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ORNL/ER-350

ENVIRONMENTAL RESTORATION PROGRAM

Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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B. A. Rosensteel

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PREFACE

This wetland survey report regarding wetlands within Melton Valley and Bethel Valley areas of the Oak Ridge Reservation was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act for reporting the results of a site characterization for public review. This work was done under Work Breakdown Structure number 1.4.12.6.1.15.41. This document provides the Environmental Restoration Program with information on the results of the wetland survey conducted during fiscal year 1995. It includes information on the physical characteristics, location, approximate size, and classification of wetland areas identified during the field survey.

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ABBREVIATIONS

ANA	Aquatic Natural Area
ARA	Aquatic Reference Area
BD	Bearden Creek
DOE	Department of Energy
ET	east tributary
FAC	facultative
FACW	facultative wetland
GWOU	groundwater operable unit
HFIR	High Flux Isotope Reactor
HGM	Hydrogeomorphic Approach
IC	Ish Creek
MB	Melton Branch
NA	Natural Area
NEPA	National Environmental Policy Act
NT	north tributary
OBL	obligate wetland
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	Operable Unit
PEM1	palustrine emergent persistent wetland
PFO1	palustrine forested broad-leaved deciduous wetland
PSS1	palustrine scrub–shrub broad-leaved deciduous wetland
RA	Reference Area
RC	Raccoon Creek
SDI	Shared Data Initiative
ST	south tributary
SWSA	solid waste storage area
ROW	right-of-way
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
WAG	Waste Area Grouping
WET	Wetland Evaluation Technique
WO	White Oak Creek
WT	west tributary
08	X-10 0800 Area

EXECUTIVE SUMMARY

Executive Order 11990, Protection of Wetlands, (May 24, 1977) requires that federal agencies avoid, to the extent possible, adverse impacts associated with the destruction and modification of wetlands and that they avoid direct and indirect support of wetlands development when there is a practicable alternative. In accordance with Department of Energy (DOE) Regulations for Compliance with Floodplains and Wetlands Environmental Review Requirements (Subpart B, 10 CFR 1022.11), surveys for wetland presence or absence were conducted in both the Melton Valley and the Bethel Valley Groundwater Operable Units (GWOU) on the DOE Oak Ridge Reservation (ORR) from October 1994 through September 1995. As required by the Energy and Water Development Appropriations Act of 1992, wetlands were identified using the criteria and methods set forth in the *Wetlands Delineation Manual* (Army Corps of Engineers, 1987).

Wetlands were identified during field surveys that examined and documented vegetation, soils, and hydrologic evidence. Most of the wetland boundary locations and wetland sizes are approximate. Boundaries of wetlands in Waste Area Grouping (WAG) 2 and on the former proposed site of the Advanced Neutron Source in the upper Melton Branch watershed were located by civil survey during previous wetland surveys; thus, the boundary locations and areal sizes in these areas are accurate. The wetlands were classified according to the system developed by Cowardin et al. (1979) for wetland and deepwater habitats of the United States.

A total of 215 individual wetland areas ranging in size from 0.002 ha to 9.97 ha were identified in the Bethel Valley and Melton Valley GWOUs. The wetlands are classified as palustrine forested broad-leaved deciduous (PFO1), palustrine scrub–shrub broad-leaved deciduous (PSS1), and palustrine persistent emergent (PEM1) (Cowardin et al. 1979).

The total area of wetlands is approximately 76.7 ha or roughly 3.8% of the total Oak Ridge National Laboratory (ORNL) GWOU area. Within these wetlands, 86% (185) measure less than ½ ha, and 71% (152) are less than 1/4 ha. Eleven wetland areas range between ½ and 1 ha. Only 19 of the 215 wetlands are greater than 1 ha. Ten wetland areas are between 1 and 2 ha. Five wetlands, four of which are river embayments, are between 2 and 2.5 ha. Two of the wetlands are approximately 3.3 ha each, and two wetland areas are greater than 5 ha. Among the largest wetlands are those that occur in the human-influenced aquatic environments of Clinch River embayments, White Oak Lake, and the White Oak Creek floodplain. The hydrology of these wetlands is strongly influenced by the fluctuations in water level caused by operation of Watts Bar Dam and Melton Hill Dam and by smaller dams and road culverts. The White Oak Lake/White Oak Creek floodplain is, at 9.97 ha, the largest single wetland area in the ORNL GWOU.

Among the watersheds in which all or most of the watershed area was included in the survey, Bearden Creek has the smallest area in wetlands (5.85 ha). White Oak Creek watershed, which includes the Melton Branch subwatershed, has the largest number (148) and the largest area (approx. 39.9 ha) of wetlands in the ORNL GWOU.

Wetlands identified during this survey include atypical situations wetlands (USACE 1987) in which one or two of the wetland criteria are absent (three identified); wetland/upland mosaics in which wetlands and uplands are interspersed in an irregular pattern (one identified); and wetlands in areas of past or continuing disturbance in which the disturbance itself appears to be the primary factor leading to wetland presence (five identified).

Additional information provided in this report includes the location of previously unmapped streams and stream sections, the location of Research Park Natural Areas (NA) and Reference Areas (RA) in the GWOU, and a discussion of wetland functions. Previously unmapped streams or sections of streams were identified throughout the ORNL GWOU. A stream was considered to be unmapped if it were not shown as a blue-line stream on the ORR S16-A map or was not present in the ORNL Shared Data Initiative X-10 water layer. Located either fully or partially in the Bethel Valley and Melton Valley GWOUs are 24 Research Park NAs, RAs, Aquatic NAs, and Aquatic RAs. Of these, 13 contain wetlands. Six of these RAs and NAs were designated as such because of the presence of a particular wetland plant community or a rare plant species that occurs in wetlands. A thorough assessment of wetland functions is outside of the scope of this project. However, important wetland functions are briefly discussed, and a description of two wetland functional assessment methodologies is provided.

1. INTRODUCTION

Executive Order 11990, Protection of Wetlands, (May 24, 1977) requires that federal agencies avoid, to the extent possible, adverse impacts associated with the destruction and modification of wetlands and that they avoid direct and indirect support of wetlands development when there is a practicable alternative. In accordance with Department of Energy (DOE) Regulations for Compliance with Floodplains/Wetlands Environmental Review Requirements (Subpart B, 10 CFR 1022.11), surveys for wetland presence or absence were conducted in both the Melton Valley and the Bethel Valley Groundwater Operable Units (GWOU) from October 1994 through September 1995. The wetland survey was conducted for the Oak Ridge National Laboratory (ORNL) Environmental Restoration (ER) Program. As required by the Energy and Water Development Appropriations Act of 1992, wetlands are identified using the criteria and methods set forth in the Wetlands Delineation Manual [U.S. Army Corps of Engineers (USACE 1987)]. Wetlands were identified during field surveys in which vegetation, soils, and hydrologic evidence were examined and documented.

This report includes data for all of the wetlands that have been identified during the 1994–1995 ORNL ER Program wetland survey and in other wetland surveys conducted after January 1992 in the Bethel Valley and Melton Valley groundwater operable units. A thorough assessment of wetland functions is outside the scope of this project. However, important wetland functions are briefly discussed, and a description of two wetland functional assessment methodologies is provided.

2. METHODOLOGY

2.1 WETLAND IDENTIFICATION METHODOLOGY

2.1.1 U. S. Army Corps of Engineers Wetland Delineation Methodology

As required by the Energy and Water Development Appropriations Act of 1992, wetlands are identified using the criteria and methods set forth in the *Wetlands Delineation Manual* (USACE 1987). USACE defines wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

USACE lists three characteristics that are diagnostic of wetlands: (1) the vegetation is characterized by a prevalence of macrophytes typically adapted to wetland soil and hydrological conditions; (2) the substrate is undrained hydric soil; and (3) the area is inundated either permanently or periodically at depths less than 2 m (6.6 ft.), or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

2.1.1.1 Hydrophytic vegetation

USACE (1987) defines hydrophytic vegetation as "the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present." The U.S. Fish and Wildlife Service (Reed 1988) has developed a classification system that assigns species to wetland indicator classes according to the frequency with which a species occurs in a wetland (Table 1). If more than 50% of the vegetation in each strata (i.e., canopy, sapling/shrub, vines, herbaceous) have an indicator status of obligate (OBL), facultative wetland (FACW), and/or facultative (FAC), the vegetation is classified as hydrophytic. A positive (+) or negative (-) sign following any of the facultative indicator categories indicates, respectively, a frequency toward the higher end of the category (more frequently found in wetlands) or the lower end of the category (less frequently found in wetlands).

2.1.1.2 Hydric soils

Hydric soils are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in a major part of the root zone. The following indicators are used to determine whether a given nonsandy soil meets the definition and criteria for hydric soils:

1. Organic soils. An organic soil is one in which more than 50%, by volume, of the upper 82 cm (32 in.) of soil is composed of organic soil material. Organic soils are saturated for long periods and are commonly called peats or mucks.

2. Sulfidic material. The presence of a rotten egg odor is indicative of the presence of hydrogen sulfide, which is produced only in a reducing environment (e.g., saturated, waterlogged soils).

3. Aquic or peraquic moisture regime. An aquic moisture regime is one in which the soils are virtually free of dissolved oxygen because of saturation by groundwater or water of the capillary fringe. Peraquic moisture regimes are characterized by the presence of groundwater always at or near the soil surface.

4. Iron and manganese concretions. These concretions are formed during the oxidation-reduction process. Concretions less than 2 mm in diameter occurring within 7.5 cm of the surface are evidence that the soil is saturated for long periods near the surface.

5. Soil colors. Soil colors are often the most diagnostic indicator of hydric soils. Mineral hydric soils either will be gleyed (bluish, greenish, or grayish colors resulting from chemical reduction under anaerobic conditions) or will have bright mottles (speckles of oxidized iron indicative of fluctuating water table and alternating anaerobic and aerobic conditions) and a low chroma matrix.

Table 1. Plant indicator classifications and frequency of occurrence in wetlands*

Classification	Occurrence in Wetlands(%)
Obligate Wetland	> 99
Facultative Wetland	67–99
Facultative	34–66
Facultative Upland	1–33
Upland	< 1

*Source: P. B. Reed. 1988. *National List of Plant Species That Occur in Wetlands: Tennessee.* USFWS Biological Report NERC-88/18.42. U.S. Fish and Wildlife Service, Washington, D.C.

Munsell Soil Color Charts (Kollmorgen Instrument Corp. 1992) were used to determine soil colors. The Munsell notation for color consists of separate notations for hue, value, and chroma. The hues are R (red), YR (yellow-red), and Y (yellow) and refer to the soil color in relation to the primary colors (red, yellow, and blue). The hues are further defined by the numbers 2.5, 5.0, 7.5, and 10 preceding the hue designation. The numbers indicate the gradation from red through yellow within each hue, with 2.5 being more red and 10 being more yellow. The value notation refers to the lightness of the hue, and ranges from 0 (absolute black) to 10 (absolute white). Chroma refers to the strength, or saturation, of the color, and ranges from 0 (neutral gray) to 8. In writing Munsell color notations, the sequence is always hue, value, and chroma. For instance, 10YR 5/2 indicates a soil on the yellow end of the yellow-red hue, with a value of 5 (mid-range) and a chroma of 2. Each Munsell notation corresponds to a color. For example, 10YR 5/2 is grayish-brown. Mineral hydric soils have one of the following features in the horizon immediately below the A-horizon, or between 0 and 25.6 cm (10 in.), whichever is shallower: (1) a matrix chroma of 2 or less in mottled soils or (2) a matrix chroma of 1 or less in unmottled soils.

Not all of the indicators listed above can be used in sandy soils because hydric features develop more slowly in sandy soils. Soil colors, in particular, should not be used as an indicator in most sandy soils. Hydric indicators for sandy soils include

- high organic matter content in the surface horizon,
- streaking of subsurface horizons by organic matter; and
- organic pans which are accumulations of organic matter at the point representing the most commonly occurring depth to the water table.

In areas of sediment mixing and deposition, such as accreting sandbars and floodplains, indicators of hydric soil may not have time to develop within the upper 25.6 cm of the soil. For the purposes of wetland determinations, these sites are treated according to guidelines for atypical situations and problem areas described in Sect. 2.1.2.

2.1.1.3 Wetland hydrology

Of the three technical criteria, wetland hydrology is generally the least exact. Field indicators are useful for confirming wetland presence but are unreliable for delineating precise wetland boundaries. Indicators of wetland hydrology include recorded data (e.g., aerial photographs, soil surveys, floodplain delineations) and field evidence such as drainage patterns (surface scouring, absence of leaf litter, eroded soil, and drift lines), sediment deposition, watermarks, visual observation of either inundation or saturated soils or both, and oxidized rhizospheres.

2.1.2 Atypical Situations and Problem Areas

The USACE *Wetlands Delineation Manual* (1987) addresses atypical situations and problem areas in which one or more positive indicators of wetland presence may be absent in a wetland and describes procedures for determining whether the area in question is a wetland. Atypical situations are those in which positive indicators of either hydrophytic vegetation, hydric soils, or wetland hydrology are absent because of effects of recent human activities or natural events. Atypical situations include areas in which there are unauthorized discharges requiring enforcement actions; natural events such as changing river courses, beaver dams, mudslides, and earthquakes; and human-induced wetlands that have been purposely or incidentally created by human activities. Problem areas are those "wetland types in which wetland indicators of one or more parameters may be periodically lacking due to normal seasonal or annual variations in environment conditions that result from causes other than human activities or catastrophic natural events" (USACE 1987). Problem area wetlands include seasonal wetlands (in which wetland hydrology is absent during dry seasons), prairie potholes (in which wetland hydrology is absent during dry years), and vegetated flats (in which vegetation is absent during the nongrowing season).

2.2 WETLAND CLASSIFICATION

The wetlands identified in this survey were classified according to the system developed by Cowardin et al. (1979) for wetland and deep-water habitats of the United States. This hierarchical system describes wetlands and deep-water habitats by system, class, and subclass. Additional modifiers are added for water regime, chemistry, soil, and disturbances. The systems are marine, estuarine, riverine, lacustrine, and palustrine. The marine and estuarine systems are oceanic and coastal and thus do not occur at ORR. The lacustrine and riverine systems encompass freshwater lakes and rivers/streams, respectively. The palustrine system includes nontidal wetlands dominated by trees, shrubs, persistent emergents, and/or emergent mosses or lichens and includes vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and pond.

The palustrine system includes five classes that are vegetated and are thus considered as wetlands under the USACE definition (1987): (1) aquatic bed (dominated by submerged or floating plants), (2) moss–lichen, (3) emergent (dominated by herbaceous plants that rise above the water surface), (4) scrub–shrub (dominated by shrubs and saplings), and (5) forested. Subclasses of the vegetated classes indicate differences in vegetative form, such as broad-leaved or needle-leaved, deciduous or evergreen, and persistent (species that normally remain standing at least until the beginning of the next growing season) or nonpersistent (plants that fall to the surface of the substrate or below the surface of the water at the end of the growing season).

A non-Cowardin System modifier was added by this author to describe certain wetlands at ORR. Because most of the ORNL GWOU area has received land disturbance in the past 100 to 150 years, it is very likely that most of the wetland areas have been subjected to some type of disturbance at some time in the past, ranging from clearing for agriculture and forestry to road, building, and power-line construction. Therefore, the term "disturbed" was used as a modifier for the wetland classification only for those wetlands that continue to receive a direct disturbance or are known to have been recently disturbed (e.g., within the last 3 years). In most cases, the direct disturbance consists of maintenance mowing of utility line rights-of-way and mowing of stream riparian zones in developed areas of the ORNL plant. Wetlands classified as "disturbed" have a lower-case "d" following the Cowardin (1979) wetland classification.

2.3 IDENTIFICATION OF UNMAPPED STREAMS

Numerous streams at ORR have not been mapped. Many of these streams have seasonal flow only and may appear to be dry channels during the summer and early fall. Although these streams do not appear on the widely used ORR S16-A map (which was prepared by the Tennessee Valley Authority Mapping Services Branch in 1985 for DOE), in most cases, the topography indicates their possible presence. As with mapped blue-line streams, these unmapped streams are Waters of the State and thus are subject to regulation under the Tennessee Water Quality Control Act of 1977 (TCA 69-3-101 et seq.).

Identification of streams was based on the State of Tennessee definitions of streams and wet-weather conveyances (TCA Chap. 1200-4-3-04). According to these definitions, a stream is a watercourse that supports fish and aquatic life and has a groundwater connection. This definition applies even if the groundwater connection is seasonal or intermittent. Unlike streams, wet-weather conveyances do not have a groundwater connection, flow only in direct response to precipitation, and do not support fish or other aquatic life.

In some areas, primarily the portions of watersheds in which wetlands were identified, the locations of any unmapped streams or unmapped portions of blue-line streams were noted during the field surveys for later mapping. Because identification of unmapped stream locations was incidental to the main task of wetland identification, those streams mapped as a result of this survey may not represent all of the unmapped streams that may exist in the survey area.

2.4 FIELD SURVEY

Existing maps, reports, and other information sources were consulted to determine potential and known wetland locations (i.e., stream bottoms, floodplains, topographic depressions, and ponds). To determine wetland presence or absence and to verify the areal extent of some of the previously identified wetlands, wetland field surveys were conducted from October 1994 through September 1995 in the Bethel Valley and Melton Valley groundwater operable units (also referred to herein as the X-10 GWOU).

The base maps for the field surveys and for the report figures presented later in this report are the ORR S16-A map and the ORNL map layers that are maintained by the ORNL Shared Data Initiative (SDI). The base maps and figures are in Administrative and State Plane coordinates. The sizes and boundaries of the wetlands are approximate because of the low resolution of the available maps, the lack of updated geographic information and topographic relief in some of the survey areas, and the small size (< 1/ 4 ha) of some of the wetlands. Boundary locations for some wetlands in the 0800 Area and the Raccoon Creek watershed were determined by using Global Positioning System receivers (AshTech

Surveyor, AshTech Corp.). These systems are used to identify the latitude and longitude of a given ground location.

Hydrophytic vegetation communities and evidence of wetland hydrology provided the initial indications of possible wetland presence. In all bottom land areas and where the vegetation community was dominated by facultative, facultative wetland, and/or obligate wetland species, or there was evidence of wetland hydrology, soil samples were collected throughout the area to a depth of 25 to 30 cm (10 to 12 in.) and were examined for hydric soil characteristics.

