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OAK RIDGE RESERVATION LAND-USE PLAN

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Prepared by

Oak Ridge Operations

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OAK RIDGE RESERVATION LAND-USE PLAN

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1
INTRODUCTION

On Oct. 1, 1977, the programs of the Energy Research and Development Administration (ERDA) became a part of the newly created U. S. Department of Energy (DOE), the nation's twelfth cabinet agency.

DOE brings together the many fragmented energy programs and offices created over the years within the Federal Government. The Department was established to carry out in a coherent and effective manner the elements of the nation's energy policy, giving to them unified leadership for the first time.

In addition to the programs of the former ERDA, DOE also assumed responsibility for all resources and functions of the Federal Energy Administration and the Federal Power Commission as well as the energy-related responsibilities of the Department of the Interior, Department of Defense, Interstate Commerce Commission, Department of Commerce, and Department of Housing and Urban Development.

The first *Oak Ridge Reservation Land-Use Plan* (ERDA Report ORO-748) was published in 1975 soon after ERDA succeeded the U. S. Atomic Energy Commission (AEC). Although real property surveys have been conducted each year, as required by ERDA, DOE, and GSA regulations, the expanded role of the DOE over that of ERDA has dictated the need to update the 1975 Plan. This study is intended to establish a basis for long-range land-use planning to accommodate both present and projected DOE program requirements in Oak Ridge.

In addition to technological requirements, this land-use plan incorporates in-depth ecological concepts that recognize multiple uses of land as a viable option. Neither environmental research nor technological operations need to be mutually exclusive in all instances. Unique biological areas, as well as rare and endangered species, need to be protected, and human and environmental health and safety must be maintained. The plan is based on the concept that the primary use of DOE land resources must be to implement the overall DOE mission in Oak Ridge.

2
BACKGROUND

As of Dec. 31, 1979, the Oak Ridge reservation contained approximately 37,000 acres (14,980 ha) of land compared to the total of about 58,000 acres (23,482 ha) previously acquired for nuclear energy programs. Selective disposals, totaling about 21,000 acres (8502 ha), began in 1949 and have continued to the present. The majority of the disposals involved land in or adjacent to the residential, commercial, and industrial areas of the Oak Ridge community. These disposals were determined to be compatible with program requirements, approximately 64% of them representing disposals under the Atomic Energy Community Act (P.L. 221).

Currently, the principal plant complexes located on the reservation are as follows:

Oak Ridge Gaseous Diffusion Plant (ORGDP)
Y-12 Plant (Y-12)
Oak Ridge National Laboratory (ORNL)
Comparative Animal Research Laboratory (CARL)

During the preparation of this plan, all parties having current or potential operational and program requirements were contacted; basic assumptions and the timing and relative firmness of programs and projects were considered; and constraints, such as those involving availability of services, security considerations, etc., viable alternatives, and previously adopted positions in response to GSA and others were considered. This plan identifies and describes current, projected, and potential land-use requirements and will serve as the basic document to aid future decisions regarding land use, acquisition, and disposal consistent with federal laws and regulations.

3
SUMMARY AND ANALYSIS

This document, along with the base map and overlay maps, provides a reasonably detailed description of the DOE Oak Ridge land resources and of the current and potential uses of the land. A description of the land characteristics, including geomorphology, agricultural productivity and soils, water courses, vegetation, and terrestrial and aquatic animal habitats, is presented to serve as a resource document. Essentially all DOE land in the Oak Ridge area is being fully used for ongoing DOE programs or has been set aside as protected areas. As is evident from the plan, much of the land is in multiple program use.

Of the 37,000 acres (14,800 ha) presently in the Oak Ridge reservation, some 1500 acres (4%) are protected from activities that would alter the land's unique character. These areas include archeological sites, antiquities, and approximately 30 cemeteries that have been protected since the establishment of the reservation. There are also natural areas that contain stands of timber, floodplain areas, and plant species, all of which are rare on the reservation but typical of regional biotic association. Uranium-enrichment activities use approximately 4700 acres of the reservation (14%). This area includes 3000 acres of required buffer zone that is also used for ecological research and forestry management. Weapons manufacturing and primary research activities at the Y-12 Plant use some 3400 acres (10%). This includes 2500 acres of required buffer zone, of which 2000 acres are also used for ecological and agricultural research. The primary research facilities at ORNL occupy 8800 acres (26%), of which 7700 acres represent required buffer zones. Waste-management activities use some 500 acres (1%) of the land for both nuclear and nonnuclear waste disposal.

Terrestrial ecological research uses some 36 areas comprising 5400 acres (16%) for current program studies. Aquatic ecological research is conducted in 18 areas, which include streams, rivers, and their associated land watershed areas and total 7000 acres (21%). Agricultural research requires assignment of 10 parcels of agriculturally improved land consisting of 2500 acres (7%). Most of this land is pasture required for the maintenance of swine, sheep, cattle, and burros. Some of this land is used to grow mutant plants of agronomic importance. Forest lands on the reservation are managed to provide disease and wildfire control, for conservation of natural resources, and to contribute to the development of a stable local timber-products industry.

Selective disposals, compatible with program requirements and totaling some 21,000 acres (36% of the original reservation), began in 1949 and have continued to the present. Because the expanded role of DOE over that of the AEC or ERDA is resulting in additional land-use needs, further disposals of land must be carefully evaluated.

Continued requests for transfer of DOE land holdings can be expected from local, county, and state governments as well as from other government agencies and private individuals and organizations. Requests are prompted by the need for land for such things as residential, recreational, and industrial development, highway easements, electrical and telephone transmission-line corridors, and sanitary landfill sites. Such requests for land must be critically evaluated in terms of the potential impact on current and future DOE programs. Intensified use of existing land resources must be anticipated, and options for expansion or addition of new DOE facilities must be recognized, including sufficient land for waste-management activities. Moreover, biomedical and environmental research programs require undisturbed watersheds, terrestrial and aquatic animal habitats, and land capable of agricultural production.

Implicit in the mission of energy research and development is that emerging technologies and changing program requirements bring about revisions in priorities that dictate the optimum use of land resources. This plan, therefore, should not be viewed as representing permanent land assignments to particular programs but rather a document that supplies data on land characteristics and identifies rare or unique land resources that should be considered in relating future programmatic needs to decisions on land use, acquisitions, or disposals.

4

LAND CHARACTERISTICS

A GEOMORPHOLOGY

1. Geology and Geohydrology*

The Oak Ridge reservation is in the Tennessee section of the Valley and Ridge province and is underlain by consolidated marine sediments of Paleozoic age. The topography is characterized by subparallel northeast-trending ridges and valleys and reflects the geologic structure of the area, which consists of generally southeast-dipping strata. The different lithologies of the formations result in different rates of weathering and erosion. The more resistant ridge-producing formations are the Rome formation, the Knox group, the Rockwood formation, and the Fort Payne chert. Most of the valleys are underlain by the Conasauga group and the Chickamauga limestone.

The drainage of the area is mostly of the trellis type. The major stream is the Clinch River, which is an incised meandering stream. The largest tributary to the Clinch River in the reservation is the East Fork Poplar Creek.

The groundwater table in the ORNL area can be described as a subdued replica of the surface topography. Thus the groundwater flows from areas of high elevation to areas of low elevation and ultimately discharges into surface streams. In general, this description may be extended to the entire reservation where groundwater occurs under water table conditions. This is characteristic of groundwater conditions in a humid region.

The western part of the Tennessee section of the Valley and Ridge province is structurally characterized by major subparallel thrust faults that trend northeast and dip southeast. Along most of these faults, the Rome formation has been thrust over younger formations, which causes repetition of geologic sequence within the area. The two major faults on the reservation are the Copper Creek fault and the Whiteoak Mountain fault. The latter exhibits several subsidiary features, including branch faults, a syncline, and two slices of dolomite of the Knox group. There is no evidence of recent displacement along either of the faults.

The reservation is underlain by nine geologic formations ranging in age from Cambrian to Mississippian (Overlay 1, Section 8). The formations are of sedimentary origin: limestone, dolomite, sandstone, and shale. From oldest to youngest the formations are the Rome formation, the Conasauga group, the Knox group, the Chickamauga limestone, the Reedsville shale, the Sequatchie formation, the Rockwood formation, the Chattanooga shale and Maury formation, and the Fort Payne chert.

The Rome formation is a fine-grained shaly sandstone that is generally well cemented. Its ability to hold and transmit groundwater is due almost entirely to fractures. However, because of the composition of the formation, the fractures have not been enlarged by solution.

The Conasauga group is primarily silty, slightly calcareous shale interbedded with thin limestone units. The permeability seems to be associated with changes due to weathering of the rock above and somewhat below the water table. Where the shale is saturated, movement of groundwater is concentrated in a zone near the water table and perhaps locally deeper along some fractures. The fractures in the Conasauga group, and therefore the permeability, are evenly distributed; this results in a more uniform flow of groundwater than occurs in other formations.

The Knox group is composed largely of thick beds of dolomite and limestone, and, where it is unweathered and undeformed, it has low porosity and low permeability. However, where it has been fractured by folding or faulting, its permeability has been greatly increased. In many places these fractures have been enlarged by solution, and large openings have been formed. Sinkholes and caverns are common. These openings give rise locally to large springs and wells of high capacity, although there are wells that are almost dry. The permeability and porosity of the formation are unevenly distributed and have been localized by fracturing and later solution by groundwater movement.

The Chickamauga limestone is composed largely of thin beds of shaly limestone and shale. The porosity of the formation is low; fractures have been enlarged by solution but not, however, to the extent of the cavernous Knox

*W. M. McMaster, Geologic Map of the Oak Ridge Reservation, USAEC Report ORNL-TM-713, Oak Ridge National Laboratory, 1963.

group. These fractures and solution channels form a network of open channels and voids which permits the free movement of groundwater.

In view of the groundwater flow characteristics of the Knox group and the Chickamauga limestone, industrial facilities that are likely to release pollutants through either planned or accidental release should not be located on these formations. The movement of groundwater through the formations is primarily in fractures that have been enlarged by solution. These channels have the ability to transport a pollutant over long distances, with little opportunity for adsorption, in a relatively short period of time.

2. Flood-Hazard Potential

The DOE Oak Ridge reservation is located in the lower portion of the Clinch River valley. The Clinch River, a major tributary of the Tennessee River, bounds the reservation on the west and south for a length of approximately 34 miles (54 km) from Clinch River Mile (CRM) 9.3 to 43.6. Two major tributaries of the Clinch River also pass through the reservation. Poplar Creek enters the reservation north of the Oak Ridge Gaseous Diffusion Plant (ORGDP), meanders for about 6.3 miles (10 km) through the plant area, and enters the Clinch River at CRM 12. East Fork Poplar Creek passes through the reservation for about 4.5 miles (7.2 km) and enters Poplar Creek northeast of the ORGDP. The character and relative positions of the watersheds of these streams are conducive to quick concentration of flood runoff into the DOE Oak Ridge reservation during intense storm periods.

The Oak Ridge reservation lies within the watershed of the Tennessee River, having the advantage of being included in the area under Tennessee Valley Authority flood control. As a flood-control dam, Norris Dam, on the Clinch River upstream from the reservation, considerably reduces the Clinch River drainage area applicable to the reservation, and, through controlled discharge in time of flood, it greatly reduces potential flooding downstream. Controlled discharges at Melton Hill Dam adjacent to the reservation at CRM 23 and at Watts Bar Dam on the Tennessee River downstream from the reservation also reduce the potential for flooding. Since the Oak Ridge area was acquired by the government in 1942, only minor flooding problems have occurred. These have basically been confined to flooding within the urban area of the City of Oak Ridge, which is no longer under government control, and to some flooding of roads and low areas adjacent to the East Fork Poplar Creek and Clinch River within the current DOE Oak Ridge reservation. Virtually no damage to plant facilities has occurred. The Tennessee Valley Authority, however, has conducted studies relative to flooding within the area, and these studies have been used in recent years to evaluate flood hazards in constructing new facilities and for land use within the DOE Oak Ridge reservation. The "regional flood," established by TVA and derived from consideration of the largest floods known to have occurred on streams whose watersheds have similar characteristics and are located in the same general geographic region as that of the Oak Ridge area, has been used in these evaluations. The effects on the DOE Oak Ridge reservation of such a regional flood* for the Clinch River, Poplar Creek, and East Fork Poplar Creek, based on regulation of discharges through Norris, Melton Hill, and Watts Bar dams, are shown on Overlay 2, Section 8.

A regional flood on East Fork Poplar Creek and Poplar Creek would inundate approximately 829 acres (335 ha) of DOE land. Only minimum damage would occur, although there would be interruption to traffic flow on portions of the Oak Ridge Turnpike (Tenn. State Highway 95) which are within the floodplain. A regional flood on the Clinch River would inundate approximately 1123 acres (454 ha) of DOE land located adjacent to the river below Melton Hill Dam. Major flooding within the ORGDP would be confined to the former powerhouse area located adjacent to the river at CRM 13. This has precluded major use of this facility since the powerhouse was shut down. Above Melton Hill Dam, a regional flood would have no effect on DOE's land owing to TVA's controlled discharges from the Norris and Melton Hill dams.

Other areas within the DOE Oak Ridge reservation are affected only by small streams that serve relatively small drainage areas. These areas involve only local drainage problems with no potential for flood hazard.

3. Seismic Characteristics

The DOE Oak Ridge reservation is located in Seismic Zone 2 of the United States. The site lies in the Southern Appalachian Seismo-Tectonic province, which is characterized by a series of northeast- to southwest-trending folds and thrust faults in Paleozoic rocks. The region has been the source of continuing minor seismic activity; however, no correlation between seismic events and known tectonic structures has been confirmed. A review of pertinent literature has indicated no reports of earthquake activity or surface rupturing associated with any of the faults within the site vicinity, and the possibility of these events is considered extremely unlikely.

Forty (40) recorded earthquakes have occurred within 155 miles (250 km) of the site. The most severe local earthquake occurred northeast of Knoxville on Mar. 28, 1913, with an epicentral modified Mercalli intensity of VII (see Table 4-1). Moderately strong epicentral shaking (maximum intensity VI) also occurred from local events in 1956 and 1844. Comparable intensities were also observed in the Knoxville–Oak Ridge area during the 1811–1812 Mississippi Valley, Mo., earthquakes and the 1886 Charleston, S.C., earthquake, although the epicenters of these large earthquakes were located over 280 miles (450 km) from

*Tennessee Valley Authority, Report No. 0-5922, September 1959, Floods on Clinch River East Fork Poplar Creek in Vicinity of Oak Ridge, Tennessee.

Oak Ridge. The geology and tectonic structures in both the New Madrid and Charleston areas are completely unrelated to the structure in the Southern Appalachians.

Table 4-1 PREDICTED SITE SEISMIC CHARACTERISTICS

Maximum earthquake	
Peak acceleration, % *g*	15
Intensity (MM)*	VI–VIII
Richter magnitude†	4.7
Design earthquake	
Peak acceleration, % *g*	6
Intensity (MM)*	V–VII
Richter magnitude†	3.0

*Modified Mercalli intensity dependent on foundation condition.

†Will produce accelerations near the epicenter approximating those given.

The most intense earthquakes recorded in the Southern Appalachians were those occurring near Gadsden, Ala. (Jan. 27–28, 1905, maximum intensity VIII), and Giles County, Va. (May 31, 1897, maximum intensity VIII). These earthquakes were located about 155 miles (250 km) and 220 miles (350 km), respectively, from Oak Ridge, and, although they were most likely felt in the area, the intensities at that distance were far below the damaging level.

Two studies were performed during FY 1973 by professional seismic-evaluation organizations to determine seismic factors at the ORGDP.[1,2] Both John A. Blume & Associates and Dames & Moore studied the probabilities of seismic events and intensities. Two levels of seismic events were defined; a design earthquake and a maximum earthquake. The design earthquake is that event for which a 50% probability of occurrence is expected once in 50 years. The maximum earthquake is that event for which a 16% probability of occurrence is predicted once in 50 years. These predictions are based on studies of the seismic histories and geologic structures of the region surrounding the plant site. Table 4-1 contains a summary of the seismic characteristics associated with the plant site which would also be applicable to the total DOE reservation.[3] Values for peak horizontal ground accelerations and a range of modified Mercalli intensities are listed.

Currently, consultants are conducting a review of seismic data to ensure that the latest material and techniques are being applied to the predicted seismic characteristics for this area.

References

1. Seismic Design Criteria, Gaseous Diffusion Plants, April 1973, prepared by Dames & Moore.
2. Seismic Investigations for the AEC Gaseous Diffusion Plants, May 1973, prepared by John A. Blume & Associates.
3. Preliminary Site Evaluation Report for Additional Enrichment Capacity, USAEC Report ORO-745, January 1975.

4. Meteorology and Climatology[1]

The prevailing wind at Oak Ridge is from the southwest and near the surface tends to follow the trend of the valley and ridge topography. In winter the Cumberland Mountains have a moderating influence on the local climate by retarding the flow of cold air from the north and west. Winter and early spring are the seasons of heaviest precipitation, with monthly maximum rainfalls normally occurring from January through March. The mean annual precipitation is approximately 54 in. The average number of days between the last freeze in spring and the first freeze of fall is about 200. For the 26-year period from 1948 to 1974, the annual mean maximum and minimum temperatures at Oak Ridge were 68.7°F and 46.9°F, respectively. The extreme low and high temperatures at Oak Ridge have been –9°F in January 1966 and 105°F in July 1952. Light snow usually occurs in the months from November to March. The total snowfall for some winters is less than 1 in. (2.54 cm). The maximum 24-hr snowfall was 12.0 in. (30.5 cm) in March 1960.

The level of risk at Oak Ridge from tornadoes is relatively low. On the basis of available statistics, the probability of occurrence of a tornado at Oak Ridge would be as follows:

Probability of 1 tornado/year	0.00024
Recurrence (years)	4167

Reference

1. Tornado Risks & Design Windspeeds for the Oak Ridge Plant Site, TTU.

B AGRICULTURAL PRODUCTIVITY AND SOILS

The land-use types for agricultural productivity of the Oak Ridge reservation are based on soil productivity potential as described below.

1. Criteria for Agricultural Productivity

Soils on the Oak Ridge reservation differ widely in productivity. Although agronomy is practiced intensively on only part of the reservation, other sites possess varying potential for productivity. The potential for productivity is based on a survey of physical and chemical characteristics of soil and on topographic and conservation features of the landscape. The most significant characteristics considered are depth, texture, structure, organic matter, fertility, reaction, drainage, moisture-holding capacity, erosion, stoniness, and slope. Soils are commonly ranked into five classes (first, second, third, fourth, and fifth), first-class

soils being most productive and fifth-class soils being least productive.[1]

First-class (I) soils are very productive, easily worked, and possess simple problems with conservation.

