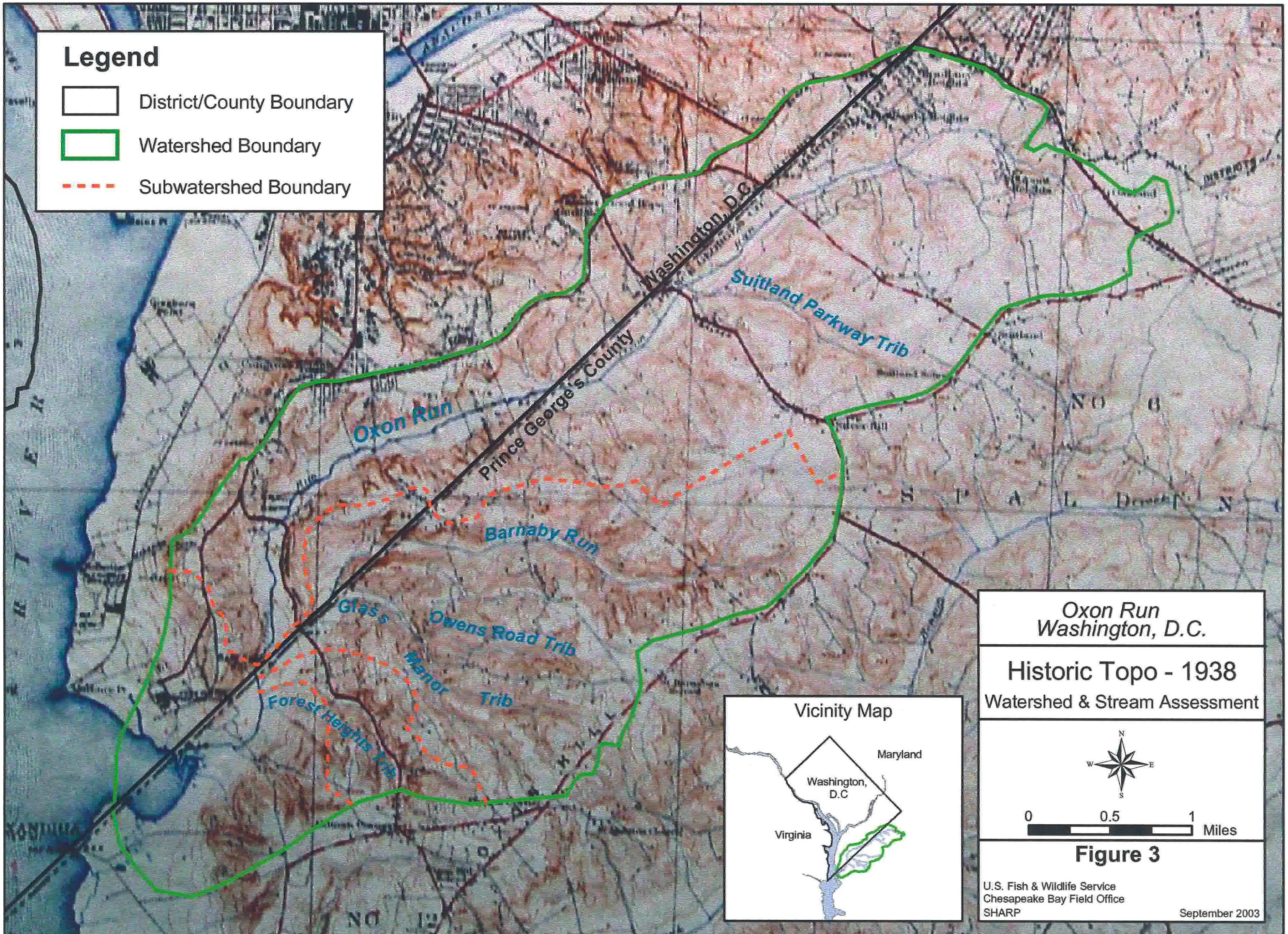
Oxon Run
Washington, D.C.

Historic Topo - 1900
Watershed & Stream Assessment

Figure 2

U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP

September 2003



Legend
District/County Boundary
Watershed Boundary
Subwatershed Boundary
Washington, D.C.
Prince George's County
Suitland Parkway Trib
Oxon Run
Barnaby Run
Glass
Owens Road Trib
Manor
Trib
Forest Heights Trib
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
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Historic Topo - 1938
Watershed & Stream Assessment
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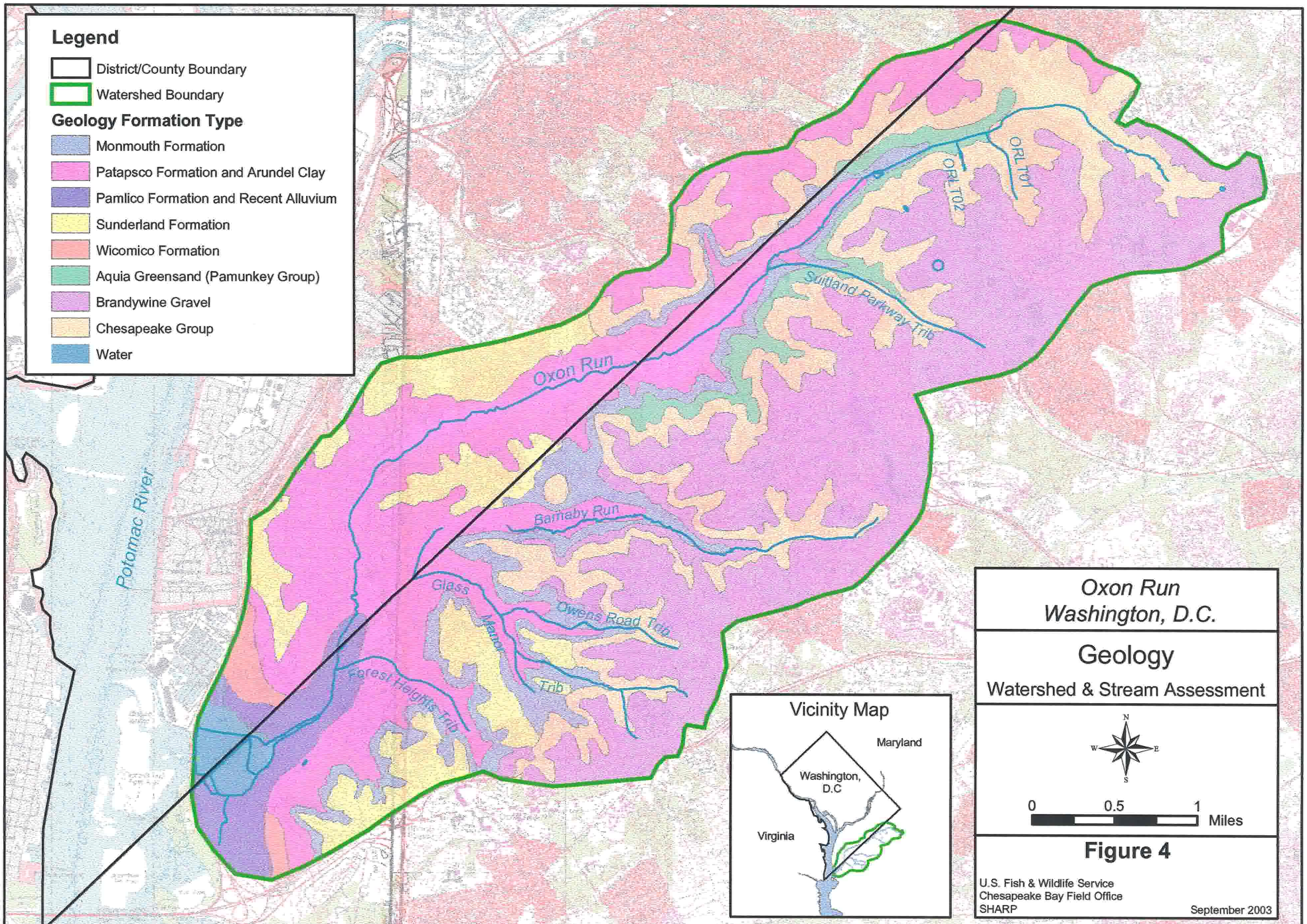
Figure 3
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003

The post World War II building boom affected the Oxon Run watershed, and by 1949 (based on aerial photos), a significant portion of the watershed was suburban or urban housing. The streams are visibly degraded, evidenced by widening and extensive bar development. Substantial lengths of stream along Suitland Parkway and Southern Avenue have been realigned. Following the 1955 flood caused by Hurricane Connie, the U.S. Army Corps of Engineers (USACE) constructed a flood control project near Forest Heights. The channel was realigned, dredged to 100 ft wide (theoretically accommodating a flood of 8,000 cubic feet per second (cfs)), and a concrete drop structure (~3 ft vertical) was installed (USACE 1959; USACE 1998). Throughout the D.C. portion of Oxon Run, especially the stretch between 13th Street and South Capitol Street, the stream appears unstable.

Current D.C. land use data shows an unlined landfill along the left bank of Oxon Run, downstream of South Capitol Street, and in 1963 aerial photographs, this facility appears active. A portion of Barnaby Run, located behind current-day Eastover Shopping Center, was straightened in this period. After straightening, the channel runs directly along the D.C./Prince George's County boundary. In 1963, stream conditions in the D.C. portion of Oxon Run are similar to 1949. Buildings at Camp Simms were still present, but the facility was no longer an active firing range (EA Engineering 1998). By 1977, the majority of the watershed was developed. The streams have widened and developed extensive point and lateral bars in many of the natural channel reaches. The D.C. portion of the watershed is mostly high-density residential or commercial structures. Development in Prince George's County was varied, with some areas high-density residential and commercial, and others comprised of single-family dwellings with small yards. In 1978 and 1979, a concrete-lined channel was installed between 13th Street and South Capitol Street by the D.C. stormwater management authority. In both the 1988 and 2000 photographs, overall stream conditions (an over-wide channel and extensive gravel bars) appear similar to current day, although at the scale of the photographs (approximately 1:20,000), it is difficult to estimate the rate of stream migration.

2. Geology and Soils

The stream valley is underlain by sand and clay (Patapsco Formation, Figures 4 and 5). Soils in the valley consist of moderately well drained, stratified alluvial sediment. Uplands also have well drained soils, with a gravel or clay under-layer. Valley slopes (Monmouth Formation) tend to contain a higher percentage of sand than the stream valley. Two soil associations comprise the majority of the watershed, the urban land-Beltsville-Chillum association and the urban land-Christiana-Sunnyside association (DCWPD 2001). Iuka is found in the floodplain areas. These types of unconsolidated silt and sand soils are highly erodible. Once a stream has begun to incise or migrate laterally, the process will continue until it reaches an underlying clay lens. Stabilization is also sometimes provided (intentionally or unintentionally) by anthropogenic structures such as retaining walls, riprap, utility lines, bridge abutments, or road embankments. When undisturbed, soils typically found in this area are permeable, limiting runoff and providing groundwater recharge. Modification in the soil structure caused by construction activity and fill material reduces permeability and increases runoff.



Legend
District/County Boundary
Watershed Boundary
Geology Formation Type
Monmouth Formation
Patapsco Formation and Arundel Clay
Pamlico Formation and Recent Alluvium
Sunderland Formation
Wicomico Formation
Aquia Greensand (Pamunkey Group)
Brandywine Gravel
Chesapeake Group
Water
Potomac River
Oxon Run
ORLT01
ORLT02
Suitland Parkway Trib
Barnaby Run
Glass Manor Trib
Owens Road Trib
Forest Heights Trib
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Geology
Watershed & Stream Assessment
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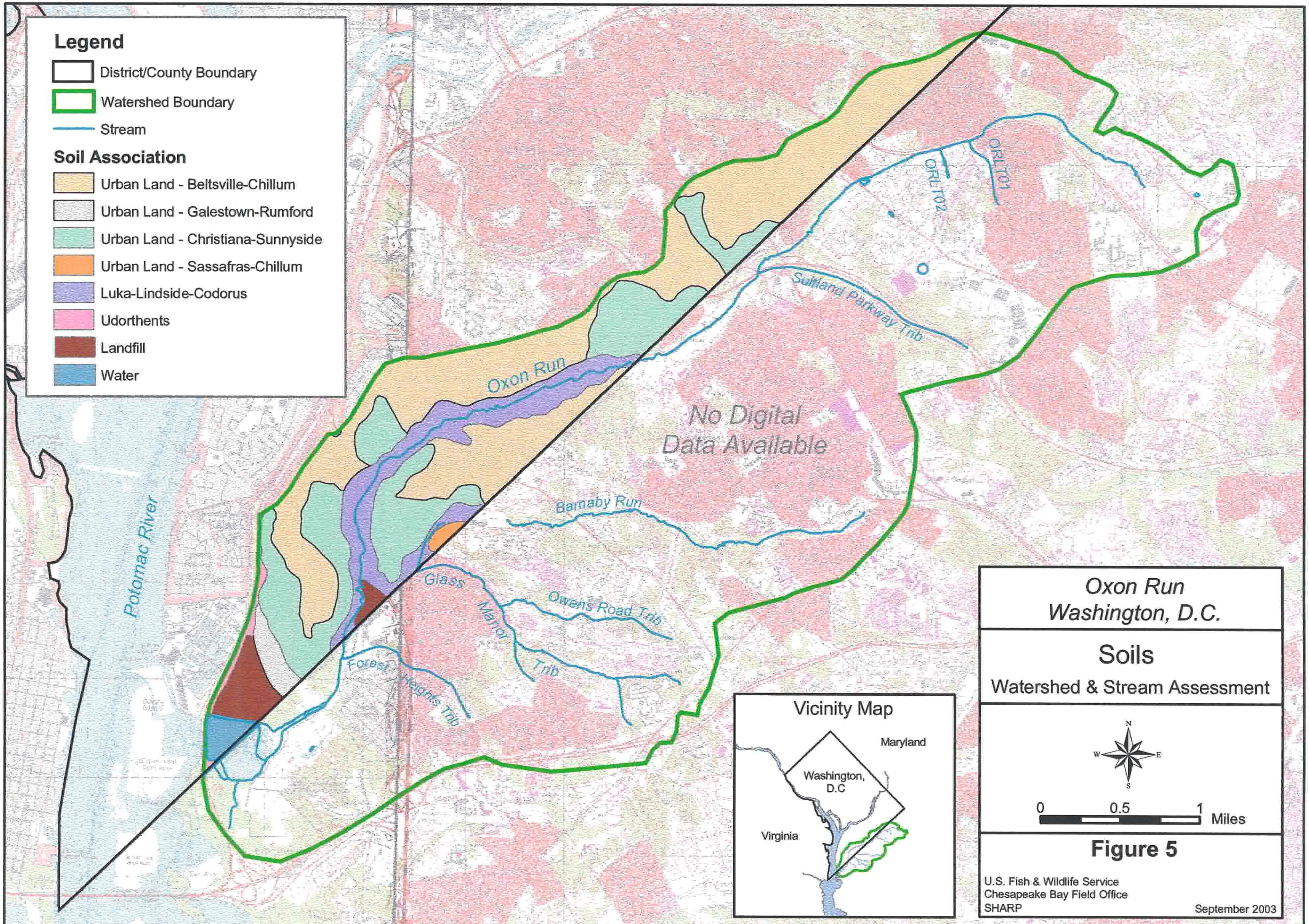
1
Miles
Figure 4
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003



Oxon Run
Washington, D.C.
Soils
Watershed & Stream Assessment
Figure 5

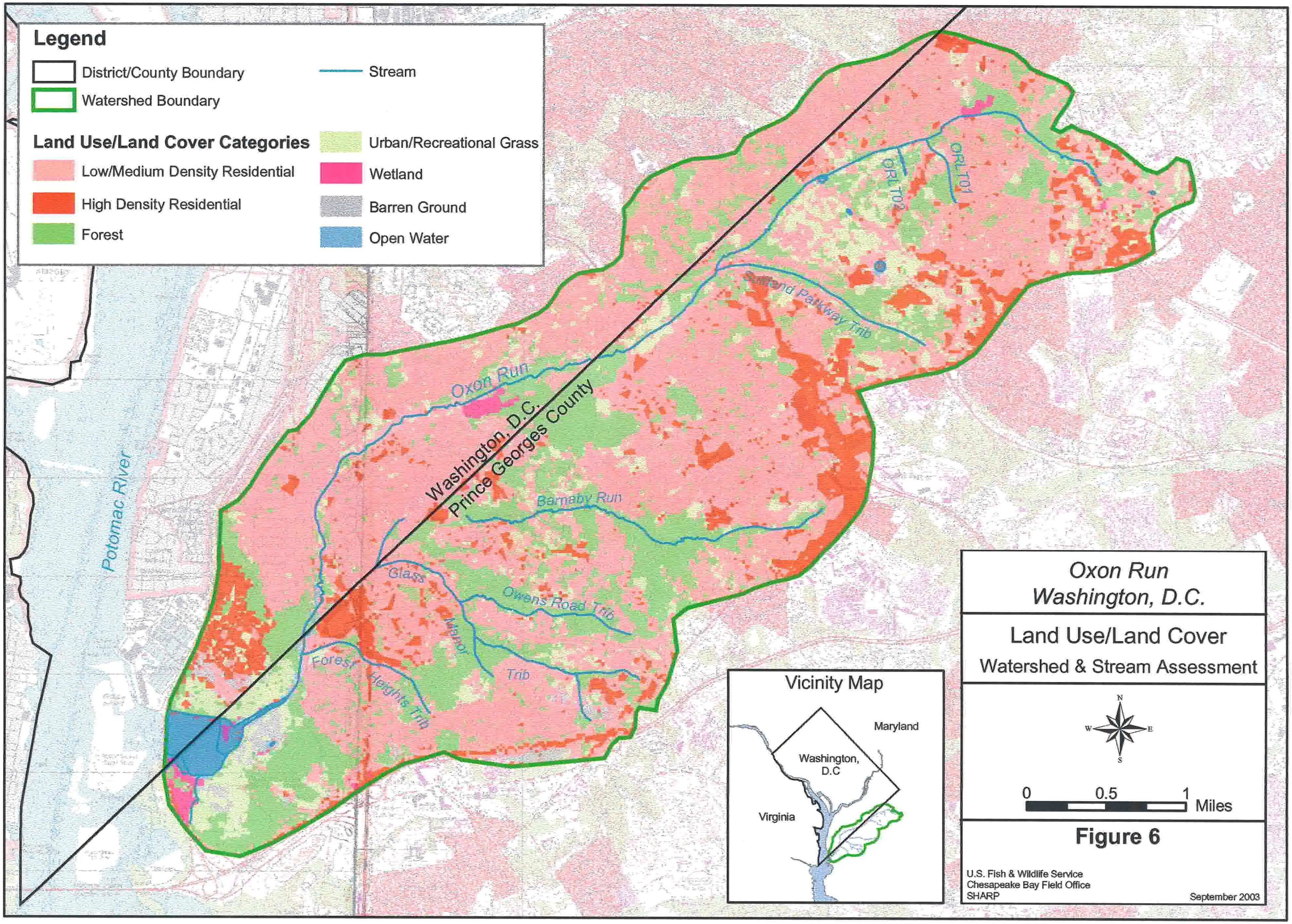
3. Land use/Land cover

The watershed is highly urbanized, with a land use/land cover of 67 percent urban, 9 percent agricultural, and 24 percent forest (Millard *et al.*,. 2001). The majority of the watershed is low to medium density residential, with high density residential or residential commercial areas along Branch Avenue, in the town of Forest Heights, and in the lower part of the watershed near an area known as D.C. Village (Figure 6). Many portions of Oxon Run and its tributaries have a narrow stream corridor. Most of the forested and grassland areas in the watershed are county, city or National Park Service (NPS) parks and are classed as urban/recreational grass. Land cover to impervious surface conversions have been developed for Chesapeake Bay watersheds (Capiella and Brown 2001). Using these conversions, an estimated 33 percent of the watershed is impervious surface.