If the soils were hydric, soil samples from adjacent upland areas were examined for presence or absence of hydric characteristics. The approximate wetland boundary was considered to be at the interface between the hydric and nonhydric soils. If hydric soil indicators were not present because of an atypical situation, the boundary determination was based on changes in topography, vegetation community, and hydrologic indicators. The wetland boundaries identified during this and some of the earlier surveys were not physically marked (i.e., with flagging or stakes) in the field and were not located by civil survey. Therefore, the wetland boundary locations and sizes are approximate. Boundaries of wetlands in Waste Area Grouping (WAG) 2 and on the former proposed site of the Advanced Neutron Source in the upper Melton Branch watershed were marked in the field and located by civil survey during previous wetland surveys; thus, the boundary locations and area measurements are accurate (pedigree).

The mapped wetlands are identified with codes of letters, numbers, or both. In most cases the first letters of the code refer to the watershed the wetland is in. If the watershed is unnamed, such as is the case in the X-10 7600 Area and the 0800 Area, the code refers to the particular area. The watershed and area codes are as follows:

- BD: Bearden Creek
- IC: Ish Creek
- MB: Melton Branch
- 76: The X-10 7600 (Robotics) Area
- RC: Raccoon Creek
- WO: White Oak Creek
- 08: X-10 0800 Area

The watershed and area codes are followed by letters or numbers that refer to the location of the wetland in the watershed. If the wetland is located along the main stem of the stream, the watershed code is followed by an "M." If it is located along a tributary stream, the wetland is given a code that indicates whether the tributary is a south (ST), north (NT), east (ET), or west (WT) tributary. The wetlands are then sequentially numbered, in most cases beginning at the mouth of the stream. The exception is Melton Branch, in which the numbering begins at the headwater position. Two examples of the coding system are the first wetland at the downstream end of Raccoon Creek, which is designated as RCM-1, and wetland MBNT2-3, which refers to the third wetland upstream from the tributary mouth in the Melton Branch North Tributary 2 catchment.

The naming of the streams and tributaries referred to in this report follows no particular system because, to date, a stream-naming convention for ORR has not been fully developed or distributed. This information can be updated in the future if a reservation-wide stream nomenclature system is developed.

3. SURVEY FINDINGS

3.1 OVERVIEW

Several areas in the Bethel Valley and Melton Valley GWOUs have been surveyed for wetlands within the last 3 years. These areas include the proposed site for the Advanced Neutron Source, WAG2, WAG 4, WAG 5, WAG 7, WAG 10, SWSA 7, the High Flux Isotope Reactor (HFIR) area, and adjacent areas. The areas in which field surveys were conducted between October 1994 and September 1995 include the Raccoon Creek watershed, lower Ish Creek watershed, Bearden Creek watershed, the 0800 Area, WAG 6, the area south of the White Oak Creek embayment, the south side of Haw Ridge, and several smaller areas not included in previous surveys. Wetland areas in northeast SWSA 7 were field reviewed for accuracy, which resulted in changes in wetland boundaries and size previously reported in this area. The location of the Bethel Valley and Melton Valley GWOUs on the ORR is shown in Fig. 1. A closer view of the survey area showing streams and roads is provided in Fig. 2.

3.2 DESCRIPTION OF SURVEY AREAS

3.2.1 Primary Forest Communities

Forest communities in the Bethel Valley and Melton Valley GWOU's include pine plantations, mixed pine-hardwood forest, oak-hickory forest, pine/hardwood/cedar forests, cedar barrens, and bottomland hardwood. The pine plantations include mature (planted in the 1940s and 1950s) and immature (planted in the late 1970s) loblolly and shortleaf pine plantations in and adjacent to the floodplain and riparian zones of Ish Creek, Raccoon Creek, and Bearden Creek, on the lower slopes of Chestnut Ridge, and in the 0800 Area and the 0800 South area. Mixed pine-hardwood forests and oak-hickory forests are found on the slopes and ridge tops of Chestnut Ridge, Haw Ridge, and the lower slopes of Copper Ridge in the survey area. Forests dominated by red cedar, Virginia pine, tulip poplar, sweetgum, red maple, white ash, and sycamore are found in the floodplains and riparian zones and on lower slopes in the watersheds of Raccoon Creek, Ish Creek, Bearden Creek, the middle reach of White Oak Creek, and Melton Branch. Cedar barrens are located on the lower slopes of Chestnut Ridge. The bottomland hardwood communities are dominated by sweetgum, red maple, sycamore, green ash, box elder, slippery elm, and ironwood and are found in many locations along the main streams and headwater tributary streams.

3.2.2 Research Park Natural Areas and Reference Areas

National Environmental Research Park Natural Areas (NA), Reference Areas (RA), Aquatic Natural Areas (ANA), and Aquatic Reference Areas (ARA) have been established to protect state- or federally-listed species, species under consideration for listing, and special habitats, and to serve as reference or control areas for biological monitoring, environmental remediation, characterization, and other ecological research activities (Pounds et al. 1993). A map of all of the ORR Natural and Reference Areas is found in Pounds et al. (1993). Additional areas have been added or proposed since 1993. The updated map of Natural and Reference Areas is expected to be available soon for distribution on the ORNL SDI.

Twenty four Research Park NAs, RAs, ANAs and ARAs are located either fully or partially in the Bethel Valley and Melton Valley GWOUs (Fig. 3). Of these, thirteen contain wetlands. Those containing wetlands are ANA1, ARA3, ARA4, ARA9, NA6, NA25, NA26, NA 35, NA36, RA9,

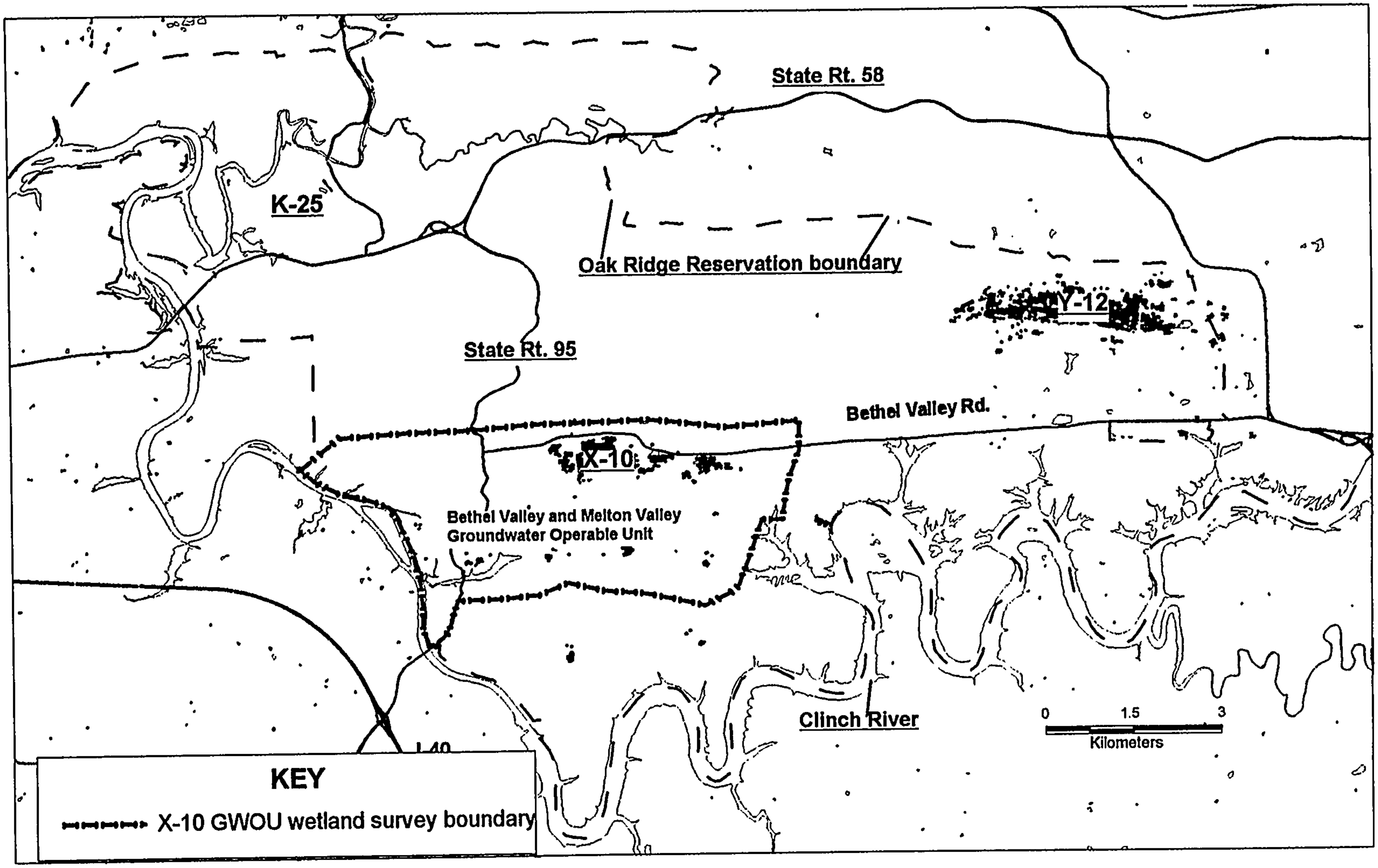

Fig. 1. X-10 groundwater operable unit wetland survey area boundary, Oak Ridge Reservation, Oak Ridge, Tennessee.

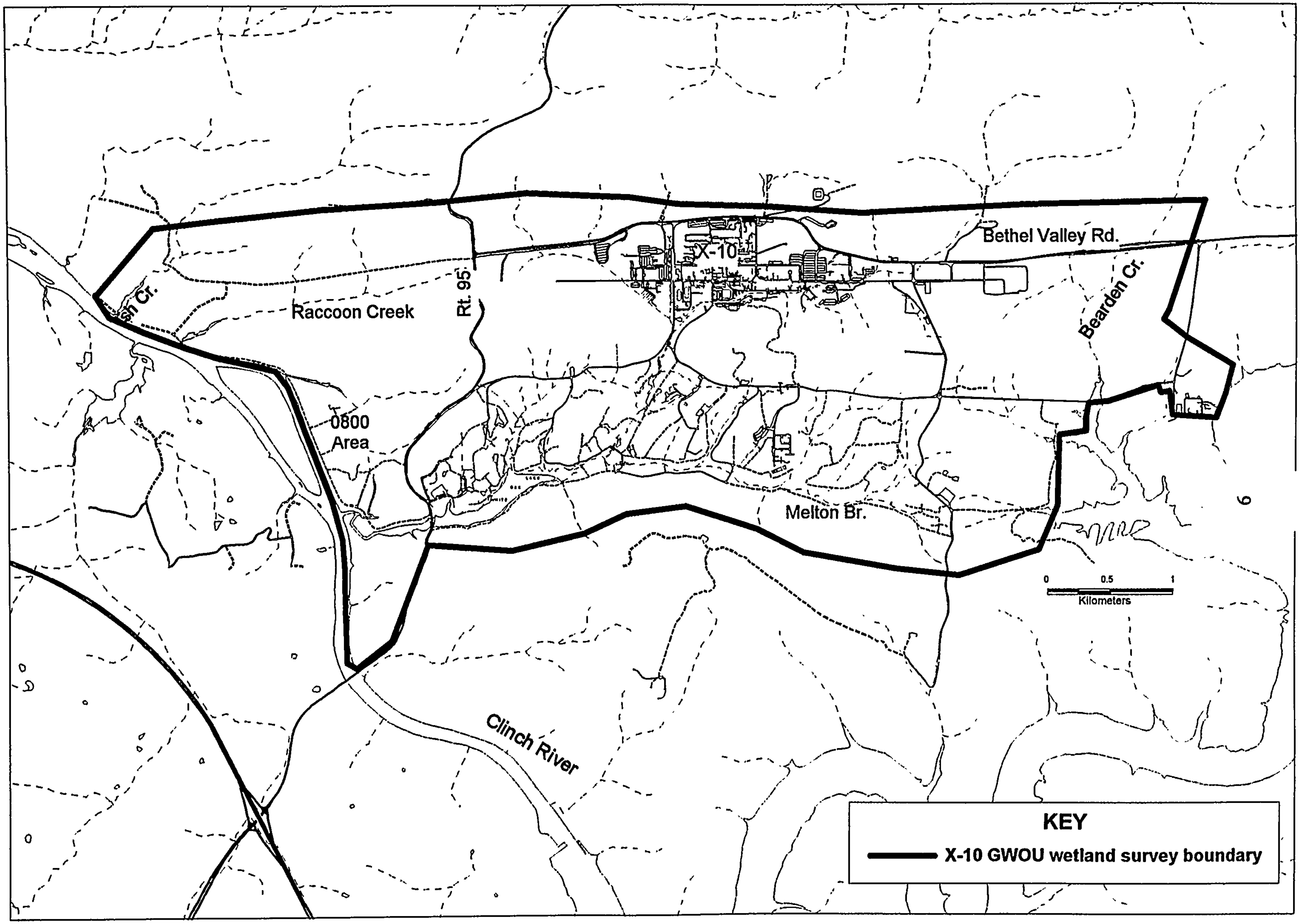

Fig. 2. Bethel Valley and Melton Valley groundwater operable units wetland survey area.

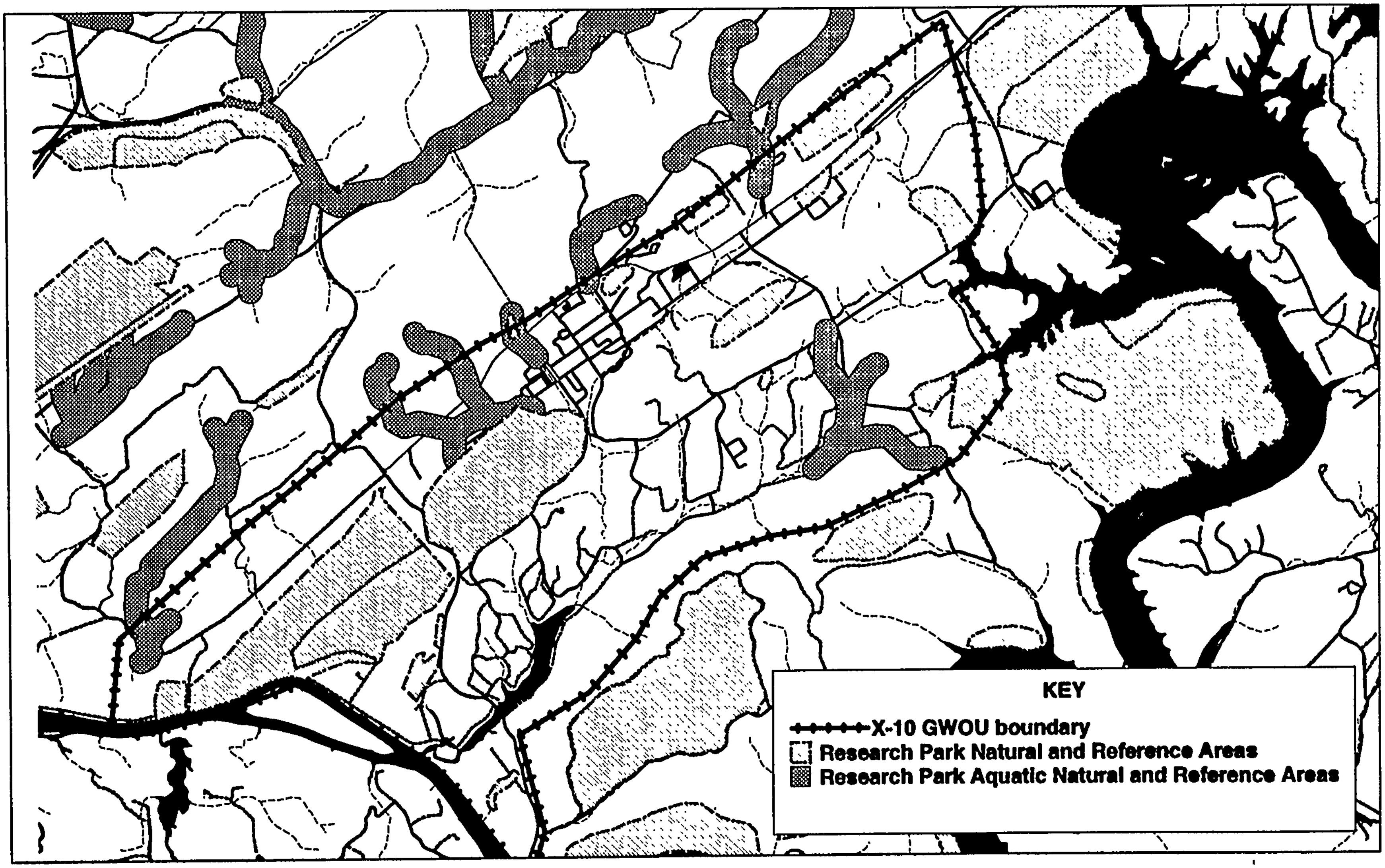

Fig. 3. Research Park Natural Areas and Reference Areas in the Bethel Valley and Melton Valley groundwater operable units, September 1995.

RA16, RA19, RA28, and RA10 (Pounds et al. 1993). Six of these NAs and RAs—ARA4, RA16, RA19, NA25, NA26, and NA36—were designated as such because of the presence of particular wetland plant community or a rare plant species that occurs in wetlands.

3.3 PREVIOUSLY UNMAPPED STREAMS

Previously unmapped streams or sections of streams were identified throughout the X-10 GWOU. A stream was considered to be unmapped if it was not shown as a blue-line stream on the ORR S16-A map or was not present in the ORNL SDI Water Layer, which shows more streams than does the ORR S16-A map. The stream substrates include bedrock outcrops, stone, shaly, and gravel bottoms, silt-covered stone bottoms, and silt and mud bottoms. Many of the headwater tributaries are seasonal or have intermittent flow that occurs only during late fall, winter, and spring, and during periods of high or prolonged precipitation in other seasons. Some of the tributaries have sinking reaches in which the surface flow enters subsurface conduits formed in the underlying karst. In some of the tributaries, years of sediment accumulation have resulted in buried stream sections.