Second-class (II) soils are moderately productive, less workable, with more conservation problems than class I.

Third-class (III) soils are adverse to productivity, workability, with greater conservation problems. Intense management practices are required, and growth of field crops is impractical.

Fourth-class (IV) soils are not suitable for growth of crops but may be moderately productive for pasture.

Fifth-class (V) soils are not suitable for crops or pasture; forestry is best use of the land.

2. Land-Use Types for Potential Agricultural Productivity

The land-use categories identify areas on the reservation possessing relative potential for food and fiber production (Overlay 3, Section 8). Soil classes provide the basis for summarizing land-use potential for agricultural purposes. The broader categories of land type are as follows:

Type 1: Land is characterized by favorable productivity, workability, and minimum problems of conservation; land consists of soil classes I, II, and III. Approximately 15% of the land on the Oak Ridge reservation qualifies as land type 1.

Type 2: Land is characterized by moderate productivity but possesses unfavorable workability; frequent problems with conservation are encountered; land consists of soil class IV. Approximately 35% of the reservation is land type 2.

Type 3: Land is not suitable for agriculture; land is best suited for forest management; land consists of soil class V. Approximately 50% of the reservation is land type 3.

Reference

1. M. E. Swann et al., Soil Survey of Roane County, Tennessee, USDA Document Ser. 1936, No. 15, 1942.

C WATERCOURSES

The main bodies of water of the Oak Ridge reservation are described in this section.

1. White Oak Creek and White Oak Lake

White Oak Creek basin has an area of 6.53 sq. miles (16.9 km^2). The headwaters of White Oak Creek originate on the forested slopes of Chestnut Ridge, north of ORNL. Numerous springs intersecting with the upper reaches of White Oak Creek provide a relatively stenothermic aquatic environment. Stream width varies from 2.0 to 4.0 ft (0.6 to 1.2 m), and depth, from 3.9 to 9.8 in. (10 to 25 cm). Stream-bed substrate is predominately rocks of 2.0 to 3.2 in. (5 to 8 cm) diameter with some exposed bedrock.

After approximately 1.55 miles (2.5 km) of flow, White Oak Creek enters the confines of ORNL in Bethel Valley. A substantial part of the flow in White Oak Creek is waste-water from ORNL. Gravel substrate predominates. The Melton Branch tributary of White Oak Creek drains 1.48 sq. miles (3.83 km^2) in Melton Valley and enters White Oak Creek 1.55 miles (2.5 km) above the Clinch River. Melton Branch bottom is mainly gravel with a few clay portions. Both creeks receive additional drainage and leachates from ORNL chemical and solid and liquid radioactive-waste disposal areas.

Before converging with the Clinch River (CRM 20.8), White Oak Creek flows into White Oak Lake, a 20-acre (8-ha) impoundment formed in 1943. White Oak Lake serves as the final settling basin for ORNL waste management. Bottom sediments are primarily silt and mud contaminated with low levels of radioactivity. The waters of White Oak Lake spill over White Oak Dam with a discharge of 15 cfs (425 liters/sec) 80% of the time. The creek meanders for approximately 0.6 mile (1 km) and empties directly into the Clinch River. Gravel and clay–mud substrates are the predominate bottom material in White Oak Creek below the dam.

Because most of the basin is underlain by the Rome formation and Conasauga group, the base-flow discharge of White Oak Creek is low, and, at times in late fall, periods of no natural flow have occurred. The belt of Knox dolomite underlying Chestnut Ridge, which forms the northwestern drainage divide of the basin, is the principal water-bearing formation. Several springs along the base and in the Ridge valleys are tributaries to White Oak Creek. Ninety percent of the White Oak Creek dry-weather discharge originates as groundwater discharge from the Knox dolomite of Chestnut Ridge, the Chickamauga limestone of Bethel Valley, and ORNL plant effluent.

2. Clinch River

The Clinch River, with a drainage area of 4412 sq. miles (11,430 km^2), is the major source of water used in the Oak Ridge area. The section of the Clinch River directly adjoining the DOE area extends from CRM 43.6 on Melton Hill reservoir to CRM 9.3. The Clinch River flows into the Tennessee River at Tennessee River Mile (TRM) 567.7.

River flow in the 34-mile (54-km) stretch (CRM 43.6 to 9.3) along the south and west boundaries of the DOE reservation is regulated principally at Melton Hill Dam (CRM 23.1). Melton Hill reservoir extends approximately 43 miles (70 km) upstream (to CRM 67), with a shoreline of 143 miles (230 km), a surface area of 5718 acres (2315 ha), and a maximum width of 0.8 mile (1.3 km). Flow below the Melton Hill Dam since 1963 has averaged 7800 cfs (220,700 liters/sec). The maximum daily average release was 26,900 cfs (761,270 liters/sec) on Mar. 16, 1973. Since the closure of the dam in 1963, there has been an average of 46 days per year on which no water was released from Melton Hill Dam.

Water flow in the Clinch River below Melton Hill Dam is affected by the operation of Watts Bar Dam, located at TRM 529.9, 38 miles (60.9 km) downstream from the mouth of the Clinch River. Before construction of Melton Hill Dam, Watts Bar reservoir extended upstream to CRM 28.

The Clinch River is a highly turbid, hardwater system, but water quality generally complies with Tennessee State water-quality standards. Bottom composition varies throughout the 34-mile (54-km) stretch (CRM 43.6 to 9.3). Substrates range from silt-clay and fine sand to coarse sand and gravel. Construction of the Melton Hill Dam altered the sediment regime, resulting in the deposition of the silt, clays, and fine-grained materials in the slower waters above the dam. Waters below the dam, therefore, have a lower concentration of suspended solids, and substrates are of coarse-grained sands and gravels.

3. Scarboro Embayment

Scarboro embayment, formed by Melton Hill reservoir at CRM 41.2, is about 0.6 mile (1 km) long, with an average width of 328 ft (100 m). It lies roughly parallel to Haw Ridge in Bethel Valley and is separated from the reservoir proper by a highway fill with two 4.6-ft(1.4-m)-diameter culverts. North of Haw Ridge the embayment is further divided, forming an east and a west arm that are connected by a culvert.

The east arm of Scarboro embayment is bordered on the north by the Comparative Animal Research Laboratory (CARL), which consists of a complex of research and livestock-holding facilities. The surrounding fields of this area slope toward the embayment at less than 5%. Haw Ridge, forested by secondary-growth deciduous trees, borders the south shore of Scarboro embayment. The east arm of Scarboro embayment has a maximum depth of 6.6 ft (2 m). The entire embayment is covered with a layer of silty bottom sediments. Scarboro Creek flows into the east arm of Scarboro embayment from a north-northeast direction.

The west arm of Scarboro embayment is bordered by pasture on the north and west and by Haw Ridge on the south. The land use, slopes, water depth, and bottom sediments are similar to those reported for the east arm. Kerr Hollow Branch flows into the western portion of this embayment from a northwest direction.

4. McCoy Embayment

McCoy embayment is formed by Melton Hill reservoir at CRM 37.4. McCoy embayment receives flow from McCoy Branch from the northeast and an unnamed tributary from the northwest. McCoy embayment runs through a gap in Haw Ridge and is separated from the reservoir proper by a highway fill with two 4.6-ft(1.4-m)-diameter culverts. Depth in the embayment is approximately 9.8 ft (3 m). Gravelly substrate exists near the ridge slopes; a mud substrate exists in most other areas. The land surrounding McCoy embayment is forested except for CARL pastures in Bethel Valley to the north.

5. Bear Creek

Bear Creek flows in a southwest direction from the Y-12 Plant to White Wing Road (State Highway 95) through second-growth hardwood forests and late-successional old fields. At White Wing Road, Bear Creek turns northwest for the final 2 miles (3.2 km) of the approximately 7-mile (11.3-km) course, converging with East Fork Poplar Creek at mile 1.5. Stream width from Y-12 to the mouth of Bear Creek increases from 3 to 15 ft (0.9 to 4.6 m), and depth, from 4 in. to 3 ft (0.1 to 0.9 m). Bear Creek basin has a drainage area of 7.4 sq. miles (18.3 km^2). About 65% of the basin is wooded; the open land is mostly old fields. Several small perennial springs flow into Bear Creek from the limestone beds in the upper part of the Conasauga formation and Knox dolomite in Bear Creek Valley. Rome formation occurs in the northern part of Bear Creek Valley. Residual soils in the valley consist of silt, sand, and coarse-textured material with small amounts of micaceous clay.

Stream habitat varies little as Bear Creek flows through Bear Creek Valley. The narrow stream flows over clay and rock substrate covered by precipitates and a floc of aluminum hydroxide. The natural water flow in Bear Creek is augmented by discharges of Y-12 industrial wastewater and seepages from Y-12 acid settling ponds and sanitary landfills.

6. Poplar Creek

Poplar Creek, with a 136-sq. mile (352-km^2) drainage area, is the largest stream flowing into the Clinch River from the Oak Ridge reservation. Poplar Creek flows generally southwest for 24.8 miles (40 km) from the Cumberland Mountain section of the Appalachian Plateau province, through the Valley and Ridge province around Oak Ridge, to the Clinch River (at CRM 12.0). About 65% of the total basin is wooded, and the remainder is largely farmland. Coal mining, principally by the stripping method, is extensive in the Cumberland Mountain part of Poplar Creek basin. The headwaters are adversely affected in many areas because of acid mine drainage. Undetermined amounts of domestic sewage from several small communities in the Upper Poplar Creek basin are discharged into the stream. The largest development in the basin is Oliver Springs, which has a population of about 4000.

Poplar Creek, upon entering the DOE Oak Ridge reservation, is characteristically turbid, with high concentrations of dissolved and suspended particulate matter but with satisfactory water quality. Stream width averages 49.2 ft (15 m), and depth, 9.8 ft (3 m). The drainage area doubles in extent from the time the creek flows past Oliver Springs until it enters the Clinch River. Watts Bar Dam at

TRM 579.9 backs up water in Poplar Creek to Poplar Creek Mile (PCM) 3.5. Stream slope substrates consist of a mud–clay mixture. Bottom substrates vary with the fluctuations in Watts Bar reservoir water storage. Principal substrates are large sand to gravel-sized coal grains.

Poplar Creek enters the Oak Ridge reservation at mile 5.8. East Fork Poplar Creek meets Poplar Creek at mile 5.5 and is a major source of water pollutants in Poplar Creek. Most of Poplar Creek basin is underlain by shale and sandstone of low water-bearing capacity. Knox dolomite, which outcrops mostly in the southeastern part of the basin, occupies only about 5% of the basin surface area but is the source of all large springs in the basin.

7. East Fork Poplar Creek

The headwaters of East Fork Poplar Creek originate on the northwestern slopes of Chestnut Ridge in the vicinity of the Y-12 Plant. Streamflow is controlled by New Hope Pond, approximately 0.5 acre (0.2 ha), on the east side of the Y-12 Plant which serves as a settling basin.

East Fork Poplar Creek below New Hope Pond runs through the Y-12 Plant area for 0.3 mile (0.5 km) and is confined by 8-ft(2.4-m)-high riprapped streambanks of limestone rock. Stream substrate also consists of limestone rocks with some interspersed gravel. The pool immediately downstream from the dam averages about 15 ft (4.6 m) in width and 3 ft (0.9 m) in depth. Pools and riffles alternate, with a maximum depth in the pools of about 2 ft (0.6 m). Stream width varies from 10 to 15 ft (3 to 4.6 m).

East Fork Poplar Creek, after leaving the Y-12 Plant area, flows northwest through densely forested secondary-growth hardwoods. The predominant substrate is 1- to 4-in. (2.5- to 10.2-cm) rocks. Stream width varies from 10 to 25 ft (3.0 to 7.6 m). Average stream gradient is about 21 ft/mile (4 m/km). At the Oak Ridge Turnpike (State Highway 95), East Fork Poplar Creek turns southwest and passes through several large pastures before entering hardwood forests. The Oak Ridge sewage-treatment plant (west) is located on EFPCM 8.5. Substrates above the sewage-treatment plant are primarily gravel.

D VEGETATION

Vegetation maps provide information useful in several contexts. For example, the ecosystem approach to land management is based on natural vegetation. Moreover, vegetation is an indicator of geologic, pedologic, topoclimatic, and hydrologic characteristics. A knowledge of regional plant communities is important to planning inasmuch as these communities reduce air, noise, and water pollution, are important in controlling erosion and sedimentation, and determine the esthetics of the landscape. Furthermore, the distribution of plant types is a major factor in hazard mapping (such as fire potential and radionuclide or pollutant distribution) and is basic to determining and managing wildlife habitat.

Vegetation maps are inventories of plant cover-type units existing at a given time and place. From such maps the spatial distribution of vegetation types in the landscape can be determined. An evaluation can then be made of what is valuable and desirable and what is not. Vegetation maps also provide a means for analyzing the natural environment. Once correlations are made between vegetation cover types and environmental parameters, the influence of such parameters can often be deduced from the vegetation. Hence vegetation maps show units of vegetation and, directly or by implication, the quality of the sites on which they grow.

Present analysis of the vegetation, based on preliminary mapping (none included in this document), incorporates (presently) eight categories: Pine, Hemlock and/or White Pine, Cedar, Bottomland, Upland, and Northern Hardwoods, Non-Forest, and Water. Although the mapping does not provide the amount of detail that either larger scales or differing conceptual interpretations might, it is believed that the result is a valuable and extremely useful tool for both short- and long-term land-use planning for facilities, programmatic research, and ancillary activities on the Oak Ridge reservation.

Vegetation types on the reservation are described in the following paragraphs.

Yellow Pine/Yellow Pine–Hardwoods. Presently this is the most extensive type on the reservation, occupying large areas in all sectors, but particularly abundant in the northwest region. Natural forests dominated by shortleaf pine (*Pinus echinata*) and Virginia pine (*Pinus virginiana*) are associated with large tracts of planted loblolly pine (*Pinus taeda L.*), a valuable timber species. The loblolly pine plantations are monocultures, whereas associated species in the successional forests include oaks (*Quercus* spp.), hickories (*Carya* spp.), and tulip poplar (*Liriodendron tulipifera*).

Hemlock and/or White Pine/Hemlock and/or White Pine with Hardwoods. This type, representing a Southern Appalachian extension of a northern (and higher elevation) forest, is extremely restricted on the reservation. Small areas on Pine Ridge, Black Oak Ridge, Haw Ridge, McKinney's Ridge, and north of Melton Hill Dam, all on the western half of the reservation, are virtually all that remain. Total area is estimated to be no more than 99 acres (40 ha). Dominant species are hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*).

Cedar and Cedar Pine/Cedar–Hardwoods. This type is extensive on the reservation, predominating in Bethel Valley and in southern areas adjacent or close to the Clinch River and Melton Hill reservoir. Although not uncommon anywhere, the area of this type decreases markedly north of Bear Creek Road. The type is best developed on limestone (or dolomite) and appears rapidly following disturbance. Thus the present pattern reflects both substrate and the past history (recent) of land use. The dominant species is eastern red cedar (*Juniperus virginiana*), associated with

shortleaf and Virginia pine, tulip poplar, oaks, hickories, redbud (*Cercis canadensis*), sassafras (*Sassafras albidum*), and other hardwoods.

Bottomland Hardwoods. This type, restricted to small floodplains along creek bottoms, is rare on the Oak Ridge reservation. Small areas occur along Robert's Branch, Gum Hollow Creek, Bear Creek, and Grassy Creek, with larger areas along White Oak Creek and in the reservation portion of the East Fork Poplar Creek drainage. All of the type exists in the western two-thirds of the reservation. Much of this type has been planted and includes cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), elm (*Ulmus americana*), ash (*Fraxinus* spp.), willow (*Salix* spp.), silver maple (*Acer saccharinum*), and red maple (*Acer rubrum*).

Upland Hardwoods. This type is important on the reservation, occupying roughly 20% of the total land area. Largest concentrations occur on Black Oak, East Fork, Pine, Chestnut, and Copper ridges. Scattered patches occur almost throughout the reservation area. This forest is essentially an oak–hickory complex, representative of the terminal type in this region of the eastern United States. Important species include chestnut oak (*Quercus prinus*), white oak (*Q. alba*), black oak (*Q. velutina*), northern red oak (*Q. rubra*), scarlet oak (*Q. coccinea*), post oak (*Q. stellata*), various hickories (*Carya* spp.) and ash (*Fraxinus* spp.), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), dogwood (*Cornus florida*), beech (*Fagus grandifolia*), and others. A showy vernal flora is characteristic of this type, and many common wildflowers in east Tennessee are virtually restricted to upland hardwood forests.

Northern Hardwoods. Northern hardwood forest is extremely rare on the Oak Ridge reservation, occurring in small areas only on Black Oak Ridge, on East Fork Ridge, and on Copper Ridge in the western part of the area. Composition is similar to the Upland Hardwood forest, with admixtures of sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), basswood (*Tilia heterophylla*), and buckeye (*Aesculus octandra*).

Nonforest. This is a variable category that includes primarily grassland, devegetated areas, and cultural features. The grasslands are of two types. Native or seminative successional areas are either maintained (e.g., under power-transmission lines) or are reverting to forest. Dominants include species of bluestem (*Andropogon* spp.), fescue (*Festuca* spp.), and bluegrass (*Poa* spp.). Cultivated grasslands are lawns and pastures. These predominate in and around the three plant areas (ORNL, Y-12, and ORGDP) and on CARL lands at the eastern extremity of the reservation. Grasses include fescues, bluegrass, and orchard grass (*Dactylis glomerata*) with other species.

Large tracts of bare soil occur along the shorelines of Melton Hill and Watts Bar reservoirs. These are maintained seasonally owing to controlled fluctuation in water levels in the reservoirs.

Cultural areas include roads, buildings, parking lots, railroads, power lines, and incidental items primarily associated with the three plants and CARL activities.

E TERRESTRIAL AND AQUATIC ANIMAL HABITATS

1. Distribution of Bird and Mammal Species in Terrestrial Habitats of the Oak Ridge Reservation

The variety of wooded and open areas, as well as extensive edge communities, creates favorable habitats for a wide variety of mammalian and avian species residing on the Oak Ridge reservation. Both bird and mammal fauna population densities are generally correlated with vegetation cover and type.

An important factor in determining whether a given species will, in fact, occur in a given area is the nature of the habitat in the area. Small mammals, such as rodents, may be confined to a single habitat type, whereas the larger sized species may range over several habitats in order to fulfill their existence requirements. The same can be said for avian populations. Most of the birds and mammals found on the Oak Ridge reservation have the capability of tolerating and adapting to a variety of habitats and therefore may be found in habitats other than those which are typical for the respective species. Habitat preference for average conditions is designated in Table 4-2, and representative animal species of the habitat types are described below.