The extensive development in the watershed changes the rainfall-runoff regime. In an undisturbed, vegetated watershed, a significant portion of rainfall is taken up by the vegetation or percolates through the soil, eventually reaching the stream as groundwater. The roads, parking lots, and buildings associated with urbanization prevent rain from infiltrating the soil. Even grassy areas in an urban setting are often manicured and have a higher runoff rate than their rural counterparts. Thus, both the amount of water and the speed at which it arrives at the stream increase, causing stream instability (widening and downcutting). Land cover and land use affect the amount and size of sediment provided to the stream. Runoff from impervious surfaces often carries very little sediment, although it may be laden with pollutants or trash. In some locations, such as construction sites, large amounts of fine sediment are washed into the stream. Because the form of the stream is driven, in part, by the water and sediment produced in its watershed, changes in sediment and water supply will cause the stream to adjust. Significant development is still occurring in many portions of the watershed, and increased stormwater loads will continue to cause stream instability.

4. Hydrology

Streams in the Oxon Run watershed are a combination of natural and concrete-lined channels, with some reaches completely enclosed in concrete pipes. Within the watershed, there are 15.3 miles of natural channel, approximately 40 percent less than the stream miles that existed in 1938, prior to development in the watershed. Drainage density, a ratio of stream miles to drainage area, was 1.78 mi/mi^2 in 1938. Currently, when miles of stormwater drains are included, the drainage density is 2.40 mi/mi^2, an increase of approximately 35 percent. Higher drainage densities are associated with higher flood peaks (Dunne and Leopold 1978). In an undeveloped watershed, the stream channel and adjacent wetlands provide storage for the runoff. Loss of this storage capacity creates a "flashy" flow regime, with peak flows exhibiting a rapid response to rainfall events. Additionally, the lower roughness and increased hydraulic efficiency associated with piping, channelization, and concrete-lining increases the velocity and erosive force of water entering the natural channel reaches in the stream. Streambank erosion increases sediment load.


Legend
District/County Boundary
Watershed Boundary
Stream
Land Use/Land Cover Categories
Low/Medium Density Residential
High Density Residential
Forest
Urban/Recreational Grass
Wetland
Barren Ground
Open Water
Oxon Run
Washington, D.C.
Prince Georges County
Potomac River
ORLT01
ORLT02
Barnaby Run
Glass
Manor
Trib
Owens Road Trib
Forest Heights Trib
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Land Use/Land Cover
Watershed & Stream Assessment
0
0.5
1
Miles
Figure 6
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003

5. Riparian Vegetation

The riparian buffer is an integral part of the stream ecosystem, providing bank stability and nutrient uptake, serving as a food source for aquatic organisms, and providing terrestrial habitat and migration corridors for various types of wildlife, including migratory neotropical songbirds. Shading provided by the buffer moderates stream temperature and prevents excessive algal growth. Large woody debris derived from the buffer is an important component of aquatic habitat. The Service evaluated quality of the riparian buffer based on buffer width, vegetation diversity, and vegetation density.

Buffer width, species composition and density are described for each of the stream reaches in the appropriate section. Generally, the buffer ranges from 20-120 ft (width includes buffer on both banks) in the locations where the stream is not piped or lined with concrete, although it varies greatly. In almost all cases, the buffer is of low to moderate density and low to moderate diversity. In many locations, the stream is surrounded by a remnant of the original floodplain forest. Vegetation in the buffer area is a deciduous overstory of tulip poplar *(Liriodendron tulipifera),* red and silver maple *(Acer rubrum* and *Acer saccharinum),* sycamore *(Platanus occidentalis),* box elder *(Acer negundo),* and oak *(Quercus spp.).* Understory plants include poison ivy *(Toxicodendron radicans),* spicebush *(Lindera benzoin)*, and jewelweed *(Impatiens capensis),* as well as some exotics such as Japanese knotweed *(Polygonum cuspidatum)* and multi-flora rose *(Rosa multiflora).* Some exotic plant species, including Japanese knotweed and multi-flora rose, are considered invasive species. They grow rapidly, creating a monoculture, and choking out native vegetation. These invasive monocultures are generally poor quality wildlife habitat, providing little in the way of food and cover.

B. Stream Geomorphology

The Service based assessments of stream type, stability, and condition on fieldwork conducted in 2002.

1. Bankfull Determination

In Oxon Run, there were often distinct geomorphic features at two or three elevations, due to continuing stream adjustment. Bankfull indicators are distinct and consistent linear features running relatively parallel to the trend in water surface elevation. In Oxon Run, these features consisted of the tops of the point bars in meandering reaches; slope breaks, often at the front of a small bench or flat; or inflection points on a steep or eroding bank.

Based on surveyed cross sections and Manning's by stream type, estimated discharges for the Upper Reach, Oxon Run Park, and the Lower Reach were 277 - 319 cfs, 320 cfs, and 377-392 cfs, respectively. Overall, bankfull discharges in Oxon Run were much higher than predicted by the Western Coastal Plain regional curve (McCandless 2003). Hammer (1972) suggests stream channels may enlarge by a factor of 2.5 - 3 times the original channel following urbanization. Applying these factors to the bankfull discharges predicted by the Western Coastal Plain regional curves gives an expected discharge of 310 - 375 cfs for the Upper Reach and 375 - 450 cfs for the Lower Reach.

2. Tributaries in Prince George's County

Conditions in the watershed upstream of the project reach have significant impact on the project reach. Although detailed assessments were only conducted within D.C. jurisdiction, the headwaters of Oxon Run and the Suitland Parkway tributary (Figure 7), located upstream of the project area, were evaluated as described in the watershed assessment methodology section. Barnaby Run (Figure 8) drains into Oxon Run just below the southeastern D.C./Prince George's County boundary, as does the Forest Heights tributary (Figure 9). The Service evaluated these streams (Table 1), although they enter Oxon Run downstream of the project area and represent separate sub-watersheds. In some cases, tributaries are unnamed. For ease of discussion, these have been named, generally after the area in which they are located. Any stream name with "tributary" was named for the sole purposes of this report, and is not designated as such on a USGS topographical map.

a) Oxon Run (Prince George's County)

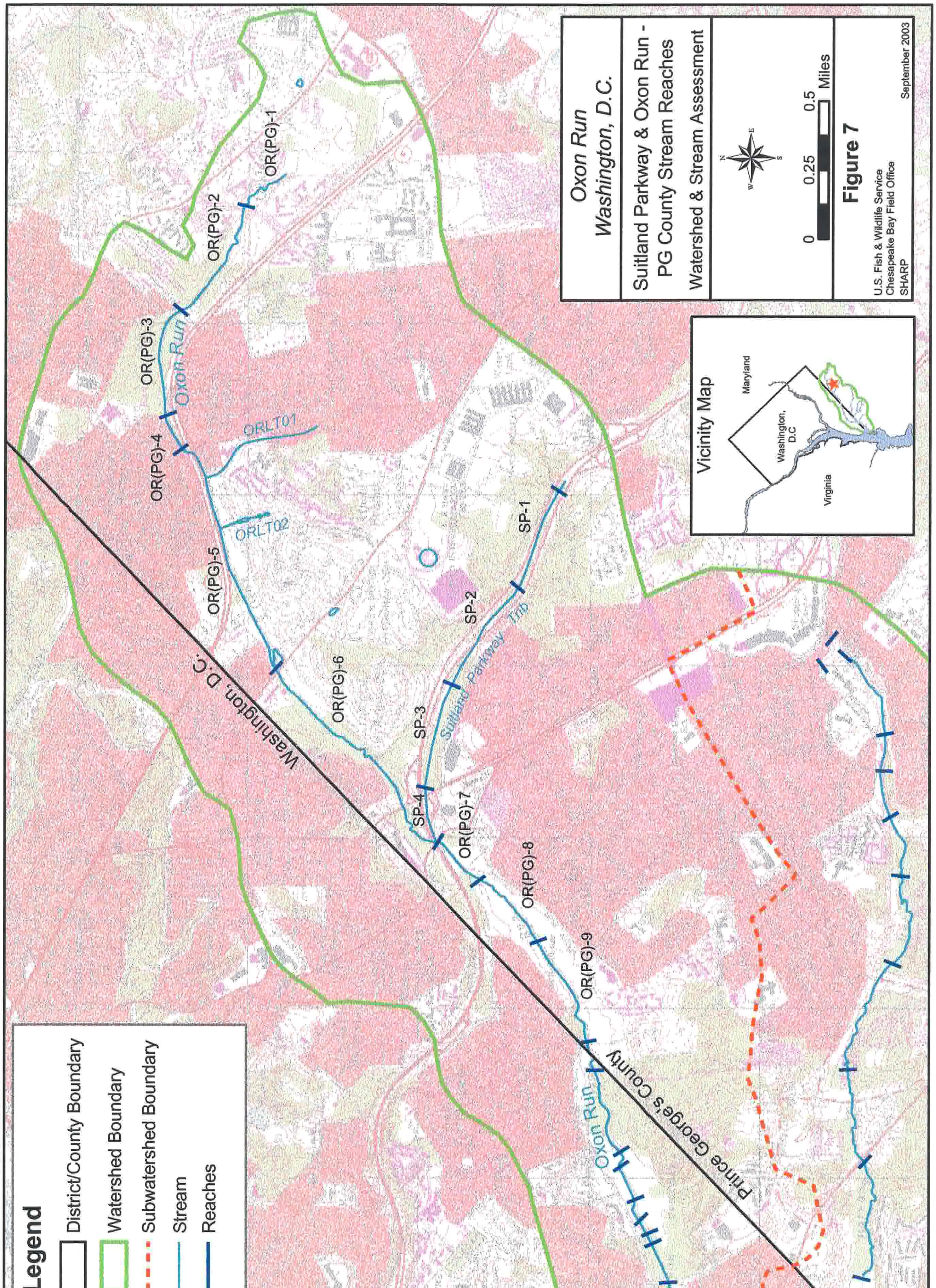
The headwaters of Oxon Run (OR(PG)-1) are a storm drainpipe from a shopping center just northeast of Pennsylvania Avenue, in the Oakland area. Land use in this area is predominantly medium density residential. Drainage from the pipe enters a stormwater management pond, and flows from this pond into a steep-sided channel with riprap armored sides. Due to the armoring, this part of the reach is relatively stable. Upstream of Brookes Drive the stream is a stable E4 type stream, with a low sediment supply. The stream is bordered by a floodplain forest of approximately100 ft, containing predominantly canopy trees of red maple, and an understory of immature red maple, box elder, and sweetgum. The Service noted extensive beaver activity in this area. The stream passes under Brookes Drive in a concrete box culvert. Downstream of Brookes Drive (OR(PG)-2), the stream is an unstable C4 type stream with a high sediment supply, but has a good recovery potential, based on Rosgen interpretation by stream type (Rosgen 1996), should the destabilizing influences be corrected (Photo 1). The destabilizing influence in this reach is primarily stormwater, but high velocity flow through the culvert may also be a factor. The stream is migrating across the floodplain, with numerous cut-off channels, and extensive sediment deposition. The floodplain forest here is similar in composition to that in Reach (OR(PG)-1), but slightly wider. The Service also noted beaver activity in this location. A monumented cross section is installed in this reach to monitor erosion rates.

The stream passes under Quarter Avenue in a galvanized steel culvert (Reach OR (PG)-3). In the reach downstream of the culvert, the stream is an unstable C4 type stream, with a high sediment supply and good recovery potential. The stream is in a degrading trend and will not recover if the causes of instability (primarily stormwater input) are not corrected. The riparian buffer (100 - 150 ft) has canopy trees similar to upstream, but the understory is denser. The Service installed an erosion cross section in this reach. Downstream, the stream flows under Pennsylvania Avenue (at approximately Houston Street), and is contained in a concrete-lined channel (OR(PG)-4). During two separate site visits (February 2002 and July 2002), the water was black, indicating a sanitary sewer leak. Riparian buffer in this location is narrow (0 - 5 ft) on both sides of the channel.

South of Pennsylvania Avenue, the stream flows alongside the boundary of Cedar Hill Cemetery (OR(PG)-5), upstream of Suitland Road, and Lincoln Memorial Cemetery (OR(PG)-6), downstream of Suitland Road. Both of these reaches have been straightened (before 1938, see Historical Overview). Reach OR(PG)-5 is an unstable F4 type stream, confined on one and sometimes both banks by a cement retaining wall. F4 stream types have a very high sediment supply and a poor recovery potential. There is some riparian forest (0 - 80 ft) immediately adjacent to the stream. Reach OR(PG)-6 is an unstable F4 type stream, with a very high sediment supply and poor recovery potential. A number of utility lines are located near the stream, and field crews noted a sewage odor and green tint in the pools on several site visits. The Service installed an erosion cross section in this reach.

Oxon Run flows under Suitland Parkway near the Naylor Road Metro Station (OR(PG)-7), and in 1995, a stabilization/channel realignment project was completed to allow installation of the subway station piers (Biohabitats 1995). Banks have been stabilized either with large riprap or root wads, and grade control structures were installed. This reach is a moderately unstable C4 type stream, with a high sediment supply. Some lateral erosion is occurring in the meander, and the streambed is aggrading. It has a good recovery potential. A willow and locust riparian buffer (10 - 15 ft) was planted as part of the restoration project.

Downstream of the project, the stream runs through Oxon Run Stream Valley Park. This stretch comprised of Reaches OR(PG)-8 (a C4 type stream) and OR(PG)-9 (an F4 type stream) has also been channelized (Photo 2). Both reaches are unstable, with a high to very high sediment supply and poor recovery potential. Several stormwater outfalls are located in both reaches, and there is a large utility crossing in Reach OR(PG)-9. Both have a narrow riparian buffer (5 - 15 ft) on the left bank, which opens onto mowed parkland, and a wider (15 - 40 ft) buffer on the right hand bank. An erosion cross section has been installed in Reach OR(PG)-9.


Oxon Run
Washington, D.C.
Suitland Parkway & Oxon Run - PG County Stream Reaches
Watershed & Stream Assessment
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0.25
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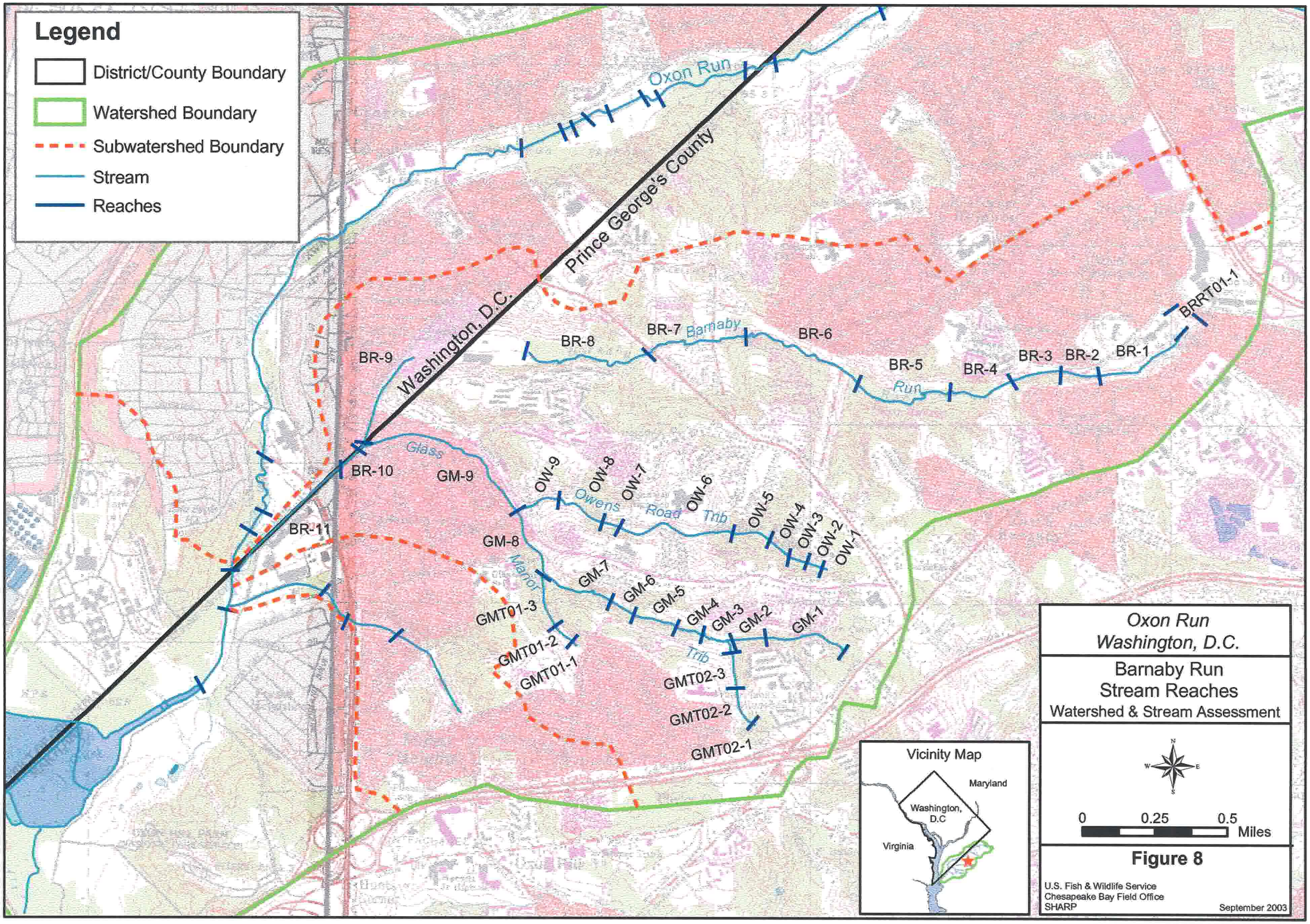
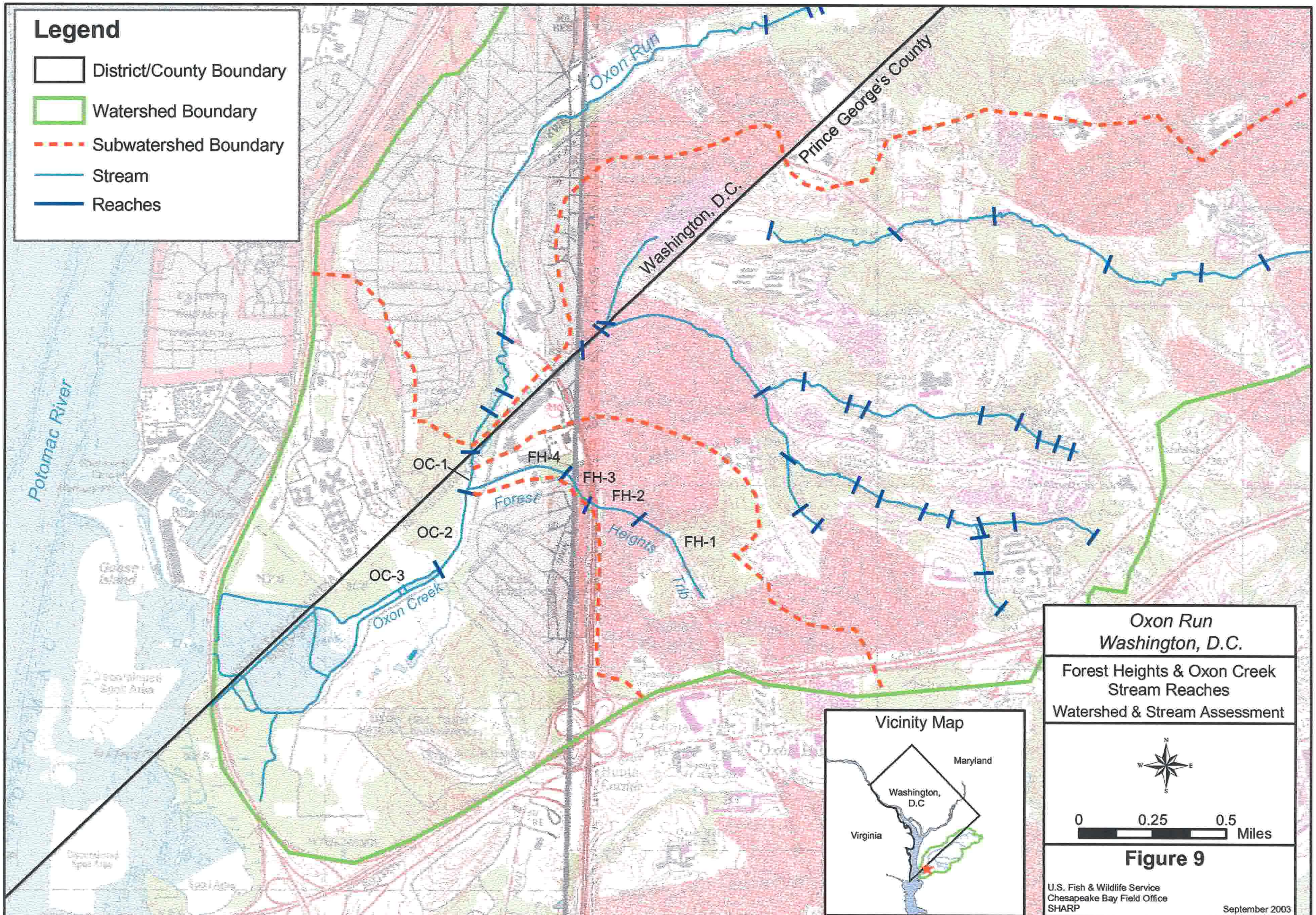
Miles
Figure 7
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003
Vicinity Map
Maryland
Washington, D.C
Virginia
Legend
District/County Boundary
Watershed Boundary
Subwatershed Boundary
Stream
Reaches
OR(PG)-1
OR(PG)-2
OR(PG)-3
OR(PG)-4
OR(PG)-5
OR(PG)-6
OR(PG)-7
OR(PG)-8
OR(PG)-9
ORLT01
ORLT02
SP-1
SP-2
SP-3
SP-4
Oxon Run
Suitland Parkway Trib
Washington, D.C.
Prince George's County