3.4 WETLANDS

3.4.1 Overview

The wetlands are shown in Figs. 4 through 16. Because of the small size of many of the wetlands, the GWOU survey area was divided into smaller areas for map display. There is some overlap in the wetland areas portrayed on the figures, with some wetland areas showing up on more than one figure. Figs. 4 through 15 have differing scales and, therefore, cannot be pieced together to form a whole map of the area. An entire overview of the wetlands in the X-10 GWOU is shown in Fig. 16. The main areas included in each of the figures are as follows:

- Fig. 4. Raccoon Creek, lower Ish Creek, and the northern portion of the 0800 Area
- Fig. 5. Eastern half of the ORNL main plant in the middle reach of White Oak Creek
- Fig. 6. Western half of the ORNL main plant in the middle reach of White Oak Creek
- Fig. 7. Upper Bearden Creek watershed
- Fig. 8. 0800 Area
- Fig. 9. Lagoon Road area, including all or parts of WAGs 2, 4, 6, 7, and 10
- Fig. 10. WAG 5, the HFIR area, portions of WAG 2, SWSA 7
- Fig. 11. Northern half of SWSA 7
- Fig. 12. Lower Bearden Creek watershed and a portion of the upper Melton Branch watershed
- Fig. 13. 0800 South area, south of White Oak Creek embayment
- Fig. 14. White Oak Lake, portions of WAGs 2, 5, and 6
- Fig. 15. Southern half of SWSA 7 and upper Melton Branch

Two hundred and fifteen individual wetland areas ranging in size from 0.002 ha to 9.97 ha were identified in the Bethel Valley and Melton Valley GWOUs. The total wetlands area is about 76.7 ha.

The approximate size of the wetland survey area, as outlined in Fig. 2, is approximately 2000 ha. (This is a somewhat larger number than is reported elsewhere for the X-10 GWOU study area because of the inclusion in the wetland survey of the 7600 Area and the 0800 South area that are outside of the X-10 GWOU boundaries.) Based on the 2000 ha and 77 ha estimates, approximately 3.8% of the total X-10 GWOU area is in wetlands.

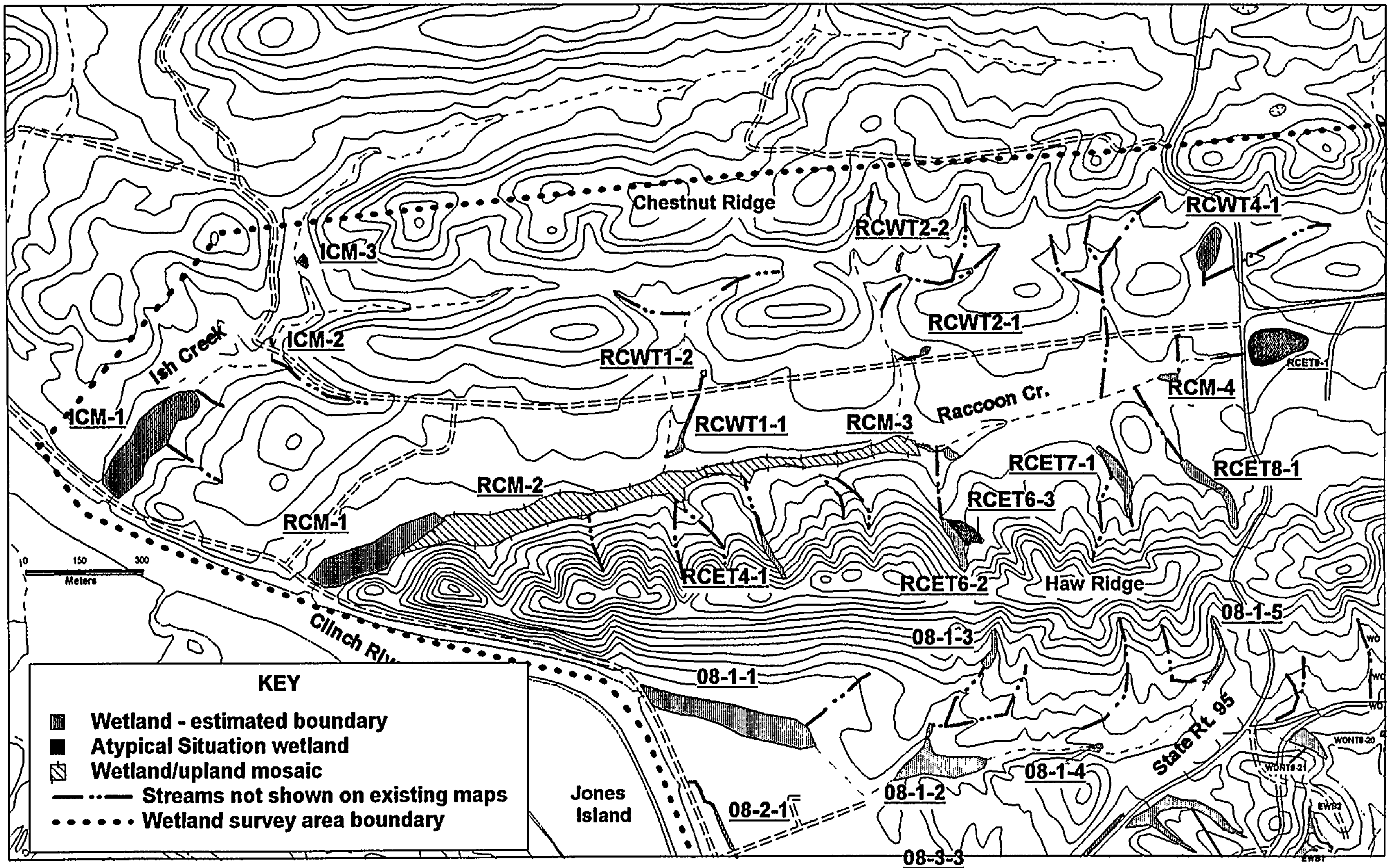

Fig. 4. Wetlands and streams in the Raccoon Creek and lower Ish Creek watersheds and the northern portion of the 0800 Area in the Bethel Valley and Melton Valley groundwater operable units, September 1995.

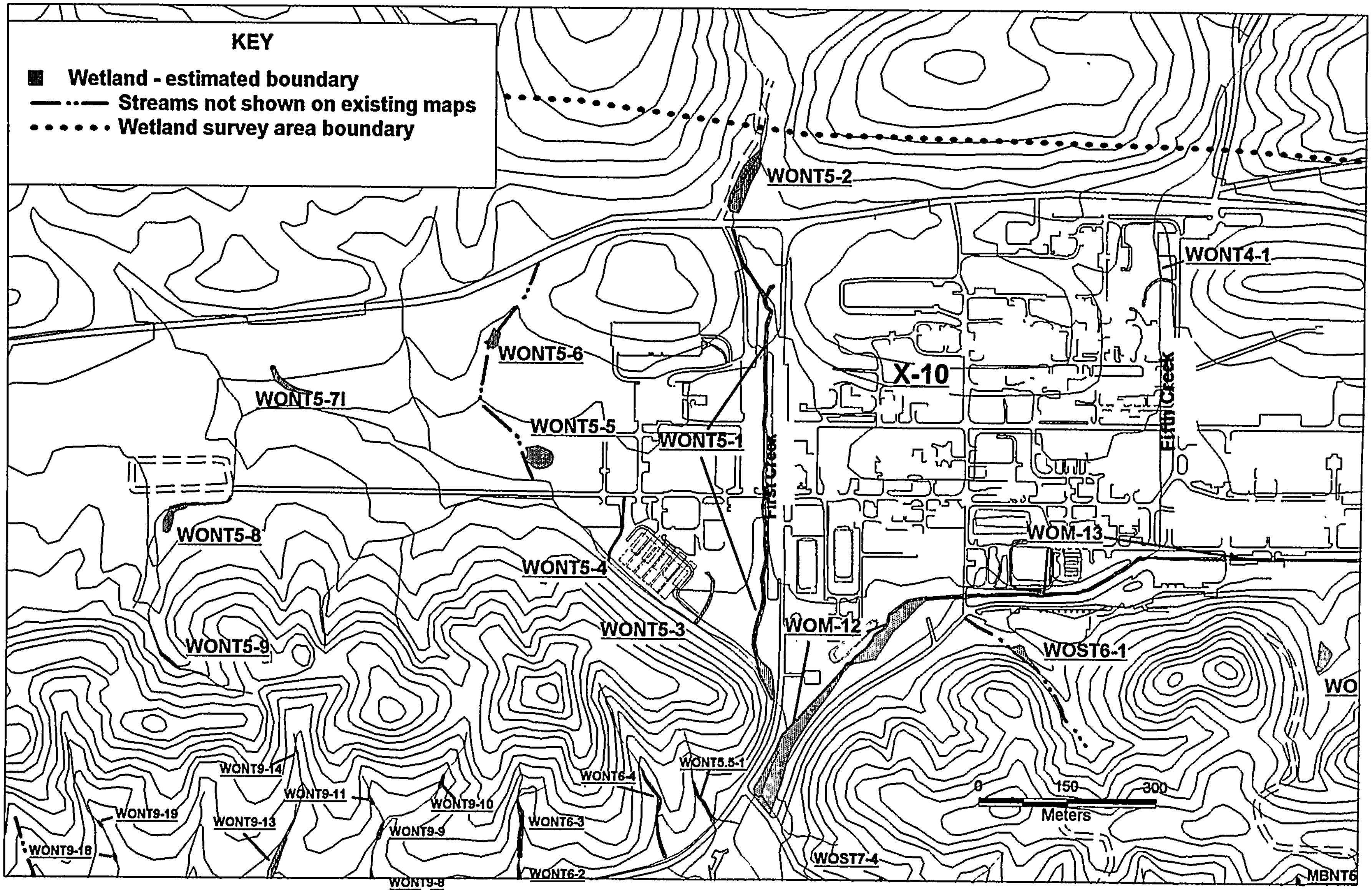

Fig. 5. Wetlands and streams in the middle portion of the White Oak Creek watershed, western half of the ORNL main plant area, Bethel Valley and Melton Valley groundwater operable units, September 1995.

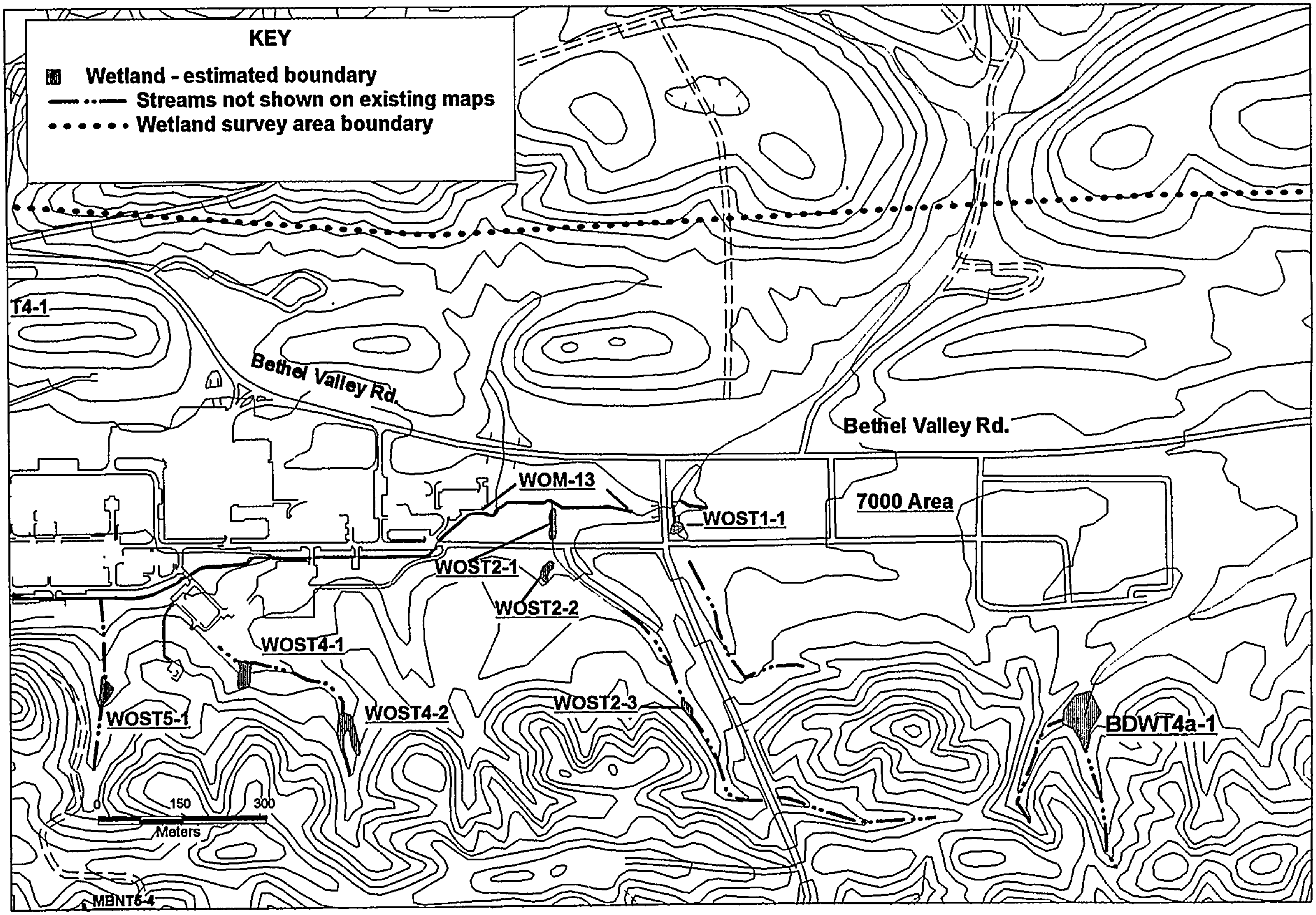

Fig. 6. Wetlands and streams in the White Oak Creek watershed, eastern half of the ORNL main plant area, Bethel Valley groundwater operable unit, September 1995.

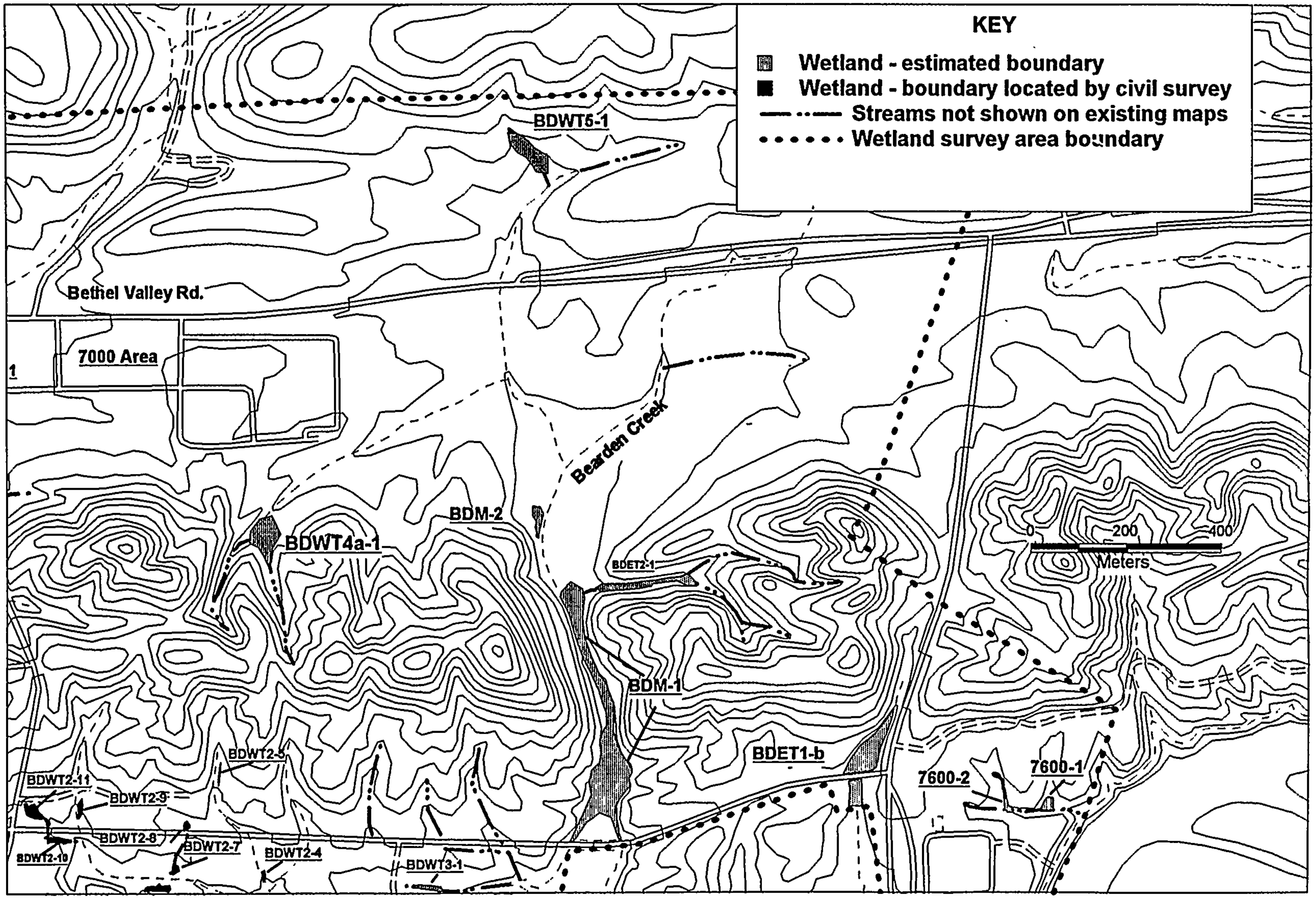

Fig. 7. Wetlands and streams in the upper Bearden Creek watershed in the Bethel Valley and Melton Valley groundwater operable units, September 1995.