Hardwood–Mixed Hardwood Habitat

Small-mammal populations in the upland forest types of the reservation have been sampled sporadically, usually as a part of collection programs for laboratory experiments. Six species common in oak–hickory, chestnut oak, and pine forest types were the white-footed mouse, eastern chipmunk, golden mouse, short-tailed shrew, flying squirrel, and house mouse. Both the red and the gray fox are common predators throughout the area. Opossum, raccoon, striped skunk, and bobcat inhabit numerous varied areas throughout the reservation but also roam extensively through the upland forest areas. White-tail deer are also inhabitants of upland and bottomland forests.

The upland forest, as typified by Walker Branch watershed, provides habitat for a large number of avian species. The yellow-shafted flicker is found in habitats where there are many large trees and a well-developed canopy and subcanopy. The red-bellied woodpecker is commonly found on all areas of the watershed. The hairy woodpecker shows a preference for habitats with a large number of tall trees. The downy woodpecker selects plots that have more than the average number of saplings. The crow is not found in large numbers on the watershed, but it uses the deciduous forest as part of its search area.

Birds typically select habitats on the basis of structure and food resources. The blue jay selects areas with a dense understory and a well-developed canopy. The Kentucky warbler is somewhat more specialized and selects areas which have a more open overstory and which generally have smaller understory plants. The pine warbler selects areas with an open overstory comprised of trees with larger than average canopy and with smaller than average trees in the lowest canopy layers. The yellow-breasted chat is found on areas with dense overstory vegetation and an open sub-canopy layer and where understory plants are smaller than average. The ovenbird is found in habitats that exhibit an open tree canopy and a dense understory.

The Carolina chickadee and the tufted titmouse are considerably less selective of habitats. The scarlet tanager is distributed on sites with dense canopies. When the two tanager species are compared, the scarlet tanager is distributed according to canopy, and the summer tanager is distributed according to understory vegetation density.

A large number of raptorial birds use the woodlands on the reservation for nesting and hunting. The red-shoulder hawk and the redtailed and broad-winged hawks are common throughout the area.

Pine Plantation Habitat

Animal and bird populations of the pine communities of the reservation, particularly the plantations, have not been sampled as extensively as those of the hardwood or grassland areas. A recent survey of the small-mammal inhabitants of a pine stand and an associated transmission right-of-way indicates that only three species use the pine habitat to any great extent, the white-footed mouse, golden mouse, and short-tail shrew. Additional species were present (pine mouse, cotton rat, and harvest mouse), but their presence appeared to be a function of the edge community created by a transmission-line corridor. Large mammals, gray squirrels, opossum, deer, and predators probably take shelter in this type of habitat.

Avian species had a low preference for the pure pine areas bordering the transmission-line corridor. The pine warbler (*Dendroica pinus*) and the white-throated sparrow (*Zonotrichia albicollis*) were very common, but few other species were heard or seen during the early morning surveys.

Old-Field and Grassland Habitat

Mammalian species inhabiting old-field or disturbed areas are quite similar, whether the vegetative cover is early grass-forb or the later tree seedling–woody shrub successional stages. The small-mammal community structures indicative of these habitats were determined for a 0.4-acre (0.16-ha) area in the vicinity of the Oak Ridge Gaseous Diffusion Plant. Small mammals recently trapped from this habitat type were cotton rats, white-footed mice, golden mice, rice rats, short-tailed shrews, and eastern harvest mice. Early grassland stages of old-field areas are used by some game birds, such as quail, for courtship displays and breeding purposes. Raptorial species generally use the old-field areas for hunting purposes.

Selection by bird species for old-field and grassland habitat was similar to that observed on many of the transmission-line corridors, particularly when the corridor runs through another habitat type. Sparrows, towhees, blue grosbeaks, and other field species tend to select for the vegetation within the corridor.

2. Unique or Endangered Vertebrate Species

Two species considered endangered by the U. S. Department of the Interior have been observed on or around the reservation. The southern bald eagle (*Haliaeetus l. leucocephalus*) has been sighted numerous times, most recently along both Melton Hill Lake (June 1974) and Watts Bar Lake (May 1974). It nests in large trees along waterways, but no nest has been observed, and its status on the reservation is unknown. During the past 30 years, numerous reports of individuals' seeing an eastern cougar have surfaced. Twenty such sitings of the long-tailed cats were reported from 1976 through 1978. A number of these reports are highly reliable; so it appears that the Oak Ridge reservation is within the established territory of one or more eastern cougars. The actual status of this animal on the reservation has not been determined.

3. Representative Plants and Animals of the Clinch River

The 34-mile stretch of the Clinch River from CRM 43.6 to 9.3 (70.2 to 15.0 km) represents a variety of different ecological habitats. The changing water levels, resulting from operation of Melton Hill and Watts Bar dams, and high levels of turbidity limit the degree to which rooted aquatic plants can permanently become established. Submergent plants, which are generally distributed in the slower moving waters of Melton Hill reservoir and Watts Bar Lake, include *Potamogeton, Chara,* and *Najas*. Shallow waters at the mouths of inflowing tributaries and along the Clinch River above Solway Bridge CRM 43.8 (70.5 km) support *Elodea* and *Myriophyllum* (Milfoil).

Phytoplankton populations have been found to exhibit two major growth pulses. The first usually occurs in late spring and is followed by a second pulse in late summer or early fall. Cryptophytes (e.g., *Rhodomonas minuta*, a unicellular flagellate) are abundant and exhibit considerable spatial and temporal constancy, whereas diatoms (*Cyclotella* sp. and *Synedra delicatissima*), greens (*Carteria* sp. and *Ankistrodesmus falcatus*), and blue-greens (*Schizothrix*) bloom sporadically within two growing seasons. Diatoms are an important component of the phytoplankton community during the winter.

Table 4-2 TYPICAL HABITAT TYPES FOR ANIMALS AND BIRDS OF THE OAK RIDGE RESERVATION

Name	Genus	Species	Streams and swamps	Old field	Pine	Flood-plain forest	Mesic forest	Xeric forest
		AVES						
COMMON LOON	GAVIA	IMMER	X	X				
		PODICIPITIFORM						
PIED-BILLED GREBE	PODILYMBUS	PODICEPS	X	X				
		CICONIIFORMES						
GREAT BLUE HERON	ARDEA	HERODIAS	X	X				
CATTLE EGRET	BUBULCUS	IBIS						
GREEN HERON	BUTORIDES	VIRESCENS	X	X				
COMMON EGRET	CASMERODIUS	ALBA	X	X				
		ANSERIFORMES						
WOOD DUCK	AIX	SPONSA	X	X				
PINTAIL	ANAS	ACUTA	X	X				
GREEN-WING TEAL	ANAS	CAROLINENSIS	X	X				
BLUE-WING TEAL	ANAS	DISCORS	X	X				
MALLARD	ANAS	PLATYRHYNCHOS	X	X				
BLACK DUCK	ANAS	RUBRIPES	X	X				
GADWALL	ANAS	STREPERA	X	X				
LESSER SCAUP	AYTHYA	AFFINIS	X	X				
REDHEAD	AYTHYA	AMERICANA	X	X				
RING-NECK DUCK	AYTHYA	COLLARIS	X	X				
CANVASBACK	AYTHYA	VALISINERIA	X	X				
CANADA GOOSE	BRANTA	CANADENSIS	X	X				
BUFFLEHEAD	BUCEPHALA	ALBEOLA	X	X				
COMMON GOLDENEYE	BUCEPHALA	CLANGULA	X	X				
HOODED MERGANSER	LOPHODYTES	CUCULLATUS	X	X				
AMERICAN WIDGEON	MARECA	AMERICANA	X	X				
COMMON MERGANSER	MERGUS	MERGANSER	X	X				
RED BREASTED MERGANSER	MERGUS	SERRATOR	X	X				
RUDDY DUCK	OXYURA	JAMAICENSIS	X	X				
		FALCONIFORMES						
COOPER'S HAWK	ACCIPITER	COOPERII	X	X	X	X	X	X
SHARP-SHINNED HAWK	ACCIPITER	STRIATUS	X	X	X	X	X	X
RED-TAILED HAWK	BUTEO	JAMAICENSIS	X	X	X	X	X	X
RED-SHOULDERED HAWK	BUTEO	LINEATUS	X	X	X	X	X	X
BROAD-WINGED HAWK	BUTEO	PLATYPTERUS	X	X				
TURKEY VULTURE	CATHARTES	AURA	X	X	X	X	X	X
MARSH HAWK	CIRCUS	CYANEUS	X	X				
BLACK VULTURE	CORAGYPS	ATRATUS	X	X	X	X	X	X
SPARROW HAWK	FALCO	SPARVERIUS	X	X	X	X	X	X
BALD EAGLE	HALIAEETUS	LEUCOCEPHALUS	X	X	X	X		
OSPREY	PANDION	HALIAETUS	X	X	X	X		
		GALLIFORMES						
RUFFED GROUSE	BONASA	UMBELLUS	X			X	X	X
BOBWHITE	COLINUS	VIRGINIANUS	X			X	X	X
TURKEY	MELEAGRIS	GALLOPAVO	X			X	X	X
AMERICAN COOT	FULICA	AMERICANA	X	X				
COMMON GALLINULE	GALLINULA	CHLOROPUS	X	X				
		CHARADRIIFORME						
SPOTTED SANDPIPER	ACTITUS	MACULARIA	X	X				
COMMON SNIPE	CAPELLA	GALLINAGO	X	X				
KILLDEER	CHARADRIUS	VOCIFEROUS	X	X				
BLACK TERN	CHLIDONIAS	NIGER	X	X				

HERRING GULL	LARUS	ARGENTATUS	X	X				
RING-BILLED GULL	LARUS	DELAWARENSIS	X	X				
AMERICAN WOODCOCK	PHILOHELA	MINOR	X	X		X		
		COLUMBIFORMES						
ROCK DOVE	COLUMBIA	LIVIA		X				
MOURNING DOVE	ZENAIDURA	MACROURA		X				
		CUCULIFORMES						
YELLOW-BILLED DOVE	COCCYZUS	AMERICANUS				X	X	X
		CAPRIMULGIFORM						
CHUCK-WILL'S-WIDOW	CAPRIMULGUS	CAROLINENSIS			X	X	X	X
WHIP-POOR-WILL	CAPRIMULGUS	VOCIFEROUS				X	X	X
COMMON NIGHTHAWK	CHORDEILIS	MINOR		X				
		STRIGIFORMES						
GREAT HORNED OWL	BUBO	VIRGINIANUS				X	X	X
SCREECH OWL	OTUS	ASIO		X				
BARRED OWL	STRIX	VARIA	X	X		X	X	X
BARN OWL	TYTO	ALBA	X	X				
		APODIFORMES						
RUBY-THROATED HUMMINGBIRD	ARCHILOCHUS	COLUBRIS		X				
		PICIFORMES						
RED-BELLIED WOODPECKER	CENTURUS	CAROLINUS				X	X	X
YELLOW-SHAFTED FLICKER	COLAPTES	AURATUS		X				
DOWNY WOODPECKER	DENDROCOPUS	PUBESCENS		X				
HAIRY WOODPECKER	DENDROCOPUS	VILLOSUS				X	X	X
PILEATED WOODPECKER	HYLATOMUS	PILEATUS			X	X	X	X
RED-HEADED WOODPECKER	MELANERPES	ERYTHROCEPHALUS				X	X	X
YELLOW-BELLIED SAPSUCKER	SPHYRAPICUS	VARIUS		X				
		CORACIIFORMES						
BELTED KINGFISHER	MEGACERYLE	ALCYON	X	X				
		PASSERIFORMES						
RED-WINGED BLACKBIRD	AGELAIUS	PHOENICEUS	X	X				
BACHMAN'S SPARROW	AIMOPHILA	AESTIVA		X				
GRASSHOPPER SPARROW	AMMODRAMUS	SAVANNARUM		X				
CEDAR WAXWING	BOMBYCILLA	CEDROSUM		X				
PURPLE FINCH	CARPODACUS	PURPUREUS		X				
BROWN CREEPER	CERTHIA	FAMILIARIS				X	X	X
EASTERN WOODPEWEE	CONTOPUS	VIRENS				X	X	X
COMMON CROW	CORVUS	BRACHYRHYNCHOS		X		X	X	X
BLUE JAY	CYANOCITTA	CRISTATA		X		X	X	X
BAY BREASTED WARBLER	DENDROICA	CASTANEA			X			
CERULEAN WARBLER	DENDROICA	CERULEA	X			X	X	
MYRTLE WARBLER	DENDROICA	CORONATA		X	X	X	X	X
PRAIRIE WARBLER	DENDROICA	DISCOLOR				X	X	X
YELLOW-THROATED WARBLER	DENDROICA	DOMINICA				X	X	X
MAGNOLIA WARBLER	DENDROICA	MAGNOLIA					X	
CHESTNUT-SIDED WARBLER	DENDROICA	PENSYLVANICA		X				
YELLOW WARBLER	DENDROICA	PETECHIA		X				
PINE WARBLER	DENDROICA	PINUS				X	X	X
CATBIRD	DUMETELLA	CAROLINENSIS		X				
LEAST FLYCATCHER	EMPIDONAX	MINIMUS		X				
ACADIAN FLYCATCHER	EMPIDONAX	VIRESCENS				X	X	X
HORNED LARK	EREMOPHILA	ALPESTRIS	X	X				
YELLOW THROAT	GEOTHLYPIS	TRICHAS		X				
BLUE GROSBEAK	GUIRACA	CAERULEA		X				
WORM EATING WARBLER	HELMITHEROS	VERMIVORUS				X	X	X
EVENING GROSBEAK	HESPERIPHONA	VESPERTINA			X			
BARN SWALLOW	HIRUNDO	RUSTICA	X	X				
HERMIT THRUSH	HYLOCICHLA	GUTTATA				X	X	X

(Table continues on the following page.)

Table 4-2 (Continued)

Name	Genus	Species	Streams and swamps	Old field	Pine	Flood-plain forest	Mesic forest	Xeric forest
WOOD THRUSH	HYLOCICHLA	MUSTELINA				X	X	
YELLOW-BREASTED CHAT	ICTERIA	VIRENS				X	X	X
ORCHARD ORIOLE	ICTERUS	SPURIUS		X				
SLATE-COLORED JUNCO	JUNCO	HYEMALIS				X	X	X
LOGGER-HEAD SHRIKE	LANIUS	LUDOVICIANUS		X				
SWAINSON'S WARBLER	LIMNOTHLYPIS	SWAINSONII	X	X			X	
RED CROSSBILL	LOXIA	CURVIROSTRA	X				X	X
SONG SPARROW	MELOSPIZA	MELODIA		X				
MOCKING BIRD	MIMUS	POLYGLOTTOS	X	X				
BLACK-AND-WHITE WARBLER	MNIOTILTA	VARIA				X	X	X
BROWN-HEADED COWBIRD	MOLOTHRUS	ATER		X				
GREAT CRESTED FLYCATCHER	MYIARCHUS	CRINITUS				X	X	X
WHISTLING SWAN	OLOR	COLUMBIANUS	X					
KENTUCKY WARBLER	OPORORNIS	FORMOSUS				X	X	
PARULA WARBLER	PARULA	AMERICANA				X	X	X
TUFTED TITMOUSE	PARUS	BICOLOR		X				
CAROLINA CHICKADEE	PARUS	CAROLINENSIS		X				
ENGLISH SPARROW	PASSER	DOMESTICUS		X				
HENSLOW'S SPARROW	PASSERHERBULUS	HENSLOWI		X				
INDIGO BUNTING	PASSERINA	CYANEA		X				
ROSE-BREASTED GROSBEAK	PHEUCTICUS	LUDOVICIANUS		X		X	X	X
RUFOUS-SIDED TOWHEE	PIPILO	ERYTHROPHTHALMUS		X				
SCARLET TANAGER	PIRANGA	OLIVACEA				X	X	X
SUMMER TANAGER	PIRANGA	RUBRA				X	X	X
BLUE-GRAY GNATCATCHER	POLIOPTILA	CAERULEA				X	X	
PURPLE MARTIN	PROGNE	SUBIS	X	X				
PROTHOROTARY WARBLER	PROTONOTARIA	CITREA	X			X		
COMMON GRACKLE	QUISCALUS	QUISCULA		X				
RUBY-CROWNED KINGLET	REGULUS	CALENDULA					X	X
GOLDEN-CROWNED KINGLET	REGULUS	SATRAPA					X	X
CARDINAL	RICHMONDENA	CARDINALIS		X		X	X	X
BANK SWALLOW	RIPARIA	RIPARIS	X	X				
EASTERN PHOEBE	SAYORNIS	PHOEBE		X				
LOUISIANA WATER THRUSH	SEIURUS	MOTACILLA	X	X				
OVENBIRD	SEIVURUS	AUROCAPILLUS				X	X	X
AMERICAN REDSTART	SETOPHAGA	RUTICILLA				X	X	
EASTER BLUEBIRD	SIALIA	SIALIS		X				
WHITE-BREASTED NUTHATCH	SITTA	CAROLINENSIS				X	X	X
PINE SISKIN	SPINUS	PINUS				X	X	X
AMERICAN GOLDFINCH	SPINUS	TRISTIS		X				
CHIPPING SPARROW	SPIZELLA	PASSERINA		X				
FIELD SPARROW	SPIZELLA	PUSILLA		X				
ROUGH WINGED SWALLOW	STELGIDOPTERYX	RUFICOLLIS	X	X				
EASTERN MEADOWLARK	STURNELLA	MAGNA		X				
STARLING	STURNUS	VULGARUS		X				
BEWICK'S WREN	THRYOMANES	BEWICKII		X				
CAROLINA WREN	THRYOTHORUS	LUDOVICIANUS		X				
BROWN THRASHER	TOXOSTOMA	RUFUM		X				
HOUSE WREN	TROGLODYTES	AEDON		X				
ROBIN	TURDUS	MIGRATORIUS		X				
EASTERN KINGBIRD	TYRANNUS	TYRANNUS	X	X				
BLUE-WINGED WARBLER	VERMIVORA	PINUS		X				
YELLOW-THROATED VIREO	VIREO	FLAVIFRONS				X	X	