Oxon Run
Washington, D.C.
Barnaby Run
Stream Reaches
Watershed & Stream Assessment

Figure 8


Legend
District/County Boundary
Watershed Boundary
Subwatershed Boundary
Stream
Reaches
Oxon Run
Prince George's County
Washington, D.C.
Potomac River
OC-1
OC-2
OC-3
FH-1
FH-2
FH-3
FH-4
Forest
Heights
Trib
Oxon Creek
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Forest Heights & Oxon Creek
Stream Reaches
Watershed & Stream Assessment
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Miles
Figure 9
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003

Table 1 - Prince George's County Stream Stability Summary

PG County Streams		Rosgen Stream Type	Reach Length (ft)	Bankfull Width (ft)	Total Riparian Buffer Width (Range, ft)	Instream Habitat	Bank Height (Range, ft)	Incision	Vertical Stability	Lateral Stability	Sediment Supply,	Predicted Erosion Rate (tons/yr)	Predicted Erosion Rate (tons/ft/yr)	Disturbance Sensitivity	Recovery Potential
Oxon Run Mainstem	OR-LT-01	Concrete channel	2,686	N/A	N/A	Poor	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OR-LT-02	Piped	1,015	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OR (PG) - 1	E4	1,117	16	55 - 125	Poor	1 - 2	Low	Stable	Stable	Moderate	75	0.07	Very high	Good
	OR (PG) - 2	C4	2,335	10 - 25	150 - 310	Poor	1 - 4	Low	Degrading	Unstable	High	157	0.07	Very high	Poor
	OR (PG) - 3	C4	2,132	25	250+	Poor	2 - 5	Moderate	Degrading	Unstable	High	519	0.24	Very high	Poor
	OR (PG) - 4	Concrete channel	508	N/A	5 - 20	Poor	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OR (PG) - 5	F4	4,468	15	0 - 80	Poor	3 - 4	Low	Degrading	Unstable	Very high	1,397	0.31	Extreme	Poor
	OR (PG) - 6	F4	4,468	20	20 - 200+	Poor	3 - 8	Moderate	Stable	Unstable	Very high	1,397	0.31	Extreme	Poor
	OR (PG) - 7	C4	914	18	10-20	Poor	2 - 4	Low	Degrading	Unstable	High	61	0.07	Very high	Poor
	OR (PG) - 8	F4	1,523	23	20 - 50	Poor	2 - 8	Low to moderate	Stable	Unstable	High	255	0.17	Very high	Poor
	OR (PG) - 9	F4	2,030	23	25 - 40	Poor	3	Moderate	Stable	Unstable	Very high	340	0.17	Extreme	Poor
	Reach Total		23,196									4,201	0.18		
Suitland Parkway Tributary	SP - 1	Gabion-lined	2,171	18	60	Poor	6	Moderate to high	Stable	Stable	Low	0	0.00	N/A	N/A
	SP - 2	F4	4,171	15 - 22	60	Poor	3 - 5	Moderate to high	Stable	Unstable	Very high	1304	0.31	Extreme	Poor
	SP - 3	F4	1,771	15-22	120	Poor	5-6	High	Unstable	Unstable	High	337	0.19	Extreme	Poor
	SP - 4	C4	1,015	15-20	20-30	Fair	2-3	Low	Stable	Unstable	Low	68	0.07	Very high	Poor
	Reach Total		9,128									1,709	0.19		
Barnaby Run	BR RT01 - 1	G5	457	8 - 10	+/- 75	Poor	5 - 7	High	Degrading	Unstable	Very high	115	0.25	Extreme	Very poor
	BR - 1	F4	2,457	23 - 32	+/- 250	Poor	3 - 9	High	Aggrading	Unstable	Very high	768	0.31	Extreme	Poor
	BR - 2	Piped	400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	BR- 3	C4	457	31	+/- 200	Poor	3 - 12	Low	Aggrading	Unstable	High	81	0.18	Very high	Poor
	BR - 4	C4	1,314	18	+/- 200	Poor	5.5 - 7	Low	Stable	Stable	High	234	0.18	Very high	Poor
	BR - 5	C4	1,943	50	+/- 1000	Fair	2 - 20	Low	Aggrading	Unstable	High	420	0.22	Very high	Poor
	BR - 6	C4	2,514	60	+/- 1000	Poor	2 - 6	Low	Aggrading	Unstable	High	448	0.18	Very high	Poor
	BR - 7	C4	2,000	41	> 200	Fair	4 - 20	Low	Aggrading	Unstable	High	357	0.18	Very high	Poor
	BR - 8	C4	2,457	44	> 200	Poor	5 - 16	Moderate	Aggrading	Unstable	High	438	0.18	Very high	Poor
	BR - 9	Piped	4,514	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	BR - 10	Concrete channel	514	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	BR - 11	F4	3,543	36	6	Poor	10 - 12	High	Stable	Unstable	Very high	1,107	0.31	Extreme	Poor
	Reach Total		22,570									3,968	0.18		
Glassmanor Tributary	GM T02 - 1	A4	343	5 - 6	+/- 75	Poor	2.5 - 4.5	Low	Stable	Stable	Very high	43	0.12	Extreme	Very poor
	GM T02 - 2	B4	286	7 - 10	+/- 75	Poor	2.5 - 4.5	Low	Stable	Stable	Moderate	36	0.12	Moderate	Excellent
	GM T03 - 3	G6	686	5 - 7	+/- 75	Poor	10 - 15	High	Degrading	Unstable	High	173	0.25	Very high	Poor
	GM T01 - 1	F4	343	12	+/- 500	Poor	8 - 12	High	Degrading	Unstable	Very high	133	0.39	Extreme	Poor
	GM T01 - 2	F4	400	11	+/- 500	Poor	3 - 5	High	Degrading	Unstable	Very high	155	0.39	Extreme	Poor
	GM T01 - 3	F4	857	18	+/- 500	Poor	6 - 12	High	Degrading	Unstable	Very high	332	0.39	Extreme	Poor
	GM - 1	F6	1,657	10 - 16	+/- 75	Poor	4 - 8	High	Degrading	Unstable	High	417	0.25	Very high	Fair
	GM - 2	F6	571	13 - 18	+/- 75	Poor	10 - 15	High	Degrading	Unstable	High	144	0.25	Very high	Fair
	GM - 3	G6	571	10 - 13	+/- 75	Poor	10 - 12	High	Degrading	Unstable	High	144	0.25	Very high	Poor
	GM - 4	F6	514	18 - 23	+/- 100	Poor	8 - 10	High	Degrading	Unstable	High	129	0.25	Very high	Fair
	GM - 5	C4	914	20 - 24	+ 200	Poor	4 - 6	Moderate	Degrading	Unstable	High	154	0.17	Very high	Poor
	GM - 6	G4	457	22	+/- 500	Poor	10 - 15	High	Degrading	Unstable	Moderate	77	0.17	Extreme	Very poor
	GM - 7	F4	1,489	21	+/- 500	Poor	6 - 12	High	Degrading	Unstable	High	576	0.39	Extreme	Poor
	GM - 8	F4	1,314	25	+/- 125	Poor	6 - 20	High	Degrading	Unstable	High	509	0.39	Extreme	Poor
	GM - 9	Concrete channel	4,456	27	N/A	Poor	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	Reach Total		14,858									3,022	0.20		
Owens Road Tributary	OW - 1	Piped or concrete channel	400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OW - 2	Piped or concrete channel	268	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OW - 3	Piped or concrete channel	286	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	OW - 4	F4	457	+/- 15	+/- 250	Poor	5 - 6	High	Degrading	Unstable	Very high	160	0.35	Extreme	Poor
	OW - 5	C4	800	8 - 12	+/- 250	Poor	2.5 - 4.5	Moderate	Degrading	Unstable	High	280	0.35	Very high	Poor
	OW - 6	C4	2,343	15 - 27	+/- 250	Poor	3 - 20	Moderate	Degrading	Unstable	High	821	0.35	Very high	Poor
	OW - 7	C4	286	15 - 25	+/- 250	Poor	2 - 3	Moderate	Stable	Stable	High	7	0.02	Very high	Poor
	OW - 8	C4	971	25	+/- 250	Poor	3 - 4	Moderate	Degrading	Unstable	High	340	0.35	Very high	Poor
	OW - 9	C4	343	18	+/- 250	Poor	4 - 8	Moderate	Degrading	Unstable	High	120	0.35	Very high	Poor
	Reach Total		6,154									1,728	0.28		
Forest Heights Tributary	FH - 1	F4	1,943	15 - 20	40 - 50	Fair	5 - 6	Moderate to high	Aggrading	Unstable	Very high	589	0.30	Extreme	Poor
	FH - 2	Concrete channel	971	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	FH - 3	Piped	629	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.00	N/A	N/A
	FH - 4	F4	6,514	15 - 20	40 - 50	Fair	5 - 6	Moderate to high	Aggrading	Unstable	Very high	1976	0.30	Extreme	Poor
	Reach Total		10,057									2,565	0.26		

*Note: Although the Rosgen interpretation for recovery potential of C4 channels is "good," the evolutionary trends indicate a "poor" recovery potential.

Photo 1. Near the headwaters Oxon Run is not deeply incised, but it has begun to both downcut and widen. Note obvious floodplain break. This is Reach OR(PG)-2, an unstable C4.

Photo 2. In many locations the stream has been channelized, resulting in an over-wide channel with poor bed features. This is Reach OR(PG)-9, an unstable F4.

b) Suitland Parkway Tributary

Headwaters of the Suitland Parkway tributary are a stormwater outfall draining Suitland Federal Center. The pipe empties into a stable gabion-lined channel (SP-1) just east of the Silver Hill Road intersection. This reach has a low sediment supply, due primarily to bank armoring. Field crews noted extensive orange staining on rocks in this reach. For a short distance (~100 ft), the channel between the lanes is a moderately stable F4 natural channel (SP-2), and then it bends to the left and passes under the westbound lane in a box culvert. On the other side of the road, the stream is natural channel (SP-3), and is severely incised (Photo3). Several outfalls are perched high (4 - 6 ft) above the streambed in this reach. The stream is an unstable F4 type stream, with a very high sediment supply and poor recovery potential. The tributary empties into the Oxon Run mainstem near the Naylor Road Metro Station. A stabilization project has been constructed on the Suitland Parkway Tributary adjacent to the subway support piers (SP-4). The specific age of this project is unknown, but it consists of grade-control structures constructed out of large boulders, and bank stabilization with fiber mats, willow stakes, and riprap. The stream is a moderately unstable C4 type stream, with some evidence of bank erosion. Stormwater input from upstream reaches and the heavy sediment load generated in Reach SP-3 are affecting the stability of this project.

c) Barnaby Run

Barnaby Run is the largest tributary to Oxon Run, entering near Forest Heights, at the D.C./Prince George's County border. It is a sub-watershed of approximately 6 mi^2, around 40 percent of the total Oxon Run watershed, and is mostly contained in Prince George's County. It has two unnamed second order tributaries, referred to in this report as the Glassmanor Tributary and the Owens Road Tributary (Figure 8). Headwaters for Barnaby Run are stormwater drainage from Marlowe Heights Shopping Center and a small gully (BRRT01-1). The gully is an unstable G5, with high sediment supply, and very poor recovery potential. The riparian buffer is approximately 75 ft wide. The main stem of Barnaby (BR-1) runs for a short stretch in a natural channel behind Benjamin Stoddart Middle School. The channel is in transition from a C4 type stream to an F4 type stream, with high sediment supply and poor recovery potential. During a site visit in July 2002, field crews noted a leaking sanitary sewer and notified Prince George's County. At Raleigh Road (BR-2), the channel is piped under the grounds of an apartment building, daylighting downstream in Barnaby Run Stream Valley Park (BR-3). In the park, the stream has a riparian buffer of approximately 200 ft. The vegetation is of moderate density and diversity, with canopy trees of tulip poplar, maple, beech and sycamore. This portion of Barnaby Run has been separated into six reaches (BR-3, BR-4, BR-5, BR-6, BR-7, and BR-8), based on condition (Figure 8). With the exception of Reach BR-4, where a utility line crossing provides grade control, all of these reaches are unstable C4 type streams, with a high sediment supply (Photo 4). These reaches have a poor recovery potential, unless the causes of instability (primarily stormwater input) are adequately addressed. The stream is migrating laterally, and in many locations, it now runs at the base of the high terrace, with banks 12 - 20 ft high. In some locations, flow is subsurface. A sanitary sewer break was observed behind apartments on Southview Drive.

Downstream of the apartments, the stream is piped (BR-9). A portion of the piped reach is located in Prince George's County, and a portion is located in D.C. It daylights in a concrete channel (BR-10). The concrete channel, running alongside Southern Avenue, is in D.C jurisdiction. After it goes under Indian Head Highway (Route 210), it is a channelized natural bed, located behind Eastover Shopping Center. This part of the stream is located directly on the D.C./Prince George's County boundary. Bank material is either consolidated silt/clay or revetted in some fashion, such as by concrete blocks. It is an unstable F4 type stream with very high sediment supply, and poor recovery potential. In this location, there is no riparian buffer.

Photo 3. Portions of Suitland Parkway Tributary are deeply incised and have extensive gravel bars. Note the high, eroding banks and trees which have fallen as a result of the bank erosion. This is Reach SP-3, an unstable F4.

Photo 4. The majority of Barnaby Run carries a heavy sediment load, and is characterized by extensive gravel bars. In some locations, the stream has migrated across the floodplain, and is cutting into the high terrace (visible in left foreground). This is Reach BR-8, an unstable C4.

d) Glassmanor Tributary

Headwaters of the Glassmanor Tributary (GM) are a stormwater pipe behind Roscroft Village Circle and a sub-tributary originating behind the terminus of Alice Avenue (GMT02). Stormwater input has caused severe erosion in Reaches GM-1 and GM-2 (Photo 5). The reaches are unstable F6 type streams, with a high sediment supply and fair recovery potential. In these reaches, the stream is actively incising, with a series of small headcuts moving upstream. The stream has eroded below a historic marine clay layer, and in some locations, fossil shells are visible in the bank. The riparian buffer for both the Glassmanor Tributary and the sub-tributary is approximately 75 ft wide, with a canopy of tulip poplar, beech, ironwood, and maple. The sub-tributary (GMTO2-1) is a stable A4 type stream, and then it changes to a stable B4 type stream (GMTO2-2). Prior to the confluence (GMT02-3), the stream changes to an unstable G6 type stream. All three reaches have a high sediment supply. Recovery potential for GMT02-3 is very poor. The G6 reach is actively incising, with a headcut visible, and high (10 - 15 ft) eroding banks. Left unchecked, the headcut will continue to move upstream, and destabilize the upstream reaches (GMT02-1 and GMT02-2).

The main stem of the Glassmanor Tributary (GM-3 to GM-8) is unstable, with a high sediment load, and a wide riparian buffer of (75 - 500 ft) in nearly all locations. Stream type varies from reach to reach, with the majority an F6 or G6 type stream, although there are short stretches of C4 type stream where utility lines or other structures are maintaining some grade control. Recovery potential for the F6 and G6 reaches is poor. Should the stream erode under or around the utility lines, the C4 reaches will quickly become unstable. Prior to Kennebec Street, another unnamed first order tributary (GMT01) drains into the Glassmanor Tributary main stem. This tributary is unstable, evolving from a C4 type stream to an F4 type stream, with a high sediment supply and poor recovery potential. From Kennebec Street to the confluence with Barnaby Run (GM-9), the stream is a concrete-lined channel.

e) Owens Road Tributary

Headwaters of the Owens Road tributary (OW) are just south of the intersection of Woodland Boulevard and Boulder Drive. Reaches OW-1 to OW-3 are either piped or concrete-lined. For the rest of its length (OW-4 to OW-9), this tributary is either an unstable C4 type stream (Photo 6), or an unstable F4 type stream. Sediment supply is high to very high, and recovery potential is poor. The dominant process in this stream is bed erosion. A number of headcuts are gradually working their way upstream. For short stretches, the stream is a stable C4 because of utility line crossings or other anthropogenic structures serve as grade controls. Should the stream erode under or around the utility lines, the C4 reaches will quickly become unstable. Located in a valley between residential streets, it has a riparian buffer approximately 250 ft wide, with a canopy of tulip poplar, locust, and maple.

Photo 5. Most of the Glassmanor Tributary has incised and is characterized by high, eroding banks. In many locations, it has downcut to a clay lens. This is Reach GM-2, an unstable F6.