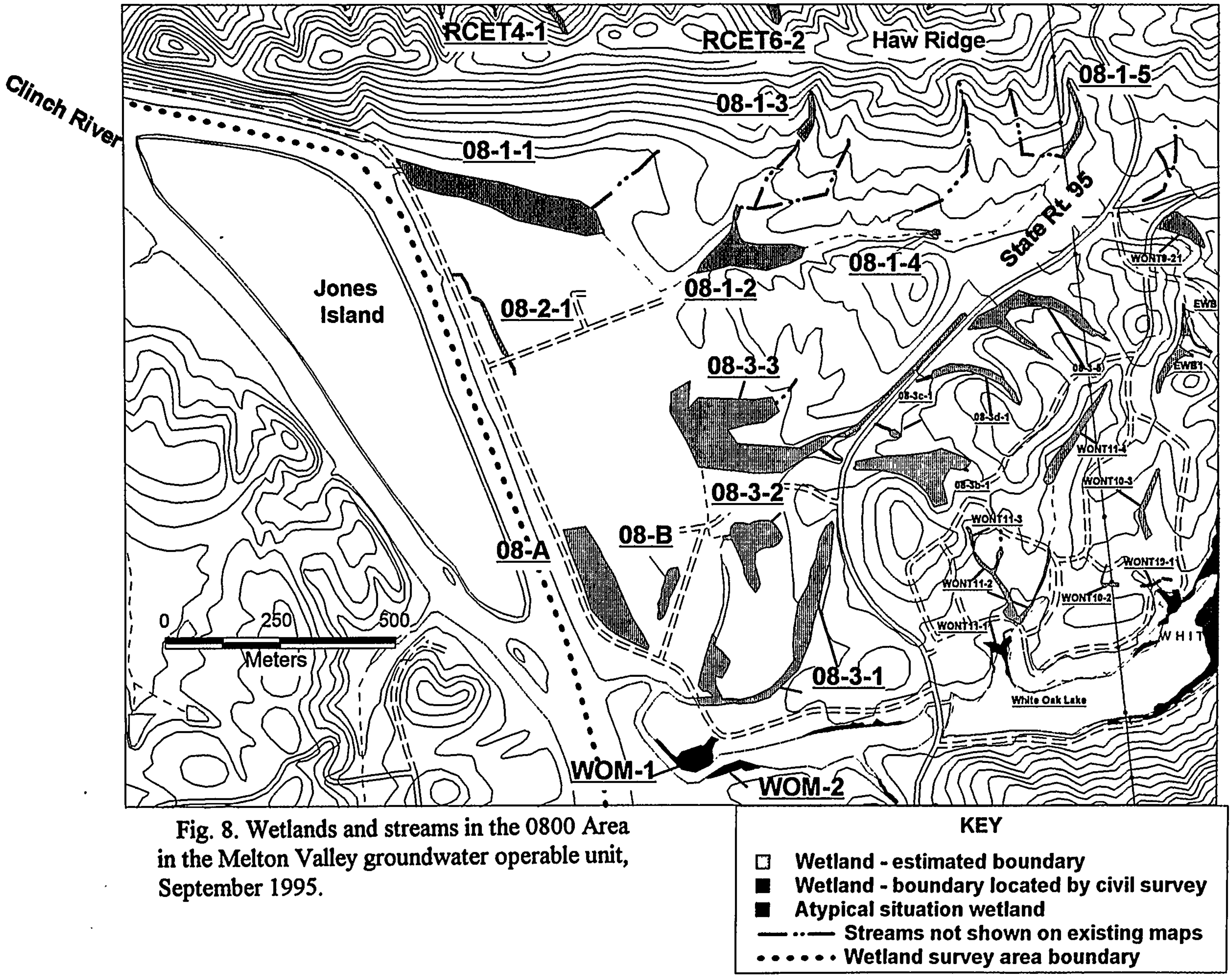

Fig. 8. Wetlands and streams in the 0800 Area in the Melton Valley groundwater operable unit, September 1995.

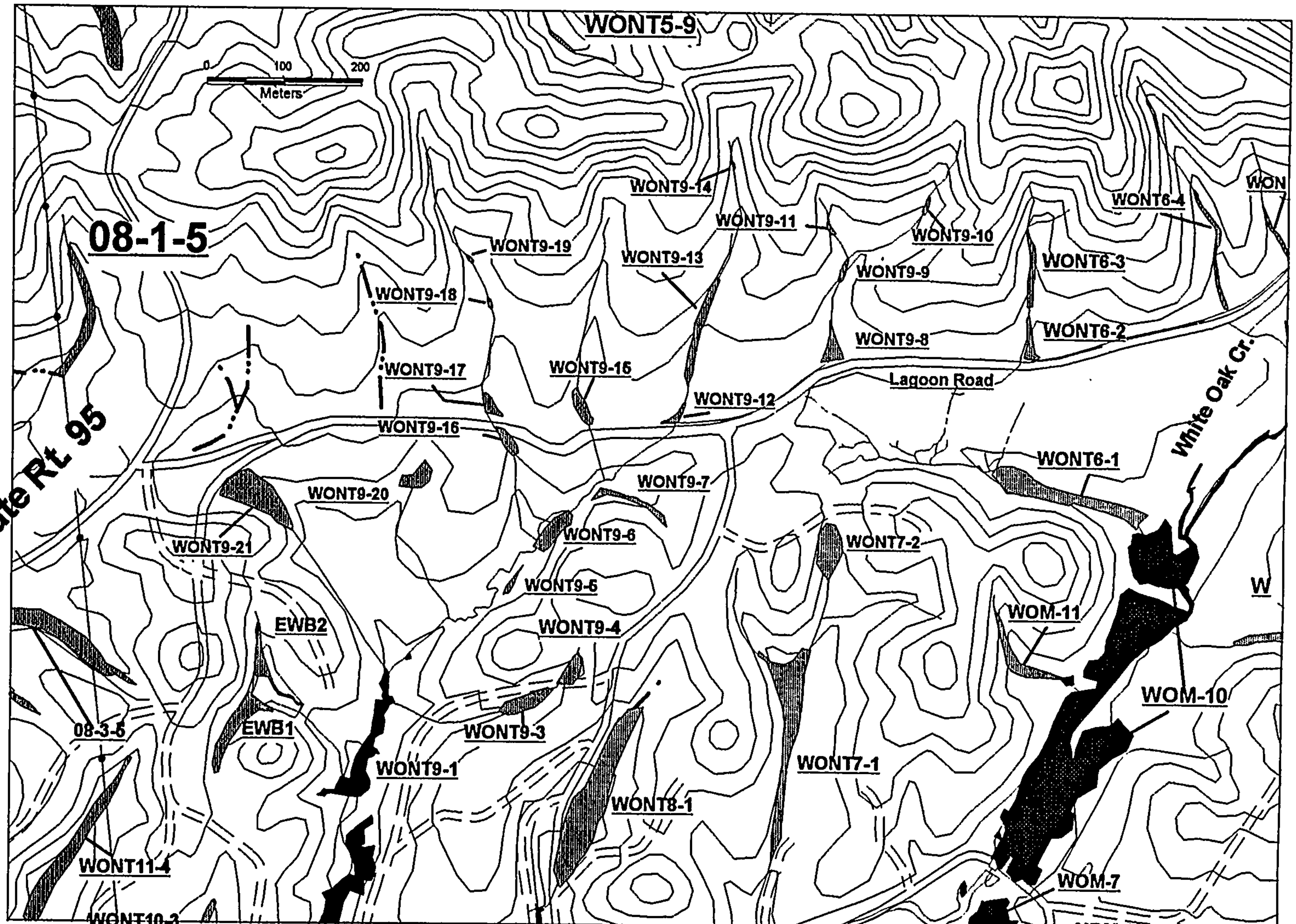

Fig. 9. Wetlands and streams in the Lagoon Road area in the Melton Valley groundwater operable unit, September 1995.

KEY

- Wetland - estimated boundary
- Wetland - boundary located by civil survey
- Streams not shown on existing maps
- Wetland survey area boundary

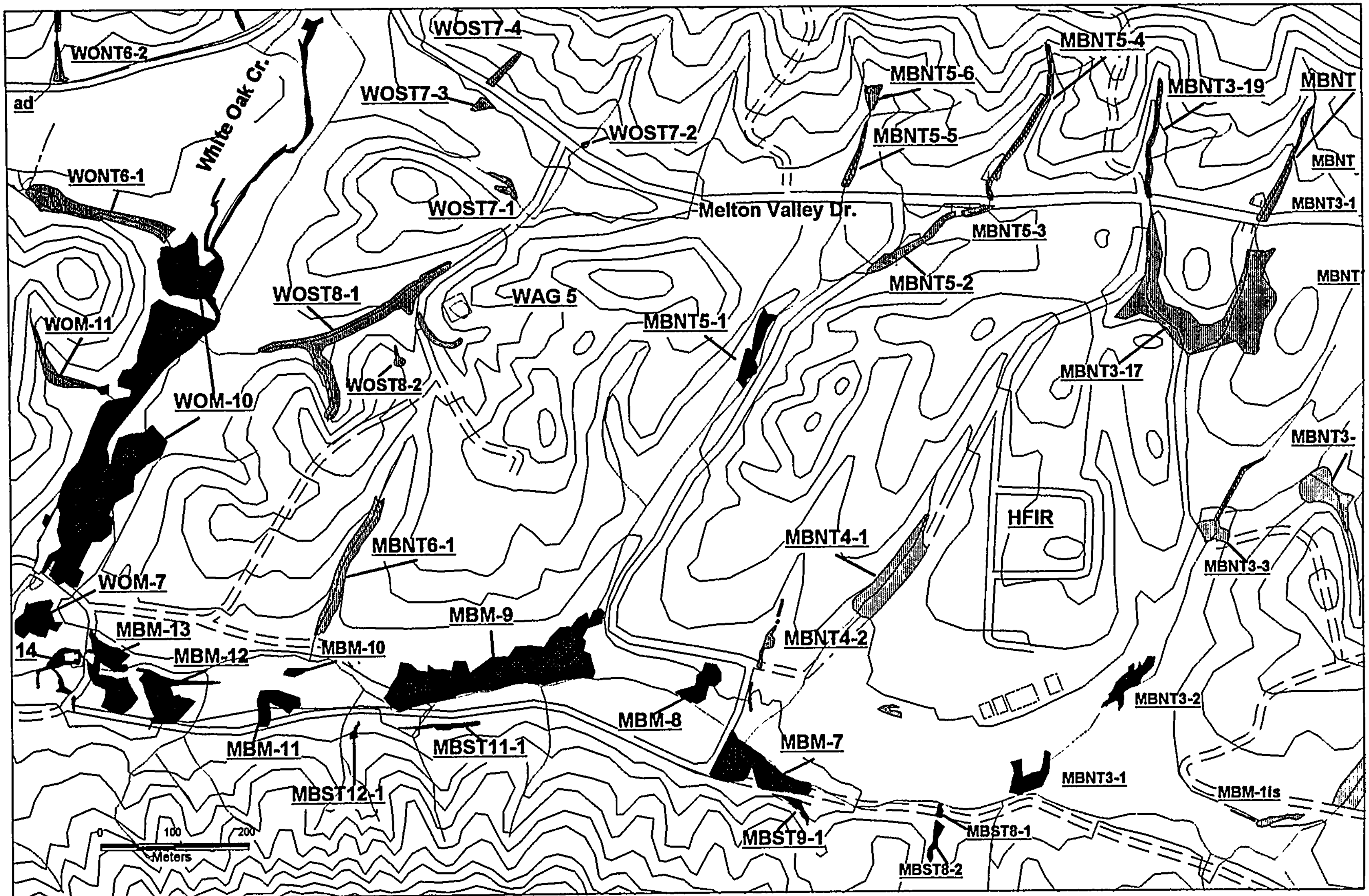

Fig. 10. Wetlands and streams in WAG 5, the HFIR area, portion of WAG 2, SWSA 7, and adjacent areas in the Melton Valley groundwater operable unit, September 1995.

KEY

- ▢ Wetland - estimated boundary
- ■ Wetland - boundary located by civil survey
- — ·· — Streams not shown on existing maps

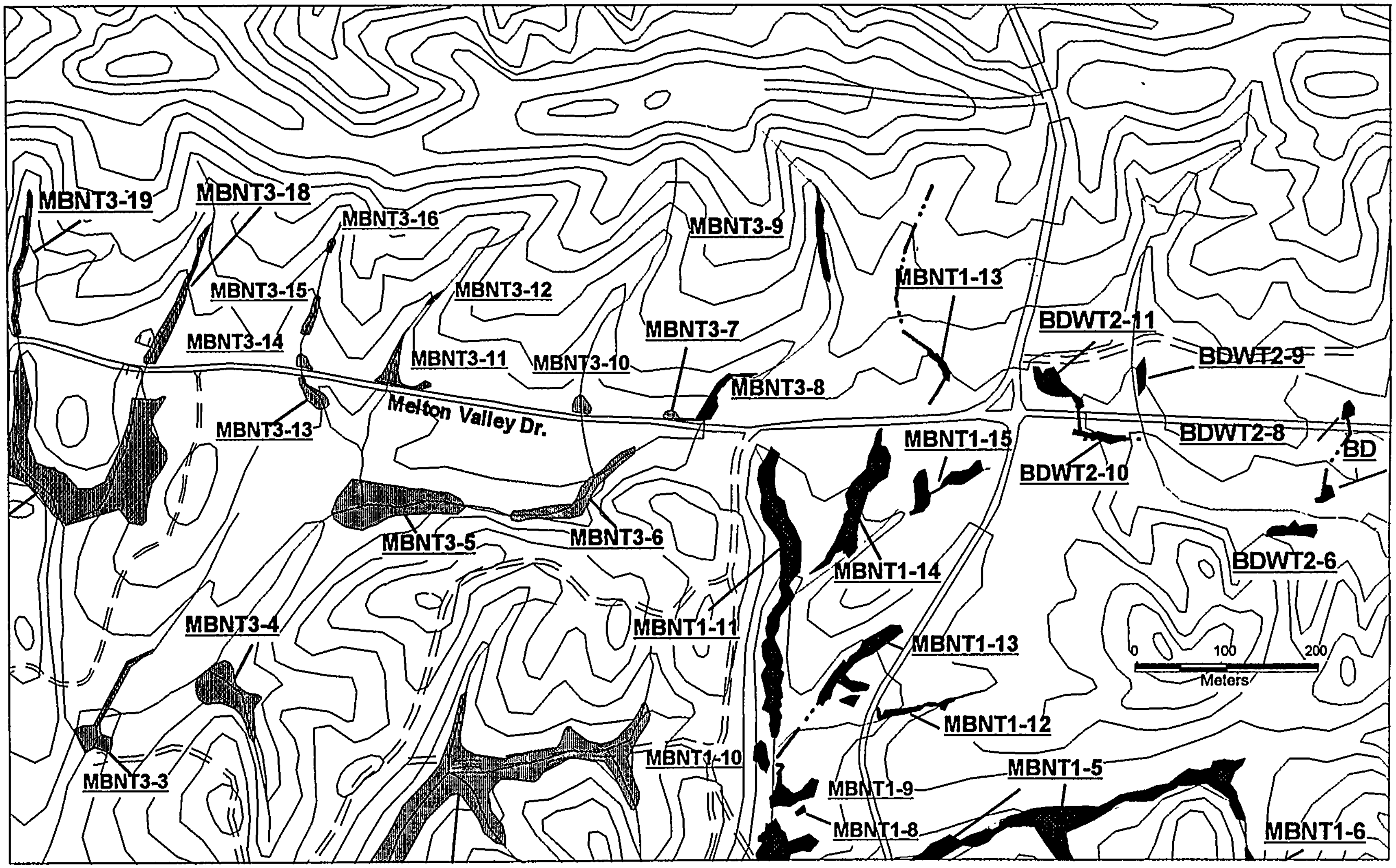

Fig. 11. Wetlands and streams in the northern portion of SWSA 7, a portion of the Bearden Creek watershed, and adjacent areas in the Melton Valley groundwater operable unit, September 1995.

KEY

- Wetland - estimated boundary
- Wetland - boundary located by civil survey
- Streams not shown on existing maps

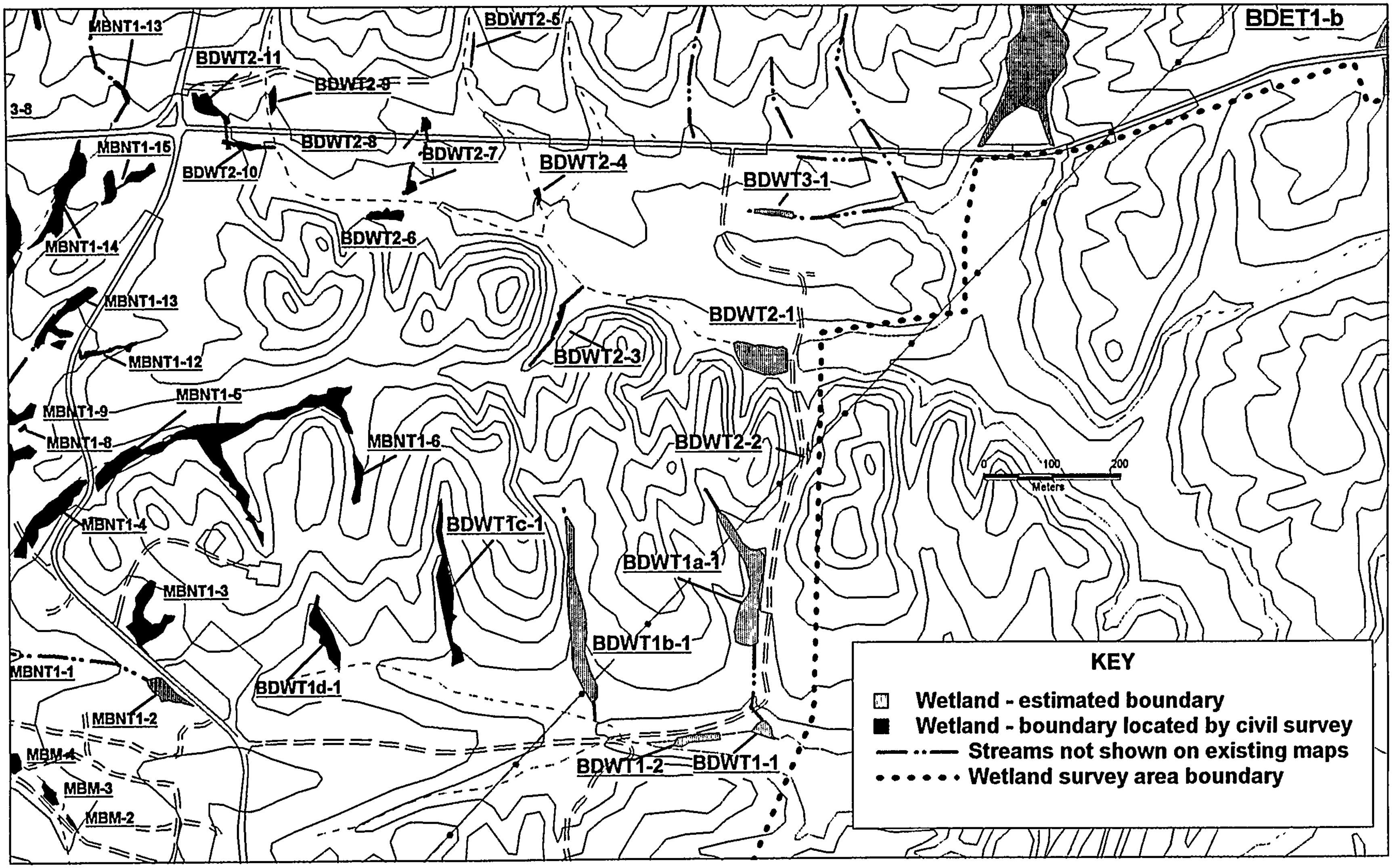

Fig. 12. Wetlands and streams in the lower Bearden Creek watershed and a portion of the upper Melton Branch watershed in the Melton Valley groundwater operable unit, September 1995.