WHITE-EYED VIREO	VIREO	GRISEUS				X	X	X
RED-EYED VIREO	VIREO	OLIVACEOUS				X	X	X
HOODED WARBLER	WILSONIA	CITRINA				X	X	
WHITE-THROATED SPARROW	ZONOTRICHIA	ALBICOLLIS		X				
		MAMMALIA						
		MARSUPIALIA						
OPPOSSUM	DIDELPHIS	MARSUPIALIS					X	X
		INSECTIVORA						
SHORT-TAILED SHREW	BLARINA	BREVICAUDA					X	X
LEAST SHREW	CRYPTOTIS	PARVA		X				
EASTERN MOLE	SCALOPUS	AQUATICUS		X				
SOUTHEASTERN SHREW	SOREX	LONGIROSTRIS					X	
		CHIROPTERA						
BIG BROWN BAT	EPTESICUS	FUSCUS		X		X	X	X
SILVER HAIRED BAT	LASIONYCTERIS	NOCTIVAGANS		X		X	X	X
RED BAT	LASIURUS	BOREALIS		X		X	X	X
HOARY BAT	LASIURUS	CINEREUS		X		X	X	X
KEEN'S MYOTIS	MYOTIS	KEENII		X		X	X	X
LITTLE BROWN BAT	MYOTIS	LUAFUGUS		X		X	X	X
INDIANA MYOTIS	MYOTIS	SODALIS		X		X	X	X
EVENING BAT	NYCTICEUIS	HUMERALIS		X		X	X	X
EASTERN PIPISTRELLE	PIPISTRELLUS	SUBFLAVUS		X		X	X	X
		LAGOMORPHA						
EASTERN COTTONTAIL	SYLVILAGUS	FLORIDANUS		X		X	X	X
		RODENTIA						
BEAVER	CASTOR	CANADENSIS	X	X		X	X	
SOUTHERN FLYING SQUIRREL	GLAUCOMYS	VOLANS					X	
WOODCHUCK	MARMOTA	MONAX		X				
WOODLAND VOLE	MICROTUS	PINETORUM		X				
HOUSE MOUSE	MUS	MUSCULUS		X				
GOLDEN MOUSE	OCHROTOMYS	NUTTALLI			X			X
MUSKRAT	ONDATRA	ZIBETHICUS				X		
MARSH RICE RAT	ORYZOMYS	PALUSTRIS	X	X				
WHITE-FOOTED MOUSE	PEROMYSCUS	LEUCOPUS					X	X
NORWAY RAT	RATTUS	NORVEGICUS		X				
EASTERN HARVEST MOUSE	REITRODONTOMYS	HUMULIS		X				
GRAY SQUIRREL	SCIURUS	CAROLINENSIS				X	X	X
HISPED COTTON RAT	SIGMODON	HISPIDUS	X	X				
EASTERN CHIPMUNK	TAMIAS	STRIATUS					X	X
		CARNIVORA						
BOBCAT	LYNX	RUFUS	X	X		X	X	X
STRIPED SKUNK	MEPHITIS	MEPHITIS		X				
LONG-TAILED WEASEL	MUSTELA	FRENATA		X		X	X	
MINK	MUSTELA	VISON		X				
RACCOON	PROCYON	LOTOR	X	X		X	X	X
GRAY FOX	UROCYON	CINEREOARGENTIU	X	X		X	X	X
RED FOX	VULPES	FULVA	X	X		X	X	X
		ARTIODACTYLA						
WHITE TAILED DEER	ODOCOILEUS	VIGINIANUS	X	X		X	X	X

N=212

Periphyton

The riverine periphyton community consists primarily of diatoms from late fall through early spring. With an increase in water temperature, the composition of the community shifts, and the green and blue-green algae increase in abundance during the summer and early fall. Maximum periphyton abundance (both cell numbers and biomass) also occurs during this period. Common diatoms include *Melosira varians, Gomphonema olivaceum, Cymbella affinis*, and *Navicula crytocephala*.

Zooplankton

Stable zooplankton communities are not able to develop in a flowing river system. The prime areas where zooplankton populations of the Clinch River develop are in slower waters of the Melton Hill reservoir and in backwaters within the main river and incoming tributaries. The abundance of zooplankton in other parts of the Clinch River is dependent on recruitment from these "dead" water zones. Zooplankton populations in flowing waters are therefore often highly variable. The zooplankton communities in the limnetic habitats of Melton Hill reservoir would tend to stratify, and dam discharge may not include all the strata.

Zooplankton communities and species often display a marked seasonal variation. In the Clinch River, maximum zooplankton densities occur in early summer and fall. Rotifers tend to be dominant for most of the year, reaching their lowest diversity and abundance during the colder months and their highest levels from early spring through summer. The most abundant genera are *Polyartha, Branchionus*, and *Keratella*. Although crustaceans (cladocerans and copepods) are an important component of lacustrine zooplankton communities, they are rarely abundant in the open waters of rivers, such as the Clinch River below Melton Hill Dam. Both groups are most abundant from April through October. The dominant cladoceran in both the Melton Hill reservoir and the Clinch River below the reservoir is *Bosmina longirostris.*

Forty species of zooplankton were identified in Melton Hill reservoir. Fifty percent of those identified were Rotifera; the remaining species were Cladocera and Copepoda. The most abundant cladoceran was *Bosmina longirostois.*

Benthic Macroinvertebrates

Benthic macroinvertebrate communities in the lower Clinch River are generally low to moderately diverse. The families Tubificidae (Oligochaeta) and Chironomidae (Diptera) comprised 44 and 24%, respectively, of the benthos found in samples collected near Poplar Creek. Peak densities of benthic macroinvertebrates occurred during the summer months.

Distribution of benthic macroinvertebrates appears related to the particle-size composition of the sediment. *Corbicula* clams are the most abundant organisms at stations having the largest particle size (coarse sand through gravel–boulder). In sediments predominately composed of the smallest particle sizes (fine sand through silt and clay), the oligochaete *Najas* are the most abundant. Chironomidae are most abundant where sediment is mostly fine to medium sand type. Where sediment was fairly evenly distributed in size from medium sand to silt-clay, *Corbicula, Najas,* and Chironomidae are present, and none of these groups show predominance.

Other macroinvertebrates found in the Clinch River are annelids, arthropods (insects and crustaceans), and coelenterates. Hydra (phylum coelenterata) is the dominant organism. *Corbicula,* which feeds on phytoplankton and is not substrate selective, is the dominant macroinvertebrate in terms of biomass.

Fish

Fish represent the highest trophic level in most aquatic ecosystems and as such hold a conspicuous position as indicators of the general condition of the ecosystem.

Predominate species of the Clinch River in the vicinity of the Oak Ridge reservation are gizzard shad (*Dorosoma cepedianum*), threadfin shad (*Dorosoma petenense*), skipjack herring (*Alosa chrysochloris*), carp (*Cyprinus carpio*), smallmouth buffalo (*Ictiobus bubalus*), white bass (*Morone chrysops*), white crappie (*Pomoxis annularis*), sauger (*Stizostedion canadense*), and freshwater drum (*Aplodinotus grunniens*).

The standing fish crop for Melton Hill reservoir in 1964 was estimated by TVA (after two rotenone samples) to be 104 pounds per acre (116 kg/ha) total fish. Of this, 10 lb/acre were game fish; 14 lb/acre rough fish; and 80 lb/acre forage fish.

Results of ichthyoplankton (fish eggs and larvae) studies conducted near Poplar Creek in 1978 suggest that this tributary of the Clinch River is an important spawning area for clupeids (shad) and *Morone* (probably white bass). Larvae of other fishes, including carp, crappie, sauger, sunfishes, buffalo, and suckers, were also collected in both the creek and river.

F IMPORTANT NATURAL AREAS, ARCHEOLOGICAL SITES, ANTIQUITIES, AND CEMETERIES

The purpose of this land-use category is to identify those areas which should be preserved in a relatively undisturbed state and which possess unusual and important biotic associations noteworthy for their rareness, uniqueness, or endangered status. Protection afforded by the Oak Ridge reservation has resulted in the preservation of several natural areas whose species composition and/or stage of development make them of considerable scientific value. Continued protection of unique and natural areas is one

objective of the land-use plan. Overlay 4, Section 8, shows the locations of the natural areas (including protective zones), potential archeological sites,[1] and other cultural features presently included in these categories. The numbers on the map are keyed to brief descriptions contained in this section. Entries in this classification are expected to increase as the continued research identifies unique wildlife areas. Certain biotic associations are also designated for protection because they are representative of the regional biogeography. In addition to their historical and archeological value, burial grounds, antiquities, and cemeteries frequently exhibit unique and characteristic ecologic communities (Overlay 4, Section 8). Cemeteries have been protected since the Federal Government acquired the land in the 1940s.

1. Criteria for Identification of Unique Natural and Cultural Areas

As the development of environmental and ecology research has progressed on the Oak Ridge reservation, natural areas and reference areas have been established to guarantee habitat for rare or endangered plant and animal species and to preserve areas representative of the region's natural resources. Natural areas denote a land unit that is a habitat for a regionally unique plant or animal species. The reference areas provide research sites for activities related to predicting fluctuations in the structure and function of natural systems. Monitoring sites are needed to measure changes in the background levels of various environmental pollutants, particularly those transported long distances through the atmosphere. Reference areas also serve as sites from which baseline measurements can be taken and compared with measurements from manipulated sites. Reference areas permit data to be collected (1) on areas with little human influence; (2) over as long a temporal scale as possible; (3) over as wide a spatial scale as possible; and (4) on numerous physical, chemical, and biotic variables.

Designation in this category excludes the area from forest-management activities and intensive use for environmental research. However, unique natural areas will continue to remain available for nondestructive or nonmanipulative ecological research. Natural areas indicated to be worthy of preservation are identified in the field and on master land-use maps. These areas are then excluded from other use (e.g., forestry management or environmental research requiring significant disturbance) and designated for restricted access. A program of periodic reinventory will be established to provide for updating of status.

2. Significance of Unique Natural and Cultural Areas

The significance of this land-use category is the required commitment to preserve the unique or representative biotic features and archeological and other cultural features of the reservation for research and education of present and future generations. This is consistent with recommendations of select federal councils and panels. The National Environmental Policy Act of 1969 and Public Law 93-205, 1973, have obligated the Federal Government and federal research institutions to "preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice." Tennessee State Senate Bill 366, Natural Areas Preservation Act of 1971, embraces the same philosophy but divides the areas to be preserved into Scenic–Recreational and Natural–Scientific.

3. Rare and Endangered Species

In compliance with federal guidelines, plants occurring on the DOE Oak Ridge reservation which are considered rare, threatened, or of special concern have been located, identified, and provided protection. At present nine candidate species are known to occur in the area. Efforts are being made to locate additional species that have been casually observed and reported but not verified by voucher specimens. The purpose of this activity is to summarize present knowledge of the occurrence and distribution of threatened and endangered plant species for long-range management decisions of the DOE Oak Ridge reservation.

The status of rare plants on the DOE Oak Ridge reservation is summarized in Table 4-3. The three categories (rare, threatened, and special concern) are defined as follows:

Rare: Species that presently occur infrequently and are few and widely separated (possibly because of habitat destruction or commercial exploitation).

Threatened: As described by Tennessee Committee for Rare Plants (1978), species likely to become endangered in the immediately foreseeable future as a result of present rapid habitat destruction or commercial exploitation.

Special concern: Plants listed by Tennessee Committee for Rare Plants (1978) as requiring particular attention because they are at the limit or near-limit of the geographic range in Tennessee or because their status is undetermined owing to insufficient information.

Within the sheltered north-facing coves of Haw Ridge (Area 20) golden seal (*Hydrastis canadensis*) occurs. Since this plant is rare, its habitat should receive as much protection as possible. This unique area is important as a reference area, and it serves as a biological refuge in a heavily developed region.

4. Important Natural Areas

Although plant species characteristic of Braun's[2] mixed mesophytic forest associations commonly occur in cooler, more moist regions in the mountains and to the north, they are unusual in the Valley and Ridge province. But many of the relatively undisturbed, steep north-facing slopes, steep-sided coves, and some gently sloping sheltered coves on the

Table 4-3 PLANTS OF THE OAK RIDGE RESERVATION THAT ARE RARE, THREATENED, OR OF SPECIAL CONCERN

Genus species and authority	Family	Common name	List	Status	Flower	Seed	Habitat
Cimicifuga rubifolia Kearney	Ranunculaceae	Bugbane	USDI-*Fed. Reg.**	Threatened	August	August	Rich, sheltered, steep limestone bluff
			USDA-SCS†	Threatened			
Delphinium exaltatum Aiton	Ranunculaceae	Tall larkspur	TCRP‡	Special concern	July–August	October	Dry, calcareous, open woodland
Fothergilla major (Sims) Lodd	Hamamelidaceae	Large *Fothergilla*	TCRP‡	Threatened	April–May	July–October	Dry woods
			Sharp§	Rare			
			USDA-SCS†	Rare			
Hydrastis canadensis L.	Ranunculaceae	Golden Seal	Sharp§	Rare	April–May	July	Rich woods
Lilium canadense L.	Liliaceae	Canada lily	TCRP‡	Threatened	June–July	July–August	Edge of woods
Panax quinquefolius L.	Araliaceae	Ginseng	Sharp§	Rare	June–July	August–October	Rich, cool, moist woods
			USDA-SCS†	Rare			
Philadelphus sharpianus Hu	Saxifragaceae	Sharp's mock-orange	Sharp§	Rare	May	June–September	Wooded, limestone bluff
Saxifraga careyana Gray	Saxifragaceae	Carey's saxifrage	USDI-*Fed. Reg.**	Threatened	April	June	Wooded, limestone bluff
			USDA-SCS†	Threatened			
Spiranthes ovalis Lindley	Orchidaceae	Lesser ladies' tresses	TCRP‡	Special concern	August–October	November	Moist, shady, rich woods
			USDA-SCS†	Rare			

*USDI, U. S. Department of the Interior, Threatened or Endangered Fauna or Flora, *Fed. Reg. (Washington, D. C.)*, 40(127) (1975).

†USDA, U. S. Department of Agriculture, *Rare, Threatened or Endangered Plant Species of Tennessee*, U. S. Department of Agriculture, Soil Conservation Service, Nashville, Tenn., May 1975.

‡J. L. Collins (TVA), H. R. DeSelm (UT), A. M. Evans (UT), R. Kral (Vanderbilt), and B. E. Wofford (UT), Tennessee Committee for Rare Plants, September 1976.

§A. J. Sharp, *Tennessee Conservationist*, July 1974.

reservation contain combinations of these species. The following important natural areas are scarce or absent in surrounding counties, but isolated pockets of representative mixed mesophytic forest associations do indeed occur on the reservation. Locations are shown on Overlay 4, Section 8.

(1) Cedar barrens (areas 7 and 9), which contain many prairie species, and mixed cedar stands (areas 22 and 24) occur throughout the reservation on calcareous soils, especially on the nearly level lower slopes on the south side of Chestnut Ridge. One example of an open barren is area 7; cedar is the dominant tree species, accompanied by white pine (*Pinus strobus*) and Virginia pine (*Pinus virginiana*). Associated tree species are winged elm (*Ulmus alata*), black walnut, oaks, redbud, hackberry (*Celtis* sp.), and ash (*Fraxinus* sp.). The area has a park-like appearance with the trees widely spaced and the ground cover mostly little bluestem (*Andropogon* sp.). Scattered species of aster (*Aster* sp.), goldenrod (*Solidago* sp.), beggar ticks (*Desmodium* sp.), and yucca (*Yucca smalliana*) are present also. Cacti (*Opuntia compressa*), aloe (*Agave virginica*), and rosinweed (*Silphium terebinthinaceum*) are herbaceous plants that occur in similar areas on other parts of the reservation as do redbud (*Cercis canadensis*) and Carolina buckthorn (*Rhamnus caroliniana*). Limestone ledges breaking through the shallow soil in this and other areas support a rich flora of mosses, lichens, and algae (*Nostoc* sp.). Rare and endangered plants that occur on the reservation in barrens and cedar stands include purple coneflower (*Echinacea purpurea*) and delphinium (*Delphinium exaltum*).

(2) On the upper slope and top of Copper Ridge (area 9) overlooking the western end of the reservation is an extensive old-field area containing several pure stands of sassafras, many of which are 5 in. in diameter or larger. Several mixed sassafras–black locust (*Robinia pseudoacacia*) stands containing an abundance of locust stump sprouts occur on the ridge top. Since sassafras is known to inhibit the invasion of many other species,[2] these unusually extensive stands will probably be persistent.

(3) West of Bearden Creek embayment (area 10) is an unusual old-field site dominated by pine with extensive mats of lichens and mosses forming the dominant ground cover. Reindeer moss (*C. subtenius*) is the most conspicuous lichen, but British soldiers (*Cladonia cristatella*) are abundant. Windswept moss (*Dicranum* sp.) is the most common moss. Another lichen, old man's beard (*Usnea* sp.), is unusually abundant in this area, covering the lower branches of many of the trees.

(4) A few areas on the reservation are dominated by white oak (*Quercus alba*), one of the original associations found in the Valley and Ridge province prior to settlement. The south slope of Chestnut Ridge north of Bethel Valley quarry (area 14) contains a watershed system that is

dominated by large second-growth white oak. This area has evidently not been disturbed for many years except perhaps by grazing livestock prior to 1942. The trees are widely spaced and not deformed by fire or wind damage. Pure stands of white oak and mixed white oak, chestnut oak, black and red oaks, and sugar maple (*Acer saccharum*) all 1 to 2 ft in diameter cover an area several acres in extent.

(5) Mixed mesophytic forest associations occur throughout the reservation (areas 1, 3, 5, 6, 15, 17, 19, and 21). These associations are some of the most varied and luxuriant in the eastern deciduous forests.

Area 15 is dominated by chestnut oak. Large tulip poplar, beech (*Fagus grandifolia*), and sugar maple are common; two species of magnolia (*Magnolia acuminata* and *M. tripetala*) and basswood (*Tilia americana*), white pine, and hemlock (*Tsuga canadensis*) also occur. The understory is very dense with extensive thickets of locally rare maple leaf viburnum (*Viburnum acerifolium*) and pawpaw (*Asimina triloba*) and one thicket of rhododendron (*Rhododendron maximum*). Herbaceous ground-cover species observed in the fall include several species of ferns [maidenhair (*Adiantum pedatum*), walking fern (*Asplenium rhizophyllum*), Christmas fern (*Polystichum acrostichoides*), etc.], hepatica (*Hepatica americana*), saxifrage, and many species of mosses and lichens growing over the vertical limestone outcroppings.