Photo 6. Much of the Owens Road Tributary still maintains some connectivity with the floodplain but the stream is migrating laterally, and eroding the banks. This is Reach OW-6, an unstable C4.

f) Forest Heights Tributary

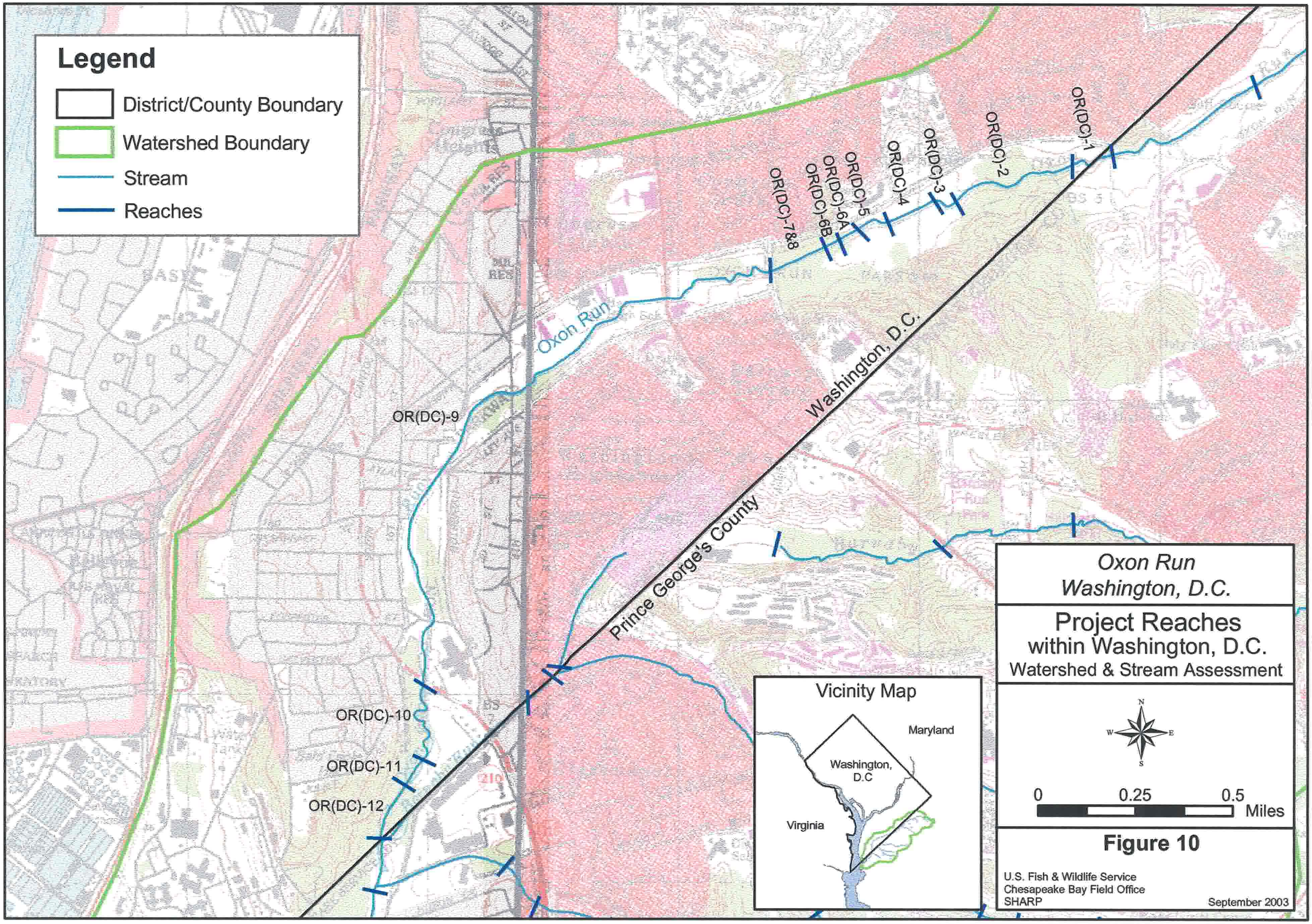
The Forest Heights tributary runs alongside Livingston Road, beginning around Crisfield Drive. In its natural channel portions (FH-1 and FH-4), the stream is an unstable F4 type stream. The sections immediately up- and downstream of Indian Head Highway (Rte. 210) are a concrete-lined channel (FH-2), and piped (FH-3), respectively. The F4 reaches (Photo 7) have a very high sediment supply and poor recovery potential. In 2003, Prince George's County constructed a flood control wall along the left bank of Reach FH-4. Prior to emptying into Oxon Run, the stream passes over a concrete drop structure installed as part of the original Forest Heights flood control project (Photo 8). Just upstream of the confluence is a larger drop structure on Oxon Run. Land use in this area ranges from medium density residential to high density commercial.

Photo 7. The natural channel reaches of the Forest Heights Tributary are characterized by high eroding banks. This is Reach FH-4, an unstable F4.

Photo 8. Concrete drop structure on the Forest Heights Tributary, at the confluence with Oxon Run (Reach FH-4). This structure is a barrier to fish passage.

3. Oxon Run Mainstem (D.C. Portion)

Although 12 separate reaches (Figure 10) were assessed, for ease of discussion and restoration planning shorter reaches have been combined into three sections, designated the Upper Reach, Oxon Run Park (a concrete-lined channel), and the Lower Reach. The Upper Reach runs from Southern Avenue to 13th Street, and includes numbered Reaches 1 – 8. The concrete-lined channel extends from 13th Street to South Capitol Street. This section represents a significant portion of the length of stream flowing through D.C. The Lower Reach, comprised of numbered Reaches 10 - 12, begins downstream of South Capitol Street and ends at the confluence with Barnaby Run. In the natural channel portions of the stream (the Upper and Lower Reaches), some reaches of the stream are meandering. Other reaches have obviously been straightened at some time in the past and are now confined by high banks. In both the Upper and Lower Reaches, there are multiple terraces (abandoned floodplains), and relict channels, indicating the stream has migrated across the floodplain in the past. This migration may have been in response to changes in the watershed, or the stream may have been intentionally altered. Present-day bed elevation is lower than the historical one, decreasing connectivity with the floodplain. In its current condition, the stream has lost much of its ability to dissipate floods and high flows are contained in the channel. Summary data for the stream classification and the stability assessment are shown in Tables 2 and 3.



Legend
District/County Boundary
Watershed Boundary
Stream
Reaches
OR(DC)-1
OR(DC)-2
OR(DC)-3
OR(DC)-4
OR(DC)-5
OR(DC)-6A
OR(DC)-6B
OR(DC)-7&8
OR(DC)-9
OR(DC)-10
OR(DC)-11
OR(DC)-12
Oxon Run
Washington, D.C.
Prince George's County
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Project Reaches
within Washington, D.C.
Watershed & Stream Assessment
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Miles
Figure 10
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003

Table 2 - Oxon Run Classification Summary

Reach		Reach Length (ft)	Rosgen Stream Type		Drainage Area (mi^2)	Cross-Sectional Area (ft^2)	Bankfull Width (ft)	Mean Bankfull Depth (ft)	Width / Depth Ratio	Wetted Perimeter (ft)	Manning's n	Entrench-ment	Sinuosity	Stream Slope (ft/ft)	Bankfull Discharge (cfs)	Riparian Buffer Width (ft)	
																Right Bank	Left Bank
Upper Reach	1	460	F	4	6.2	Similar channel conditions to Reach 4										0-154	21-45
	2	1,796	B	4c	6.2	90	43	2.1	20	44.1	0.056	2.0	1.2	0.005	277	10-492	66-290
	3	460	F	4	6.2	Similar channel conditions to Reach 2										50-465	274-1,008
	4	550	F	4	6.6	74	33	2.2	15	36.4	0.034	1.4	1.2	0.004	319	14-51	1,030-1,230
	5	385	B	4c	6.6	78	35	2.2	16	36.4	0.041	1.7	1.2	0.005	315	40-104	124-1,502
	6	370	C	4	6.6	74	36	2.1	18	36.7	0.038	3.1	1.2	0.005	307	35-231	669-922
	7	320	D	4	6.6	94	87	1.1	81	89.1	0.032	1.9	1.2	0.005	N/A	35-231	669-922
	8	779	B	4c	6.9	89	43	2.1	21	45.2	0.056	1.5	1.2	0.005	249	275-388	619-1,016
Oxon Run Park	9	7,920	N/A		7.0-8.2	66	45	1.5	30	45.8	0.028	N/A	N/A	0.005	320	0-500 Mowed lawn	0-500 Mowed lawn
Lower Reach	10	1,200	C	4	8.2	85	42	2.0	21	45.2	0.038	2.5	1.1	0.006	377	500-550	20-248
	11	320	B	4c	8.3	104	52	2.0	26	55.5	0.036	1.5	1.1	0.003	380	0-154	21-45
	12	523	F	4	8.3	96	47	2.1	23	50.8	0.034	1.4	1.1	0.003	392	717-1,000	100-360

Notes: 1) Bankfull discharges were computed based on Manning's n by stream type.

Table 3 - Oxon Run Stability and Erosion Summary

Reach		Pfankuch Channel Stability	Vertical Stability	Lateral Stability	Sediment Supply	Predicted Erosion (tons/yr)	Predicted Erosion (tons/yr/ft)	Disturbance Sensitivity	Recovery Potential
Upper Reach	1	Poor	Stable	Stable	Moderate	41	0.09	Extreme	Poor
	2	Poor	Degrading	Unstable	High	158	0.09	Moderate	Poor
	3	Poor	Degrading	Unstable	High	69	0.15	Extreme	Poor
	4	Fair	Stable	Stable	Moderate	23	0.04	Extreme	Poor
	5	Fair	Degrading	Unstable	Moderate	40	0.10	Moderate	Poor
	6	Poor	Degrading	Unstable	High	98	0.26	Very High	Good
	7	Poor	Aggrading	Unstable	Very High	140	0.44	Very High	Poor
	8	Poor	Degrading	Unstable	Moderate	85	0.11	Moderate	Poor
Oxon Run Park	9	N/A	Aggrading	Stable	Low	0	0.00	N/A	N/A
Lower Reach	10	Fair	Degrading	Unstable	High	170	0.14	Very High	Good
	11	Fair	Aggrading	Unstable	Moderate	87	0.27	Moderate	Poor
	12	Fair	Aggrading	Unstable	Moderate	122	0.23	Extreme	Poor

a) Upper Reach

The Upper Reach (Figure 11) is 5120 ft long, and represents 33.9 percent of the total stream length in D.C. jurisdiction. Within this section, there are three straightened reaches (Reaches 1, 4, and 8) connected by meandering reaches (Reaches 2, 3, 5, and 6), and a braided reach (Reach 7). The Service selected Reach 2 as representative of the meandering reaches (Photo 9) and Reach 4 as representative of the straightened reaches and (Photo 10). Much of the Upper Reach has an extensive riparian buffer (500 - 1,000 ft) along the left bank. There are locations in Reach 1 and 2 where there is little buffer on the right bank, but in most other areas, the buffer is 25 - 200 ft wide.

The meandering reaches are F4, B4c, and C4 type streams. All reaches are unstable, with highly mobile beds. Reach 2 is a B4c type stream with a bankfull width of 43 ft; bankfull mean depth of 2.1 ft and cross-sectional area of 90 ft^2. Bankfull dimensions in the other meandering reaches are similar. Bottom material consists of coarse gravel. Sediment supply is high (ranging from 0.8 - 0.15 tons/foot/yr), and the bed is mobile. There is moderate development of riffles and pools. Large woody debris is common in these reaches, due to trees falling from eroded banks. Generally, there is a deep scour hole to the side or immediately behind the debris. Extensive gravel bars, many with transverse riffles, characterize these reaches. The low bank is about 4 - 5 ft high, with the high banks significantly taller, around 8 - 9 ft. A number of storm drains empty directly into the stream. These storm drains have caused visible erosion in the streambank and bed adjacent to the outfall, and often on the opposite bank as well. Many of the drains are elevated 1 - 2 ft above the existing streambed. Of particular note is a large (6 ft in diameter) outfall emptying into a bend of the stream. This outfall has eroded a deep (5.5 ft) pool immediately below the concrete apron, and the bank on the upstream side is eroding rapidly. In several locations, there were collapsing concrete support structures. In seven locations, there were exposed utility lines. The water was generally clear, except after a rainfall, but often had a sewage odor. In some areas, there were noticeable oil slicks on the water, and/or reddish staining on the rocks. Trash was present in all reaches, and ranged from small debris such as wrappers and aluminum cans to shopping carts, and in several instances, cars. Aquatic habitat quality was poor to fair, and fish were rarely seen. Aquatic habitat rating is based on impaired water quality, lack of good quality pools, water levels in riffles inadequate to allow passage of fish at low flow conditions, the mobility of the bed, which disrupts spawning activity, and significant changes in bed elevation, which constitute a barrier to fish passage.

The straightened reaches (Reaches 1, 4, 8) were essentially single long riffles with some lateral bar development, although Reach 8 had more defined bed features than the others. Reaches 1 and 4 are F4 type streams, and Reach 8 is a B4c type stream. Reaches 1 and 4 are relatively stable, but Reach 8 is unstable. Reach 4 channel dimensions are bankfull width of 33 ft, bankfull mean depth of 2.2 ft, and cross-sectional area of 74 ft^2. Bottom material consists of coarse gravel. Bank heights were similar on both sides of the stream, but varied between reaches. Bank heights were 3 - 4 ft in Reach 1, 6 - 7 ft in Reach 4, and 8 - 10 ft in Reach 8. Reach 1 and Reach 8 had stormwater outfalls. Reach 4 has a single exposed sewer line, acting as a grade control.

Reach 7 (320 ft) has is a D4 type stream (multiple channels). Bankfull width in Reach 7 is 87 ft, bankfull mean depth is 1.1 ft and cross-sectional area is 94 ft^2. Bottom material consists of coarse gravel. Reach 7 is unstable, with a high sediment supply. When surveyed, Reach 7 had four active channels, with large debris piles in between. A sewer pipe armored the toe of the left bank. The sewer pipe was broken at the head of the reach, and a manhole stack, possibly originally located at or near the break, was lying on the right bank.

From 1904 to 1958, the D.C. National Guard operated a firing range facility, Camp Simms, in an area along the Upper Reach of Oxon Run (EA Engineering 1998). Reaches 3 - 8 are located in the former Camp Simms area, now owned by NPS. As part of the Camp Simms site investigation and remedial activities, a number of unexploded ordnance (UXOs) were identified and removed from the premises. The USACE conducted a risk assessment evaluating the potential hazard posed by lead from expended ammunition (EA Engineering 1998). Several categories of human users were identified, including construction workers, maintenance workers, and children using the site for play. Based on exposure modeling, the risk assessment concluded there was a low level of risk for all these users, although it recommended that protective equipment (gloves, long-sleeve shirts, and long pants) should be worn by maintenance and construction workers to minimize lead exposure. Four northern magnolia bogs are located in the floodplain to the left of the stream (EA Engineering 1998). These are the only ones known to exist in the NPS system (EA Engineering 1998), and this type of coastal plain bog is nearly extinct, so an ecological risk assessment was conducted as well. American robin *(Turdus migratorius),* deer mouse *(Peromyscus maniculatus),* and red fox *(Vulpes vulpes)* were selected as ecological receptors. Based on food-web modeling, significant potential risk to the American robin was identified, from both drainage pathway sediment and bog sediment. For these media, risk was low for the deer mouse and negligible for the red fox. Greater risk to the robin was associated with consumption of soil invertebrates. In spite of the risk associated with lead exposure, removal of the contaminated sediment was not recommended due to the unique nature of the bog. Although there is potential for lead to migrate to the stream via drainage swales or groundwater, elevated lead levels were not found in the sediment and surface water of Oxon Run (EA Engineering 1998).

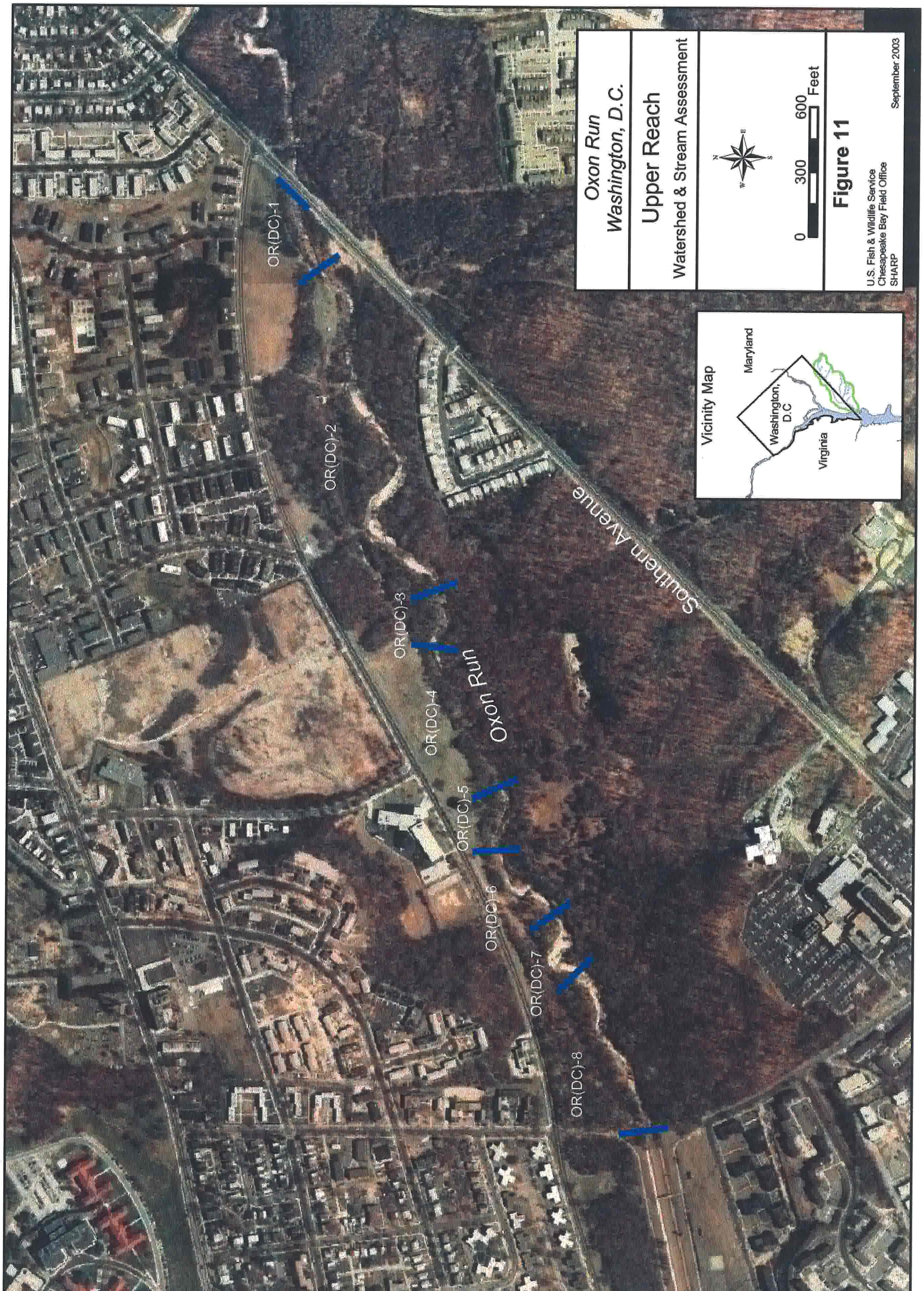
Oxon Run
Washington, D.C.
Upper Reach
Watershed & Stream Assessment
0 300 600 Feet
Figure 11
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003
Vicinity Map
Maryland
Washington, D.C
Virginia
Southern Avenue
Oxon Run
OR(DC)-1
OR(DC)-2
OR(DC)-3
OR(DC)-4
OR(DC)-5
OR(DC)-6
OR(DC)-7
OR(DC)-8

Photo 9. The meandering channel portions of the Upper Reach are characterized by an over-wide channel, shallow water, and extensive gravel bars. The stream is migrating laterally across the floodplain. This is OR(DC)-2.

Photo 10. The shallow water and lack of bed features in straightened reaches provide poor aquatic habitat. This is Reach OR(DC)-4, which was straightened when the area was Camp Simms.

b) Oxon Run Park

Washington D.C. Parks and Recreation manages Oxon Run Park (13th Street to South Capitol Street). No natural stream remains in this stretch (Figure 12). In 1978 - 79, a continuous concrete-lined channel was installed for flood control purposes. It extends for 7,920 ft, and represents 53 percent of the D.C. portion of Oxon Run. The channel was designed to contain the 15-year storm, with expectations that the 100-year flood would be contained within park boundaries, except at Yuma and Xenia Streets, where structures in the floodplain may be at risk (DCDES 1979). The channel is trapezoidal in shape, with a bottom width of 50 ft, a top width of 75 ft, and a slope of 2:1 on the sides (Photo11). Height from the bottom of the channel to the top is 5.5 ft. In most locations, the land surrounding the channel has been graded. The majority of the buffer is mowed grass, although patches of the original woodland remain, and in some locations mature canopy trees were left standing after the concrete-lined channel was completed.