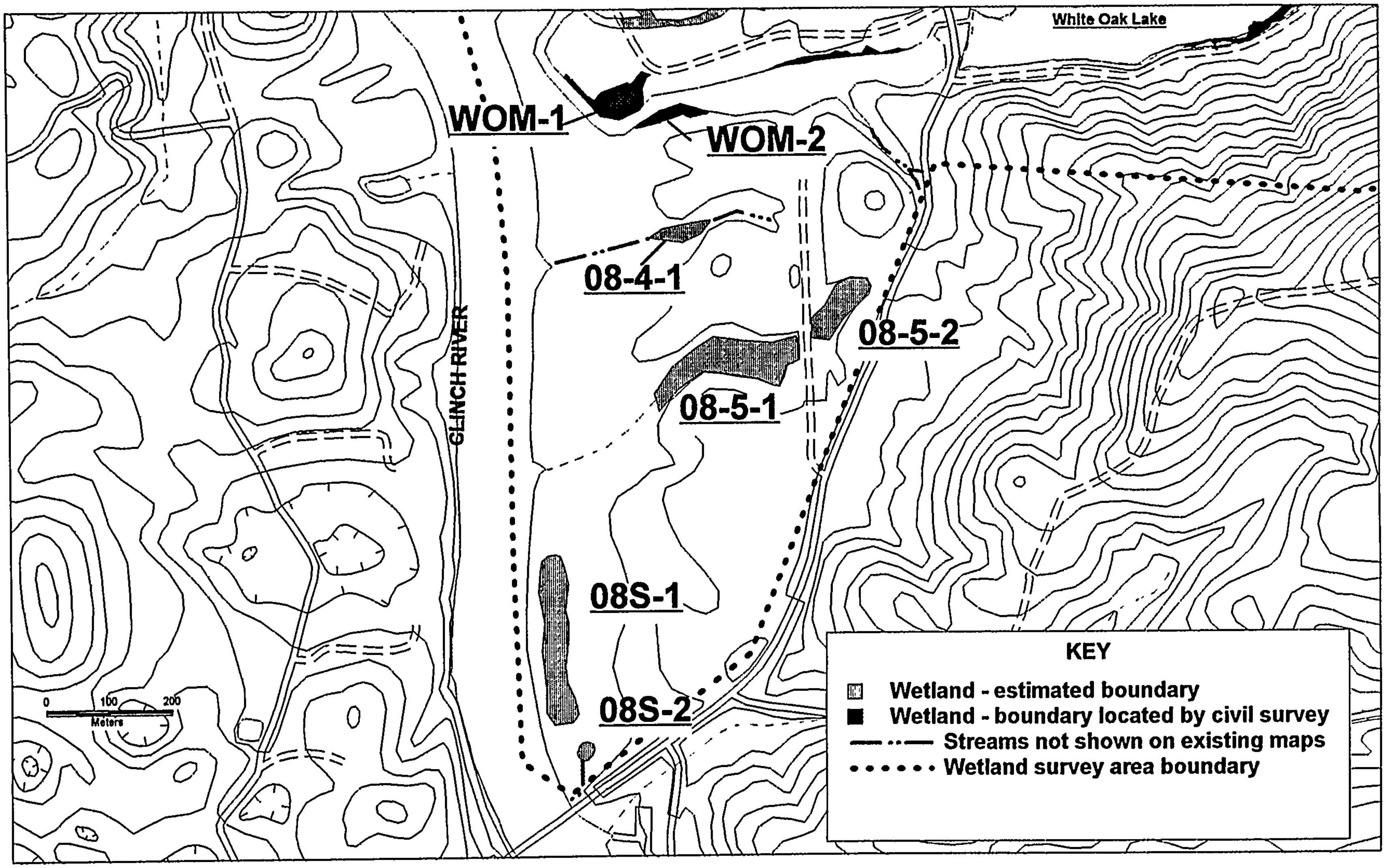

Fig. 13. Wetlands and streams in the area south of the White Oak Creek embayment in the Melton Valley groundwater operable unit, September 1995.

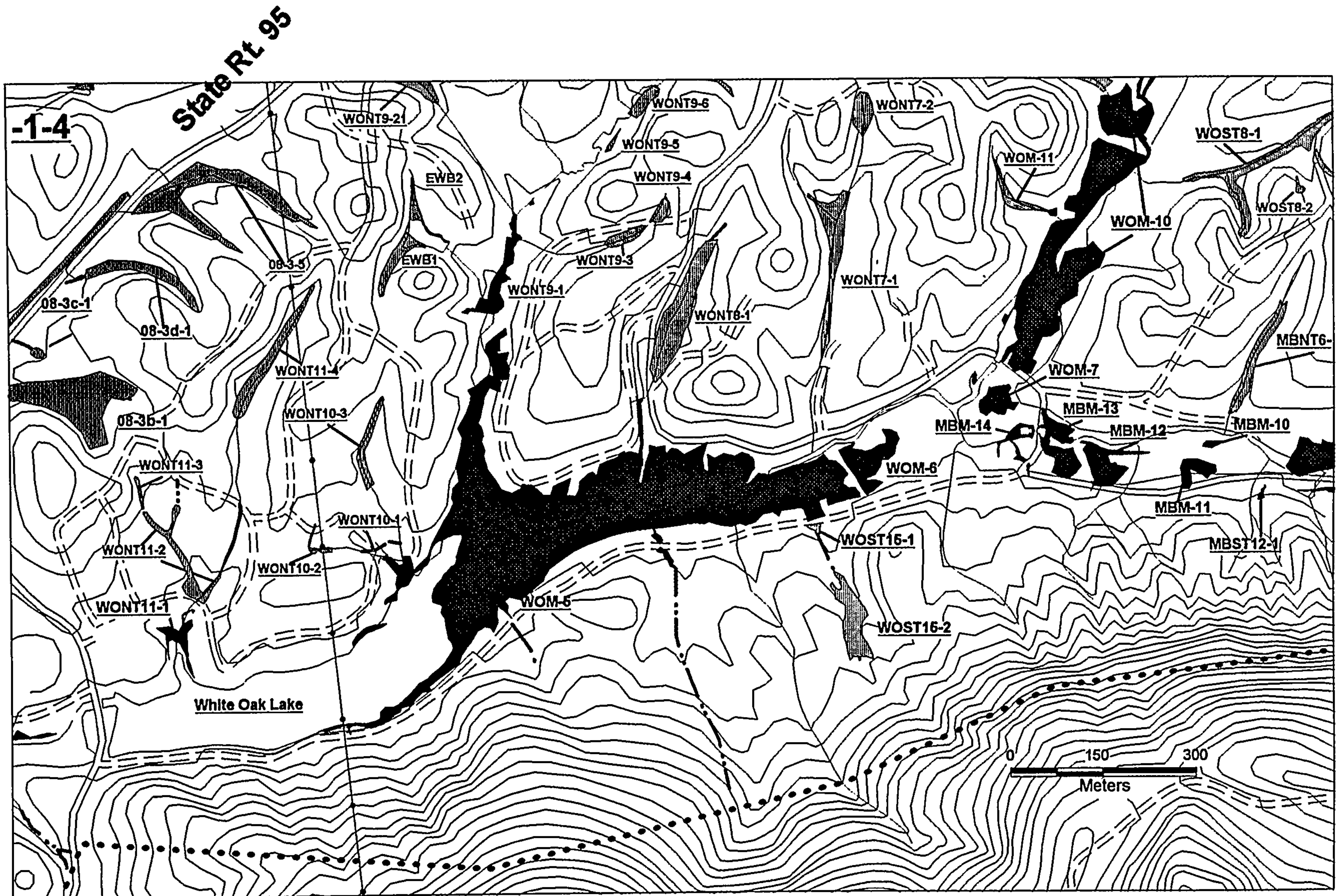

Fig. 14. Wetlands and streams in White Oak Lake, WAG 6, and adjacent areas in the Melton Valley groundwater operable unit, September 1995.

KEY

- Wetland - estimated boundary
- Wetland - boundary located by civil survey
- Streams not shown on existing maps
- Wetland survey area boundary

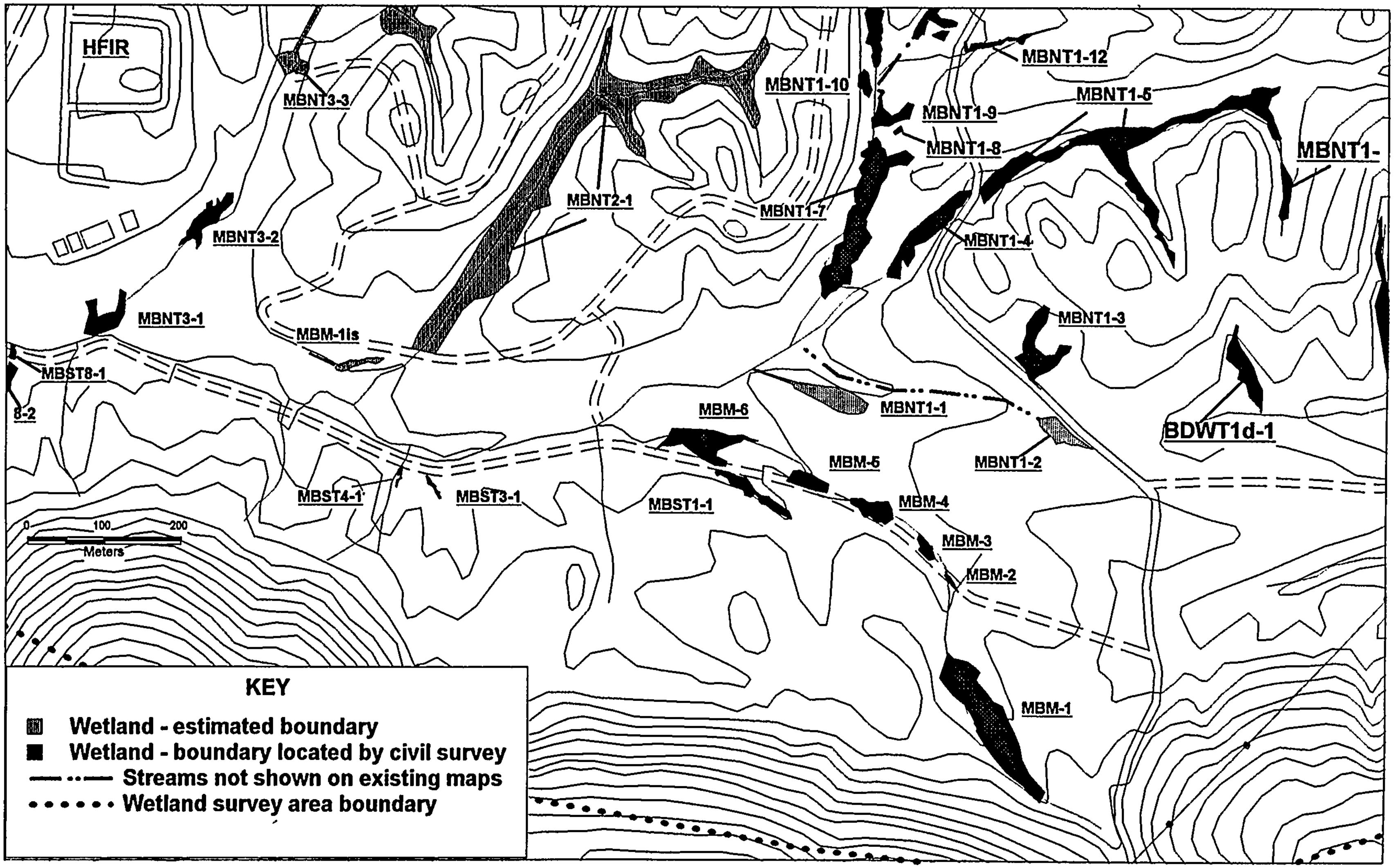

Fig. 15. Wetlands and streams in the southern portion of SWSA 7, upper Melton Branch, and adjacent areas in the Melton Valley groundwater operable unit, September 1995.

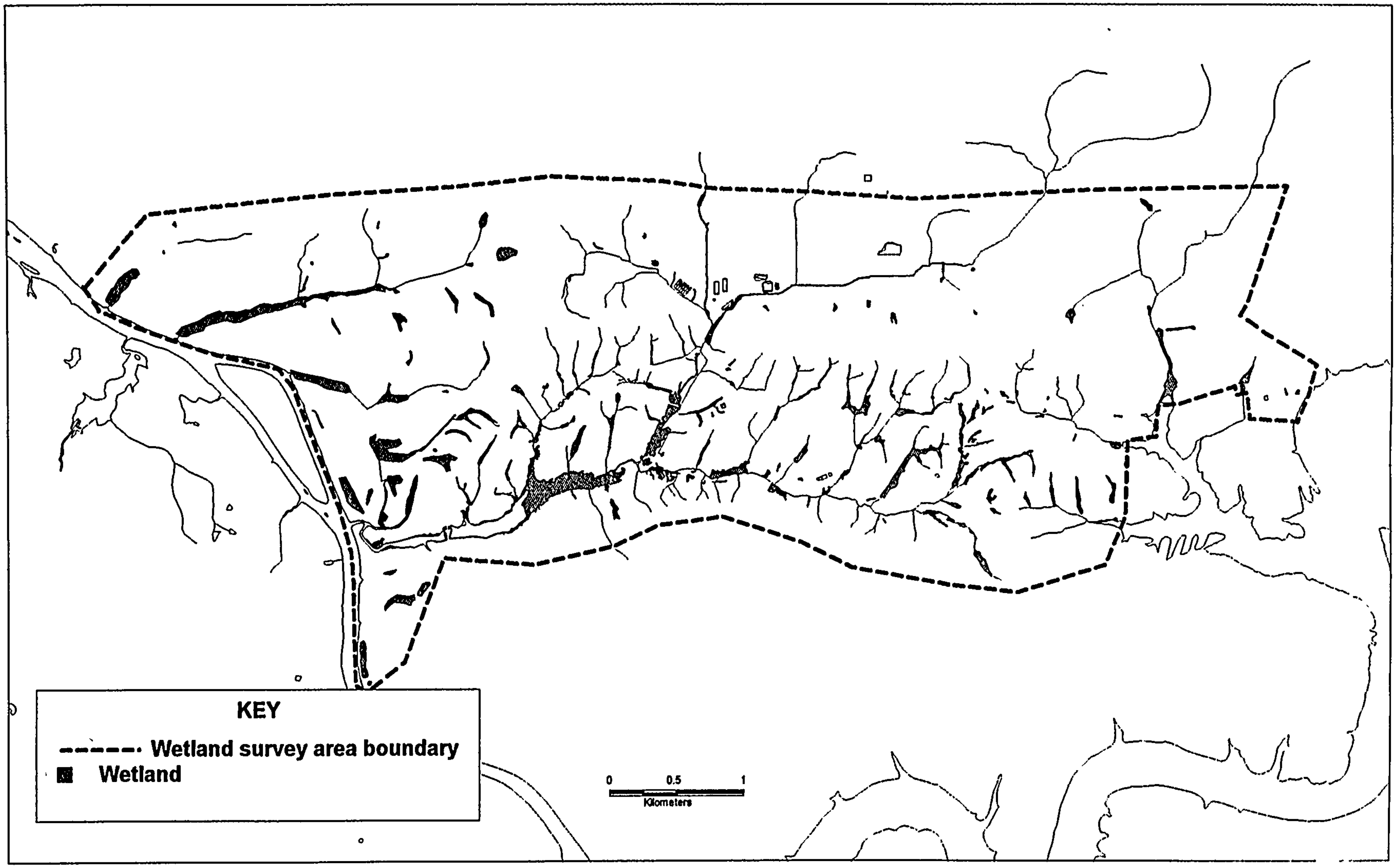

Fig. 16. Wetlands in the Bethel Valley and Melton Valley groundwater operable units, September 1995.

Table 2 presents data for each wetland ordered by watershed and, within each watershed, by size in hectares. Table 2 also includes the wetland classification (Cowardin et al. 1979) and the type of wetland boundary, which is either estimated or located by civil survey (pedigree).

Eighty-six percent (185) of the wetlands are less than ½ ha. Seventy-one percent (152) are less than 1/4 ha. Eleven wetland areas are between ½ and 1 ha. Ten wetland areas, six of which are in the 0800 and 0800 South areas (Figs. 5, 8, and 13), are between 1 and 2 ha. The other four wetland areas that are between 1 and 2 ha in size are WOM-12 (Fig. 5), RCET9-1 (Fig. 4), MBNT3-17 (Fig. 10), and MBM-9 (Fig. 10).

Five wetlands, four of which are river embayments, are between 2 and 2.5 ha. The four river embayment wetlands are BDM-1 (Fig. 7), RCM-1, ICM-1, and 08-1-1 (Fig. 4). The fifth wetland (MBNT2-1) is 2.35 ha in size and is located in the bottomland of a Melton Branch tributary stream (Fig. 15).

There are two wetlands that are approximately 3.3 ha each. Wetland 08-3-3 (Fig. 8) is a forested wetland that includes Reference Area 16 (Fig. 3). Wetland WOM-10 is a forested wetland in the White Oak Creek floodplain upstream of the X-14 weir (Fig. 10).

Two wetland areas are greater than 5 ha. RCM-2, the wetland/upland mosaic wetland in the Raccoon Creek floodplain, is 5.67 ha (Fig. 4). WOM-5, which includes the upper portion of White Oak Lake and the White Oak Creek floodplain is, at 9.97 ha, the largest single wetland area in the X-10 GWOU (Fig. 14). WOM-5 may have increased in size since the original survey in 1992 because beavers have constructed a dam across the upper portion of the lake. Field surveys of the White Oak Lake area to assess any changes in the wetland boundaries or characteristics were not conducted during the 1994-1995 X-10 GWOU survey.

Table 3 provides a synopsis of wetland numbers and size within each watershed. Ish Creek has the smallest number and area of wetlands in the X-10 GWOU area. However, only the lower portion of the watershed was investigated during this survey. Of those watersheds in which all or most of the watershed area was included in the survey area, Bearden Creek has the smallest area in wetlands (5.85 ha.). White Oak Creek watershed has the largest number (79) and the largest area (24 ha) of wetlands. Because Melton Branch is a White Oak Creek tributary, the total number and area of wetlands in the White Oak Creek watershed is actually 148 wetland areas and approximately 39.3 ha. About one-tenth of the total wetland area in the White Oak Creek watershed is in the White Oak Lake wetland (WOM-5).

The smaller (< 1 ha) wetland areas tend to occur in association with seeps and springs in the relatively undisturbed headwater tributary bottomlands. The largest wetlands occur in the river embayments and in White Oak Lake—areas which have had site hydrology altered by human activities. Among the largest wetlands are those that occur in the human-influenced aquatic environments of Clinch River embayments, White Oak Lake, and the White Oak Creek floodplain. They hydrology of these wetlands is strongly influenced by the presence of dams and road culverts and by the fluctuations in water levels caused by operation of Watts Bar and Melton Hill dams.