Two areas (1 and 6) contain species and communities that are very rare locally and are typical of Braun's generalized mixed mesophytic association found in the Appalachian Plateau. Area 6 and area 1 are similar in canopy species composition. On the lowest part of the slopes, basswood, sugar maple, and buckeye (*Aesculus* sp.) are dominant, with magnolias, oaks, elm (*Ulmus americana*), cherry (*Prunus serotina*), and tulip poplar as codominants. The shrub layer is very dense, but here it is composed mainly of pawpaw and sugar maple seedlings. Herbaceous plants uncommon in the Oak Ridge area include little brown jug (*Asarum canadense*), blue cohosh (*Caulophyllum thalictroides*), bugbane (*Cimicifuga racemosa*), doll's eyes (*Actaea pachypoda*), and walking fern. Other ground-cover species include several species of ferns, jack-in-the-pulpit (*Arisaema triphyllum*), rue anemone (*Anemone quinquefolia*), grape (*Vitis* sp.), hepatica, and Solomon's seal (*Polygonatum biflorum*).

Further up the slope of area 6, the overstory changes to sugar maple with a few hickories and oaks. There is an occasional beech, sweet gum, buckeye, and ironwood (*Ostrya virginiana*). The shrub layer is composed mainly of sugar maple seedlings but also contains spice bush (*Lindera benzoin*), strawberry bush (*Euonymus americanus*), hydrangea, and buckeye seedlings. Ground cover in this area is composed of bugbane, foamflower (*Tiarella cordifolia*), and a different species of little brown jug (*Hexastylis arifolium*).

The upper slope (area 6) is yet another mixed mesophytic association with beech and sugar maple as codominants. In this drier zone, cedars, hickories, tulip poplar, flowering dogwood, and sassafras also occur. The shrub layer is composed primarily of overstory tree seedlings. Extensive patches of parasitic beech-drops (*Epifagus virginiana*) occur under beech trees, but little other ground cover is present, consisting mainly of scattered Christmas ferns and Virginia creeper.

Another unusual beech area (area 5) is in a gap through Pine Ridge. The canopy on this northwest-facing slope is composed mainly of beech. Mountain laurel (*Kalmia latifolia*) forms dense thickets under the beech, oaks, tulip poplar, and sourwood, excluding most herbaceous vegetation. Downslope from the laurel, witch hazel (*Hamamelis virginiana L.*) borders the small stream flowing through the gap. This extensive laurel growth is the largest on the reservation.

Some of the largest beeches on the reservation occur in area 3. Beech, white oak, and white pine exceeding 30 in. in diameter are on the lower slopes of this north-facing watershed draining into Poplar Creek. Tulip poplar and chestnut oak are also abundant in this area, and ash, sugar maple, cherry, hickories, sourwoods, and hemlock are other canopy species. This area contains over 50 species of herbs, including the uncommon herbaceous species Vasey's trillium (*T. Vaseyi*), showy orchis (*Orchis spectabilis*), Golden Seal (*Hydrastis canadensis*), and Canada violet (*Viola canadensis*).

(6) Another major grouping of the mesic hardwood type is the community dominated by hemlock (*Tsuga canadensis*) (areas 15 and 17). The community is unusual in this portion of the Valley and Ridge province because it normally occurs in the higher elevations. On the reservation its occurrence seems restricted to rocky, limestone outcroppings. Especially in area 15 extensive patches of both laurel and rhododendron are found. The hemlock community provides habitat for a rare parasitic shrub species, *Buckleya* sp.

(7) White pine (*Pinus strobus*) occurs as an occasional canopy tree in most of the mixed mesophytic associations, but it assumes a dominant role in a few areas on the reservation (areas 11 and 21). White pine is the dominant in area 11 with tulip poplar and white oak codominants. Many of these trees are over 2 ft in diameter, which is rare in this region because of extensive lumbering. Other canopy trees include hickories, beech, oaks, red maple, and sugar maple. The understory is composed of strawberry bush and tree seedlings, most of which are sugar maple and white pine. Holly (*Ilex opaca*) occurs frequently in the shrub stratum of some white pine areas on the reservation.

(8) The banks of the main channel of Poplar Creek are lined with large sycamore and occasional oaks and sugar maples. Extensive stands of box elder (*Acer negundo* L.), ash, willow, and sycamore with an occasional hackberry and black walnut cover the floodplain with cane or dogwood forming impenetrable thickets in some areas. The surface of the ground is covered with sparse grass

(*Microstegium* and *Elymus* sp.) in the more open areas, with species of asters and other composites and lobelia (*Lobelia cardinalis* and *Lobelia siphilitica*) abundant in localized areas. This floodplain is probably one of the few of comparable size remaining in the eastern part of the state that is undisturbed by agriculture. Associated with Poplar Creek in area 16 is a high limestone bluff along Bear Creek before its convergence with Poplar Creek.

(9) Many swampy areas occur on the reservation, but none are extensive. Therefore the few areas present contribute to valuable ecological resource, and it is essential that they are present in an undisturbed condition. There is a swampy area on the Watts Bar floodplain below Gallaher Bridge (part of area 25, close to half an acre in extent) which is probably the largest on the reservation. Also included in area 25 are the ponds near ORGDP that serve as resting and feeding areas for many migratory bird species. Numerous species of ducks use them, and both Canada and snow geese were sighted this past year. Area 8 contains the most extensive canebreaks on the reservation. Another less disturbed, although much smaller, marshy area occurs in McNew Hollow (area 4). A large forested swampy area with many springs and seeps parallels Bear Creek (area 26). The overstory of this area consists of planted stands of sycamore, poplar, and ash. Unusual herbs include over 20 species of sedges (*Carex* sp.), tall scouring rush (*Equisetum hyemale*), and little green orchid (*Habenaria flava*).

(10) Old-field communities in various successional stages, most of them containing arboreal components, occur throughout the reservation (areas 12 and 23, Overlay 4, Section 8) and are composed of different species, depending on edaphic factors and land use at the time of DOE acquisition. Other areas, although not virgin timber, are mature second growth and are representative of forest types that were in the Valley and Ridge province prior to settlement. These successional areas serve as an important source for biological materials for ecological research on natural communities.

It should be emphasized that conservation of the areas discussed above is the major objective. However, such areas are also important as sites for ecological research. In particular, some of these areas can act as baselines against which long-term observations may be carried out to evaluate natural and anthropogenic induced changes and trends on the reservation in particular and in the southeast region in general. The unique and natural areas are useable for nonmanipulative research, and preservation of these areas can also provide supervised educational and training opportunities to students, university scientists, and the community at large.

References

1. G. F. Fielder, Jr., An Archaeological Survey with Emphasis on Prehistoric Sites of the Oak Ridge Reservation, Oak Ridge, Tennessee, USAEC Report ORNL-TM-4694, Department of Anthropology, University of Tennessee, 1974.
2. E. Lucy Braun, Deciduous Forests of Eastern North America, Blakiston, Philadelphia, 1950.

5
PROGRAM REQUIREMENTS

A URANIUM-ENRICHMENT ACTIVITIES

1. Property Currently Assigned (Base Map and Overlays 5 and 12, Section 8)

The DOE Oak Ridge uranium-enrichment activities, consisting mainly of ongoing gaseous-diffusion production and gas-centrifuge development programs, are carried on at the Oak Ridge Gaseous Diffusion Plant, which is located on a site in the northwest corner of the Oak Ridge area. The total site comprises 4720 acres (1911 ha) consisting of an inner industrial plant complex of 1740 acres (704 ha) surrounded by a buffer area of 2980 acres (1206 ha). The industrial plant complex includes five large process buildings covering approximately 250 acres (101 ha) and other small process pilot plants, laboratories, machine and maintenance shops, numerous plant support facilities, and utility systems. The buffer area surrounding the industrial complex provides a required controlled-occupancy area for the health and safety of the public from accidental release of toxic and/or radioactive materials used in plant operations. Portions of the buffer area are used for other DOE programs administered by ORNL and involve 550 acres (223 ha) for environmental research, approximately 2000 acres (810 ha) for forestry management, and approximately 3 acres (1.2 ha) for waste management as a "contaminated burial ground" (see Section 5D). A plant support area containing approximately 5 acres (2 ha) for a raw-water pumping station and sanitary water-treatment plant is located south of the plant area and outside the buffer area. The Clinch River, a part of the TVA Watts Bar reservoir, crosses through the buffer area from CRM 10.7 to 12.6. Also crossing through the buffer area is approximately 2¾ miles (4.4 km) of State Highway 58 (Oak Ridge Turnpike), approximately 2 miles (3.2 km) of Blair Road, and approximately ¾ mile (1.2 km) of the Southern Railway Company railroad spur serving the ORGDP.

B WEAPONS-MANUFACTURING ACTIVITIES AND PRIMARY RESEARCH FACILITIES—Y-12 PLANT (Base Map and Overlays 5 and 12, Section 8)

1. Property Currently Assigned

Weapons manufacturing for DOE and a portion of the primary research activities for ORNL are carried on at the Y-12 Plant located in Bear Creek Valley at the eastern boundary of the DOE reservation. The Y-12 Plant site contains a total of 3420 acres (1385 ha) consisting of an inner industrial plant complex covering approximately 850 acres (344 ha) surrounded by a required buffer area of approximately 2570 acres (1040 ha). The industrial plant complex is roughly divided into two portions, the western portion being devoted to DOE ongoing weapons-manufacturing activities and the eastern portion being devoted to DOE–ORNL primary research programs in biology, reactor, fusion energy, and stable isotope separation activities. The plant facilities include about 300 buildings, including large machine shops, chemical processing buildings, laboratories, maintenance buildings, change houses, and numerous plant support facilities. Within the surrounding buffer area and outside the main industrial complex, approximately 55 acres (22 ha) are allocated to an ash-retention pond for ashes and residues pumped through a pipeline from the Y-12 steam plant; a fenced area located on Bethel Valley Road immediately south of the plant containing approximately 30 acres (12 ha) surrounding a former quarry, now filled with water, which was formerly used as a disposal site for obsolete classified tools and equipment, is now used as an overflow and dilution basin receiving the outflow from the Y-12 Plant ash-retention pond; and approximately 125 acres (51 ha) are allotted for a sanitary water-treatment plant which serves the Y-12 Plant, the ORNL, and the City of Oak Ridge. The other facilities of the water supply system are the river intake and pumping station located on the north bank of the Clinch River, the raw-water booster pumping station located between the intake and pumping station and the water-treatment plant, the raw-water transmission mains, and that part of the distribution system serving Y-12 and ORNL. The distribution system serving

the City of Oak Ridge is owned by the city. Other portions of the buffer area are used for other DOE programs administered by ORNL, involving approximately 1400 acres (567 ha) for environmental research and forestry management, and for programs administered by the Comparative Animal Research Laboratory, involving approximately 600 acres (243 ha). Approximately 3 miles (4.8 km) of the extreme eastern end of Bear Creek Road on the north side of the industrial complex also passes through the buffer area. Plant support areas outside the buffer area include approximately 150 acres (61 ha) for a sanitary waste landfill used to dispose of solid wastes from the Y-12 Plant, ORNL, and ORGDP; approximately 65 acres (26 ha) located west of the main plant used as a burial ground for contaminated solid wastes generated in Y-12 Plant operations; an approximately 4-acre (1.6-ha) site comprising an abandoned quarry filled with water located north of Bethel Valley Road and approximately 2000 ft west of the intersection of Bethel Valley and Scarboro roads which was formerly used as a disposal and dilution basin for selected chemical wastes obtained from Y-12 Plant operations; and a 1-acre (0.4-ha) site located on the north bank of Melton Hill Lake at Clinch River Mile 41.5 for a pumping station which supplies raw water to the Y-12 Plant and the water-filtration plant.

2. Property Required for Projected Expansion

Current planning and future budget submissions do not indicate any requirement for expansion of the Y-12 Plant beyond the currently established boundaries of the industrial plant complex.

3. Property Required for Potential Expansion

The Y-12 Plant industrial complex currently extends from the eastern DOE reservation boundary westward into Bear Creek Valley. Because the site is bounded by ridges on the north and south, the potential for expansion of the plant would be westward into Bear Creek Valley. Therefore use of land immediately west of the current industrial plant complex must be carefully considered in order not to jeopardize any potential for plant expansion.

C PRIMARY RESEARCH FACILITIES (Base Map and Overlays 5 and 12, Section 8)

The primary research facilities for DOE's Oak Ridge Operations are at ORNL. The laboratory site contains a total of 8770 acres (3549 ha) consisting of the main laboratory area covering 920 acres (372 ha); the Tower Shielding Facility area covering 30 acres (12 ha); the Health Physics Research Reactor area covering 65 acres (26 ha); the Experimental Gas-Cooled Reactor area covering 45 acres (18 ha); the main reservoir, substation, and target range covering 11 acres (4 ha); and a required buffer area of approximately 7700 acres (3117 ha). The laboratory facilities include approximately 250 buildings with a floor space of two million square feet. As indicated in Section 5B, research programs in biology, reactor, fossil, fusion, conservation, and stable isotope separation activities are located at the Y-12 plant.

One of the major programs at ORNL is the Consolidated Fuel Reprocessing Program. This national program is headquartered in the former Experimental Gas-Cooled Reactor area. The offices and turbine hall have been converted to laboratories and equipment-development test areas. Remaining portions of the turbine hall and service buildings are currently being remodeled to include additional facilities for an integrated equipment test facility where new process equipment can be tested in concert with adjacent equipment and where remote operating and maintenance procedures can also be tested. This is a $16 million line item expected to be completed in FY-1981. As part of this program, a conceptual design for a major hot experimental facility that will have the capability to demonstrate the reprocessing of nuclear fuels of interest is currently under way. The planned facility includes the test facilities and support structures occupying an estimated 30 acres plus a 1-mile-radius exclusion area. The construction of such a facility is contingent on a favorable decision to proceed with a breeder development program, including a large demonstration breeder reactor. The Oak Ridge area has been designated as the site locale for this facility, and site identification activities are planned in 1980.

Reactor technology development continues to be a significant program at ORNL. The present program includes development work on and evaluation of two advanced types of reactors, the Liquid-Metal Fast Breeder Reactor (LMFBR) and the High-Temperature Gas-Cooled Reactor (HTGR), along with supporting work in safety and code development for light-water reactors. A number of related studies are devoted to nuclear safety and include structural studies of both steel and concrete pressure vessels, investigation of reactor shielding, the development of reactor codes and standards, and maintenance of a nuclear safety information center serving the nuclear industry. Other studies involve high-temperature design, reactor physics, and reactor instrumentation and controls.

Additional nuclear-related work includes efforts associated with the ORNL assignment as the national ^{233}U repository. The program includes the storage and preparation of ^{233}U materials for others, processing of scrap received from others, and solidification of some liquid currently in storage. The last item will involve a project for the installation of processing facilities, and existing buildings and support facilities will be used.

Since 1953, ORNL has been involved in research in ways of obtaining power from the fusion process. The latest device being tested in the program is the Impurity Study Experiment (ISX). Success with ISX could help lead to the design of a next-generation experimental machine capable of proving the engineering feasibility of fusion.

coal gasification and liquefaction, energy use in transportation, integrated urban energy systems, alternative energy sources and improved-efficiency conversion devices, and electricity generation from low-temperature power cycles applied to geothermal and solar energy.

In the physical sciences ORNL has a broad program of research in physics, chemistry, engineering, metallurgy, instrumentation, and applied mathematics. Research is performed on the fundamental structure of matter, interaction of radiation with matter, properties of materials, synthesis of new compounds having improved properties, and the prediction of the effects of time, use, and radiation on these properties. A large portion of the physics research program concerns reactions of heavy ions, which are studied both in connection with reactor development and as tools for research.

Both basic and applied chemistry projects are conducted. Studies of chemical properties and of reactions in aqueous and nonaqueous media are carried out in support of reactor programs. The chemical technology phase of the research and development activities in addition to fuel reprocessing are currently focusing on fuels in general and materials and methods for waste storage.

Work in life sciences at ORNL consists of fundamental and applied projects involving research in biology, environmental sciences, and health and safety. In biology the emphasis is on the effects of various energy-related pollutants on living systems. Studies include research on mutagenesis, somatic effects, immunological systems, viral components, biochemistry, and biophysics. Problems related to the genetic and somatic effects of drugs, smog, toxic materials, and energy-related pollutants in the environment are being investigated.

Bioengineering efforts range from the production and isolation of important biological materials to the development of bioreactors for treatment of liquid waste streams.

Environmental research at ORNL is concerned with basic and applied questions dealing with the impact of man's energy-related activities on the environment.

A more detailed discussion of the environmental research program at ORNL is contained in Section 5E.

Health and safety functions are conducted in both service and research areas. Responsibilities include protection of personnel from radiation and toxic materials generated in fossil-fuel technologies; providing education and training in health physics; and conducting research primarily in dosimetry, instrumentation, internal dose estimation, radioactive waste disposal, and civil defense problems.

The radioactive-waste-management effort is largely concerned with the processing and disposal of solid, liquid, and gaseous radioactive wastes and with research and development on improved processing of radioactive wastes. Large burial grounds are operated for solid radioactive-waste disposal. Additional land will be required as indicated in separate alpha-emitting isotopes; process development for krypton, iodine, and tritium removal from chemical plant gaseous wastes; transportation of wastes; and the waste-handling procedures associated with the ORNL burial grounds.

The long-range property requirements for ORNL are based on projected growth of high-priority DOE programs. Office space and general support facilities are expected to increase in line with this growth; however, the major property required for office space will, in general, be adjacent to existing ORNL facilities. As much as 100 acres (40 ha) total land might be required for these structures.

In reactor technology ORNL is expected to continue development work on the LMFBR and the HTGR. In addition, program reorientation in reactor technology can be expected to require other facilities. These facilities would generally be based on the modification of existing buildings.

The ORNL fusion-research program located at the Y-12 Plant can be expected to expand during the next 10 years. However, much of the expanded program can be housed in existing buildings. ORNL is currently the host for a National Design Team to prepare a preliminary design for an Engineering Test Facility (ETF), the first phase of a three-phase program leading to operation of an Engineering Prototype Reactor (EPR) followed by a Commercial Demonstration Reactor. Construction of an ETF would require a sizeable site for the reactor itself and for its supporting services. A site of no less than 30 acres (12 ha) will be needed to provide an exclusion radius compatible with current regulatory standards. If regulatory standards change, an even larger site would be required. A potential site under consideration for an ETF is at the west end of the Y-12 Plant, west of the present settling basins. Because this location does not have a natural flowing stream into which the approximately 1500 MW of heat could be dissipated, cooling towers would have to be constructed.

As indicated above, ORNL is currently engaged in nonnuclear research activities. Many of these activities are, at present, in conceptual and study phases. Projects analyzing and modeling residential and industrial energy-use systems and new energy distribution and generation techniques and basic studies of economics and environmental impacts are presently primarily theoretical but within the next 10 years are expected to evolve into facility-oriented experiments for verification of the theories currently being developed.

A demonstration plant for the bioconversion of wastes to fuel gas using the ANFLOW Process is located at the City of Oak Ridge east-end sewage-treatment plant. In addition to ORNL and the City of Oak Ridge, the Norton Company, a private industrial firm, is participating in this project.