The concrete channel is too wide to maintain any significant water depth during base flow. In several locations, sediment has deposited, creating bars within the concrete channel. While many of these consist of gravel that is mobile at each high flow event, some bars have mature trees (Photo 12). The Service surveyed a cross section at a vegetated bar, using the top of the bar as the bankfull feature. Bankfull width was 44 ft, mean bankfull depth was 1.5 ft, and cross-sectional area was 66 ft^2. Water in the concrete channel is typically less than 0.1 ft deep, even in locations where the flow is constricted. Although the concrete provides significant stability, it has no value as aquatic habitat, and constitutes a major barrier to fish passage. Twenty-five stormwater outfalls empty into this reach. While most are stormwater supplied, one located near Oxon Run Neighborhood Pool had significant flow even during dry conditions. A small tributary and wetland are present on the right side of the channel, although it is uncertain whether the water source is natural (*i.e.*, a spring) or anthropogenic (*i.e.*, a leaking water main). Following a rainstorm, the volume of water entering the channel, and the lack of resistance from the concrete surface combine to create high velocity flows. These high velocity flows can cause significant erosion in the natural channel reaches downstream.

The master landscape plan for the park, developed in 1979, envisions the park as a greenway linking the NPS lands (Oxon Run Park from Southern Avenue to 13th Street and the Oxon Cove National Park, near Forest Heights) (DCDES 1979). An 8-ft wide pavement hike and bike path was constructed along both sides of the channel. Five pedestrian bridges (two between 13th Street and Wheeler Avenue, one behind Oxon Run Neighborhood Pool, and two just upstream of South Capitol Street, behind Friendship Educational Center) connect the two sides of the park. In the 1979 plan, pedestrian underpasses were planned for Wheeler Avenue, 4th Street, and Atlantic Avenue, all of which cut through the park, but none were constructed. Playgrounds, tennis courts, and picnic tables are scattered throughout the park.

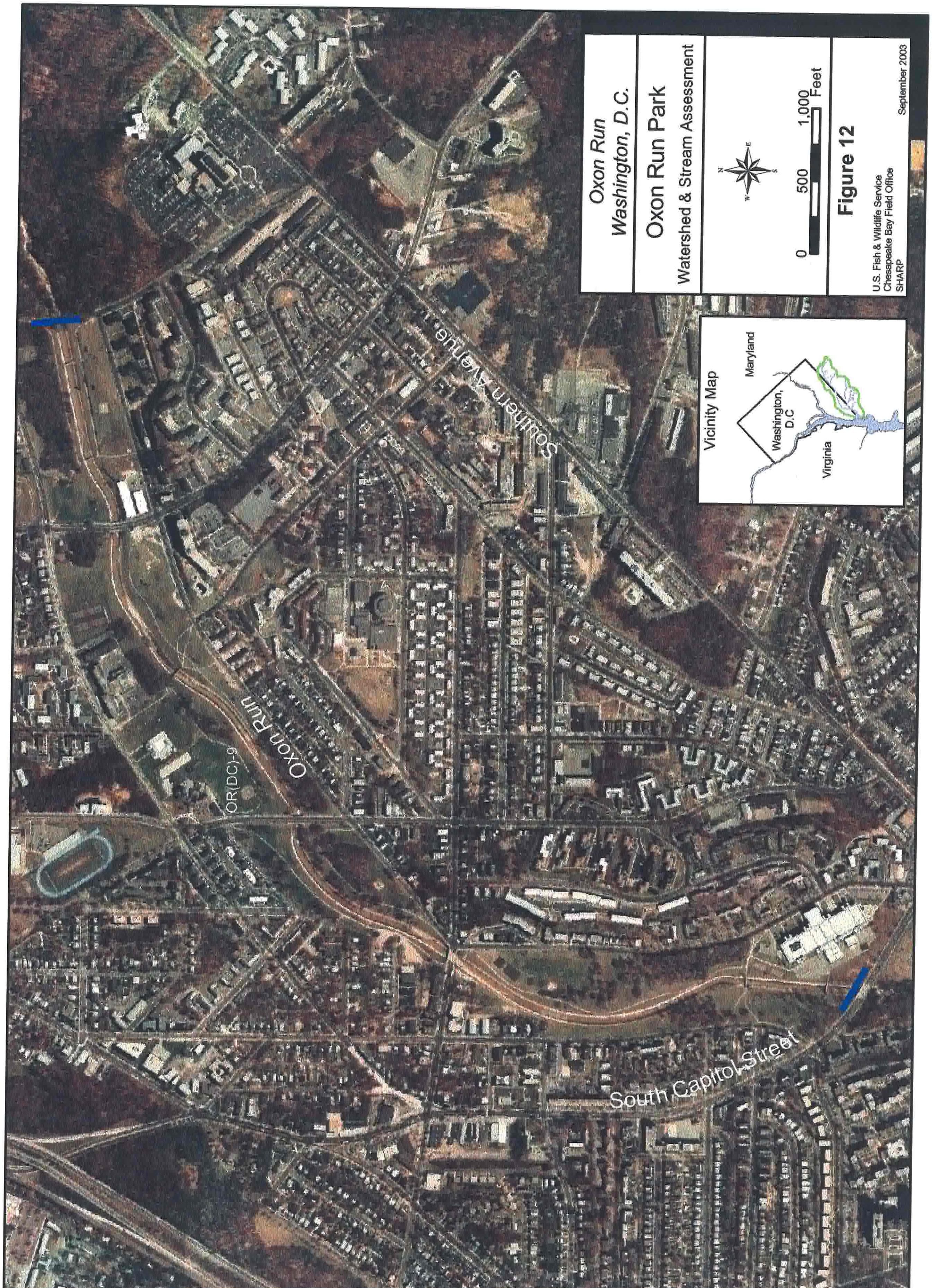
Oxon Run
Washington, D.C.
Oxon Run Park
Watershed & Stream Assessment
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Figure 12
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003
Vicinity Map
Maryland
Washington, D.C
Virginia
Southern Avenue
Oxon Run
OR(DC)-9
South Capitol Street

Photo 11. In 1978-79, a concrete-lined channel was installed for flood protection. Shallow water during low flow conditions is a barrier to fish passage. This is Reach OR(DC)-9.

Photo 12. In some locations, vegetated bars have formed within the channel. This is Reach OR(DC)-9.

c) Lower Reach

The Lower Reach (2,043 ft, 14 percent of the D.C. portion) extends from just downstream of South Capitol Street to the confluence with Barnaby Run at the D.C./Prince George's County border (Figure 13). Here the stream is natural channel, and has been divided into three reaches. Reach 10, immediately downstream of the concrete channel is meandering (Photo 13). The other two reaches, 11 and 12, are straight (Photo 14). On the left bank of all three reaches is an area designated in the D.C. GIS database as a sanitary landfill and in the Oxon Run landscape plan as an area of urban refuse (DCDES 1979). Field crews found tires, glass and metal fragments, and other types of debris embedded in the bank where the stream has adjusted laterally, indicating that at least the portion of the landfill bordering the stream is unlined. Streambank erosion and subsurface water flow from this area may be a source of contaminants and debris. Additionally, near the upstream end of the landfill, field crews repeatedly noted a petroleum odor. At the upstream edge of the landfill, the stream makes a sharp bend and the bank is 20 ft high. The combination of erosive forces from the water and high banks is causing mass wasting and portions of the upper bank are falling into the stream. This condition has apparently existed at least since 1979, as the landscape plan notes this area is "to be channelized by the National Park Service", and recommends construction of a retaining wall. The specific reason(s) for straightening Reaches 11 and 12 is uncertain. Downstream of Reach 12 is a concrete drop structure (Photo 15). The drop structure was installed in 1962 - 63 by the USACE as part of the Forest Heights flood control project. The drop structure, although it serves as a grade control and has prevent headcutting in response to the change in bed elevation, is a significant barrier to fish passage. The flood project consisted of relocating and dredging the channel to "accommodate twice the highest known flood", plus a 3-foot freeboard (USACE 1998). Design discharge was 8,000 cfs. Levees were built along the stream. This area includes the confluence of Oxon Run with the Potomac River, and the portion of the stream that is tidal (Photo 16). Flows here are significantly higher than just upstream, as Barnaby Run and its tributaries account for approximately 5 mi^2 (36 percent) of the watershed.

Reach 10 (1,200 ft), the meandering reach, classified as a C4 type stream. Bankfull width is 42 ft, mean bankfull depth is 2 ft, and cross-sectional area is 85 ft^2. Bottom material consists of medium gravel. Reach 10 is unstable and sediment supply is high (170 tons/yr). Based on type stream, recovery potential is good, but the quantity and velocity of the stormwater from the concrete-lined channel just upstream will prevent the stream from recovering on its own. The reach has moderate development of riffles and pools. It contains two sharp (nearly right angle) meander bends, and extensive mid-channel and lateral gravel bars. Three sanitary sewer lines cross the stream in the middle of the reach. These lines, encased in concrete, are a barrier to fish passage. Aquatic habitat is poor, due to lack of cover, moderate riffle-pool development, water quality impairment, and a large quantity of trash. The low bank ranges from 3-8 ft, and the high bank ranges from 12-20 ft. For much of the reach, the left bank is the landfill. On the right hand bank, there is a wooded buffer, ranging from 80-290 ft. This buffer contains relict channels.

Reaches 11 (320 ft) and 12 (523 ft) are straight, and are essentially long riffles with poor development of bed features and extensive gravel bars. Reach 11 is a B4c type stream and Reach 12 is an F4 type stream. Reach 12 has a bankfull width of 47 ft, mean bankfull depth of 2.0 ft, and cross-sectional area of 96 ft^2. Bed material is coarse gravel. Sediment supply is high (122 tons/yr). Both reaches are unstable, with poor recovery potential. Aquatic habitat is poor, due to poorly developed bed features and water quality impairment. The low bank is 3-6 ft high, and the high bank is 13-16 ft high. In these reaches, the landfill runs along the left bank. The bottom of Reach 12 is the confluence with Barnaby Run, and in that location, the right bank is armored by gabions. The right bank has an extensive wooded buffer, ranging from 500 ft to 1,000 ft and a substantial portion of it is NPS property.

Photo 15. A concrete drop structure was placed on the main stem of Oxon Run (Reach OC-1) at the upstream terminus of the Forest Heights flood control project. This structure is a barrier to fish passage.

Photo 16. This is Reach OC-2, part of the channel constructed to prevent flooding in Forest Heights. The town is located to the left of the grassy area, behind levees.

Photo 13. Reach OR(DC)-10 is a meandering reach with extensive gravel bars. An unlined landfill exists along most of the reach on the left bank.

Photo 14. Reach OR(DC)-12 has been straightened in the past. The reach is over-wide and has poorly developed bed features.

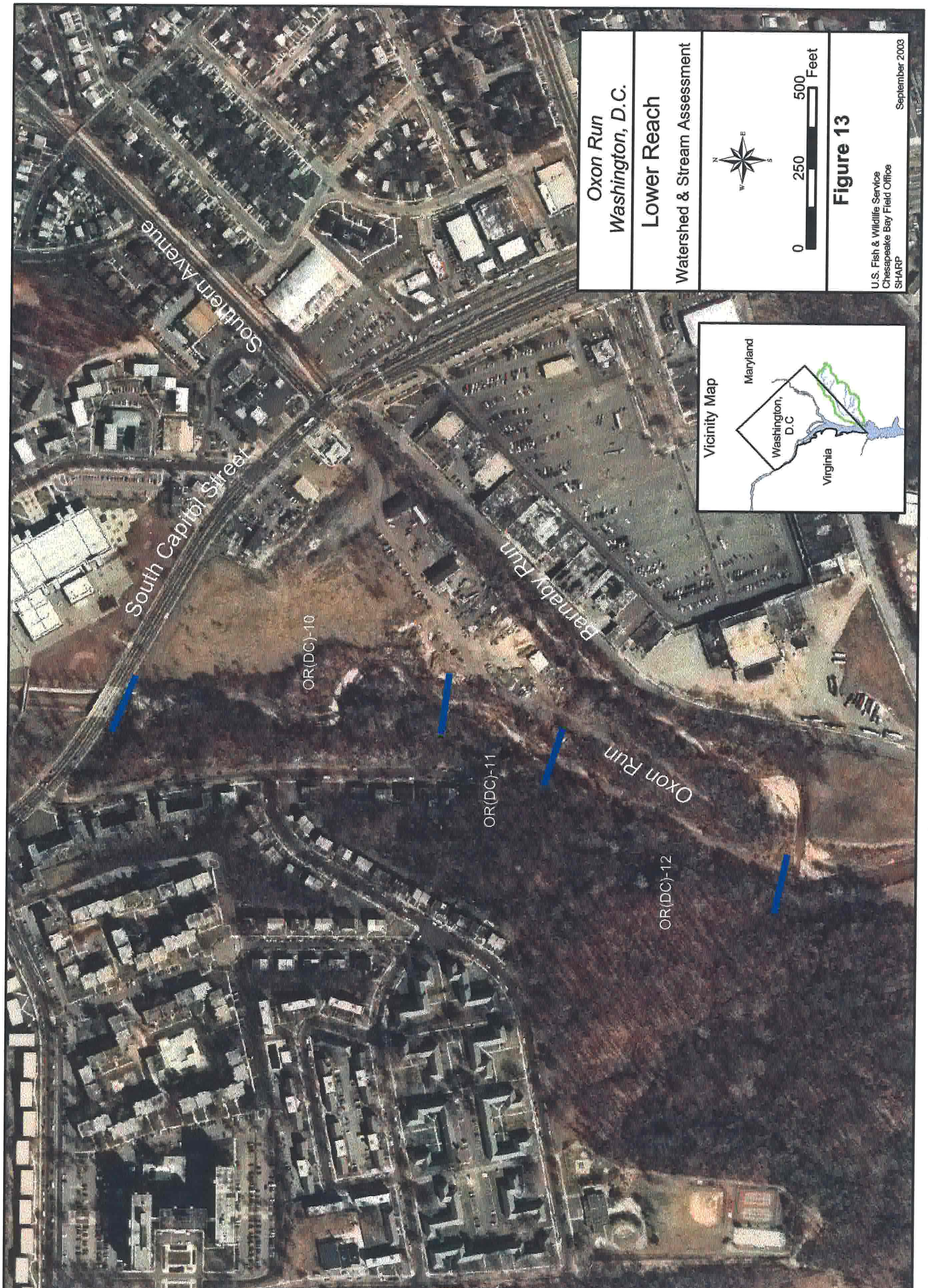
Oxon Run
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Figure 13
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Vicinity Map
Maryland
Washington, D.C
Virginia
Southern Avenue
South Capitol Street
Barnaby Run
Oxon Run
OR(DC)-10
OR(DC)-11
OR(DC)-12

V. PROBLEM IDENTIFICATION

Problems noted during the assessment have been grouped into several categories. These categories and their impacts on the stream are described below.

A. Watershed Processes

Changes in the watershed have direct influence on stream morphology, stability, water quality and aquatic habitat. High percentages of impervious surface in the watershed, along with conversion of many of the tributaries to piped or concrete-lined storm drains (Photo 17) have altered the natural hydrology. Base flow (groundwater derived flow) is lower than in a predominantly forested or agricultural watershed and stormflow peaks are of greater intensity and occur quickly after the rainfall. These higher flows and greater velocities, some of which are extremely concentrated at outfalls, cause bed and bank erosion (Photo 18). The stormwater also carries contaminants, nutrients and trash into the stream. These hydrological changes affect the entire Oxon Run watershed. Oxon Run is typical of urban streams, where stormwater and deliberate alterations have destabilized the stream. Because of the continued rapid pace of development in the watershed, Oxon Run will continue adjusting to changes in water and sediment supply. Stream adjustment is carried out through the processes of incision and lateral migration, thus erosion and potential damage to nearby infrastructure will continue unless stormwater controls are implemented.

Photo 17. In many locations, a concrete-lined channel, such as Reach OR(DC)-9, was constructed to prevent flooding. This increases flow velocity, erosion downstream, and disruption of the hydrological regime.

Photo 18. Stormwater outfalls drain high velocity water directly into the stream, causing bed and bank erosion. This outfall is located in Reach BR-1.

B. Stream Morphology Processes

The morphology of the stream is affected by adjustment processes of the stream itself, changes in sediment transport, urban infrastructure, and the quality of the riparian buffer. These factors also influence water quality and instream habitat.

1. Stream Processes

Nearly all of the natural channel streams in the watershed have incised, and/or widened (Photos 19 and 20). In the D.C. portion of Oxon Run, all of the meandering reaches in the Upper Reach (Reaches 2, 3, 5, and 6) and the Lower Reach (Reach 10) have both widened and incised. In highly erodible materials such as those found in the coastal plain, the stream may continue to incise and laterally adjust until it encounters more resistant material, either natural or anthropogenic. Streams dissipate energy in high flow situations by overtopping the streambanks and spreading across the floodplain. As the stream incises, it loses access to the floodplain, which then becomes a low terrace. With higher flows contained in the channel, erosive forces on the bed and banks increase. Eventually, it may recreate a new floodplain within the incised channel. Intentional channelization of the stream also initiates instability, although the response of the stream within the channelized reach may be different. Frequently, the stream will attempt to recreate a meander pattern within the over-wide channel, by building benches or point bars. Within the D.C. portion of Oxon Run, this response is visible in Reach 2 and 4 (Upper Reach), Reach 9 (Oxon Run Park) and Reaches 10, 11, and 12 (Lower Reach). This pattern was also noted at other locations in the watershed that had been channelized in the past.

Photo 19. In reaction to changes in the watershed, the stream channel adjusts, first cutting down through the bed and then widening, as seen here in Reach OR(PG)-3. In the highly erodible soils of the coastal plain, the high raw banks produce a large sediment load.

Photo 20. Concrete structures serve as grade control at many locations in the Oxon Run watershed. Here, in Reach BR-5, the stream has headcut up to the structure to adjust to changes in bed elevation downstream.

2. Sediment Processes

Stream instability directly influences both sediment supply and sediment transport. An unstable stream often increases the amount of sediment available to the stream when significant amounts of material are eroded from the banks and bed. This erosion may also change the particle size of sediment available to the stream. Throughout the Oxon Run watershed, bed and bank erosion have increased the sediment load. In many coastal plain streams, the bed is sand or fine to medium gravel. In Oxon Run, the bed median particle size (D_{50}) is medium to coarse gravel. Based on the stratification observed in many of the streambanks, this bed material is derived from the gravel layer underlying the fine alluvial sediment that once formed the bed and banks of the stream. Extensive bar formation is also indicative of increased sediment load. In both the Upper and Lower Reaches of Oxon Run, all but two reaches (Reach 4 and Reach 12) have large gravel bars, which shift frequently. Changes in slope and width/depth ratios affect sediment routing, with sediment scoured out of steep and/or narrow reaches and deposited in flat and/or wide reaches. Sediment transport relationships have changed in all reaches of the D.C. portion of Oxon Run, and the bed is highly mobile. Net trends of degradation or aggradation are difficult to discern.

The Service estimated streambank erosion for the D.C. portion of Oxon Run (Table 3), and for Oxon Run, Barnaby Run, and their tributaries in Prince George's County (Table 1). These estimates are based on a Bank Erosion Hazard Index (BEHI) and a Near Bank Stress (NBS) rating (Rosgen 2002b). For the D.C. portion of Oxon Run, all banks were assessed. Sixteen monumented cross sections were installed in Prince George's County. Using these representative cross sections and a BEHI from the same location, the Service estimated erosion for all the tributaries. Because not all the banks were assessed, the tributary estimate is less precise than the estimate for the D.C. portion. Listed below are sediment production estimates.