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class [a]	Boundary [b]
BEARDEN CREEK	BDWT2-2	0.008	PEM1d	ESTIMATED
BEARDEN CREEK	BDWT2-5	0.013	PEM1	PEDIGREE
BEARDEN CREEK	BDWT2-4	0.014	PEM1	PEDIGREE
BEARDEN CREEK	BDWT2-8	0.020	PSS1d	PEDIGREE
BEARDEN CREEK	BDWT2-7	0.023	PEM1	PEDIGREE
BEARDEN CREEK	BDWT2-3	0.026	PFO1	PEDIGREE
BEARDEN CREEK	BDWT2-9	0.030	PFO1	PEDIGREE
BEARDEN CREEK	BDWT2-10	0.041	PEM1d	PEDIGREE
BEARDEN CREEK	BDWT3-1	0.049	PEM1d	ESTIMATED
BEARDEN CREEK	BDWT1-1	0.051	PSS1	ESTIMATED
BEARDEN CREEK	BDWT2-6	0.062	PFO1	PEDIGREE
BEARDEN CREEK	BDWT1-2	0.075	PSS1	ESTIMATED
BEARDEN CREEK	BDM-2	0.087	PEM1	ESTIMATED
BEARDEN CREEK	BDWT2-11	0.097	PFO1	PEDIGREE
BEARDEN CREEK	BDET1-a	0.151	PSS1	ESTIMATED
BEARDEN CREEK	BDWT1d-1	0.169	PFO1	PEDIGREE
BEARDEN CREEK	BDET2-1	0.267	PFO1	ESTIMATED
BEARDEN CREEK	BDWT1c-1	0.271	PFO1	PEDIGREE
BEARDEN CREEK	BDWT2-1	0.292	PEM1	ESTIMATED
BEARDEN CREEK	BDWT5-1	0.318	PSS1; PFO1	ESTIMATED
BEARDEN CREEK	BDWT4a-1	0.380	PEM1	ESTIMATED
BEARDEN CREEK	BDWT1a-1	0.455	PFO1; PSS1d	ESTIMATED
BEARDEN CREEK	BDWT1b-1	0.464	PFO1; PSS1d	ESTIMATED
BEARDEN CREEK	BDET1-b	0.470	PFO1	ESTIMATED
BEARDEN CREEK	BDM-1	2.002	PFO1, PSS1	ESTIMATED
CLINCH RIVER	08-1-4	0.028	PEM1	ESTIMATED
CLINCH RIVER	08-3c-1	0.028	PFO1	ESTIMATED
CLINCH RIVER	7600-2	0.035	PEM1d	ESTIMATED
CLINCH RIVER	7600-1	0.057	PSS1	ESTIMATED
CLINCH RIVER	08S-2	0.062	PSS1	ESTIMATED
CLINCH RIVER	08-2-1	0.110	PSS1	ESTIMATED
CLINCH RIVER	08-1-3	0.154	PFO1	ESTIMATED
CLINCH RIVER	08-4-1	0.171	PSS1	ESTIMATED
CLINCH RIVER	08-1-5	0.179	PFO1; PSS1d	ESTIMATED
CLINCH RIVER	08-3-4	0.204	PFO1	ESTIMATED
CLINCH RIVER	08-B	0.238	PEM1d	ESTIMATED
CLINCH RIVER	08-3d-1	0.303	PFO1	ESTIMATED
CLINCH RIVER	08-5-2	0.454	PSS1	ESTIMATED
CLINCH RIVER	08-3-2	0.842	PEM1	ESTIMATED
CLINCH RIVER	08-3-5	0.918	PFO1; PSS1d	ESTIMATED
CLINCH RIVER	08S-1	1.049	PFO1	ESTIMATED

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class [a]	Boundary [b]
CLINCH RIVER	08-1-2	1.143	PFO1; PSS1; PEM1	ESTIMATED
CLINCH RIVER	08-5-1	1.148	PSS1; PEM1	ESTIMATED
CLINCH RIVER	08-3b-1	1.234	PFO1	ESTIMATED
CLINCH RIVER	08-A	1.706	PSS1	ESTIMATED
CLINCH RIVER	08-3-1	1.814	PFO1	ESTIMATED
CLINCH RIVER	08-1-1	2.487	PFO1;PSS1;PEM1	ESTIMATED
CLINCH RIVER	08-3-3	3.264	PFO1	ESTIMATED
ISH CREEK	ICM-2	0.011	PSS1	ESTIMATED
ISH CREEK	ICM-3	0.056	PSS1; PEM	ESTIMATED
ISH CREEK	ICM-1	2.436	PSS1; PEM1	ESTIMATED
MELTON BRANCH	MBNT1-8	0.007	PEM1	PEDIGREE
MELTON BRANCH	MBST4-1	0.007	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-12	0.008	PFO1	ESTIMATED
MELTON BRANCH	MBNT3-16	0.009	PFO1	ESTIMATED
MELTON BRANCH	MBM-2	0.010	PFO1	PEDIGREE
MELTON BRANCH	MBST8-1	0.011	PFO1	PEDIGREE
MELTON BRANCH	MBST12-1	0.012	PFO1	PEDIGREE
MELTON BRANCH	MBST3-1	0.012	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-7	0.016	PEM1d	ESTIMATED
MELTON BRANCH	MBNT3-14	0.018	PEM1d	ESTIMATED
MELTON BRANCH	MBNT1-16	0.024	PFO1	PEDIGREE
MELTON BRANCH	MBM-10	0.024	PEM1	PEDIGREE
MELTON BRANCH	MBIS-1	0.026	PEM1	ESTIMATED
MELTON BRANCH	MBNT3-10	0.030	PEM1d	ESTIMATED
MELTON BRANCH	MBNT5-3	0.035	PFO1	ESTIMATED
MELTON BRANCH	MBNT3-15	0.036	PFO1	ESTIMATED
MELTON BRANCH	MBNT4-2	0.036	PEM1d	ESTIMATED
MELTON BRANCH	MBST9-1	0.038	PFO1	PEDIGREE
MELTON BRANCH	MBM-3	0.039	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-10	0.039	PEM1	PEDIGREE
MELTON BRANCH	MBST8-2	0.040	PFO1	PEDIGREE
MELTON BRANCH	MBM-1IS	0.042	PEM1	ESTIMATED
MELTON BRANCH	MBST11-1	0.048	PSS1	PEDIGREE
MELTON BRANCH	MBNT1-12	0.049	PFO1	PEDIGREE
MELTON BRANCH	MBNT5-6	0.049	PEM1	ESTIMATED
MELTON BRANCH	MBNT3-13	0.052	PFO1	ESTIMATED
MELTON BRANCH	MBNT5-5	0.062	PFO1	ESTIMATED
MELTON BRANCH	MBNT3-8	0.064	PFO1, PEM1d	PEDIGREE
MELTON BRANCH	MBNT1-6	0.068	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-9	0.070	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-11	0.073	PEM1d; PFO1	ESTIMATED

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class[a]	Boundary[b]
MELTON BRANCH	MBM-5	0.086	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-9	0.097	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-19	0.097	PFO1	ESTIMATED
MELTON BRANCH	MBM-4	0.107	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-2	0.109	PEM1d	ESTIMATED
MELTON BRANCH	MBST1-1	0.111	PFO1	PEDIGREE
MELTON BRANCH	MBM-14	0.117	PSS1d	PEDIGREE
MELTON BRANCH	MBNT1-15	0.122	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-18	0.138	PFO1; PEM1d	ESTIMATED
MELTON BRANCH	MBNT3-2	0.140	PFO1d	PEDIGREE
MELTON BRANCH	MBNT3-3	0.140	PFO1	ESTIMATED
MELTON BRANCH	MBNT5-2	0.144	PFO1	ESTIMATED
MELTON BRANCH	MBNT3-1	0.146	PFO1, PEM1d	PEDIGREE
MELTON BRANCH	MBM-8	0.147	PFO1	PEDIGREE
MELTON BRANCH	MBM-11	0.151	PFO1	PEDIGREE
MELTON BRANCH	MBNT5-1	0.159	PFO1, PEM1d	PEDIGREE
MELTON BRANCH	MBNT5-4	0.160	PFO1	ESTIMATED
MELTON BRANCH	MBNT3-6	0.195	PFO1	ESTIMATED
MELTON BRANCH	MBNT1-13	0.199	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-1	0.213	PFO1d	ESTIMATED
MELTON BRANCH	MBNT1-3	0.246	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-4	0.260	PFO1, PEM1	ESTIMATED
MELTON BRANCH	MBM-6	0.264	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-4	0.280	PFO1	PEDIGREE
MELTON BRANCH	MBNT6-1	0.288	PFO1	ESTIMATED
MELTON BRANCH	MBNT1-14	0.292	PFO1	PEDIGREE
MELTON BRANCH	MBM-12	0.319	PFO1	PEDIGREE
MELTON BRANCH	MBM-13	0.377	PFO1, PSS1d	PEDIGREE
MELTON BRANCH	MBNT4-1	0.436	PFO1	ESTIMATED
MELTON BRANCH	MBM-7	0.458	PFO1, PEM1d	PEDIGREE
MELTON BRANCH	MBNT3-5	0.486	PFO1	ESTIMATED
MELTON BRANCH	MBNT1-11	0.565	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-7	0.651	PFO1, PEMd	PEDIGREE
MELTON BRANCH	MBM-1	0.696	PFO1	PEDIGREE
MELTON BRANCH	MBNT1-5	0.908	PFO1	PEDIGREE
MELTON BRANCH	MBNT3-17	1.234	PFO1	ESTIMATED
MELTON BRANCH	MBM-9	1.372	PFO1, PSS1	PEDIGREE
MELTON BRANCH	MBNT2-1	2.357	PFO1	ESTIMATED
RACCOON CREEK	RCWT1-2	0.019	PSS1	ESTIMATED
RACCOON CREEK	RCWT2-2	0.042	PEM1	ESTIMATED
RACCOON CREEK	RCWT2-3	0.042	PEM1	ESTIMATED

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class[a]	Boundary[b]
RACCOON CREEK	RCWT2-1	0.071	PSS1	ESTIMATED
RACCOON CREEK	RCM-4	0.077	PEM1d	ESTIMATED
RACCOON CREEK	RCM-3	0.126	PFO1; PEM	ESTIMATED
RACCOON CREEK	RCWT1-1	0.130	PSS1	ESTIMATED
RACCOON CREEK	RCET4-1	0.150	PSS1; PEM	ESTIMATED
RACCOON CREEK	RCET6-2	0.278	PFO1; ATYPICAL	ESTIMATED
RACCOON CREEK	RCET6-2	0.291	PFO1	ESTIMATED
RACCOON CREEK	RCET7-1	0.393	PSS1; PEM1	ESTIMATED
RACCOON CREEK	RCWT4-1	0.428	PEM1	ESTIMATED
RACCOON CREEK	RCET8-1	0.515	PFO1; PEM1d	ESTIMATED
RACCOON CREEK	RCET9-1	1.040	PFO1; ATYPICAL	ESTIMATED
RACCOON CREEK	RCM-1	2.204	PEM1; PSS1	ESTIMATED
RACCOON CREEK	RCM-2	5.671	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-14	0.002	PEM1	ESTIMATED
WHITE OAK CREEK	WONT9-2	0.003	PSS1	PEDIGREE
WHITE OAK CREEK	WONT9-19	0.005	PEM1	ESTIMATED
WHITE OAK CREEK	WONT4-1	0.006	PSS1d	ESTIMATED
WHITE OAK CREEK	WOST7-2	0.006	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-18	0.006	PEM1	ESTIMATED
WHITE OAK CREEK	WONT9-11	0.008	PFO1	ESTIMATED
WHITE OAK CREEK	WONT10-1	0.008	PEM1d; ATYPICAL	ESTIMATED
WHITE OAK CREEK	WOM-9	0.010	PEM1d	PEDIGREE
WHITE OAK CREEK	WONT9-10	0.011	PEM1	ESTIMATED
WHITE OAK CREEK	WONT9-9	0.016	PFO1	ESTIMATED
WHITE OAK CREEK	WOST12-1	0.017	PFO1	PEDIGREE
WHITE OAK CREEK	WONT9-5	0.017	PFO1	ESTIMATED
WHITE OAK CREEK	WOST8-2	0.019	PFO1	ESTIMATED
WHITE OAK CREEK	WONT5-9	0.019	PFO1	ESTIMATED
WHITE OAK CREEK	WOST15-1	0.023	PEM1	ESTIMATED
WHITE OAK CREEK	WONT9-12	0.023	PSS1	ESTIMATED
WHITE OAK CREEK	WONT11-3	0.023	PEM1	ESTIMATED
WHITE OAK CREEK	WOST12-2	0.029	PFO1	PEDIGREE
WHITE OAK CREEK	WOST2-3	0.031	PFO1	ESTIMATED
WHITE OAK CREEK	WONT5-4	0.032	PSS1d	ESTIMATED
WHITE OAK CREEK	WOST7-3	0.032	PEM1d	ESTIMATED
WHITE OAK CREEK	WONT10-2	0.033	PEM1d	ESTIMATED
WHITE OAK CREEK	WONT5.1-1	0.033	PFO1	ESTIMATED
WHITE OAK CREEK	WOST1-1	0.038	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-17	0.038	PFO1	ESTIMATED
WHITE OAK CREEK	WOM-4	0.042	PEM1, PSS1	PEDIGREE
WHITE OAK CREEK	WONT5-3	0.043	PSS1d	ESTIMATED

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class[a]	Boundary[b]
WHITE OAK CREEK	WONT5-6	0.044	PSS1	ESTIMATED
WHITE OAK CREEK	WOST4-1	0.045	PFO1	ESTIMATED
WHITE OAK CREEK	WONT6-2	0.045	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-16	0.046	PFO1	ESTIMATED
WHITE OAK CREEK	WOST6-1	0.046	PEM1d	ESTIMATED
WHITE OAK CREEK	WOST2-2	0.047	PEM1	ESTIMATED
WHITE OAK CREEK	WOST7-1	0.048	PFO1	ESTIMATED
WHITE OAK CREEK	WOST7-4	0.051	PFO1	ESTIMATED
WHITE OAK CREEK	WOST2-1	0.054	PSS1d, PEM1d	ESTIMATED
WHITE OAK CREEK	WOST8-3	0.056	PSS1	ESTIMATED
WHITE OAK CREEK	WONT9-15	0.059	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-7	0.062	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-8	0.063	PFO1	ESTIMATED
WHITE OAK CREEK	WONT6-3	0.063	PFO1	ESTIMATED
WHITE OAK CREEK	WOM-7	0.067	PFO1	PEDIGREE
WHITE OAK CREEK	WONT9-4	0.067	PSS1	ESTIMATED
WHITE OAK CREEK	WONT5-7I	0.068	PFO1	ESTIMATED
WHITE OAK CREEK	WONT6-4	0.070	PFO1	ESTIMATED
WHITE OAK CREEK	WOST5-1	0.075	PEM1	ESTIMATED
WHITE OAK CREEK	WONT9-20	0.081	PFO1d	ESTIMATED
WHITE OAK CREEK	WONT9/EWB	0.085	PSS1, PEM1	ESTIMATED
WHITE OAK CREEK	WONT5-8	0.095	PEM1d	ESTIMATED
WHITE OAK CREEK	WONT9-6	0.106	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-3	0.108	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9-13	0.125	PFO1	ESTIMATED
WHITE OAK CREEK	WOM-3	0.132	PSS1	PEDIGREE
WHITE OAK CREEK	WONT5-5	0.136	PFO1	ESTIMATED
WHITE OAK CREEK	WONT11-1	0.143	PEM1, PSS1	PEDIGREE
WHITE OAK CREEK	WOM-11	0.144	PFO1	ESTIMATED
WHITE OAK CREEK	WOM-2	0.157	PSS1	PEDIGREE
WHITE OAK CREEK	WOST4-2	0.163	PFO1	ESTIMATED
WHITE OAK CREEK	WONT7-2	0.167	PFO1	ESTIMATED
WHITE OAK CREEK	WONT10-3	0.174	PFO1	ESTIMATED
WHITE OAK CREEK	WONT9/EWB	0.183	PFO1	ESTIMATED
WHITE OAK CREEK	WONT5-2	0.244	PSS1	ESTIMATED
WHITE OAK CREEK	WONT9-1	0.304	PFO1	PEDIGREE
WHITE OAK CREEK	WONT11-2	0.311	PFO1, PSS1, PEM1d	ESTIMATED
WHITE OAK CREEK	WONT9-21	0.314	PFO1	ESTIMATED
WHITE OAK CREEK	WONT11-4	0.366	PFO1	ESTIMATED
WHITE OAK CREEK	WONT6-1	0.375	PFO1	ESTIMATED
WHITE OAK CREEK	WOST15-2	0.400	PEM1d	ESTIMATED

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

Table 2. Selected data for wetlands in the Bethel Valley and Melton Valley groundwater operable units ordered by watershed and size, September 1995.

Watershed	Wetland ID	Area (Ha)	Wetland Class[a]	Boundary[b]
WHITE OAK CREEK	WOM-1	0.408	PSS1d	PEDIGREE
WHITE OAK CREEK	WOM-6	0.413	PFO1	PEDIGREE
WHITE OAK CREEK	WONT7-1	0.479	PFO1	ESTIMATED
WHITE OAK CREEK	WONT5-1	0.514	PEM1d	ESTIMATED
WHITE OAK CREEK	WOST8-1	0.575	PFO1, PEM1d	ESTIMATED
WHITE OAK CREEK	WOM-13	0.610	PEM1d	ESTIMATED
WHITE OAK CREEK	WONT8-1	0.731	PFO1, PEM1d	ESTIMATED
WHITE OAK CREEK	WOM-12	1.021	PEM1d, PSS1d	ESTIMATED
WHITE OAK CREEK	WOM-10	3.293	PFO1, PFO1d,	PEDIGREE
WHITE OAK CREEK	WOM-5	9.970	PEM1, PSS1, PFO1	PEDIGREE

[a] PEM1, PSS1, and PFO1 classifications are from Cowardin et al. (1979). The "d" designation is not a Cowardin modifier, but is used in this report to refer to those wetlands that receive some type of routine disturbance (most often mowing).