A facility for recovering energy from low-temperature heat would use any or all of several heat sources, solar, geothermal, or the effluent of a fossil or nuclear power

plant. The additional space required if the facility were located at an existing DOE facility would be 2 to 3 acres (0.8 to 1.2 ha).

ORNL is broadening its development program to include new projects on fossil fuels—particularly coal—with emphasis on the chemistry and chemical engineering of coal conversion, development of advanced systems for combustion and power generation, development and testing of materials and components, and engineering studies and evaluations. As these programs grow, new facilities will be required.

The physical sciences program can be expected to expand at a modest rate. A large laboratory building has been proposed for construction near the present central research laboratory building (4500). The completion of the Holifield Heavy Ion Facility and the proposed new separated-sector cyclotron to be attached to it will increase the number of visiting scientists at the Laboratory working in physical sciences. A combination office–residential structure is being built for visiting scientists with joint funding from DOE and the participating universities. A new facility for the study of materials at high temperatures has been proposed at a site south of the Heavy Ion Facility. The growth of a complex of facilities to provide space for experimental studies and offices is anticipated in the area adjacent to the present ORIC–ORELA.

The biological research program at ORNL continues to experience significant redirection with increasing emphasis on somatic and genetic effects of pollutants from emerging new technologies associated with nonnuclear energy sources, such as coal gasification and liquefaction. These new research programs will require some remodeling and upgrading of existing laboratories and facilities and will require some new construction within the Biology Division area to provide additional facilities for isolation and containment of experimental animals and for specialized laboratories. The approximately 15 acres (6 ha) of land extending eastward to the East Portal boundary and lying north of First Street is the only land that is contiguous to the Biology Division complex and as such represents the most reasonable area for growth.

More than 20 technical information groups at ORNL are involved in Information Center activities in the basic sciences; energy related research, policy and safety; environmental and social aspects of energy; and toxicology and toxicity of specific substances. These growing information needs place an ever-increasing demand on facilities and data-processing equipment.

D WASTE MANAGEMENT

1. Nuclear Activities

The information provided here is primarily restricted to land use as it pertains to radioactive-waste disposal and storage following processing. The waste-handling and -processing operations and facilities, as well as interim storage, which are carried out in the main plant area are excluded or only briefly mentioned in this portion of the report. The various areas discussed are shown on Overlay 10, Section 8.

Oak Ridge National Laboratory

SOLID WASTE. Solid waste contaminated by radioactive matter has been buried in the vicinity of ORNL since 1943, and this practice is expected to continue without major changes. To date it is estimated that over seven million cubic feet of such material has been placed in six burial grounds covering about 136 acres (55 ha) in Bethel and Melton valleys. The operational status of the ORNL burial grounds or solid-waste storage areas (SWSA) is shown below:

SWSA	Operating dates	Status	Land use, acres
1 & 2	1943–1946	Closed	5 (2 ha)
3	1946–1951	Closed	7 (2.8 ha)
4	1951–1959	Closed	23 (9.3 ha)
5	1959–	Operating	33 (13.3 ha)*
6	1969–	Operating	68 (27.5 ha)†

*33 acres (13.3 ha) used.
†15 acres (6 ha) used.

More than 96% of the volume is radioactively contaminated material and consists of a heterogeneous mass of absorbent paper, all types of glassware, scrap metal, dirt, filter media, lumber, piping, depleted uranium, animal carcasses from biological experiments, and experimental equipment that could not be economically decontaminated. At one time the laboratory's solid-waste disposal areas were designated as the Southern Regional Burial Ground, and, during the period from 1955 to 1963, about 1 million cubic feet of solid waste from various off-area sites was disposed of by underground burial in SWSA-4 and -5. The exact character of the waste is unknown. However, some of the materials are known to have been contaminated with the transuranium isotopes (primarily americium, curium, and plutonium) as well as ^{233}U and therefore could require very long surveillance periods. Since late 1970, solid waste that contains greater than 10 μCi/kg of transuranium isotopes and ^{233}U must be stored retrievably. A number of different types of facilities are used for the storage of solid radioactive wastes. These include trenches in which the material is placed and buried, stainless-steel-lined auger holes for cylindrical drums or packages of various diameters, and above-ground storage buildings. The choice of facility depends on whether or not the material is to be retrievable and on the intensity and character of the radiation involved.

It has been determined that areas underlain by Conasauga shale formations make desirable sites for underground storage or burial, not only because the shale is easily

excavated but also because the ion-exchange properties of this material inhibit the migration of positively charged water-soluble nuclides through the soil. Because the area in Melton Valley, south of ORNL, is underlain by this formation, it has been used as a site for the three burial grounds (4, 5, and 6) opened since 1951. Geologic studies indicate that there are no more suitable areas remaining in Melton Valley for solid-waste burial. It is estimated that burial ground 6 will accommodate the ORNL waste for about 7 years at projected generation rates (90,000 cu ft/year) and using current burial criteria. Thus a new burial ground, No. 7, of about 50 acres (20 ha) will be required in 7 years. Various sites on the Oak Ridge reservation are currently being examined for suitability. Various alternatives for processing solid wastes are currently under consideration. One alternative is a regional decontamination and waste-processing center that would accept waste from a large geographic area in the Eastern United States, surface store some metallic items, process waste, and ship products for permanent disposal to Nevada. This regional center would require a 25- to 50-acre (10- to 20-ha) site with truck/rail access. Another alternative under consideration is a Solid Waste Processing Facility that would process ORNL wastes only, would not require rail access, and would require approximately a 25-acre (10-ha) site.

LIQUID WASTE (INTERMEDIATE-LEVEL WASTE STREAM). Before 1966 all the ORNL intermediate-level liquid waste was pumped to seepage pits and trenches in the Conasauga shale formation in Melton Valley. These pits and trenches are located along the ridge between burial grounds 4 and 6. The four pits and three trenches are identified and shown on Overlay 10, Section 8. Over 1 million Ci was placed in these pits and trenches, of which about 97% of the curie content is due to ^{90}Sr and ^{137}Cs with traces of ^{106}Ru and ^{60}Co and transuranics. The level of activity is such that surveillance could be required for a few hundred years. This means of disposal of the intermediate-level waste was replaced by the shale-fracturing process in 1966. (Shale fracturing is similar to hydrofracture processes used for oil and gas recovery from wells in the oil and gas well-drilling industry.) In the shale-fracturing process, the waste solution is mixed with a blend of cement and other additives, and the resulting mix is injected into an impermeable shale formation at a depth of about 1000 ft, well below the level at which groundwater is encountered. A few hours after injection, the grout sheet hardens, fixing the radioactive waste in the shale formation. The practice of placing the intermediate-level waste in pits and trenches will not be resumed in the future; instead, this waste will continue to be disposed of by shale fracturing or some other permanent-fixation method. Hence additional land area other than that now in use in Melton Valley will probably not be required for this purpose beyond that indicated on Overlay 10.

GENERAL. It should be noted that many of the low-lying areas in the White Oak Creek drainage basin, including White Oak Lake, are contaminated with radioactivity and must be retained indefinitely in a controlled area.

Y-12 Plant

The principal Y-12 Plant radioactive-waste burial areas are located approximately 1 mile west of the main plant site in Bear Creek Valley. The disposal site with a total fenced area of about 65 acres (26 ha) includes burial grounds 1-A, 2-B, and 2-C. The burial ground 1-A area is used for burial of low-level materials (less than 10% by weight of normal uranium). Burial ground 2 is divided into two sections; 2-B contains large lots of depleted-uranium turnings which possibly could be reclaimed and 2-C contains materials contaminated by more than 10% by weight of normal uranium. The 2-C area is also used for materials contaminated with thorium and beryllium. Almost 900,000 cu ft of waste, consisting primarily of low-level depleted uranium and uranium-contaminated material, has been deposited in the three burial areas; approximately 10.5 acres (4 ha) of the 37 acres (15 ha) of useable land within the fenced area have been used. Current projections indicate that sufficient burial space is available to last at least 30 years.

Within the maximum security area of the Y-12 complex, depleted uranium in classified shapes is buried in three locations. The burial of massive uranium by this technique is considered long-term storage since the material can be retrieved for future use if deemed necessary. Approximately 56,000 cu ft of this material has been stored to date, and it occupies only about 0.124 acre (0.05 ha). The storage area south of the Y-12 Plant was opened in 1973 and projections indicate that it will last at least 100 years.

New Hope Pond (5.2 acres; 2.1 ha) serves as the drainage basin for the Y-12 process liquid waste and is only slightly contaminated with radioactivity. Sludge accumulation on the bottom of the pond necessitates periodic pumping of this substance to the Chestnut Ridge sludge pond (4.0 acres; 1.6 ha). These ponds are expected to last indefinitely.

Oak Ridge Gaseous Diffusion Plant (ORGDP)

The area designated as "contaminated burial ground," which is outside the ORGDP fenced area, contains essentially all the radioactive materials stored at the site. This burial ground has been closed since preliminary geological data raised questions as to the suitability of the strata for long-term storage of waste materials. The Y-12 disposal areas are being used instead. It is presently envisioned, however, that this same area will be used for surface storage of hazardous wastes after suitable treatment and containment.

The area designated as "classified burial ground 1" (now closed) contains, as the name implies, classified materials, but the radioactive content, if any, is not known. Classified burial ground 2, containing 22 acres (9 ha) that

are also inside the security fence was opened in 1974. It is estimated that about 12 acres have been used to date. As the space requirement increases, the security fence will be extended outward as necessary to enlarge the burial ground. It is not expected that significant radioactive material will be placed in this burial ground.

The other areas shown on Overlay 10, Section 8, include: (1) K-1407C sludge pits or retention basin (2.58 acres; 1 ha) containing 18 to 20 Ci of uranium resulting from removal of about 1500 cu yd of sludge which was dredged from the K-1407B holding pond, (2) K-1407B holding pond containing about 3 Ci of uranium, and (3) K-1007B and K-901-A holding ponds containing only trace quantities of uranium. All these storage or retention areas are expected to last indefinitely. However, future expansion of facilities could result in the need to reopen the railroad line in this area. Since the retention basin, K-1407C, is presently on the right-of-way, the sludge would need to be moved to another burial site.

The White Wing scrapyard area is located about 2 miles east of ORGDP (see Overlay 10, Section 8) and was originally used for the storage of contaminated materials and equipment which were removed several years ago. Since low-level residual contamination remains on the upper soil layer, this area is not suitable for unrestricted use.

2. Nonnuclear Activities (Overlay 10, Section 8)

Fly-Ash Disposal

Currently, Y-12 and ORGDP burn coal as their primary fuel, thus requiring fly-ash disposal. The Y-12 Plant pumps a fly ash–water slurry to a 20-acre (8-ha) retention basin; the overflow goes to Rogers quarry. This water-filled quarry will provide approximately 45 years' storage capacity for the Y-12 Plant at the present rate of ash accumulation. Currently ORGDP disposes of fly ash by the dry-landfill method on a site adjacent to the K-901-A holding pond. Such use would not inhibit a different use in future programs or expansions.

In addition to fly-ash disposal, if SO_2 scrubbers are required at the two coal-fired steam plants to meet emission standards, a large undetermined tract of land will be required to dispose of the generated sludge.

Cinder-Disposal Area

Located southeast of the old powerhouse is a 4.85-acre (2-ha) tract of land which previously was used exclusively for disposal of ash from the old power plant. This plant has been shut down for several years, and there is no definite plan for future disposal in this area. Although it appears unlikely at this time, this area might be considered as a site for construction of a new central coal-sizing facility.

Construction-Waste Disposal

All three major sites have areas dedicated for disposal of construction-waste material. Approximately 6 acres (2.4 ha) are presently being used in this manner. The current usage rate per year is minimal. Areas dedicated to such use are eventually covered with a suitable cover material and contoured to allow runoff. Such areas are allowed to return to natural growth and covered to be used for future needs.

Oil-Biodegradation Disposal Area

The Y-12 Plant currently uses biodegradation as the method of oil disposal. An area of about 6 acres (2.4 ha) located west of the centralized landfill is being used in this study. Some plots contain contaminated oil, but this will not restrict future use. Currently there are no plans to greatly expand these plots since they are reusable, depending on the rate of biodegradation.

Y-12 Plant S-3 Ponds

Immediately west of the Y-12 Plant, four 1-acre (0.4-ha) ponds are currently being used for disposal of liquid waste. The total area includes about 6 acres (2.4 ha). These ponds will be phased out as soon as facilities for an alternative disposal method can be authorized and constructed; this is now planned for FY-1984. The liquid in the ponds will then be neutralized, precipitated, and covered over. Although this is primarily a chemical waste facility, uranium is present in the sediments.

Swine-Waste Disposal

The Comparative Animal Research Laboratory currently has two swine-waste facilities. One is located east of the main laboratory and consists of three lagoons totaling about 2 acres (0.8 ha). These ponds have an indefinite service life. The second facility consists of two lagoons constructed at the white barn located at Freels Bend. These two lagoons cover about 1 acre (0.4 ha) in total and have an indefinite service life.

Centralized Sanitary Landfill

The sanitary landfill is located about 2 miles west of the Y-12 Plant. The 100-acre (40-ha) tract is situated north of Bethel Valley Road in a fairly level area. The landfill is used for the disposal of combustible and decomposable materials. Approximately 0.5 acre (0.2 ha) is required each year; 2.5 acres (1 ha) have been used.

Kerr Hollow Quarry

An abandoned, water-filled, limestone rock quarry known as Kerr Hollow Quarry, which has about a 2.5-acre (1-ha) surface area, is used to dispose of reactive chemicals and like materials, which include sodium, potassium, defective gas cylinders, and similar substances. The quarry is located approximately 0.5 mile (0.8 km) west of Scar-

boro Road and 0.25 mile (0.4 km) north of Bethel Valley Road. Cylinders of such materials as hydrogen, propane, acetylene, etc., are vented by the slow release of small quantities over a period of time.

The disposal area is fenced, and access is controlled by a locked gate. Appropriate signs are displayed prominently to warn of the hazardous conditions within the area. On the average, 25 defective cylinders and 500 lb of reactive chemicals are disposed of annually in Kerr Hollow quarry.

E ENVIRONMENTAL RESEARCH ACTIVITIES

The environmental research programs on the Oak Ridge reservation provide scientific insights into environmental problems associated with energy research and development. These programs encompass all aspects of the movement, metabolism, and effects of energy-related toxic agents in ecological, agricultural, and biological sectors of man's environment. A new $8.5 million Environmental Sciences Laboratory building was occupied in late FY-1978. These new facilities provide space for significant expansion of environmental research activities in Oak Ridge. To develop and maintain such a comprehensive research program requires careful advanced planning of land and water use to ensure that sufficient and appropriate areas are available for experimental purposes consistent with immediate and future priorities and objectives of the DOE mission. Identification of lands possessing suitable characteristics for sustained agricultural and forest productivity, as well as those containing suitable terrestrial and aquatic habitats, is essential if DOE is to continue to fulfill its environmental-research mission. Field-resource needs are based on:

1. Established and ongoing research programs.
2. Immediate requirements for field facilities as outlined in the ORNL 5-year research plan.
3. Anticipation of long-term (5, 10, or 20 years) directions and needs for land and water resources for ecological and agricultural research.

The established environmental research and natural areas constitute an Oak Ridge Environmental Research Park for the accomplishment of DOE research on the environmental effects of various energy technologies. On a noninterference basis, selected areas may be made available to researchers from other institutions for environmental–ecological research projects.

In this section specific criteria, objectives, and requirements are described for land-use planning involving environmental attributes for DOE environmental research needs and for long-term management of the environmental resources of the reservation.

1. Land- and Water-Use Criteria

Land-Use Criteria for Terrestrial Ecology Research

Areas designated in this report for research purposes include the range of habitat diversity typical of the region. They are further delineated to include experimental conditions (e.g., relief, geology, soils, water quality, stream characteristics, and specific biotic associations) required for the likely range of research objectives. The nature of the research often requires long-term commitment of the area. Specific treatments to research areas are carried out consistent with the research plan and sound health and safety policies and procedures. Additional treatment or use of research areas (e.g., disease control and fire control) is coordinated through the responsible operating division of ORNL. Forestry management involving designated but inactive research areas is conducted on the basis of both future research needs and established forest-management policies for sustained production of fiber.

Water-Use Criteria for Aquatic Ecology Research

Criteria for protecting and preserving aquatic habitats include identifying aquatic habitats and associated watersheds on the Oak Ridge reservation which should be protected and preserved for aquatic research. Unique and essential aquatic habitats are identified according to current research, field sites needed for planned research, and as habitats serving as control areas. Aquatic resources (spring water supplies and watersheds) needed to support specific laboratory and field research operations are also considered. Watershed management to control flooding is another important criterion. The optimal location of aquatic monitoring stations is an essential criterion for water-quality surveillance.

Land-Use Criteria for CARL Research

Areas designated for research purposes consist of agriculturally improved land. This land has been selected and improved on the basis of the U.S. Department of Agriculture land classification system and the proximity of the land to the research facilities on Bethel Valley Road. The criteria for classification are the same as those given for agricultural productivity (see Section 4B). When most of the best agricultural land (type 1, soil class I) was flooded by activation of Melton Hill Dam, virtually all the remaining adequate land on the reservation was cleared and developed by TVA. The acreage of land reclaimed by TVA to replace that lost by the raised lake level was less than the total lost to Melton Hill Lake because sufficient type I and type II land was not available on the reservation. There is an acute shortage of type I and type II land on the reservation. All areas in reasonable proximity to CARL are currently being used by CARL for established research projects.

Land-Use Criteria for Forest Management

For forest-management purposes, the reservation is divided into 27 compartments, ranging in size from 365 to 1200 acres (148 to 486 ha, respectively). Silvicultural treatment and harvesting are carried out with particular

reference to and on the basis of forest cover and site conditions in each compartment with special consideration to research and production missions served by the reservation. Silvicultural practices are based on a 5-year plan (to be revised in 1980), which is reviewed annually to ensure that proposed activities are consistent with current conditions and needs.

2. Location of Research Areas

Locations and boundaries of ecological and agricultural research areas are illustrated on Overlays 6, 7, and 8, Section 8. Terrestrial research areas are shown on Overlay 6, Section 8; the numbered sites are identified and acreages are given in Table 5-1. Brief descriptions of use are provided in the text.

Aquatic research and support facilities are shown on Overlay 7, Section 8; sites are defined and listed in Table 5-1. Brief descriptions of use are given in the text.

CARL programmatic lands are shown on Overlay 8, Section 8, and field support facilities are described in the text.