- Oxon Run (D.C) 1,032 tons/yr
- Oxon Run and tributaries (Prince George's) 5,909 tons/yr
- Barnaby Run and tributaries 8,717 tons/yr
- Forest Heights Tributary 2,565 tons/yr
- Watershed Total 18,224 tons/yr

The D.C. portion of Oxon Run produces an estimated 1,032 tons of sediment per year from streambank erosion. Of this, the majority (653 tons/yr) comes from the Upper Reach. However, the Upper Reach is significantly longer (4,800 ft) than the Lower Reach (2,043 ft), so when sediment contribution is calculated on a stream length basis, slightly more sediment (0.19 tons/foot/yr) is coming from the Lower Reach than from the Upper Reach (0.14 tons/foot/yr).

3. Urban Infrastructure

Urban infrastructure (*e.g.,* utility lines and stormwater outfalls) is an important factor in stream degradation in the Oxon Run watershed. Conversion of many tributaries to storm drains has a significant impact on the volume and velocity of water delivered to the stream. Every stream in the watershed is affected by stormwater drainage to some extent. Many of the first order tributaries shown on the 1938 map have been converted into storm drains. The position and orientation of the outfalls in relationship to the stream often cause severe vertical and lateral erosion. Based on sewershed information provided by D.C., there are approximately 38 sewersheds with storm drain outfalls discharging into the D.C. portion of the Oxon Run main stem. Sewersheds have been prioritized for action based on size of the sewershed, size of the outfall, and intensity of development (Figure 14). All outfalls will require off-channel solutions to attenuate stormwater input. Within the D.C. portion of the stream, outfalls are probably of the greatest concern in Reaches 2 and 9. Reach 2 has three outfalls, all of which are orientated such that they have caused significant bed and bank erosion. One of these is large (6 ft in diameter), is located directly in the middle of the outside bend of a meander, and field crews have observed greywater discharge from it. Reach 9 has 25 stormwater outfalls. Outfalls in Reach 9 do not cause significant erosion within the reach, as it is concrete-lined, but they serve as a conduit for trash and pollutants from the surrounding streets (Photo 21). Erosion effects from stormwater input into Reach 9 are concentrated in the upstream end of Reach 10, where the stream again becomes a natural channel. Reaches 1, 5, 8, and 10 also have outfalls draining directly into the stream.

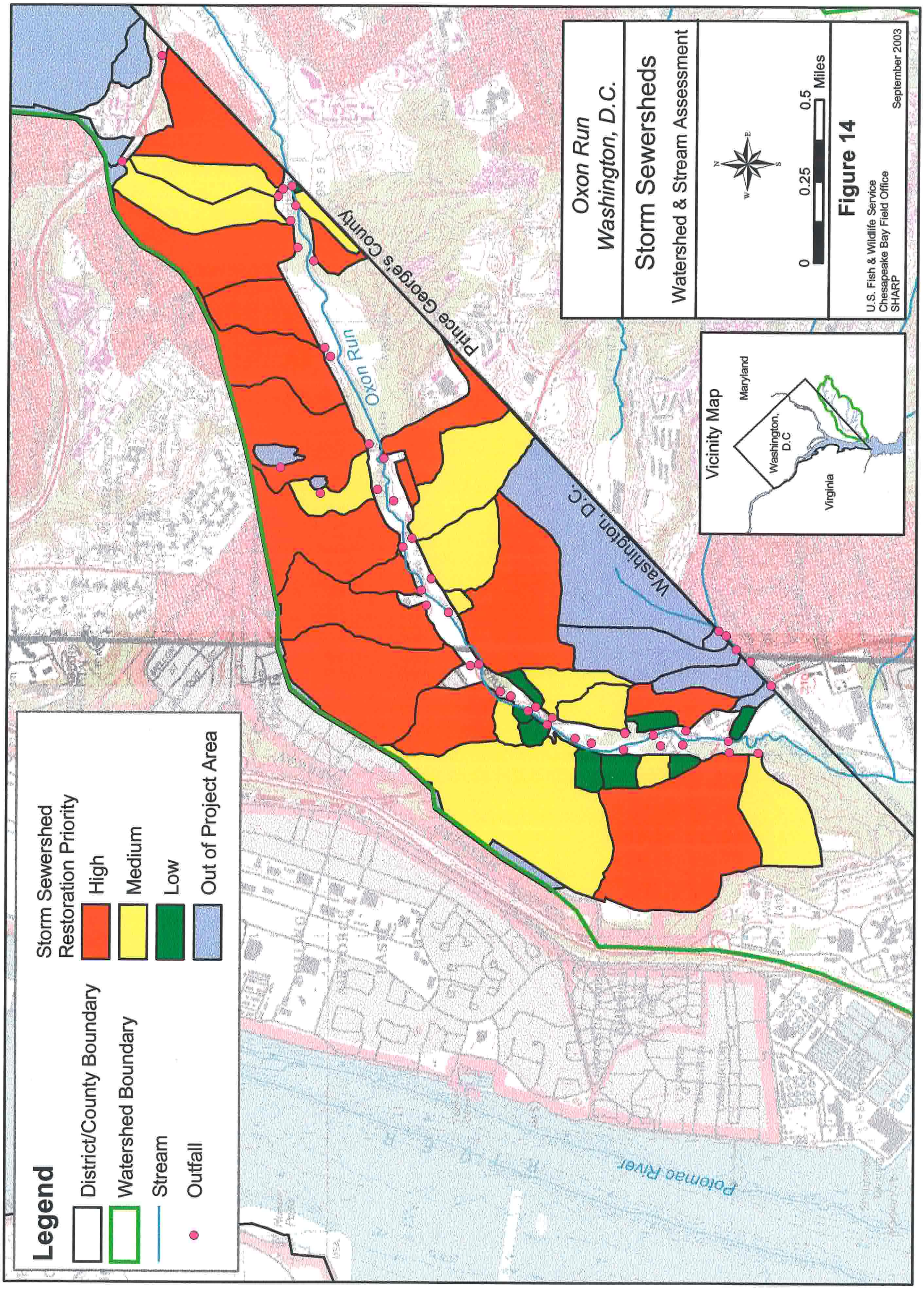
Throughout the watershed, the storm drains and sanitary systems are separate and there are no combined sewer outfalls (CSOs). However, following a common practice, the sanitary sewer pipes (which are gravity fed) are laid along the fall line of the valley, roughly parallel with the stream. In a number of instances, these sanitary sewers (as well as other utility lines) cross the stream. When the sewers were initially placed, they may have been located a distance from the stream and/or buried. The incision and lateral migration associated with stream instability has exposed and/or broken a number of these lines (Photo 22). In some cases, the pipes are acting as grade control structures, and/or protecting the toe of the bank, but this is a temporary condition due to the instability of the stream. Many create a barrier to fish passage. Broken sewer pipes degrade water quality. A significant number of these breaks were noted during the watershed and stream assessment.

Severe and/or long-term breaks were noted at the following locations.

- Headwaters of Barnaby Run, upstream of Raleigh Road (Prince George's, Reach BR-1)
- Barnaby Run, downstream of Wheeler Avenue, (Prince George's, Reach BR-8)
- Oxon Run, upstream of Pennsylvania Avenue and Shadyside Avenue intersection (Prince George's, Reach OR(PG)-3 and OR(PG)-4)

Evidence of leaks (odor, sewage fungus, broken lines) was noted at the following locations.

- Oxon Run, downstream of Southern Avenue (D.C., Reach OR(DC)-1)
- Oxon Run, upstream of 13th Street (D.C., Reach OR(DC)-7)
- Oxon Run, downstream of Suitland Road (D.C., Reach OR(PG)-6)



Oxon Run
Washington, D.C.
Storm Sewersheds
Watershed & Stream Assessment
0
0.25
0.5
Miles
Figure 14
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003
Vicinity Map
Maryland
Washington, D.C
Virginia
Legend
District/County Boundary
Watershed Boundary
Stream
Outfall
Storm Sewershed
Restoration Priority
High
Medium
Low
Out of Project Area
Prince George's County
Washington, D.C.
Oxon Run
Potomac River

Photo 21. Sanitary sewers cross the stream in many locations. Breaks or leaks, like this one in Reach BR-4, can dump raw sewage, a source of nutrients and potentially pathogenic bacteria, into the stream.

Photo 22. Runoff from storm drains, such as this one in Reach BR-4, carry pollutants such as motor oil directly into the stream. Large quantities of these substances can cause fish kills, and even in smaller quantities cause sublethal effects such as tumors and impaired reproduction.

4. Water Quality

In 1994, the Maryland Biological Stream Survey Program (MBSS) sampled several locations in the Prince George's County portion of Oxon Run, including the headwaters of Oxon Run before it enters D.C., a location (designated Oxon Creek) near the Potomac River, and an unnamed tributary in the area near Forest Heights (Millard *et al.* 2001). All locations ranked as poor or very poor based on fish and macroinvertebrate Indices of Biotic Integrity (IBI). The overall ecological health of streams in Prince George's County was classed as poor to fair, and Oxon Run was among the worst of these streams. Nitrate concentrations in the water were 1.4 - 2.1 milligrams/L (mg/L). Typically, nitrate concentrations in streams from forested catchments are 0.1 mg/L (Dunne and Leopold 1978) and the U.S. Environmental Protection Agency Water Quality Criterion (WQC) for nitrate is 10 mg/L. Other comparable biological surveys produced similar results. Biological surveys conducted in 1987 and 1988 by the District of Columbia. classed Oxon Run as poor to fair quality, based on a macroinvertebrate bioassessment (Edmondson 1988; Johnson 1988). In 1993, another biological survey ranked the stream as severely impaired (Banta 1993).

Although no documentation was available regarding concentrations of organic contaminants (polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides) or heavy metals in Oxon Run, studies in Northeast and Northwest Branch of the Anacostia River have shown levels of these contaminants, especially PAHs, sufficiently high to cause concern (Foster *et al.* 2000; Pinkney *et al.* 2002). Input of these contaminants is likely due to road runoff through the stormwater drains. Surface slicks of oil were observed at many locations in Oxon Run during field surveys (Photo 22). Other potential sources include the landfill located near Eastover Shopping Center, and certain types of refuse, such as car batteries. Field crews repeatedly noted a strong petroleum odor emanating from the streambank immediately adjacent to the landfill. At the former Camp Simms site, lead was identified as a contaminant of concern in surface soil and drainage pathway sediment (EA Engineering 1998). Elevated levels of lead were not found in the surface water and sediment of Oxon Run (EA Engineering 1998). Throughout all reaches, a prevalence of large (*e.g.*, cars, shopping carts) and small (*e.g.*, aluminum cans, plastic bottles) trash items were noted. Field crews observed leaking sanitary sewers and the gray "sewage fungus" associated with such inputs in a number of locations.

5. Riparian Buffer

The riparian buffer serves several important functions. In a less-developed watershed, the buffer slows the overland flow of water, provides nutrient uptake, and serves as a filter to settle excessive sediment and pollutants. When stormwater is channeled directly into the stream, as in Oxon Run, these important functions are bypassed. The riparian zone serves as a structural component, providing reinforcement for the bank, and shading provided by the canopy trees helps to moderate the temperature of the water in the stream. In Oxon Run, which has many areas with high streambank heights and/or an entrenched channel, the lack of streambank vegetation and shallow rooting depths increases lateral instability and subsequent sediment loads from bank erosion, particularly at higher flows.

Within D.C., the stream flows mostly through parkland (either NPS land, or land managed by the D.C. Department of Parks and Recreation). Condition of the riparian buffer in the watershed is highly variable, although in most locations, there is some forested buffer except when the stream has been channelized or piped. In the Upper Reach, the riparian buffer on the right bank ranges from 0 - 650 ft, and 35 - 1,250 ft on the left bank. Oxon Run Park has patches of woodland, but generally is mowed grass with large canopy trees, so it is virtually non-functional as a riparian buffer. It may serve as a significant barrier to wildlife migration through the stream corridor. The Lower Reach has a riparian buffer that ranges from 0 - 1,000 ft on the right bank, and 20 - 360 ft on the left bank. Vegetation in the buffer area is a deciduous overstory of tulip poplar *(Liriodendron tulipifera),* red and silver maple *(Acer rubrum* and *Acer saccharinum),* sycamore *(Platanus occidentalis),* box elder *(Acer negundo),* and oak *(Quercus spp.).* Understory plants include poison ivy *(Toxicodendron radicans),* spicebush (*Lindera benzoin*), and jewelweed, as well as some exotics such as Japanese knotweed *(Polygonum cuspidatum)* and multi-flora rose *(Rosa multiflora).*

The riparian buffer also serves as a habitat and food source for both terrestrial and aquatic biota. Leaves and other detritus provide an important energy source for small streams. Limbs and fallen trees provide cover for fish and invertebrates. Even if a stream is stable, lack of a good riparian buffer will adversely affect the biotic community. Density and diversity of vegetation in the Oxon Run buffer is sufficient to support some wildlife, although mostly only species known to thrive on the edge of development. During survey work, evidence was found (sightings, tracks, scat, carcasses) of white-tailed deer *(Odocoileus virginianus)* and raccoon *(Procyon lotor)* (Photo 23). Interestingly, a flock of wild turkey *(Meleagris gallopavo)* lives in the Upper Reach, and was frequently sighted near Reach 4 (Photo 24). The riparian buffer in Oxon Run Park (the concrete channel) is generally sparse.

Photo 23. Riparian zones serve as an important habitat in developed areas. A flock of wild turkey live in the Upper Reach of Oxon Run.

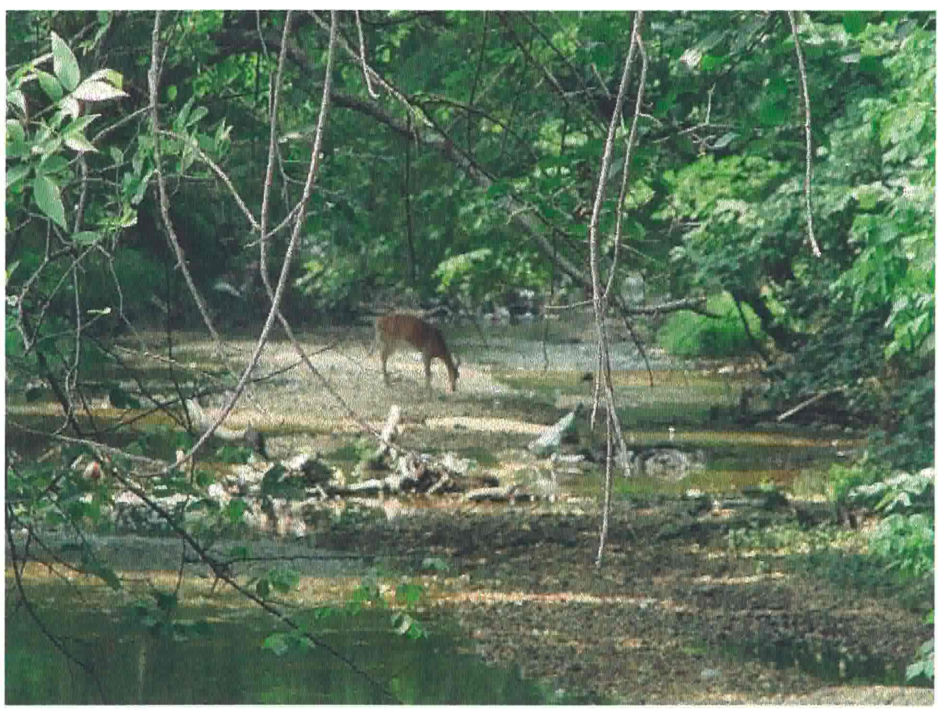


Photo 24. Whitetail deer roam through the Lower Reach, which is contiguous with some larger National Park Service properties.

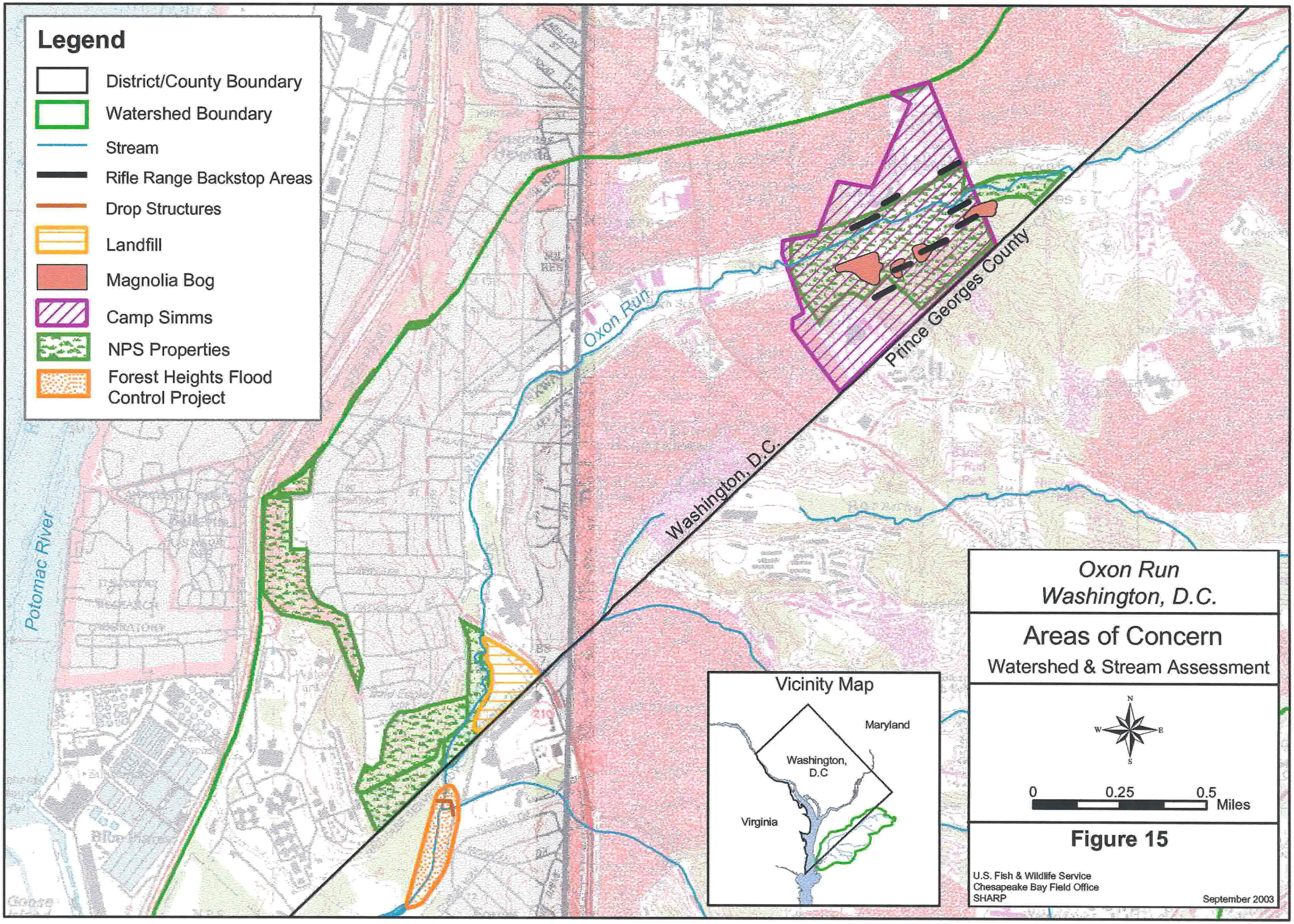
6. Instream Habitat

Overall, within the D.C. portion of Oxon Run, the instream habitat is poor. Most reaches have marginal bed feature development, and do not have the riffle/pool sequences necessary to sustain an aquatic community typical of coastal plain streams. Habitat diversity is critical for a healthy and diverse aquatic community. Riffles provide cover for many of the benthic macroinvertebrates serving as the base of the food chain in such streams, as well as some species of fishes. The mobility of the bed in Oxon Run makes it difficult for macroinvertebrates to survive in the stream, and disrupts the spawning of some fish species. Pools provide habitat for some of the larger fishes, as well as refugia for others when water levels are low. Few pools exist in Oxon Run, and where they do, most lack instream cover, which is usually provided in a coastal plain stream by large woody debris and overhanging vegetated banks. Straightened reaches (Reaches 4, 9, 11 and 12), with poorly developed bed features and shallow water, provide minimal habitat for benthic invertebrates, and are an obstacle to fish passage in low flow conditions. Utility crossings may also obstruct fish passage, especially when they are serving as grade control structures, and there is a significant elevation difference between the up- and downstream sides of the crossing. Degraded water quality, resulting from pollutants, leaking sanitary sewers, and turbid water after rainfall events, further decreases the quality of habitat in the stream. Conditions in the rest of the watershed are similar, with no locations rating more than fair in terms of aquatic habitat.