[b] Estimated - wetland boundary is estimated; Pedigree - wetland boundary is located by civil survey

3.4.2 Characteristics of the Wetlands in the X-10 GWOU Survey Area

3.4.2.1 Hydrology

Direct and indirect evidence for the presence of wetland hydrology in the wetlands includes inundation (e.g.., embayment wetlands, some forested wetlands in the 0800 and 0800 South area, White Oak Lake), saturation to or within 24.7 cm (10 in.) of the surface, drift lines, scoured soils, surface drainage patterns, and water-stained and silted leaf litter.

Table 3. Values for the wetland areas in watersheds in the Bethel Valley and Melton Valley groundwater operable units

Watershed*	Total number of wetlands	Total hectares	Minimum (ha)	Maximum (ha)	Average (ha)
Bearden	25	5.835	0.008	2.002	0.233
Clinch	23	17.628	0.028	3.264	0.766
Ish Creek	3	2.503	0.011	2.436	0.834
Melton	69	15.321	0.007	2.357	0.222
Raccoon	16	11.477	0.019	5.671	0.717
White Oak	79	23.976	0.002	9.970	0.303

*All of the wetlands on the Oak Ridge Reservation are in the Clinch River drainage. In this analysis, the Clinch River watershed heading is primarily an estimate for wetlands in the 0800 and 0800 South area, although it includes two small wetlands in the 7600 area.

The wetlands are predominantly "flow-through" hydrologic systems in which the source of water is primarily groundwater discharge (from seeps and springs), and the direction of water flow is through the wetland toward the stream or out of the site through subsurface lateral flow parallel to the stream. In the survey area, wetlands in headwater tributary catchments and in some mainstem riparian areas are flow-through systems. These wetlands have become established at springs, seeps, and in areas with a seasonal high water table.

The exceptions to the dominance of flow-through system hydrology are those wetlands found in the Raccoon and Lower Ish Creek embayments and parts of the floodplains of the main streams that may be described as flood-dominated systems. In flood-dominated wetland systems, a primary water input is stream or river overbank flooding. Water flow through the wetland can be both toward the stream and from the stream. The embayment wetland hydrology is driven primarily by the fluctuating river levels of Watts Bar Lake, which results in inundation of embayment areas throughout the growing season. Stream overbank flooding occurs occasionally in some areas of the Raccoon Creek, Ish Creek, Melton Branch, and White Oak Creek bottomlands as evidenced by the presence of hydrologic indicators such as drift lines, shallow surface channels, and absence of a litter layer.

3.4.2.2 Wetland vegetation

The dominant species identified in the wetlands in the X-10 GWOU survey area are listed in Table 4. This table represents a partial list of the dominant or commonly-occurring species and is not a complete flora of the wetlands.

The most recent update of the flora of the Oak Ridge Reservation lists 1,072 species of vascular plants. Approximately 22% of these species occur in wetland habitats, and many of them probably occur in the GWOU wetlands. However, for several reasons, including project time constraints and the time of year in which some of the areas were surveyed (e.g., fall, winter, early spring), not all of the species could be identified.

Vegetation species that are common in the embayment wetlands include sycamore, buttonbush, smooth alder, sedges, water pepper, rice cutgrass, bugleweed, creeping jennie, cattail, and microstegium. The dominant vegetation in the forested wetlands includes red maple, sweetgum, sycamore, green ash, slippery elm, ironwood, silky dogwood, spicebush, microstegium, sedges, woodreed, false nettle, poison ivy, hog peanut, Virginia knotweed, dotted smartweed, and cardinal flower. Common species in the scrub–shrub wetlands include silky dogwood, buttonbush, false indigobush, smooth alder, and saplings of black willow, sweetgum, red maple, and green ash. Herbaceous species in the scrub-scrub wetlands include jewelweed, false nettle, agrimony, Japanese honeysuckle, rice cutgrass, bugleweed, and microstegium.

Most of the PEM1 wetlands occur in utility and road rights-of-way and in some formerly cleared, but recently undisturbed, areas. The dominant species in these wetlands include sedges, rice cutgrass, monkeyflower, bugleweed, seedbox, jewelweed, sweetflag, rushes, cattail, hog peanut, and slender St. John's wort.

3.4.2.3 Wetland Soils

The soils in the X-10 GWOU wetlands are mineral hydric soils characterized by low chroma colors [chroma 1 or 2 as determined using Munsell soil color charts (1991)], and mottles. The most commonly encountered soil colors were: 10YR 2/1 (black); 10YR 3/1 (very dark gray); 10YR 4/1 (dark gray); 10YR 5/1 (gray); 10YR 6/1 (gray); 10YR 7/1 (light gray); 10YR 3/2 (very dark grayish brown); 10YR 4/2 (dark grayish brown); 10YR 5/2 (grayish brown); and 10YR 6/2 (light brownish gray). A 2/5Y 6/2 (light brownish gray) silty loam occurs in one location, underlying a very sandy layer in the 08-3-1 wetland in the area upstream of a low, breached dam. Soil gleization had occurred in a few of the wetlands resulting in gray (N 6/; N 5/; N 4/) and greenish-gray (5GY 5/1) colors.

There is a range of soil textures that includes silt, clay, silt loam, clay loam, silty clay loam, sandy loam, sandy silt loam, and very sandy silt loam. In some areas of colluvial and eroded soils, there is a high proportion of shale fragments, gravel, and other rock fragments in the soil profile.

In several of the wetlands there is an abundance of fine roots and fibrous and partially decomposed organic material (i.e., leaves, twigs) on the surface of the soil or throughout the top 10-12 inches of the soil profile. The accumulation of organic material indicates a lack of available oxygen for decomposition processes presumably as a result of constant or nearly constant inundation or saturation. A few of the wetlands that have this characteristic are: 08-1-1 (a river embayment), 08-1-3 (a headwater riparian area), 08-5-1 and the adjacent 08-5-2 (actually one wetland that has been bisected by a road); RCM-1 (Raccoon Creek embayment), ICM-1 (Ish Creek embayment), and MBNT3-11 (a sweetflag-dominated wetland in a road and utility line right-of-way adjacent to Melton Valley Drive).

Table 4. List of the plant species, with wetland indicator classifications (Reed 1988), identified in wetlands in the Bethel Valley and Melton Valley groundwater operable units (October 1994–September 1995)

Common Name	Scientific Name	Regional Indicator*
Trees		
American elm	*Ulmus americanus*	FACW
Black willow	*Salix nigra*	OBL
Box elder	*Acer negundo*	FACW
Green ash	*Fraxinus pennsylvanica*	FACW
Hackberry	*Celtis occidentalis*	FACU
Ironwood	*Carpinus caroliniana*	FAC
Loblolly pine	*Pinus taeda*	FAC
Pawpaw	*Asimina triloba*	FAC
Red maple	*Acer rubrum*	FAC
Slippery elm	*Ulmus rubra*	FAC
Swamp white oak	*Quercus bicolor*	FACW+
Sweetgum	*Liquidambar styriciflua*	FAC
Sycamore	*Platanus occidentalis*	FACW-
Tulip poplar	*Liriodendron tulipifera*	FAC
Shrubs		
Bushy St. John's-wort	*Hypericum desniflorum*	FACW-
Buttonbush	*Cephalanthus occidentalis*	OBL
Elderberry	*Sambucus canadensis*	FACW-
Flowering dogwood	*Cornus florida*	FACU
Privet	*Ligustrum vulgare*	not listed
Silky dogwood	*Cornus amomum*	FACW+
Smooth alder	*Alnus serrulata*	FACW+
Spicebush	*Lindera benzoin*	FACW
Indigobush	*Amorpha fruticosa*	FACW
Stiff dogwood	*Cornus foemina*	FACW-
Swamp rose	*Rosa palustris*	OBL
Vines		
Crossvine	*Bignonia capreolata*	FAC
Greenbriar	*Smilax* sp.	species-dependent
Hog peanut	*Amphicarpaea bracteata*	FAC
Japanese honeysuckle	*Lonicera japonica*	FAC-
Poison ivy	*Toxicodendron radicans*	FAC
Trumpet vine	*Campsis radicans*	FAC
Virginia creeper	*Parthenocissus quinquefolia*	FAC
Ferns		
Christmas fern	*Polystichum acrostichoides*	FAC
Sensitive fern	*Onoclea sensibilis*	FACW
Grasses		
Fowl manna grass	*Glyceria striata*	OBL
Giant cane	*Arundinaria gigantea*	FACW
Microstegium	*Eulalia viminea*	FAC+
Rice cutgrass	*Leersia oryzoides*	OBL
Panic grass	*Dicanthelium* sp.	species-dependent

Table 4 (continued)

Common Name	Scientific Name	Regional Indicator*
Grasses (continued)		
Wood reedgrass	*Cinna arundinaceae*	FACW
Virginia Wild Rye	*Elymus virginicus*	FAC
Sedges and rushes		
Flatsedge	*Cyperus sp.*	OBL or FACW
Fox sedge	*Carex vulpinoidea*	OBL
Frank's sedge	*Carex frankii*	OBL
Fringed sedge	*Carex crinita*	OBL
Green bulrush	*Scirpus atrovirens*	OBL
Leafy bulrush	*Scirpus polyphyllus*	OBL
Leathery rush	*Juncus coriaceous*	FACW
Sallow sedge	*Carex lurida*	OBL
Sedges	*Carex spp.*	species-dependent
Sedges	*Scirpus spp.*	species-dependent
Soft rush	*Juncus effusus*	FACW+
Soft-stem bullrush	*Scirpus validus*	OBL
Spikerush	*Eleocharis sp.*	species-dependent
Squarrose sedge	*Carex squarrosa*	OBL
Woolgrass	*Scirpus cyperinus*	OBL
Herbaceous		
Bedstraw	*Galium* sp.	species-dependent
Blue skullcap	*Scutellaria lateriflora*	FACW-
Boneset	*Eupatorium perfoliatum*	FACW+
Bugleweed	*Lycopus virginicus*	OBL
Cardinal flower	*Lobelia cardinalis*	OBL
Cattail	*Typha latifolia*	OBL
Clearweed	*Pilea pumila*	FACW
Closed gentian	*Gentiana clausa*	FAC
Creeping jennie	*Lysimachia nummularia*	FACW+
Curly dock	*Rumex crispus*	FAC
Dotted smartweed	*Polygonum punctatum*	FACW+
Water pepper	*Polygonum hydropiperoides*	OBL
Arrow leaved tearthumb	*Polygonum sagittaria*	OBL
False nettle	*Boehmeria cylindrica*	FACW+
Great lobelia	*Lobelia siphilitica*	OBL
Iris	*Iris* sp.	OBL
Ironweed	*Vernonia noveboracensis*	FAC+
Jewelweed	*Impatiens capensis*	FACW
Lizard's tail	*Saururus cernuus*	OBL
Morning glory	*Ipomoea* sp.	species-dependent
Seedbox	*Ludwigia alternifolia*	OBL
Slender St. John's wort	*Hypericum mutilum*	FACW
Small Flower agrimony	*Agrimony parviflora*	FAC
Smartweed	*Polygonum* sp.	species-dependent
Spotted joe-pye weed	*Eupatoriadelphus maculatus*	FACW-

Table 4 (continued)

Common Name	Scientific Name	Regional Indicator*
Herbaceous (continued)		
Square-stemmed monkeyflower	*Mimulus ringens*	OBL
Sweetflag	*Acorus calamus*	OBL
Turtlehead	*Chelone obliqua*	OBL
Watercress	*Nasturtium officiniale*	OBL
White avens	*Geum canadense*	FAC

*Regional Indicators are from Reed, P. B., 1988. *National List of Plant Species That Occur in Wetlands: Tennessee.* USFWS Biological Report NERC-88/18.42. The indicator classification is based on the frequency with which a species occurs in a wetland habitat.

Indicator	Percent Occurrence in Wetlands (in percent)
OBL (Obligate)	>99%
FACW (Facultative Wetland)	67 - 99
FAC (Facultative)	34 - 66
FACU (Facultative Upland)	1 - 33
UPL (Upland)	< 1

The most visible and common mottles are those formed by the oxidation of iron and are yellowish-brown (10YR 5/8; 10YR 5/6), strong brown (7.5YR 5/8; 7.5YR 5/6), yellowish-red (5YR 5/6; 5YR 5/8), and reddish brown (5YR 4/6). Manganese concretions and oxidized rhizospheres are commonly found in most of the wetland soils.

Although not related to hydric soils or wetlands, an interesting finding was glauconitic shale or sandstone fragments in two of the wetlands at the base of Haw Ridge. These are wetlands RCET7-1, in the Raccoon Creek watershed, and 08-1-3, in the unnamed stream watershed in the north part of the 0800 Area.

3.4.3 Atypical Situation Wetlands, Wetland-Upland Mosaics, and Wetlands in Disturbed Areas

In this section, several atypical or unusual wetland situations are discussed. These include atypical situations (USACE 1987) in which one or two of the wetland criteria are absent; wetland/upland mosaics in which wetlands and uplands are interspersed in such an irregular pattern that it is not feasible to map the wetlands as separate units from the surrounding landscape; and wetlands in areas of past or continuing disturbance in which the disturbance itself appears to be the primary factor leading to wetland presence.

3.4.3.1 Wetland/Upland Mosaic: Wetland RCM2

Wetland RCM2 (Fig. 4) has hydrophytic vegetation, hydric soils, and evidence of wetland hydrology. However, unlike all of the other wetland areas in which the entire area can be classified as a jurisdictional wetland, only about 10% to 20% of the area inside the RCM2 boundaries may be technically classified as a jurisdictional wetland. The wetland areas are interspersed throughout the bottomland in such a way that it is not possible to map the upland and wetland areas separately. These types of situations are sometimes referred to as wetland/upland mosaics.

The floodplain topography consists of alternating "ridges" and "valleys" that appear to be formed by the strike of the near surface bedrock. There are slanted bedrock outcrops in Raccoon Creek in this area. Hydric soils were identified within the top 30 cm (12 in) of the soil profile in the shallow valleys. The soils have a 2 or 2.5 chroma with faint mottling in the top 20 cm (8 in). Below a depth of 20 cm there is a layer of gravelly, silty alluvial till that is mottled and has manganese concretions. In contrast, the A horizons of soil samples taken from the adjacent ridges are not hydric, having chromas of 3 with no apparent mottling. However, underlying this non-hydric layer at a depth greater than 20 to 24 cm. is the layer of gravelly, alluvial till described above.

The vegetation in the floodplain is composed of Obligate Wetland, Facultative Wetland, Facultative, and Facultative Upland (Reed 1988) species and includes loblolly pine, Virginia pine, red cedar, green ash, ironwood, sweetgum, sycamore, oak seedlings, winged elm, privet, Japanese honeysuckle, microstegium, closed gentian, sedges, soft rush, leathery rush, and creeping jennie (Table 4). The hydrophytic herbaceous species, including the sedges and creeping jennie, tend to occur in the depressions. The red cedar and oak seedlings tend to occur on the ridges.

The riparian zone on the east side of Raccoon Creek is at a slightly lower elevation and more prone to flooding than is the west side riparian zone. Evidence of past flooding and standing water includes drift lines, shallow surface channels with exposed soil, and water-stained and/or silt-covered leaf litter. The flooding regime combined with the "micro ridge/valley" topography has created an irregularly patterned interspersion of wetlands and non-wetlands. Although the entire floodplain area does not meet the criteria as a jurisdictional wetland, the wetland and non-wetland areas are linked functionally and ecologically because of their interspersion and the irregular pattern in which they occur.

3.4.3.2 Atypical Situations: RCET6-3 and RCET9-1

The area designated as RCET6-3 (Fig. 4) is an atypical situation. It is in an area of gently sloping to almost level land adjacent to the riparian wetland RCET6-2. The soil in RCET6-3 has a low chroma color (chroma 2) in the top 15 to 20 cm (6 to 8 in), and a 2 to 2.5 chroma with many mottles and manganese concretions below 20 cm. The 2 chroma soil with mottles meets the hydric soil criterion. However, although there were a few sycamore trees, and some sedges and rushes present, the overall appearance and species composition of the vegetation did not indicate a hydrophytic vegetation community. In addition to the few sycamores, there were oaks, hickories, and flowering dogwood, none of which are adapted to saturated soils. The soil was not saturated and there was no free water in any of the soil borings to a depth of 30 cm, although soil in the adjacent wetland was saturated.

Possible explanations for the presence of hydric soil and the lack of water and/or hydrophytic vegetation communities in this area include past drainage and non-growing season soil microbial activity. If the area was drained in the past, the soil would retain hydric characteristics, but the vegetation community would begin to include more facultative and upland species as the vegetation responded to the drier site conditions. The timing of saturation and anaerobic soil microbial activity could also influence soil characteristics. If soil microbial activity continues through a large portion of the non-growing season (as it probably does in the wet, temperate winters in East Tennessee), hydric characteristics could develop in the soils during the nongrowing season. The USACE methodology specifies that the three parameters must be present during the growing season, which is when the hydrology can most strongly affect the vegetation community and related ecological functions. Wetland hydrology may not be present in this area during the growing season.

The other atypical situation is wetland RCET9-1 in the headwaters of Raccoon Creek (Fig. 4). The vegetation and hydrology of the site are indicative of a wetland; however, hydric soil characteristics are not present below the soil surface. The dominant vegetation includes sycamore, red maple, white ash, and green ash in the canopy, silky dogwood in the shrub layer, and microstegium, poison ivy, and sedges in the ground-cover layer and is classified as hydrophytic. There are several shallow surface channels, all of which carried water on the day of the survey. Flooding has also been observed in this area in the winter and spring of 1994. Wetland hydrologic evidence includes bare areas of soil, surface soil scouring, and siltation. Surface runoff appears to be a primary water input. There were no seeps observed; however, seeps may have been present but not discharging on the day of the survey.

The soil does not meet the hydric soil criteria. The top 24 to 30 cm of the soil profile is a heavy clay that is approximately 75% yellowish-red (10YR 5/8) and 25% brownish-yellow (10YR 6/6). No mottling or manganese concretions were present. Although the soil column was not saturated, the thin duff layer and the surface of the soil were wet. The heavy clay soil apparently perches both stormwater runoff and the seasonal stream flow that tends to spread out in shallow channels across the area. Because the area is level, the rate of runoff from the site is probably low. Perched surface water would be adequate to support the shallow-rooted herbaceous species and to discourage the invasion of upland species. It is possible that the wetland-adapted trees and shrubs may obtain water from soil layers underneath the clay layer.

3.4.3.3 Atypical Situation: Wetland WONT10-1

WONT10-1 is located in WAG 6. A short section of stream was recently rerouted so that the stream flow could be diverted to Monitoring Station 1. The area was cleared of vegetation, soil was moved, and the site was regraded. Hydrophytic vegetation has become established in a 6- to 20-ft-wide zone of saturated soil on either side of the new shallow stream channel. However, because of the recent soil movement and deposition, the soil has not had sufficient time to develop hydric characteristics. The soil has a high chroma color and does not contain mottles or manganese concretions. With continued soil saturation hydric characteristics will probably develop in this soil over a period of years.