Forest-management compartments are shown on Overlay 9, Section 8, and compartment descriptions and the management plan for sustained yield are described in the 5-year plan.*

3. Land and Water Commitments for Established Research Projects

The Environmental Sciences Division, ORNL, and the Comparative Animal Research Laboratory are presently using or have immediate plans to use (based on existing and near-term funding for programmatic research) 53 field sites for ecological, agricultural, and environmental research related to the environmental and health aspects of energy technology. Areas of selected sites (Overlays 6, 7, and 8, Section 8) are given in Tables 5-1 and 5-2. Total acreage used for aquatic and terrestrial research in environmental science and for agricultural research at CARL is given in Table 5-3. Other research activities involving studies of animals having significant "home ranges," such as bobcat and deer, use large areas of the reservation not identified on the overlays.

Thirteen additional sites have been identified for future use in anticipated projects. These sites [0801, 0913, 0923, 7733 (Overlay 6, Section 8); VI, VIII, XI, XII (Overlay 7, Section 8); and 0812, 0918, 0922, 7732, 7734 (Table 5-1, areas not on overlays)] have been selected on the basis of geologic, edaphic, aquatic, and biotic characteristics and on the basis of how the adjacent lands relate to potential energy technologies. These 13 areas should remain undisturbed, to the extent that this is compatible with other land-use needs, to maintain the desired site characteristics for projected and potential environmental science research.

With advance research planning, there is some opportunity for more intensive use of existing research areas. The long-term protection, maintenance, and development of present research sites and of the potential sites is necessary to ensure the high-quality research standards demanded by the DOE mission objectives.

Ecology Research Activities

Areas currently being used for ecological research on the Oak Ridge reservation are described in the following sections.

WATERSHEDS. The reservation comprises a series of small drainage basins through which small streams feed the Clinch River–Melton Hill reservoir. These watersheds generally drop about 200 ft from the head of the stream to the outlet of the drainage basin. Small drainage basins play a central role in monitoring the response of landscapes to environmental impacts.

Current research on the Walker Branch watershed area (area 0919) is addressed to the movement of natural and man-caused soluble and insoluble particulates and materials in the environment. As a research facility, the watershed is unique and should be protected. It is a calibrated watershed used as an environmental study site and is located on the north side of Bethel Valley Road on Chestnut Ridge. Walker Branch flows from the watershed into the embayment on Melton Hill Dam. Research at Walker Branch deals with the fundamental behavior of mineral cycles and the distribution of elements in natural ecosystems. The watershed area is used to quantify the movement of foreign and natural materials through the vegetation, soil, forest floor, and aquatic systems of the natural landscape. Research also is directed toward determining the effects on the environment of toxic airborne and waterborne materials, including the heavy metals from fossil-fuel power plants, and entrance of these materials into the life cycles of animals and man. The research being conducted on Walker Branch contributes to the basic knowledge of biogeochemical cycles in typical forested landscapes of Eastern Deciduous Forest types.

In 1978, a major 3-year research effort was initiated to examine material transport and cycling in stream ecosystems. These investigations of spiralling, a term used to denote the manner in which transport in streams modifies the spatially independent concept of recycling, are being conducted on Walker Branch and on Ish Creek, a small stream that flows into the Clinch River approximately 1.4 miles (2.2 km) below the mouth of White Oak Creek. The Ish Creek and adjacent Raccoon Creek watersheds are two of only a few watersheds that, in all likelihood, have not been impacted by pollution or construction activities. Because they are undisturbed, these two creeks can serve the important function of control areas for aquatic research.

Associated with the Walker Branch watershed is the Melton Hill embayment (area 7660) which is presently

*Forest Management Plan, DOE Oak Ridge Reservation: 1976–1980, DOE Report ORNL-TM-5833.

Table 5-1 ENVIRONMENTAL RESEARCH AREAS

Terrestrial Research Areas (Overlay 6)

0090 Mammal study area south of Lagoon Rd. (5 acres, 2 ha)
0100 Environmental monitoring area (20 acres, 8 ha)
0400 Transmission-line management area (35 acres, 15 ha)
0450 Transmission-line corridor effects study (30 acres, 12 ha)
0800 Postattack research area—NOAA Meteorological Research Area (125 acres, 50 ha)
0801 Raccoon Creek watershed (1060 acres, 430 ha)
0805 "O"-segment tree nursery area (115 acres, 45 ha)
0809 Cooling-tower drift study area (920 acres, 370 ha)
0810 Tritium study area (20 acres, 8 ha)
0852 Grubb Island embayment animal collection area west of Raccoon Creek embayment (10 acres, 4 ha)
0913 McNew Hollow watershed (proposed) (165 acres, 65 ha)
0914 Laboratory water supply and Chestnut Ridge control (4 acres, 2 ha)
0915 Walker Branch power-line research area—Bird and mammal studies (north edge of 0919) (15 acres, 6 ha)
0916 Northern cove animal collection area northeast of 0919 (60 acres, 25 ha)
0917 Forest contamination area (135 acres, 55 ha)
0919 Walker Branch watershed (515 acres, 210 ha)
0921 White Oak Creek watershed (735 acres, 300 ha)
0923 Gum Branch watershed (330 acres, 135 ha)
0924 Bethel Valley quarry (10 acres, 4 ha)
3599 Environmental monitoring area (10 acres, 4 ha)
4552 Environmental monitoring area (65 acres, 25 ha)
7565 Environmental monitoring area (70 acres, 30 ha)
7650 Radioisotope-tracer study area (15 acres, 6 ha)
7655 Radioisotope-tracer study area (2 acres, 1 ha)
7660 Melton Hill embayment (410 acres, 165 ha)
7730 Animal population collection areas (145 acres, 60 ha)
7733 Melton Hill Lake and Aquatic monitoring area (75 acres, 30 ha)
7754 Terrestrial radionuclide cycling area (155 acres, 65 ha)
7851 Environmental monitoring area (60 acres, 25 ha)
7950 Radioisotope-tracer area (5 acres, 2 ha)
7951 Radioisotope-tracer area (3 acres, 2 ha)
8000 Whole-tree harvesting watershed (30 acres, 12 ha)
3513 Waste pond—Actinide elements (1 acre, 0.4 ha)
8001 Ish Creek stream spiralling watershed
7732 Animal population and collection area
7734 Animal population and collection area

Aquatic Research Areas (Overlay 7)

I. Lambert Quarry (140 acres, 55 ha)
II. McCoy Branch, Bethel Valley quarry and associated watershed (430 acres, 75 ha)
III. Walker Branch, Melton Hill embayment and associated watershed (750 acres, 305 ha)
IV. White Oak Creek watershed, White Oak Creek, White Oak Lake, Melton Branch, Melton Branch watershed, and White Oak Creek embayment (2750 acres, 1115 ha)
V. ORNL spring water supply and associated watershed (425 acres. 170 ha)
VI. West Branch of White Oak Creek and associated watershed (95 acres, 40 ha)
VII. Raccoon Creek and associated watershed (310 acres, 125 ha)
VIII. Scarboro embayment and Kerr Hollow watershed (100 acres, 40 ha)
IX. Bear Creek drainage basin (710 acres, 285 ha)
X. Clinch River and Poplar Creek research areas and monitoring stations (385 acres, 155 ha)
X-2. Roberts Branch embayment (65 acres, 25 ha)
X-3. Embayment pond (20 acres, 8 ha)
X-4. Poplar Creek (45 acres, 20 ha)
X-5. CRM 11 sampling station (40 acres, 15 ha)
X-6. Mouth of Ellis Creek (35 acres, 14 ha)
X-7. Convergence of East Fork Poplar Creek with Poplar Creek (25 acres, 10 ha)
X-8. Grassy Creek embayment (60 acres, 25 ha)
XI. East Fork Poplar Creek (755 acres, 305 ha)
XII. Melton Lake waterfowl habitat (135 acres, 55 ha)

Important Natural Areas (Overlay 4)

1. MM*: Basswood–maple–buckeye–rhododendron (25 acres, 10 ha)
2. Sycamore–box elder floodplain (120 acres, 50 ha)
3. MM*: Beech–basswood–poplar–buckeye (40 acres, 15 ha)
4. McNew Swamp (10 acres, 4 ha)
5. MM*: Beech–mountain laurel (5 acres, 2 ha)
6. MM*: Basswood–maple–buckeye (110 acres, 45 ha)
7. Red cedar (4 acres, 2 ha)
8. Canebreaks (15 acres, 6 ha)
9. Old-field sassafras (30 acres, 12 ha)
10. Lichen and moss (10 acres, 4 ha)
11. MM*: White pine–holly (30 acres, 12 ha)
12. Red cedar (5 acres, 2 ha)
13. Red cedar (75 acres, 30 ha)
14. White oak (20 acres, 8 ha)
15. MM*: Hemlock–rhododendron (30 acres, 12 ha)
16. Chestnut oak–spring ephemeral forbs (10 acres, 4 ha)
17. MM*: Hemlock (10 acres, 4 ha)
18. Red maple (15 acres, 6 ha)
19. MM*: Beech–poplar–mountain laurel (40 acres, 15 ha)
20. MM*: *Hydrastis canadensis*–beech (135 acres, 55 ha)
21. MM*: White pine–beech (75 acres, 30 ha)
22. Red cedar (105 acres, 45 ha)
23. Old-field homesites (270 acres, 110 ha)
24. Red cedar (205 acres, 85 ha)
25. Waterfowl refuge (95 acres, 40 ha)
26. Bear Creek Floodplain (54 acres, 22 ha)
27. Hemlock (6 acres, 2 ha)
28. Barrens (96 acres, 39 ha)

*Mixed mesophytic forest types as described by E. Lucy Brown, *Deciduous Forests of Eastern North America,* Blakiston, Philadelphia, 1950.

being studied to delineate the movement of nutrient materials from terrestrial to aquatic systems. Future research on Walker Branch and the embayment will focus on the transport and fate of trace contaminants associated with both fossil-fuel and nuclear-fuel cycles.

Small watersheds in area 7660 (south slopes of Haw Ridge) are being established. These areas will be used to assess the fate, effects, and transport of emissions from coal combustion.

Small watersheds in area 800 (north slopes of Chestnut Ridge west of Highway 95) have been established as part of a national program to assess the environmental effects of whole-tree harvesting. These areas will be in use for this program for several years.

Research on the environmental consequences of sewage sludge disposal is planned on selected areas throughout the forestry compartments (Overlay 9) over the next 5 to 10 years as part of the forestry management program. The

Table 5-2 LANDS ASSIGNED TO CARL

Area	Programmatic land				
	Pastureland and/or cropland, acres*	Lots etc., acres*	Woodland within fenced boundaries, acres*	Other woodland, acres*	Total, acres*
Gallaher Bend	102	0	20		122
Freels Bend	316	32	94		442
Solway Bend/Bethel Valley	128	18†	91		237
Laboratory Area		79			79
Chestnut Ridge	348	10	140	113	611
Compartment "A"	200	2	36	10	248
Compartment "B"	175	5	21		201
Compartment "C"	171	10	46		227
Compartment "D"	130	10	23		163
Compartment "E"	150	44	16	10	220
Total	1720	210	487	133	2550

*Divide by 2.47 to convert to hectares.
†Includes 13 acres occupied by dwellings.

Table 5-3 SUMMARY OF AREAS USED FOR ESTABLISHED PROGRAMS OF ENVIRONMENTAL AND AGRICULTURAL RESEARCH

Research category*	Acres†
Terrestrial (Overlay 6, Section 8)	5356
Aquatic‡ (Overlay 7, Section 8)	6985
Agricultural§ (Overlay 8, Section 8)	2550
Natural, cultural, antiquities (Overlay 4, Section 8)	1546

*Overlap exists primarily on terrestrial and aquatic research categories.
†Divide by 2.47 to convert to hectares.
‡Area includes associated drainage basins.
§Area excludes forest land.

program will use sludge from the City of Oak Ridge sewage plants as part of the demonstration research of land rehabilitation and enhanced productivity capability (possibly in conjunction with fuels from woody biomass projects for DOE).

RADIOISOTOPE TRACER AREAS. Radionuclides are used within seven forested areas south and east of ORNL and on the crest and slopes of Chestnut Ridge southeast of Y-12. These research areas include 0810, 0917, 7754, 7655, 7650, 7951, and 7950 and contain approximately 335 acres (136 ha). They are used for an ongoing program of radionuclide cycling studies in natural forested ecosystems. One area committed to research is the site of a ^{137}Cs-tagged plot of hardwoods and shrubs (7754). Included in the area is a major meteorological research station. Other sections (7950 and 7951) have experiments on both soil and trees tagged with radioactive nuclides. Section 0917 south of Y-12 where the sludge from New Hope Pond is dumped is included in near-future plans for studying contaminated landscapes.

Tritium studies have been conducted in a forested area (0810) on the north side of the DOE reservation. The western portion is being used to monitor trace contaminants transported in the ORGDP cooling-tower plumes which drift over the area; the remaining area is needed for potential program expansion.

Numerous studies of radionuclide behavior in aquatic and terrestrial environments have been carried out in the White Oak Creek watershed. Beginning on Chestnut Ridge and flowing through the ORNL compound, White Oak Creek passes by several burial grounds and sites contaminated with radioactive waste. This entire watershed is invaluable for radionuclide cycling studies that explore questions about the long-term fate of radioactive wastes placed in surface geological formations. Both Melton Branch and White Oak Creek receive chronic and low concentrations of radionuclides and heavy metals in effluents from laboratory operations. Contaminated White Oak Lake is used for determining cycling and the effects of radioactive and toxic elements on aquatic organisms.

EXPERIMENTAL FIELD PLOT AND TREE NURSERY AREA (0800). The 0800 area is devoted to low-intensity radiation research; it contains an infinite-plane radiation source incorporated into the surface soil. This site is firmly committed to long-term radiation-effect studies. The site (125 acres; 51 ha) is located in an isolated controlled area along the Clinch River southeast of ORNL in the 0800 area west of State Highway 95. Old-field and scrub species occupy parts of the area accompanied by large areas of fescue grassland and nonforest vegetation. Part of the area is used for long-term studies to evaluate the radiation dose and environmental effects that may arise in a

postattack situation. Experiments are also conducted on small rodents, insects, and plants of agricultural importance. The site is fully instrumented. A 10-acre (4-ha) tract containing the experimental plots with cesium-tagged fallout simulant is enclosed by antipersonnel fencing and marked with appropriate hazard signs. The area also contains a meteorological monitoring tower operated by the Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration.

Part of the area is in forestry compartment 20, which contains an experimental apparatus for investigating the microclimate interface between forested and open lands. Near the radioactive plots, but south of the White Oak Creek–Lake outlet, is scrub growth and an ecological animal-trapping area. This site provides animals and ecological data for use in the postattack studies.

Research activities will be intensified in this area. The most fertile soil on the DOE reservation is derived from historical flood terraces along the Clinch River. Tree nurseries for research purposes will be established in areas formerly used as topsoil borrow pits. The tree nurseries are necessary for developing and maintaining experimental materials of uniform genetic stocks. Such biological material is essential for research on the effects of pollutants on ecosystems that will arise from new programs in nonnuclear energy technology.

ENVIRONMENTAL MONITORING AREAS. Environmental monitoring areas are located in areas 7851, 0100, 7565, 4552, and 3599 in a forested drainage adjacent to White Oak Creek and Melton Branch, to the south and southwest of ORNL, and adjacent to the radioactive-waste burial grounds. The area includes White Oak Lake and its outlet at the Clinch River. Approximately 225 acres (91 ha) are included in the area.

Ecological monitoring is conducted routinely to follow the seepage of radioactive wastes, trace the pathways of radionuclides, and assess the effects of low-level radiation exposure to the natural habitat, including the vegetation and aquatic environments of White Oak Lake. Practical aspects of the monitoring program deal with safety considerations of radioactive-waste disposal.

LABORATORY WATER SUPPLY AND CHESTNUT RIDGE CONTROL. Area 0914 (north of ORNL) is a drainage basin containing a spring, pumping station, and well; pipelines supplying research facilities at ORNL are located in this area. It is imperative that this water source be protected because it serves as the water supply for aquatic experiments conducted in conjunction with the ORNL Environmental Sciences Division at Buildings 1504 and 1505 at ORNL. As such this research area is committed in support of aquatic research. This area has provided a source of natural and high-quality water to support the long-term aquatic ecology studies dealing with radioactive tracer and productivity studies and, more recently, the developing program on thermal effects of effluents from power reactors. A portion of the area is in forestry compartment 15, and forest-management practices within the area are modified to ensure protection of the wells and springs located here.

ANIMAL POPULATION AND COLLECTING AREAS. Areas 0852, 0916, and 7730, south of the Tower Shielding Facility (TSF), are used for the collection of mammals for laboratory experiments or as field sites for studies on the relation of structural forest parameters and small-mammal population dynamics. These areas provide opportunity for program expansion in the 1892 acres (766 ha) located on diverse terrain and habitat, including grassland portions of the DOE reservation managed by the CARL. Area 0090 is presently being used to establish the dissemination of radionuclide waste from a waste-disposal area by small-mammal populations. This area is also being used to correlate small-mammal species and the structural components of the plant community that they inhabit.

Lands within these areas are used for multipurpose activities by both the Environmental Sciences Division of ORNL and the CARL facility. Parts of the area are in forestry compartments 23 and 24. Small plots within the area serve as collection sites for small mammals that show uniform nutritional and physiological conditions when reared in the same locale. Uniformity of research organisms is necessary for detecting the often subtle responses to low-level environmental stresses.

O-SEGMENT TREE NURSERY AREA. The O segment (0805) is located across the Clinch River west of ORGDP and consists of partially cleared and forested land. Forestry compartment 4 encompasses the entire area. Portions of this 115-acre (46-ha) tract have been used for military training purposes under agreement between DOE and the Tennessee National Guard. The Tennessee Game and Fish Commission also maintains a wildlife management program on the area under a permit granted by DOE.

The O segment also contains a nursery for the propagation of cottonwood clones and seedlings used as experimental material for research programs on effects of nuclear and nonnuclear pollutants. Adjacent to the nursery are areas in the early successional stage of revegetation which are used to supply animal species indigenous to such habitat. Flatlands in the northwest corner of the area are designated as an experimental area for studying radiation effects on small mammals. Sloughs on the southeast side of the area (X-2, Overlay 7) are used as collecting areas for carp, mosquitofish, midges, and other biological specimens in support of the ongoing aquatic research program.

BETHEL VALLEY QUARRY. The deep limestone quarry adjacent to Bethel Valley Road (area 0924) is presently used as a waste-disposal site and receives overflow from the Y-12 ash pit, which drains into a small tertiary stream crossing the CARL control area. On this site the ORNL Environmental Sciences Division studies the movements of toxic materials in the environment and the

dispersal and settling characteristics of particulate materials in waste. The site contains 10 acres (4 ha).