7. Site Specific Problems

Specific problems associated with each reach are listed in Table 4, and areas of concern are shown in Figure 15.

Table 4 - Oxon Run Site Specific Problem Identification													
Category	Specific Problem	Upper Reach								Oxon Run Park	Lower Reach		
		1	2	3	4	5	6	7	8	9	10	11	12
Watershed Processes	Stormwater outfalls (#)	4	3	0	0	2	0	0	1	25	3	0	0
	Floodplain loss	X			X					X		X	X
	Stream confinement	X			X					X		X	X
Stream Processes	Channelization or alteration	X			X					X		X	X
	Revetments-single bank												X
	Revetments-entire stream									X			
	Vertical instability		X	X	X	X	X	X	X		X	X	X
	Lateral instability		X	X		X	X	X	X		X	X	X
	Mass wasting		X								X		
	Stream aggradation									X			
Sediment Processes	Bank erosion	X	X	X	X	X	X	X	X	X	X	X	X
	Bed erosion	X	X	X	X	X	X	X	X	X	X	X	X
Urban Infrastructure	Utility lines and crossings		2	1	2	2		1			4		
Water Quality	Poor water quality	X	X	X	X	X	X	X	X	X	X	X	X
	Sanitary sewer leaks	X						X					
	Contaminant input	X (outfall)	X (outfall)	X (Camp Simms)	X (Camp Simms)	X (Camp Simms)	X (Camp Simms)	X (Camp Simms)	X (outfall)	X (outfall)	X (landfill)	X (landfill)	X (landfill)
	Large urban debris		X (car)	X (car)					X (car)		X (car)		
	Trash	X	X	X	X	X	X	X	X	X	X	X	X
Riparian Buffer	Lack of forested buffer									X			
	Low-quality buffer	X									X	X	X
Instream Habitat	Poorly developed bed features	X	X	X	X	X	X	X	X	X	X	X	X
	Insufficient cover	X			X			X		X	X	X	X
	Barriers to fish passage	X	X	X	X	X	X	X	X	X	X	X	X



Legend
District/County Boundary
Watershed Boundary
Stream
Rifle Range Backstop Areas
Drop Structures
Landfill
Magnolia Bog
Camp Simms
NPS Properties
Forest Heights Flood Control Project
Oxon Run
Prince Georges County
Washington, D.C.
Potomac River
Vicinity Map
Maryland
Washington, D.C
Virginia
Oxon Run
Washington, D.C.
Areas of Concern
Watershed & Stream Assessment
N
W
E
S
0
0.25
0.5
Miles
Figure 15
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
SHARP
September 2003

VI. PRIORITY RATING

For assessment the D.C. portion of Oxon Run was divided into 12 reaches, but for the purpose of restoration it is more easily addressed as three reaches defined earlier in this report: the Upper Reach, Oxon Run Park, and the Lower Reach. Generally, the entire portion of Oxon Run within the District of Columbia, with the exception of the concrete channel and Reach 4, is unstable to highly unstable both laterally and vertically (Table 3). Instream habitat quality throughout the stream is poor. The riparian buffer is poor to fair. Potential sediment supply from the unlined portions of the stream (7,163 ft or 1.36 mi) is estimated as slightly more than 1000 tons/yr. Initial causes of instability in Oxon Run are the channel realignments and conversion of the watershed from forested to agricultural to residential. Direct stormwater input and the construction of concrete-lined channels and pipes have exacerbated this instability. Based on field evidence, aerial photography, and Rosgen stream type, recovery potential for Oxon Run is poor.

The Service recommends a natural channel design for the entire D.C. portion of Oxon Run. Since a primary objective is to restore anadromous fish habitat, the restoration must include the concrete-lined channel in Oxon Run Park and a fish passageway at the Forest Heights drop structure. Based on the degree of instability, potential infrastructure at risk, sediment supply, and contaminant input, the two sections of natural channel are essentially the same in terms of priority (high). Oxon Run Park also rates as high priority based on its lack of aquatic habitat, and the amount of stormwater input. Logistically and functionally, the best way to restore a stream is from upstream to downstream, thus the following restoration order is recommended.

- Upper Reach (Reaches 1-8) — First
- Oxon Run Park — Second
- Lower Reach (Reaches 10-12) — Third

As stormwater outfalls draining directly into the stream contribute immensely to stream instability, the Service recommends retrofit, or off-channel solutions, such as created wetlands. In cases where these solutions are not feasible, the restoration design should incorporate methods to slow flow velocities and minimize trash input into the stream.

VII. GENERAL RESTORATION RECOMMENDATIONS

Restoration alternatives to the stream problems identified in Oxon Run are presented in Table 5. Detailed discussions describing the types of problems and potential remedial alternatives follow.

A. Stream Stability

Based on previous work in the Maryland Western Coastal Plain, and the Oxon Run valley slope and type, the Service recommends restoration of a Rosgen C4 type stream (McCandless 2003).

This type stream is a meandering, alluvial stream, well connected with its floodplain (Rosgen 1996). Bed features include a well-developed riffle-pool sequence and the streams morphology generally provide good habitat potential for fish and macroinvertebrates. Restoration of incised streams is divided into four major categories (Rosgen 1997).

- Create the original type stream at the original base level (Priority 1)
- Create the original type stream at the current base level or higher level but not at the original base level (Priority 2)
- Create a different type stream without an active floodplain but containing a floodprone area (Priority 3)
- Stabilize the existing stream with structures (Priority 4)

These priorities are ordered in terms of preferred alternatives. If feasible, Priority 1 is the preferred alternative as it restores a stream to its pre-disturbance state and has the greatest chance of success. Priority 4 is the least desirable as it is an attempt to stabilize the stream in a disturbed state, is costly, and has the greatest chance of failure.

The Service recommends pursuing a Priority 1 or Priority 2 restoration. Because of the available riparian corridor and the fact that the stream has only incised several feet below the historic floodplain, there is a high potential to achieve either a Priority 1 or Priority 2 restoration for the entire D.C. portion of Oxon Run. A full Priority 1 restoration is likely not possible because of stream channel and floodplain alterations, however, a highly effective restoration that combines elements of Priority 1 and 2 restorations appear feasible. The Service will determine the preferred alternative for each particular reach of Oxon Run during the design phase, based on existing conditions and restoration objectives. Some reaches may employ a combination of both alternatives.

Table 5 - Oxon Run Stream Problems and General Restoration Recommedations		
Problem		Restoration Alternative
Stream Stability	Unstable stream dimensions, patterns, and longitudinal profile	1) Create a stable meandering stream in the historic floodplain 2) Establish stream and floodplain within the existing stream 3) Establish stream and floodprone area within the existing 4) Stabilize stream in place
Water Quality	Heavy metals, PAHs, PCBs, and pesticides	1) Divert and treat road runoff 2) Relocate stormwater outfalls away from stream 3) Remove urban debris (*e.g.,* car batteries) 4) Create wetlands and ephemeral ponds
	Sewage leaks	1) Locate and repair leaks and breaks
	Sediment	1) Develop a stable stream dimension, pattern, and longitudinal profile 2) Use physical restoration techniques which reduce bank stress
	High water temperatures	1) Establish riparian buffer 2) Develop a stable stream dimension, pattern, and longitudinal profile with a lower width/depth ratio
Infrastructure	Stormwater outfalls	1) Relocate outfalls 2) Retrofit outfalls to attenuate stormwater flows
	Exposed sanitary sewers in stream channel	1) Relocate sanitary sewers 2) Encase sanitary sewers 3) Use grade control structures to protect utility crossings and restore fish passage
	Stream crossings	1) Relocate pedestrian crossings if necessary to obtain stable stream planform
Riparian habitat and riparian buffer	Water quality	1) Address contaminant, nutrient, sediment, and temperature concerns
	Stream stability	1) Develop a stable stream dimension, pattern, and longitudinal profile
	Instream cover	1) Incorporate instream cover with the restoration techniques 2) Establish bank vegetation 3) Employ large woody debris in stream restoration
	Fish Passage	1) Use restoration structure (*e.g., j-hooks and cross-vanes)* to allow fish passage
	Reforestation and riparian enhancement	1) Establish and/or expand riparian buffer 2) Improve diversity of buffer 3) Plant native vegetarion

Descriptions of the advantages and disadvantages of Priority 1 and 2 stream restorations are presented in Table 6. A Priority 1 stream restoration creates a stable, meandering stream in the existing or historic floodplain. This alternative establishes a stable and self-maintaining stream with the highest potential for success. This alternative may use a relic stream or may require excavation of a new stream and filling of the existing stream. A Priority 2 stream restoration establishes a new stream dimension, pattern, and longitudinal profile within the existing degraded stream. Excavation of the existing degraded stream may be required to create the proper meander pattern. Either the floodplain is created at the existing grade or the elevation of the streambed is raised to allow access to an abandoned floodplain. Although the floodplain is narrower than in the previous alternative, the presence of a floodplain still attenuates flow velocities and bank and bed shear stresses during higher flows. This alternative also relies more on bank vegetation to stabilize the stream but may require additional bank stabilization methods. This alternative has a lower success rate than the first alternative and may require some maintenance.

Table 6 - Comparision of Priority 1 and Priority 2 Stream Restoration
Adapted from Rosgen 1997

Description	Advantages	Disadvantages
Priority 1: Creation of the original type stream at the original base level	1) Establishes a stable and dynamic stream condition 2) Reduces bank height 3) Reduces stream erosion 4) Improves aquatic and terrestrial habitats 5) Improves natural aesthetics	1) May require extensive excavation 2) May require filling of existing stream 3) May result in loss of existing land use(s) 4) May require grade control at the downstream limit of project to prevent headcutting
Priority 2: Creation of the original type stream at the current base level or higher, but not at the original base level	1) Decreases bank heights 2) Decreases stream erosion 3) Reduces land loss 4) Improves aquatic habitat 5) Prevents wide-scale flooding of adjacent land	1) Stream may experience higher flow velocities and bank stress due to narrower floodplain 2) Requires grading and stabilization of the upper streambanks to reduce erosion during higher flows 3) May require grade control at the downstream limit of project to prevent headcutting

Unlike many other urban streams, Oxon Run stream channel is not fully confined by roadways or structures, although there are buildings in the floodplain. Some type of stream valley park, either managed by D.C. Parks and Recreation or by NPS, exists on one or both banks for the entire D.C. portion of the stream. The stream parks provide a corridor in which to locate the stream, though some portions of the original floodplain have been lost to development and the existing riparian corridor is narrower than existed prior to urbanization.

B. Water Quality

The primary source of heavy metals, PAHs, PCBs, and pesticides is most likely stormwater runoff from roads and residences. Bank erosion, which may contain historic contamination, especially near Camp Simms and the unlined landfill, is also a potential source of water quality impairment. Diverting direct road runoff and relocating existing outfalls should result in a significant decrease in these contaminants. The creation of wetlands and ephemeral ponds are recommended to treat stormwater runoff. The wetlands may be constructed within the riparian corridor and stormwater outfalls relocated to the edges of the riparian corridor. Stormwater is filtered naturally as it percolates into the soil. Diverting stormwater runoff into these wetlands and away from the stream will also assist in reducing streambank erosion. The Service recommends the removal of urban trash, especially items such as car batteries, which are a source of heavy metals. Addressing the stream stability issues will mitigate contaminant contributions from the streambanks. The D.C. government has large-scale plans for replacement and/or retrofitting existing sewer lines and addressing sanitary sewer issues. The Service and D.C. will coordinate to maximize water quality benefits as the design phase progresses.

The primary source of sediment is from instream erosion. Restoration techniques (*e.g.*, j-hooks, and cross vanes) can divert stream flows away from the streambanks and reduce bank stresses. Addressing the stream stability issues with these restoration techniques will reduce sediment contributions from within the stream. In addition, the riparian buffer establishment could function as a filter to remove sediment in overland sheet flow. Riparian buffer establishment will also help address high stream temperatures.

C. Infrastructure

Existing urban infrastructure has a significant impact on the stream, and may create or exacerbate erosion problems.

1. Stormwater

Storm sewers discharge directly into Oxon Run without treatment or energy dissipation creating several types of problems.

- Poor water quality from untreated stormwater
- Trash and debris are delivered directly to the stream
- Stormwater jets disrupt normal flow hydraulics and create stream stability problems by creating "hard-points" on streambanks
- Spills and unregulated discharges into storm sewer systems are delivered directly to the stream
- Storm sewers can capture sanitary sewer overflows and leaks

Storm sewer outfalls must be addressed on a case-by-case basis. The preferred alternative is to treat stormwater on site. Another alternative is to relocate outfalls to the edge of riparian corridors and install stormwater treatment and infiltration facilities. In some cases, because of space and grade limitations, this may not be possible. Where relocation is not feasible, energy dissipaters may be required to improve stream stability.

2. Utility Crossings

During the restoration design phase, the Service will identify any utility lines that will impact the restoration and may recommend realignment of those utilities. If realignment of the utility is not possible, the Service will attempt to develop the restoration design around the utility line. Adjacent utility lines frequently prevent the stream from achieving its proper planform for energy dissipation. In these situations, it may be necessary to use additional restoration structures to dissipate the energy on the streambed.

3. Stream Crossings

Stream crossings consist of roadways and pedestrian trails that cross the stream via bridges. Replacement of roadway bridges is generally cost-prohibitive, thus the stream restoration must accommodate existing roadway crossings to the extent possible. This will require that the stream alignment at bridges is maintained and that changes in vertical grade are evaluated for flood impacts and for bridge scour impacts. Pedestrian bridges may need replacement to accommodate planform changes.

D. Aquatic Habitat

Addressing the water quality and stream stability problems will resolve many of the aquatic habitat concerns, with the possible exception of instream cover and fish passage. Many of the restoration structures (*e.g.*, J-hooks and cross-vanes) provide instream cover by design. However, the Service may recommend incorporating additional instream cover alternatives. The riparian planting plan will provide a source for large woody debris and overhead cover along the streambank.

Two major obstacles to fish passage exist in and downstream of the D.C. portion of Oxon Run: the concrete-lined channel in Oxon Run Park (Reach 9) and the concrete drop structure downstream of Reach 12. Fish passage through the drop structure and concrete-lined channel is required to allow use of the aquatic habitat created upstream as part of the overall restoration effort. The Service recommends removal and replacement of the drop structure with a natural step-pool transition channel or creation of a new stream around the drop structure. The Service recommends the removal and replacement of the concrete channel with a Priority 1 or Priority 2 stream restoration alternative. For all other smaller fish obstructions, such as utility crossings, the Service recommends utility realignment or the use of instream structures (*e.g.*, cross-vanes and step-pools) to allow fish passage.

E. Riparian Buffer

The majority of the D.C. portion of Oxon Run has a wide riparian buffer. However, there are numerous nonnative invasive plant species overtaking the native species. In other areas, the buffer is mowed grass. The Service recommends eradication of all nonnative invasive species and replanting of grass areas with native riparian plant species.

VIII. ELEMENTS OF THE REACH RESTORATION PLAN

The Service will develop specific stream restoration plans for Oxon Run on a reach basis during the design phase. Reach designs will coordinate overall plan stability and bank configurations, while maintaining flood protection for surrounding areas. The overall plan is to create a stable C4 type stream channel. Where feasible, a Priority 1 restoration (restoring channel at original elevation) is recommended. Otherwise, a Priority 2 restoration is recommended. Using the natural channel design methodology developed by Rosgen, bankfull channel dimensions and belt width for a stable stream are calculated using the existing bankfull dimensions and scaling factors from a reference stream of the same Rosgen type stream (Rosgen 2002c).

A. Channel Planform

The Service has not identified a reference stream in the watershed. However, generalized dimensions for a C4 stream (Rosgen 2002c) and data for Maryland Coastal Plain streams (McCandless 2003) have been used to develop geomorphic parameters for Oxon Run. Key parameters used to establish planform and cross section for restored Oxon Run reaches include width/depth ratios, channel sinuosity, and relationships between meander length and bankfull width. Based on review of Coastal Plain streams with similar sediment and slope characteristics, a width/depth ratio of approximately 15 and sinuosity of 1.4 have been selected as preliminary target values for stream restoration.

Channel dimensions and shape parameter are determined by scaling reference values by bankfull width and existing bankfull cross-sectional area. For example, based on data from Reach OR-2, a target width/depth ratio of 15, and a target sinuosity of 1.4, the bankfull width in the Upper Reach would be reduced from 42 ft to 37 ft. Mean bankfull depth would increase from 2.1 ft to 2.4 ft. To achieve a sinuosity of 1.4, channel length would increase by about 17 percent and channel slope would decrease by about 16 percent. These changes will slow water velocities by providing increased form resistance, and improve aquatic habitat by increasing water depth in the riffles during low flow conditions.

Figure 16 provides an illustration of changes in planform associated with stream restoration. The Service will develop detailed plans, tailored to the constraints and opportunities in each reach, during the design phase. The proposed planform increases channel sinuosity and channel length by increasing the curvature of channel meanders. The initial planform layouts must be thoroughly evaluated and refined to produce a workable design. A number of factors are considered in the design.

- Riffle and pool placement
- Cut and fill balance
- Stable channel features maintenance
- Vegetation disturbance minimization
- Existing structures protection (*e.g.,* houses, roads, bridges)
- Flood conveyance
- Utility crossings

Site-specific constraints on the stream restoration design are also considered.