3.4.3.4 Disturbed Area: Wetland 08-A

Wetland 08-A (Fig. 8), located in a prior disturbed area bounded by Jones Island Road on the south and east, the 0816 fence on the west, and a second-growth upland forest (dominated by red cedar and pine) on the north, is not an atypical situation wetland because it has the three criteria necessary to be classified as a jurisdictional wetland. The area delineated as wetland is an interspersion of low-elevation areas, old soil piles (now vegetated), and excavated pits and depressions. The depressions, pits, and other low-lying areas are interconnected and all held water on the day of the survey. The area does not appear to have a steady surface connection to the Clinch River, to which it is adjacent, although it may at times drain to the river through a culvert under Jones Island Road. The culvert invert is at a higher elevation than the lowest surface of the wetland, and thus does not function as a drain for the area except when water levels are high. On the day of the survey (Dec. 12, 1994), 35 cm of standing water was in one of the depressions. The water may have been deeper than 35 cm at other, deeper depressions in the wetland.

The entire wetland area is currently vegetated with a thicket of young trees, shrubs, and vines. The dominant species include green ash, sycamore, red maple, elm, silky dogwood, microstegium, leafy bulrush, Japanese honeysuckle, and sedges. The soil in two separate places within the wetland includes a gray (10YR 6/1) silt loam and a grayish-brown (2 chroma) silt loam with gray (10YR 6/1) streaks and brown, yellowish-red, and yellowish-brown mottles. Thus, the area meets the requirements for USACE jurisdictional wetland classification. The establishment and continued presence of the wetland may be due, in part, to past human activities in the area. These include Jones Island Road construction and the excavation of shallow pits, which both function to retain incoming water.

3.4.3.5 Disturbed Area: Wetland 08-B

Wetland 08-B (Fig. 8) is not an atypical situation wetland because it has all three of the USACE wetland parameters. However, it is located in a disturbed area, and there is a possibility that it was established as a result of the past alterations to site soils and drainage. Wetland 08-B is located in a level, routinely mowed area on the west side of Jones Island Road. The wetland and adjacent areas have been disturbed in the past. The soil, a clayey silt loam, appears to be fill, and both external and internal drainage are poor. No surface inlet or outlet for the wetland was observed during the field visit. The main hydrologic source may be precipitation and a small amount of surface runoff, neither of which drain rapidly from the site due to the soil characteristics and the site topography.

In the A horizon (15 to 20 cm) of the wetland soil profile, the soil is gray (10YR 5/1) with manganese concretions and oxidized rhizospheres. Underlying the gray layer, the B horizon has no single, clear matrix color. The B horizon is grayish brown (10YR 5/2) and dark brown (10YR 3/3) with bright mottles (6 and 8 chroma). On the day of the survey (May 25, 1995), the A horizon was saturated and the B horizon was not saturated, which supports the idea that the hydrology is provided by precipitation and surface runoff, which is then perched on top of an impermeable layer. However, it is possible that springs or seeps also contribute part of the water budget. The wetland vegetation includes seedlings of silky dogwood and green ash, fox sedge, beggar-ticks, agrimony, soft rush, squarrose sedge, Frank's sedge, and green bulrush.

3.4.3.6 Disturbed Area: Wetland WONT5-8

This wetland is located in a routinely mowed, grassy area south of the SWSA 3 fenced area (Fig. 5). It drains to a stream that has been converted to a roadside swale in its middle reach. This wetland is unusual because it begins at a mid-slope topographic position, which is not a typical location for wetlands on ORR. The seep at which the wetland area begins is located about halfway up the slope and approximately 12 to 15 m downslope from a wellhead. It is possible that there is a naturally-occurring seep here or that the well casing is leaking and the water is coming to the surface at mid-slope.

The dominant species include green bulrush, soft rush, fox sedge, an umbrella sedge, and cattail, all of which are obligate wetland or facultative wetland species. The soil is a heavy clay loam and is gleyed (N 6/ and 5GY/1). At the downslope end, the soil is gleyed (N 4/), silty clay loam. The soil is mottled and contains oxidized rhizospheres and manganese concretions. The gleyed soil indicates that the area is saturated for all or most of the year. A large amount of oxidized iron is near the head of the seep. This is a jurisdictional wetland based on the presence of the three wetland criteria. It is not clear at this time whether the origins of the wetland are natural or man-made.

3.4.3.7 Disturbed Area: Wetland MBNT1-1

Wetland MBNT1-1 is an emergent wetland that occurs within an upland forest (Fig. 14). The area has been disturbed in the past by the construction of well roads and well installation, which has resulted in alterations in the microtopography of the site through the creation of ruts, depressions, and low berms. The wetlands position in the landscape and the surrounding vegetation community suggests that this wetland might not have become established without the human-caused site alterations. Based on topography and the dominant surrounding vegetation, the area appears to be an unlikely site for a wetland. Although it drains to a tributary of Melton Branch, it is not immediately adjacent to a stream, unlike most of the wetlands found on ORR. It has been classified as an emergent wetland due to the presence of herbaceous hydrophytic species, but the area surrounding it is dominated by an upland species, Virginia pine. It is at a higher elevation than the stream bottomlands and other wetlands in the Melton Branch watershed and the topography would not suggest an area in which groundwater seeps would be found. However, on this knoll, which extends from the HPRR Access Road to the bottomlands of Melton Branch and MBNT1, there are numerous seasonal seeps. These seeps are one of the main factors contributing to the establishment of wetland MBNT1-1.

The second controlling factor, however, may be the alterations in microtopography that function to direct seep flow toward this area, and to detain water on-site and slow the drainage of the seep water from the site. This area was first identified during a wetland survey in 1992, and the area has not been revisited since then. It is recommended that a site visit and survey of the area be conducted prior to any regulated activities to review the earlier wetland findings and to determine more precise boundaries.

4. WETLAND FUNCTIONS

A thorough assessment of wetland functions is outside the scope of this project. To properly assess wetland functions, additional literature review, field investigations, and application of wetland evaluation methodologies will be necessary. However, the following sections provide a brief overview of wetland functions and describe two of the wetland evaluation methodologies that might be considered for future assessment of those functions in ORR wetlands.

4.1 DESCRIPTION

Wetland functions are physical, chemical, and biological processes or attributes of wetlands that are vital to the integrity of the wetland system (Adamus et al. 1991). Wetland functions include groundwater recharge and discharge, floodflow alteration, sediment stabilization, nutrient removal and transformation, sediment and toxicant retention, production export, and provision of wildlife and aquatic species habitat. Not all functions will be performed in every wetland. The factors that affect the performance of wetland functions are numerous and include geographic and topographic location; wetland position in the watershed; and physical, chemical, and biological characteristics of the wetland.

4.1.1 Groundwater Discharge/Recharge

Groundwater discharge is the movement of groundwater to surface water, while groundwater recharge is the movement of surface water into the ground (Adamus et al. 1991). It is clear from the presence of numerous seeps and springs in the X-10 GWOU survey area wetlands that groundwater discharge occurs. In fact, in the headwater riparian wetlands, it appears to be the primary source of water. It is not known to what extent groundwater recharge occurs. However, recent work in the geologically similar Bear Creek valley on the ORR suggests that during the dry seasons of summer and fall some of the water flow into forested headwater riparian wetlands is the stream. Some of this stream inflow is lost to the system through evaporation, and part may move laterally to discharge in downstream locations; however, it is possible that part of the flow becomes groundwater recharge.

4.1.2 Floodflow Alteration

Floodflow alteration is the process by which peak flows from runoff, surface flow, groundwater interflow and discharge, and precipitation enter a wetland and are stored or delayed from their downstream movement. To provide effective storage, a wetland must not be filled to capacity with surface water. However, in developed watersheds, in the lower reaches of watersheds, and in watersheds with little wetland acreage, many wetlands become quickly saturated and filled to capacity (Adamus et al. 1991). Also, during the wet seasons of the year or periods of high rainfall, the wetlands might be completely saturated and unable to store additional influxes of water. Water storage and detention occur to some extent in White Oak Lake, White Oak embayment, and those river embayments that are blocked by culverts. Additional study or application of wetland evaluation methodologies is necessary to estimate the floodflow alteration function of these and other X-10 GWOU survey area wetlands.

4.1.3 Sediment Stabilization

Sediment stabilization consists of shoreline anchoring (stabilization of soil at the water's edge) and dissipation of erosive forces (the lessening of energy associated with waves, currents, water-level fluctuations, and groundwater flow) (Adamus et al. 1991). This function is probably not present in most of the X-10 GWOU wetlands that are located on first- and second-order streams. It may function in the river embayment wetlands that are affected by the river water level fluctuations. In these wetlands, the vegetation may stabilize embayment soils affected by water-level fluctuations and may reduce sediment loads to the river by capturing eroded soil and other particulates washed in with upland and upstream storm runoff.

4.1.4 Nutrient Removal and Transformation

Nutrient removal and transformation includes the storage of nutrients (primarily nitrogen and phosphorus) within the sediment or plant substrate, the transformation of inorganic nutrients to their organic forms, and the transformation and removal of nitrogen (Adamus et al. 1991). The total loading of nitrogen and phosphorus to the various X-10 GWOU wetlands from point and nonpoint sources is not known. Potential anthropogenic sources of nitrogen and phosphorus include sewage treatment plant or septic system discharges; land application of fertilizers, sludges, or compost; and grass and brush clippings. The nitrogen and phosphorus loadings to the wetlands in headwater areas or areas upstream of human activities are probably low; thus nutrient removal and transformation may be only minimally performed in these wetlands. Conversely, wetlands along Melton Branch and White Oak Creek may receive loadings of nitrogen and phosphorus from ORNL site activities. The activities that could contribute nitrogen and phosphorus to aquatic areas include parking lot and road runoff, fertilizer applications to landscaped and reforestation areas, and discharges from the sewage treatment plant.

4.1.5 Sediment and Toxicant Retention

Sediment and toxicant retention is the process by which suspended solids and adsorbed contaminants are retained and deposited in a wetland. Toxicants can include heavy metals, pesticides, and other toxic organics (i.e., solvents and polychlorinated biphenyls). Toxicant retention is associated with sediment retention because many toxicants adsorb to solids and thus will be removed from the water column when the solids settle out. In the wetland, the toxicants can be permanently or temporarily sequestered in the sediments and in plant tissue, transferred to the atmosphere through volatilization, biochemically transformed to intermediate compounds that are less or more toxic than the parent compound, or completely mineralized to carbon dioxide and water. Sediments and associated toxicants can also be resuspended and exported from the wetland in subsequent flooding events (Adamus et al. 1991). Routes of contaminant entry into a wetland include surface water, groundwater, atmosphere, and accidental spills. Numerous wetlands located downgradient from the WAGs in the lower White Oak Creek and Melton Branch watersheds have been functioning as sinks for radionuclides and other contaminants that have been transported from the former burial grounds through groundwater and shallow subsurface flow routes.

4.1.6 Production Export

Production export refers to the flushing of organic material from the wetland to downstream or adjacent waters. Another mechanism of production export is insect emergence and consumption by vertebrates that travel out of the wetland. The amount of production export depends on a variety of biotic and abiotic factors, including climate, acreage, size of watershed, wetland to watershed area ratio, gradient, wetland type, plant productivity, sheet or channel flow, water velocity, and duration of flooding (Adamus et al. 1991). Production export has not been measured in the X-10 GWOU wetlands.

4.1.7 Aquatic Diversity

Aquatic diversity is defined as the support of a notably great on-site diversity and abundance of fish or invertebrates that are mainly confined to the water and saturated soils (Adamus et al. 1991). Although this function may be performed in some of the river embayment wetlands and White Oak Lake and embayment, fish diversity and abundance is probably not as significant in most of the wetlands because of the lack of long-term inundation of most of the wetland areas. The wetlands do, however, provide habitat for wetland-dependent invertebrates, such as crayfish and some insect species.

4.1.8 Wildlife Diversity

Wildlife diversity is defined as the support of a notably great on-site diversity and abundance of wetland-dependent birds (Adamus et al. 1991). However, the focus on birds should not imply that other wildlife species, such as many furbearers (e.g., mink and beaver), other mammals (e.g., shrews), most amphibians, and some reptiles (e.g., bog turtles, water snakes), are any less important or dependent on wetlands. Therefore, wildlife diversity, for the purposes of our brief discussion, includes all wildlife species that are wetland-dependent or that may use wetlands on a daily, seasonal, or intermittent basis. Wildlife species on ORR that use or are dependent on wetlands at some time in their life include raccoons, mink, muskrat, beaver, deer, mice, shrews, frogs, turtles, and numerous bird and amphibian species. Beaver have built a dam across White Oak Lake and have built a smaller dam across White Oak Creek just upstream of the Melton Valley Drive road crossing. It is likely that the beaver will continue to expand further up this watershed, as well as that of Melton Branch.

4.2 WETLAND EVALUATION METHODOLOGIES

Techniques for assessing wetland functions and values include the Wetland Evaluation Technique (WET) and the Hydrogeomorphic Approach (HGM). WET (Adamus et al. 1987; Adamus et al. 1991) is a widely used methodology for assessing wetland functions and values. Although other wetland evaluation techniques existed before the development of WET, none addressed all of the important wetland functions and wetland types or presented a single, unified procedure that could be employed rapidly, accurately, and consistently. WET is used to evaluate wetland functions and values in terms of Social Significance (societal value as evidenced by economic worth or official recognition), Opportunity (the chance a wetland has to perform a specific function), and Effectiveness (the capability of a wetland to perform a function because of its physical, chemical, or biological characteristics). Features of the wetland's watershed, topography, vegetation, and other parameters are used to determine probability ratings of high, medium, or low for each function and value. WET estimates the probability that a particular wetland performs specific functions and provides insight as to the significance of those functions but does not provide definitive answers to specific questions regarding wetland functions.

A new assessment methodology, HGM, is being developed by the USACE (Smith 1995). This method is based on the Hydrogeomorphic Classification system for wetlands developed by Brinson (1993). The HGM system classifies wetlands on the basis of geomorphic setting, water source, and hydrodynamics and identifies groups of wetlands that function similarly. The basic HGM classes are riverine, depressional, slope, flat, and fringe. The classes can be subdivided into subclasses on the basis of landscape and ecosystem scale factors. Assessment models are developed for each function that is likely to be performed in the wetland subclass and result in an index that reflects the ability of a wetland to perform a function relative to similar wetland in the region (Smith 1995). Model calibration should be based on data collected from reference wetlands that represent the range of conditions that exist in the region (Smith 1995). HGM is still in the early development stage for many regions of the United

States. Assessment models and reference wetland sets have not yet been developed or established for the wetland classes in the Ridge and Valley Province of Tennessee in which ORR is located.

5. SUMMARY

In accordance with Department of Energy Regulations for Compliance with Floodplains/Wetlands Environmental Review Requirements (Subpart B, 10 CFR 1022.11), wetland surveys were conducted for the ORNL Environmental Restoration Program in the Melton Valley and Bethel Valley groundwater operable units. The surveys were conducted from October 1994 through September 1995. As required by the Energy and Water Development Appropriations Act of 1992, wetlands are identified using the criteria and methods in the U.S. Army Corps of Engineers *Wetlands Delineation Manual* (1987).

Two hundred and fifteen individual wetland areas were identified in the X-10 GWOU survey area with sizes ranging from 0.002 ha to 9.97 ha. Eighty-six percent (185) of the wetlands are smaller than ½ ha. Seventy-one percent (152) are less than 1/4 ha. Nineteen wetlands are greater than 1 ha. Of these nineteen wetlands, two are greater than 2 ha, two are greater than 3 ha, one is 5.6 ha, and the largest wetland area is 9.97 ha. The total wetland area in the X-10 GWOU survey area is approximately 76.7 ha, or approximately 3.8% of the X-10 GWOU wetland survey area.

Among the largest wetlands are those that occur in the human-influenced aquatic environments of Clinch River embayments, White Oak Lake, and the White Oak Creek floodplain. The hydrology of these wetlands is strongly influenced by the fluctuations in water level caused by operation of Watts Bar Dam and Melton Hill Dam and by smaller dams and road culverts.

The wetlands are characterized by hydrophytic vegetation communities, hydric soils, and wetland hydrology. One wetland in the Raccoon Creek watershed was identified as a wetland/upland mosaic. In this area, the flooding regime combined with floodplain topography has created an irregularly patterned interspersion of wetlands and non-wetlands, in which only 10-20% of the area met the criteria for a jurisdictional wetland. Two wetlands in the Raccoon Creek watershed and one wetland in the White Oak Creek watershed in WAG 6 were identified as atypical situations in which only one or two of the wetland criteria were present. Five wetlands were discussed in detail because their presence appeared to be a direct function of past or continuing site disturbance, without which they might not have developed.

The wetlands are classified as palustrine forested broad-leaved deciduous (PFO1), palustrine scrub–shrub broad-leaved deciduous (PSS1), and palustrine persistent emergent (PEM1) (Cowardin et al. 1979). PFO1 wetlands occur in the riparian areas of headwater streams and in the floodplains of major streams. PSS1 and PEM1 wetlands occur throughout the survey area and are found in White Oak Lake (WOM-5), in the river embayments, and in stream bottoms in utility and road rights-of-way. Most of the wetlands occurring in rights-of-way are classified in this report as disturbed area wetlands because they are routinely mowed and, if no road culvert is present, may be occasionally crossed by vehicles.

Wetland functions include groundwater recharge and discharge, floodflow alteration, sediment stabilization, nutrient removal and transformation, sediment and toxicant retention, production export, and provision of wildlife and aquatic species habitat. Techniques for assessing wetland functions and values include the Wetland Evaluation Technique (WET) and the Hydrogeomorphic Approach (HGM). WET (Adamus et al. 1987; Adamus et al. 1991) is used to evaluate wetland functions and values in terms of Social Significance (societal value as evidenced by economic worth or official recognition), Opportunity (the chance a wetland has to perform a specific function), and Effectiveness (the capability of a wetland to perform a function because of its physical, chemical, or biological characteristics). A relatively new assessment methodology, HGM, currently under development by the USACE (Smith 1995) is based on the Hydrogeomorphic Classification system for wetlands developed by Brinson

(1993). The HGM system classifies wetlands on the basis of geomorphic setting, water source, and hydrodynamics and identifies groups of wetlands that function similarly. HGM is still in the early development stage for many regions of the United States. Assessment models and reference wetland sets have not yet been developed or established for the wetland classes in the Ridge and Valley Province of Tennessee in which ORR is located.

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