- Realignment and repair of sanitary sewers and other utility lines located in the stream valley
- Development of storm drain solutions
- Ensuring the safety of construction activities in the former the Camp Simms firing range
- Avoiding adverse impacts to and enhancing the magnolia bogs located on the NPS property in the Upper Reach
- Adequate control of contaminants leaching from the landfill

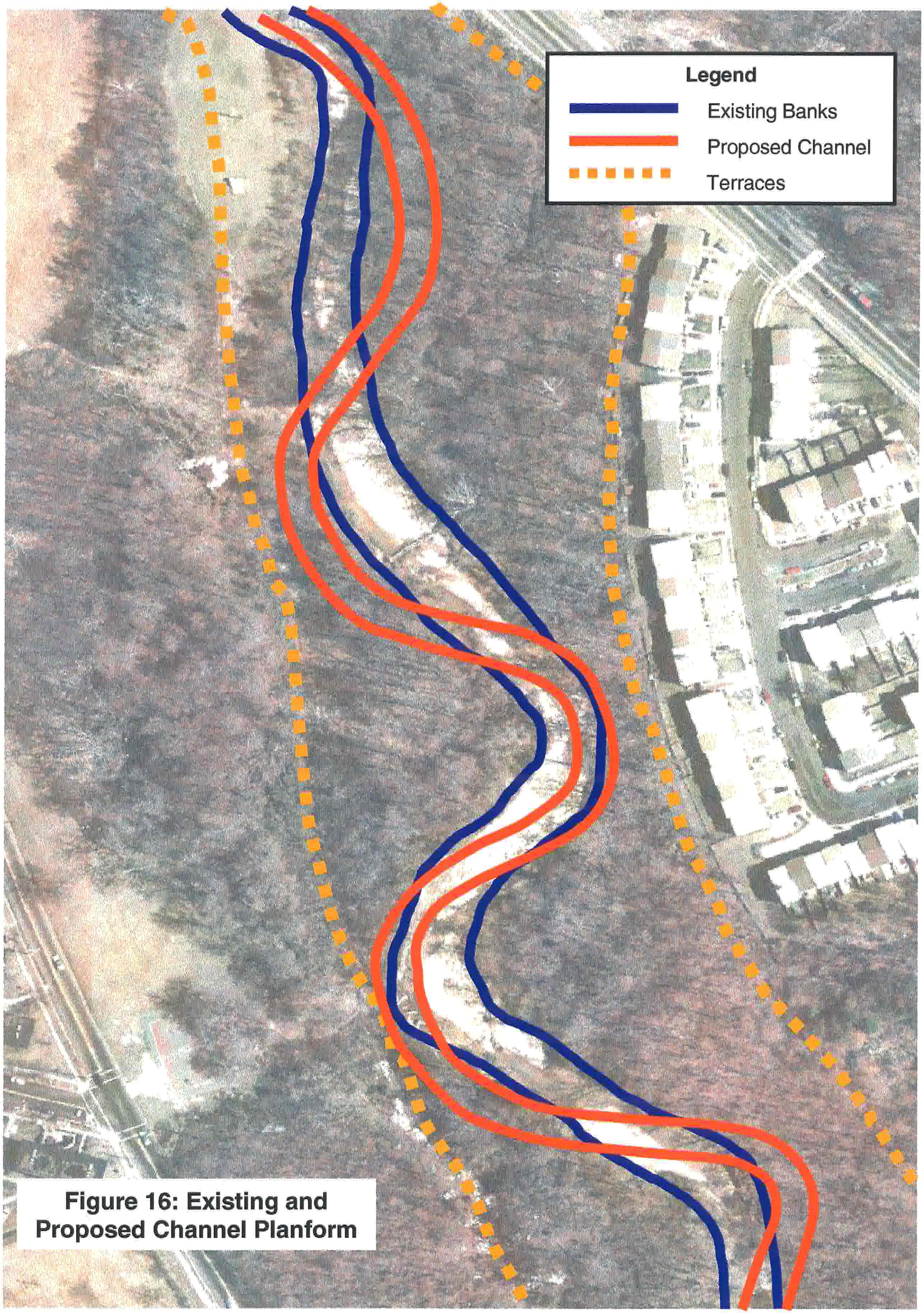


Figure 16: Existing and Proposed Channel Planform

B. Channel Cross-Sectional Area

After an initial channel planform is developed, evaluation of a large range of channel shape parameters such as the length, width, and depth of pools and riffles is required. Ideally, sizing and designing the channel shape would employ dimensionless shape parameters from a reference reach and scaled for the bankfull width and bankfull depth of the restored reach. Because a reference reach is not available for Oxon Run, the Service will use dimensionless shape parameters from other C4 channels in Maryland, as well as reference data for C4 streams located outside of Maryland.

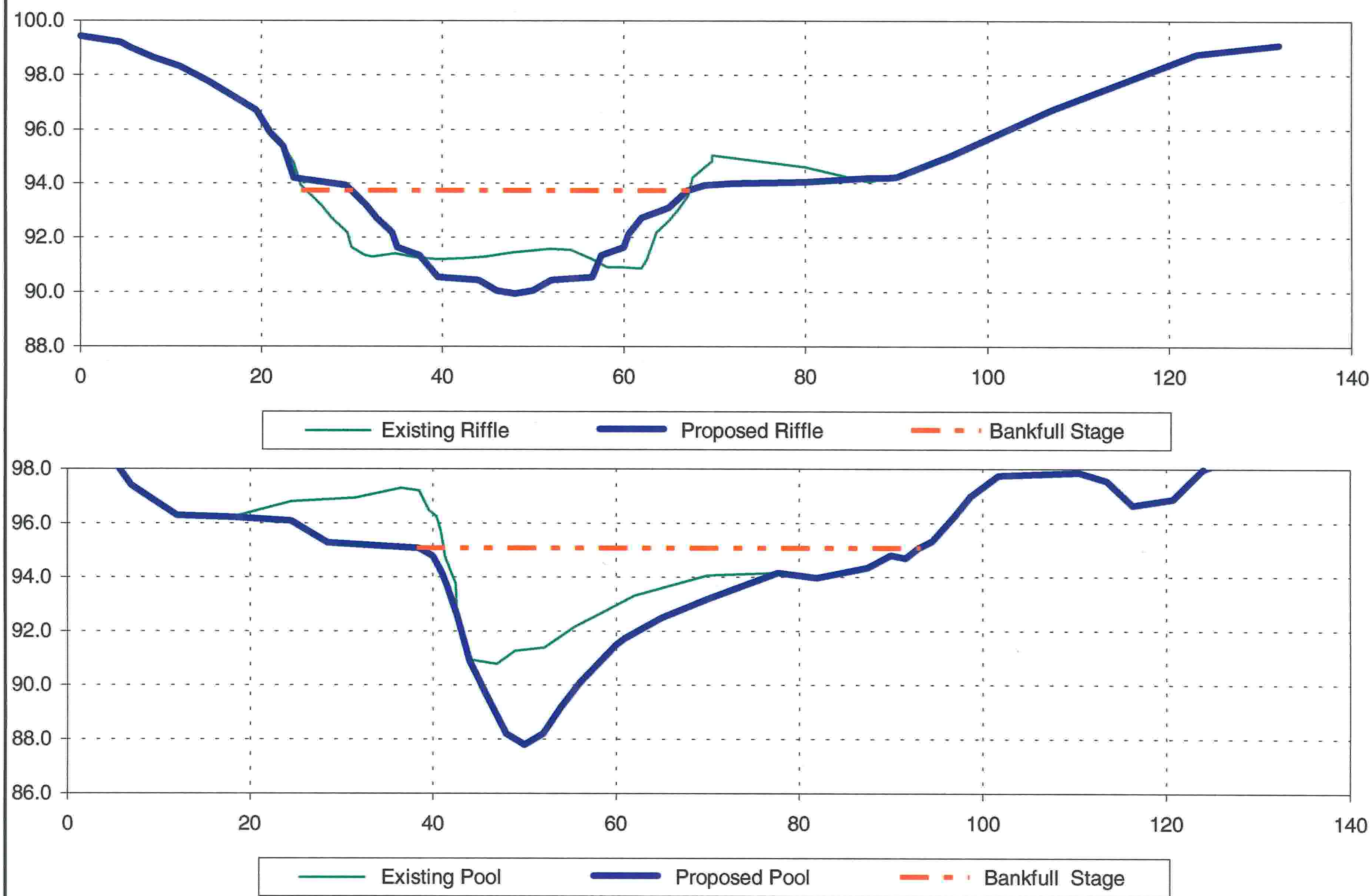
Riffle and pool cross sections are used to present changes in the channel shape. Figure 17 shows a typical riffle and pool cross section. Proposed changes for the riffle and pool cross sections are as follows.

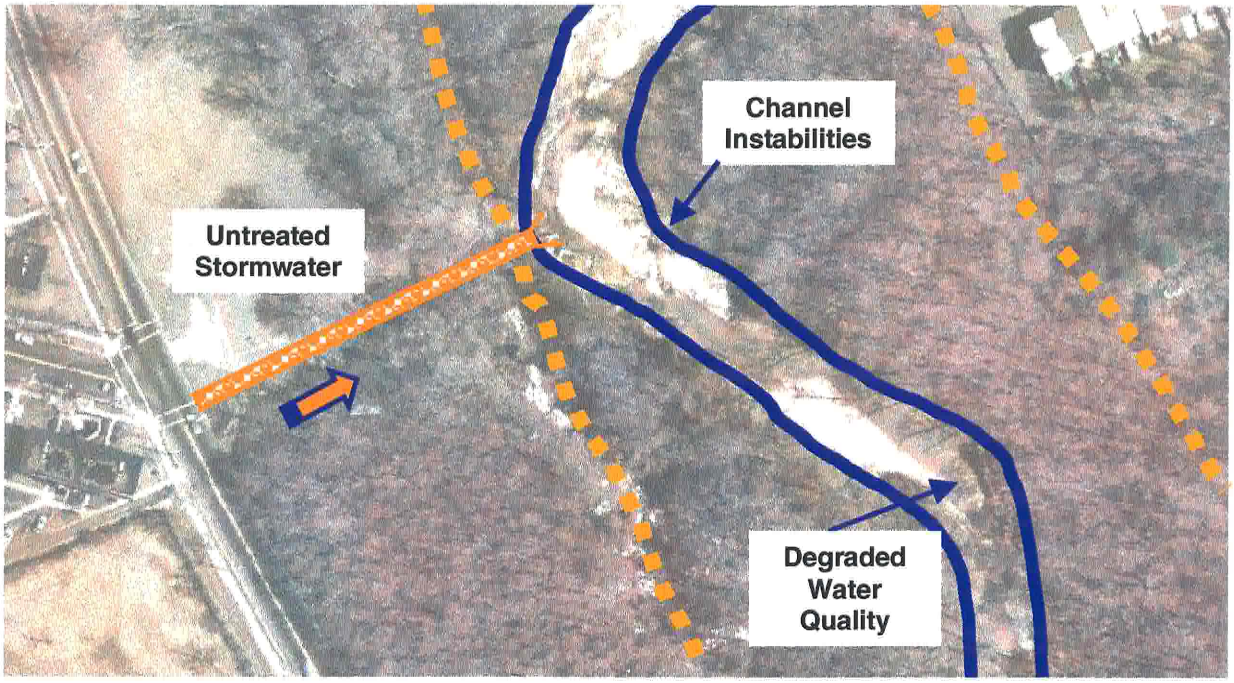
- Narrowing and deepening of the stream to achieve the desired width/depth ratio. Benches are constructed within the bankfull channel to create low flow channels.
- Wide benches above the bankfull stage to provide flood relief. Final sizing of benches will be based on hydraulic analysis of larger floods.

C. Stormwater Management Retrofit

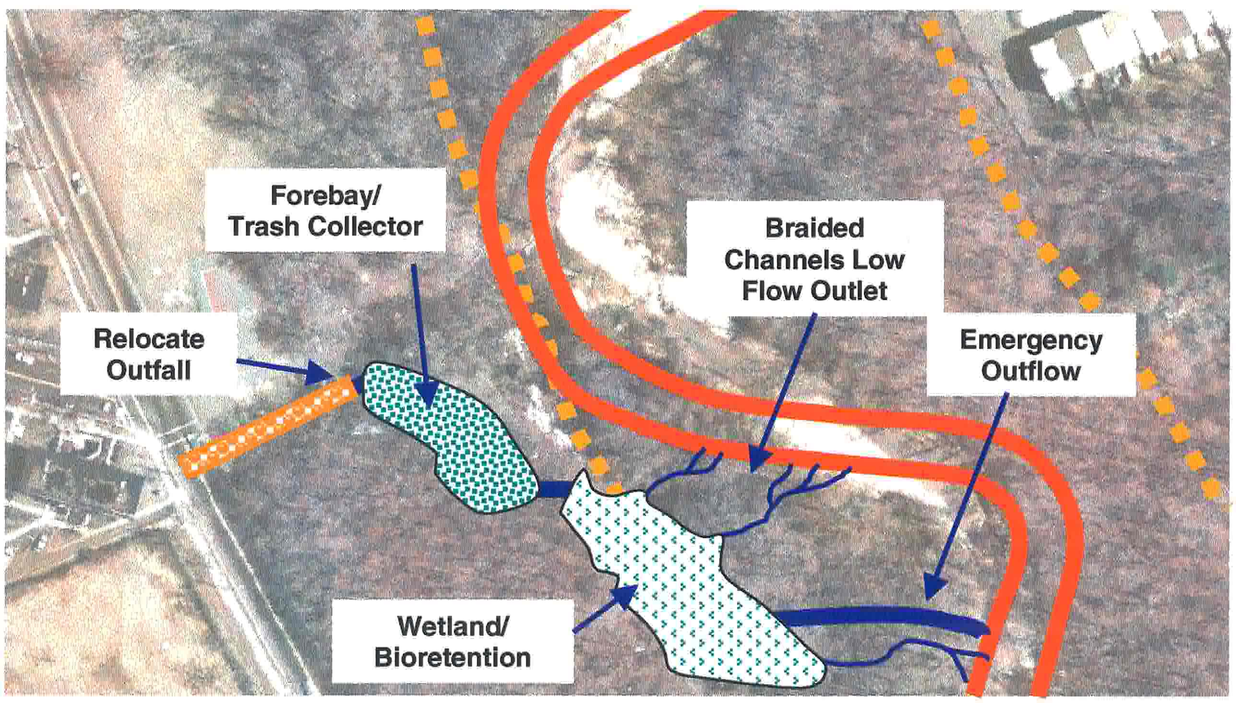
The goal of stormwater management retrofit is to improve the quality of water discharged to Oxon Run, reduce flashiness of stormwater discharges, and provide groundwater recharge to the maximum extent possible. Site-specific designs are required. Details of the design depend on the vertical and horizontal alignment of storm sewers with respect to the width and elevation of riparian corridor adjacent to the stream. Figure 18 illustrates a conceptual layout of a retrofit for one stormwater outfall. Under existing conditions, the outfall, located on the outside of a meander bend, creates significant bank instabilities due to the orientation of the outfall jet with respect to the stream. Under proposed conditions, the outfall would be relocated from the stream to create overland flow between the outfall and the stream. Flow from the pipe would pass through a stormwater management forebay designed to capture litter and trash. If possible, infiltration would be provided as well. Overflow from the forebay would pass through an over bank wetland or bio retention area. Again, the intention is to provide water quality treatment, opportunities for infiltration, and a small amount of peak storage. Discharge from the wetland would be through a series of small braided channels. The intention of the small channels is to spread the flow across the reach to minimize impacts to flow hydraulics on the stream. An emergency channel provides flow relief for large discharges and protects the smaller outfall channels.

Figure 17: Existing Riffle and Pool Cross Sections with Conceptual Adjustments





a) Existing Conditions



b) Proposed Conditions

Figure 18: Concept for Stormwater Retrofit

IX. PRELIMINARY DESIGN AND CONSTRUCTION COSTS

There are four phases associated with restoration design: 1) Development of restoration design criteria, 2) Development of 30 percent complete designs, 3) Development of 60 percent complete designs, and 4) Development of 90 percent (final) designs and specifications.

The first phase, development of restoration design criteria, is based on data collected during the stream assessment and reference reach data. However, the Service was unable to identify an appropriate stable reference reach during the stream assessment phase. The Service concentrated the reference reach search within the D.C. and Prince George's County watersheds within the vicinity of Oxon Run. The Service, as part of the subsequent design Scope of Work, will broaden the reference reach search to include other watersheds. If a reference reach is identified and surveyed, the Service will develop dimensionless ratios, based on bankfull dimensions, from the reference reach and apply them to the Oxon Run restoration design. Design criteria developed from the dimensionless ratios include, but are not limited to, bankfull channel dimensions, radius of curvature, belt width, meander length, and riffle-pool spacing. If the Service is unable to locate an appropriate reference reach, dimensionless reference reach ratios developed by Wildland Hydrology (Rosgen 2002c) and/on based on the Western Coastal Plain (McCandless 2003) will be used as a basis for the restoration design.

The remaining three phases of design involve the development of actual restoration plans. The conceptual (30 percent) Restoration Design will include a conceptual design planform with location of the stream and instream structures. The plan will include areas requiring riparian buffers and plots of typical stream cross section(s) and longitudinal profile(s). The preliminary (60 percent) Restoration Design will include detailed stream cross section(s) and longitudinal profile(s) and details of restoration techniques. The final (90 percent) Restoration Design will include specifications for all materials used, planting plan and plant specifications, construction sequence, and stakeout plan. The Service will conduct a feasibility analysis of potential restoration solutions throughout the design phase process. A variety of potential stream restoration, outfall, and source control solutions are possible and the Service will investigate feasibility and costs during the design phase for each site.

Restoration construction costs are presented in Table 7. Costs are based on the magnitude of instability problems and complexity of potential restoration solutions. The Service derived costs for each reach based on total linear ft of each stream reach. The Service will refine the restoration costs at each phase of design as details of restoration solutions and their locations are finalized. Design costs typically range from 15 percent to 25 percent of the construction costs depending upon the magnitude and complexity of problems and constraints existing at the restoration site.

Table 7 - Construction Cost Estimate			
Reach		Linear Cost	Cost
Identification	Length (ft)		
OR-1	460	$200.00	$110,400
OR-2	1,796	$150.00	$323,280
OR-3	460	$150.00	$82,800
OR-4	550	$200.00	$132,000
OR-5	385	$150.00	$69,300
OR-6	370	$150.00	$66,600
OR-7	320	$150.00	$57,600
OR-8	779	$150.00	$140,220
OR-9	7,920	$200.00	$1,900,800
OR-10	1,200	$150.00	$216,000
OR-11	320	$200.00	$76,800
OR-12	523	$200.00	$125,520
TOTAL	**15,083**	**$2,050.00**	**$3,301,320**

X. ADDITIONAL RECOMMENDATIONS

To optimize the restoration and ensure the greatest potential for success, the Service recommends additional assessment and expansion of the project scope.

A. Assess and Restore the Prince George's County Tributaries

The Service also recommends the assessment and restoration of the Prince George's portion of Oxon Run and its tributaries. Tributaries upstream of D.C. contribute significant amounts of sediment and stormwater to the project area. Assessment and restoration of the entire stream is important for ensuring the perpetual success of the restoration within D.C., and maximizing the benefits to the resources affected. Upstream reaches include the Suitland Parkway (1.6 mi), and the main stem of Oxon Run (4.2 mi). Streams in the Barnaby Run sub-watershed are also unstable. Although these streams do not affect the D.C. project reach, they contribute significant amounts of sediment to the Potomac River, and have low value as aquatic habitat. Additionally, fish passage around the Forest Heights drop structure (on the Oxon Run main stem) must be provided to achieve the objective of restoring anadromous fish habitat.

B. Biological and Chemical Assessment

Although MBSS has conducted several biological surveys in Oxon Run, the Service recommends biological surveys in the restoration area pre- and post-construction to quantify the specific response in these locations. Toxics input is a limiting factor for aquatic biota input, even if high quality habitat is created. Thus, we also recommend a more extensive pre-construction toxics evaluation, including collection and analysis of water and sediment samples to ensure troublesome areas like Camp Simms and the unlined landfill are adequately addressed in the restoration plan. Oxon Run is listed as an impaired waterway under Section 301(d) for toxics, and collection of the appropriate data would serve the dual purpose of providing a basis for Total Maximum Daily Loads (TMDLs) and highlighting areas that might need additional restoration or remediation activities. Note that to effectively compute annual loadings, continuous discharge data are required, thus establishing a gage station on Oxon Run is recommended. As part of the restoration plan, the Service will also require testing for unexploded ordnance (UXOs) in any excavation or heavy equipment transit areas located on the former Camp Simms property.

C. Develop a Sediment Rating Curve

The erosion estimates in this report are based on a sediment rating curve developed for streams in the Western United States. Development of a sediment rating curve for the coastal plain will validate the predictions and improve the accuracy of the estimates. The sediment rating curve will provide data to assist in establishing sediment TMDLs. As part of this assessment, the Service installed 31 monumented cross sections, establishing a baseline for the sediment rating curve. Yearly monitoring of these cross sections will quantify the erosion and provide data for a rating curve.

D. Expand Project Objectives

The Service recommends expanding the project objectives to include park improvements, wetland enhancement, especially in the magnolia bog, and public education and outreach. Park improvements may include introduction of native plants ("bayscaping"), enhancement of the pedestrian/bike trails, and/or creation of interpretive features such as a nature trail. Public education and outreach opportunities include interpretive signage, development of an ecological educational curriculum with local schools, and involvement of the public in the restoration effort (*e.g.*, riparian and garden plantings). A community outreach and citizen involvement component in the project will improve the likelihood of project success.

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