TRANSMISSION-LINE RESEARCH AREAS. Six management areas designated as 0400 have been established in cooperation with TVA to evaluate alternative techniques of power-line right-of-way maintenance. Ecological studies of various combinations of cover plants, represented by both shrubs and grasses, are being conducted. Alternative techniques are being compared for their effectiveness in protecting the site and their potential for sheltering and feeding small game and rodents. Studies are being conducted under varying conditions and habitat; so the results may be generally applied to regional problems of power-line maintenance. Approximately 65 acres (26 ha) are devoted to these studies. Additional areas marked as 0915 and 0450 are being used to determine the effects on small-mammal and bird communities of the modification of forest habitats for transmission-line corridor construction and maintenance.

RESERVOIR RESEARCH PROGRAM. The reservoir research program has evolved from earlier continuing research on the environmental effects of once-through cooling water from power plants and drift from cooling towers. The cooling-tower drift project uses downwind areas within area 0809 east and northeast of ORGDP in the valley floor traversed by Blair Road and Poplar Creek to study the distribution and effects of water and chemical additives from the cooling towers at ORGDP. Additional land for these studies is in use in the O segment across the Clinch River from ORGDP. The larger reservoir research program includes study of a range of ecological, physical, and chemical processes in southeastern reservoirs. At present, research activities are focused on the upper Watts Bar and Melton Hill reservoirs and involve studies of forage fish and their interactions with predators and of habitat selection by species, such as striped bass, largemouth bass, and sauger. This program will involve a comparison of conditions found in several Melton Hill reservoir embayments (Bearden Creek, Walker Branch, McCoy Branch, and Scarboro Creek).

HABITAT FOR AQUATIC RESEARCH. Several quarries, small streams with associated watersheds, and miscellaneous habitats are located on the DOE reservation. These sites are used for various aquatic ecology research and need to be protected.

1. Lambert quarry (area I, Overlay 7) is isolated, and access can be controlled. There is a small associated watershed. Research on fish tracking and the cycling of trace contaminants is in progress at Lambert quarry.

2. McCoy Branch, Bethel Valley quarry, and the associated watersheds (area II, Overlay 7) are being studied to determine transports of trace contaminants that are released from a fly-ash tailings pond east of Fanny Knob. Research will continue on transport, cycling, and effects of trace contaminants from fly ash in aquatic ecosystems inhabiting this site.

3. Although highly impacted by drainage from acid pits near Y-12, Bear Creek (area IX, Overlay 7) is a valuable aquatic habitat because of the opportunity to study recovery following cessation of acid and nitrate pollution. The creek has several monitoring stations, and the backlog of data will provide the basis for before and after comparisons during the recovery process.

CLINCH RIVER AND POPLAR CREEK. The embayments of the Clinch River and a section of Poplar Creek are used for fish-population studies and as aquatic monitoring stations (see Overlay 7, Section 8):

1. Roberts Branch embayment (area X-2), located just below Gallaher Bridge across the river from ORGDP, is used for fish-population studies and is one of the best areas for collecting spawning carp.

2. Embayment Pond (area X-3), just below Grassy Creek and above Gallaher Bridge, is used for collecting spawning carp.

3. Poplar Creek (area X-4), approximately 200 yd upstream from the mouth, is used for fish-population studies and as an aquatic monitoring station for the three-plant assessment.

4. Clinch River Mile 11 (area X-5) is used for fish-population studies and as an aquatic monitoring station for the three-plant assessment.

5. Mouth of Ellis Creek (area X-6), located at mile 4.3 on Poplar Creek, is used for fish-population studies and as an aquatic monitoring station for the three-plant assessment.

6. Poplar Creek (area X-7), 50 yd above the convergence with the East Fork of Poplar Creek, is used for fish-population studies and as an aquatic monitoring station for the three-plant assessment.

MELTON LAKE WATERFOWL HABITAT. This site (area XII, Overlay 7, Section 8) has the attractive feature of combined open upland habitat (pasture), shoreline, and open-water rest areas. Conditions are conducive to establishing resident waterfowl populations. Migrants are also attracted to this site. Both resident and migrant waterfowl populations are resources for studies of potential environmental impacts related to different energy technologies. The major emphasis at present is the establishment of giant Canada geese on the Melton Hill reservoir. This effort involves TVA, the State of Tennessee Wildlife Agency, and environmental research groups in DOE.

CARL Research Activities

Specific lands (types 1 and 2, Overlay 3, Section 8) are needed and used to support the research program of the Comparative Animal Research Laboratory (CARL). The areas are identified on Overlay 8, Section 8. This program includes studies on the metabolism and effects of energy-related toxic agents in a variety of mammalian species.

These species include small laboratory rodents, carnivores, and large domestic animals, such as swine, sheep, cattle, and horses. The large domestic animals are used not only for critical studies on the contamination of man's food chain but also (because of their large size, long life-span, and long gestation period) for interspecies comparisons designed to better extrapolate from experimental animal data to man. These species require agriculturally improved land for maintenance of healthy breeding herds, and the lands identified on Overlay 8 are required for this purpose.

In addition to agriculturally improved land, an area has been identified for future ecological studies in cooperation with the Environmental Sciences Division (ORNL) and with the Forestry and Wildlife Department of the University of Tennessee Agricultural Experiment Station (area 1, Overlay 8). This area allows control of wildlife populations, management and control of woodland areas, and appropriate management of agricultural land. These areas must be contiguous, and strict animal and personnel control must be exercised.

IMPORTANCE OF LAND IN CARL'S RESEARCH PROGRAM. The availability of agriculturally improved land is essential for the continuation of CARL programs. Without these lands, research with large domestic animals would be difficult if not impossible. CARL, with its land and facilities, represents a unique DOE laboratory well suited to carry out programs that could not be accomplished (or only with great difficulty and expense) elsewhere. Specific data from animal research are needed to adequately define the risk to man from energy-related environmental toxic agents. Without agriculturally improved land and the programs this land supports, these data might not be developed.

LAND USE IN SUPPORT OF CARL'S RESEARCH PROGRAM. Areas currently being used to support the CARL program are described below. Acreage data for the tracts are summarized in Table 5-2. Lands cited below are shown on Overlay 8 (numbers correspond to the areas on the map).

1. Gallaher Bend contains 102 acres (41 ha) of good-quality pastureland and 20 acres (8 ha) of woodland. There are no facilities other than fencing on this site.

Currently this area is used principally for the pasturing of cattle. The area has been identified and should be reserved for future studies on the environmental impact of energy-related environmental pollutants as they relate to agricultural, forestry, and wildlife management. Of all the lands in the Oak Ridge reservation, this peninsula, almost entirely surrounded by water, has the unique potential for these critical studies. Not only is the wildlife isolated and contained, but this is one of the best environments for small mammals and contains integrated pastureland and woodland for interaction studies. This area must be studied intensively, and plans must be made for wildlife, forestry, and agricultural management. Then large-scale studies on the distribution and transport of energy-related environmental pollutants should be initiated.

2. Freels Bend contains 316 acres (128 ha) of good-quality pastureland and cropland, 32 acres (13 ha) of lots, and 94 acres (38 ha) of woodland. Facilities include six barns, low-dose-rate and high-dose-rate irradiation facilities, two sheds, a silo, and a unique log house of historical interest.

The area is used principally for irradiation of large animals, maintenance of caesarian-derived SPF swine, maintenance of aged irradiated burros, maintenance of breeding sheep flocks, pasturing of cattle, and production of hay and corn silage. This area is unique for these uses because of the relatively high fertility of the cleared land, isolation from other land areas by dense woodland and water, and access by a single road over a causeway. Thus sheep are safe from wild dogs, SPF swine are safe from microbial contamination, and aged burros are safe from the stresses of dogs and people.

3. Solway Bend–Bethel Valley contains 128 acres (52 ha) of pastureland and cropland, 18 acres (7 ha) of lots, and 91 acres (37 ha) of woodland. Facilities include two general-purpose barns, one swine barn with small laboratory, and two swine sheds.

This area is used primarily for maintaining experimental swine in isolation, maintaining burros in a lifetime study, and pasturing cattle. Some hay is produced.

4. The laboratory area contains 79 acres (32 ha). This area contains CARL's principal research facilities: the main laboratory and office building, a surgery building, an autopsy building, two greenhouses, an equine building, a cattle, sheep, and swine nutritional facility, swine farrowing and rearing facilities, radioisotope laboratory, five barns, a feed mill, carpentry shop, machine shop and storage facility, cold-storage building, warehouse, and sewer plant.

5. Chestnut Ridge contains 348 acres (141 ha) of fair- to good-quality pastureland, 10 acres (4 ha) of lots, and 253 acres (102 ha) of woodland. Facilities include three barns, two concrete trench silos, machinery shed, underground gasoline tank with pump, and a pneumatic water system.

This land is used principally for the pasturing of cattle and for hay and silage production.

6. Compartment A contains 200 acres (81 ha) of fair-quality pastureland, 2 acres (1 ha) of lots, and 46 acres (18 ha) of woodland. Facilities include a shed and a silo.

The land is used principally for the pasturing of cattle and winter feeding of the cattle herd. This is particularly valuable pastureland because of its nearness to the main laboratory facilities, which reduces labor costs during the winter months when feeding is required. It is extremely important that this land be preserved.

7. Compartment B contains 175 acres (71 ha) of fair-quality pastureland, 5 acres (2 ha) of lots, and 21 acres (9 ha) of woodland. Facilities include one barn and a corral. The principal use is the pasturing of cattle.

8. Compartment C contains 171 acres (69 ha) of fair-quality pastureland and cropland, 10 acres (4 ha) of lots, and 46 acres (18 ha) of woodland. Facilities include a barn and a silo. This land is used principally for the pasturing of cattle and for hay production.

9. Compartment D contains 130 acres (53 ha) of fair-quality pastureland and cropland, 10 acres (4 ha) of lots, and 23 acres (9 ha) of woodland. Facilities include a barn and a machinery shed. This land is used principally for the pasturing of cattle and for hay production.

10. Compartment E contains 150 acres (60 ha) of cropland and pastureland, 44 acres (18 ha) of lots and plot land, and 26 acres (11 ha) of woodland. Facilities include two small barns, one barn especially designed for raising calves, one large feeding barn with silo, the agronomy fieldhouse, a machinery shed, and a shade house. The principal uses of the area are production of hay and silage crops, plant science research [20 acres (8 ha)], and cattle pasture and maintenance.

Forestry Management

The forest-management program on the Oak Ridge DOE reservation optimizes the yield of high-quality forest products in a manner compatible with plant operations, environmental research programs, and other aspects of the DOE mission at Oak Ridge.

IMPORTANCE OF LAND USE FOR FOREST MANAGEMENT. Forest management contributes to the overall Oak Ridge DOE program and in particular to the environmental research programs. Land- and forest-management activities provide for disease control, for wildfire control, and for an outlet for disposing of timber. Forest management also aids conservation of natural resources and is the major means of maintaining diversity of habitat. Through coordination of commercial forestry activities with environmental research programs, special ecological conditions can be created for experimental use. Timber sales contribute to employment in the region through both harvest and wood-product manufacture.

SPECIAL PROGRAMS. Forestry-management planning maintains sufficient flexibility in the phasing of near-term operations to allow the addition of special management treatments. The periodic outbreaks of southern pine beetle (*Dendroctonus frontalis*) activity, for example, have required special types of management operations during the past several years. These operations include rapid implementation of disease-control measures (e.g., spot cutting, clearing, and slash removal), salvage of merchantable beetle-infested timber, and forest-stand regeneration. Planning for forest-stand regeneration takes into account present and potential research needs for diverse habitat types and optimal species selection for specific site conditions.

SILVICULTURAL PRACTICES. Development of the optimum species composition for each forest site is the overall silvicultural aim of the forest-management program. Numerous silvicultural systems are used to accomplish this objective, the choice depending on the productive capabilities of the forest site in question in conjunction with environmental parameters. The more productive sites produce mature timber faster and can support greater saw timber volumes per acre than can poorer sites. Hence one can afford to invest more on silvicultural improvement of such areas.

Ridges, upper slopes, south mid-slopes, and other low-productivity sites. These areas range in oak site index* from 40 to 60. Such sites generally occupy dry rocky or cherty ridges, upper slopes, and mid-slopes facing south (topographic classes 1, 2, and 3†) and small areas of severely eroded soil. Less desirable oak species, Virginia pine (*P. virginiana* Miller), and shortleaf pine (*P. echinata* Miller) usually predominate. Yellow poplar (*Liriodendron tulipifera* L.) outgrows most oaks on the "better" poor sites but will not form pure stands. The proportion of yellow poplar can be increased with proper management. Virginia pine is best suited for the poorest sites and is favored where present. On the poorest sites the objective is to simply maintain soil cover since timber production is at best economically marginal. For instance, narrow bands of Bland soil, a highly erodable soil formed over calcareous siltstone, run east-west across the reservation and are suited only for eastern red cedar (*Juniperus virginiana* L.) and undesirable oaks.

Sites of low productivity are primarily managed by the single-tree selection system, which results in an uneven-aged forest. The better species will be favored, and selection is aimed at improving overall timber quality. This silvicultural system will tend to perpetuate the shade-tolerant species of oak and offer maximum protection to the sites through complete canopy cover. Where pine predominates and is suited to the site, a 40- to 50-year rotation will be established. Hardwoods intended for sawlogs will require a 90- to 120-year rotation. The upper diameter at breast height (4.5 ft above the ground) limit for sawtimber is 16 to 18 in. on these sites, and timber will be cut on reaching this size.

Coves, lower slopes, north slopes, and valley sites. These generally range in oak site index from 60 to 80. Such sites occupy coves, minor bottoms, north slopes, and many of the lower south slopes (topographic classes 4 through 8†). Some broad ridges with relatively deep well-drained soil developed from limestone parent material are included in this site class.

Many sites of this type can support pure stands of yellow poplar, and on the better cove sites black walnut (*Juglans nigra* L.) and northern red oak (*Q. rubra* L.) do

*Site index is a measure of the capability of land to produce timber. It is the height in feet that trees will attain in 50 years.

†See Fig. 1 in J. W. Curlin, Forest Management Plan for the Oak Ridge Reservation, USAEC Report ORNL-TM-1317, Oak Ridge National Laboratory, 1965.

well. Silviculture aims at increasing the proportion of yellow poplar on the more productive sites. White oak (*Q. alba* L.) is favored on the mid-slopes and some upper north slopes.

Even-aged silviculture is used to manage the productive sites. This method tends to increase the proportion of shade-intolerant species, such as yellow poplar. Two distinct phases make up the rotation: reproduction and harvest and intermediate cutting.

The reproduction cut is made the final year of the rotation, usually in a mature stand, although understocked stands or those composed of undesirable species can be cut before maturity in order to regenerate the area with suitable growing stock. The reproduction cut removes all mature timber and prepares the area for regeneration by advanced reproduction, by seed lying dormant on the forest floor, or by seed fall from surrounding trees. All cull sawtimber of nonmerchantable trees is removed for pulpwood or deadened after the reproduction cut to ensure successful regeneration.

Intermediate thinnings and improvement cuts are made each 12 years beginning the second management cycle after regeneration. Overall timber quality is improved by removing the poorest trees and the less desirable species. Intermediate cuts also maintain proper spacing and stocking in the interim between regeneration and the harvest cut. Initial thinnings and improvement cuts will only yield pulpwood. As the trees grow, sawtimber can also be removed, leaving the best trees each time as crop trees. Reproduction is of no concern during the intermediate stages of rotation. Thinning and improvement cuts are normally terminated after the first 60 to 70 years.

The very best cove and minor bottom sites can produce 24- to 28-in. sawtimber with a 60- to 75-year rotation. Slope sites of intermediate productivity will produce 20- to 24-in. sawtimber with a rotation of 75 to 90 years, given proper thinning and care.

Plantation Sites. Plantations of pine occur on old-field sites in the valleys and on lower slopes. The trees were planted on a nominal 6- by 6-ft spacing, and survival was generally good. The oldest of the pine plantations is now 32 years old.

A commercial thinning program was begun in 1967 on the oldest and most heavily stocked stands. Through FY-1978 approximately three-fourths of the 5700 acres (2280 ha) of pine plantations have now been thinned. An income of $154,478 has been realized. Cordwood removed to date from these thinnings amounts to approximately 45,500 standard cords.

A few stands were left unthinned as controls to be used in making comparisons with stands of similar size and stocking that were thinned. The effectiveness of the thinning program is apparent from comparisons of some of the earlier thinned stands with the control stands.

Planted areas perpetually managed for pine will be operated on an even-aged rotation of 40 years for shortleaf pine and 60 years for loblolly pine. Seed-tree regeneration cuts at rotation age will leave 15 to 20 trees per acre to provide seed for the next generation. After reproduction has been established, the seed trees will be harvested. Areas where natural regeneration is not satisfactory will be planted, and areas where hardwoods are more desirous will be converted through pine thinnings and managed according to silvicultural practices outlined in the previous two sections.

Acres planted to hardwood species will be managed on an even or uneven age basis depending on the regenerative capacity of the species with a rotation age of 60 to 75 years. Initial stand establishment will require planting on a 10- by 10-ft or 12- by 12-ft spacing, which will allow for control of competing herbaceous vegetation through discing, mowing, and spraying. Species favored for artificial regeneration include those which are moderately tolerant to intolerant and which have proved successful in the present generation program, such as black walnut *(Juglans nigra), white ash (Fraxinus americana),* green ash [*Fraxinus pennsylvanica* (var. *lanceolata*)], yellow poplar *(Liriodendron tulipifera),* eastern cottonwood *(Populus deltoides),* sycamore *(Platanus occidentalis),* and sweetgum *(Liquidambar styraciflua).* Periodic intermediate pulpwood thinnings will be required to maintain stand density, health, and vigor.

TIMBER SALES POLICY. Owing to termination of the long-term timber sales contract on the DOE Oak Ridge reservation in 1978, timber sales will be conducted via spot-bid sales in smaller lots of from 20 to 300 thousand board feet per lot. Sales will be conducted as and when the need arises for construction purposes, insect and disease control, management purposes, or research needs. As in the past, the managing forester will be responsible for (1) marking and computing timber volumes to be sold; (2) joint cruises and pre-bid inspections with prospective bidders and, as necessary, joint cruises to settle pre-bid disagreements on volume and timber type of sales; (3) conducting periodic checks on cutting operations; and (4) maintaining records.

TIMBER-STAND IMPROVEMENT. Timber-stand improvement (TSI) is needed in many naturally regenerated and planted stands on the DOE Oak Ridge reservation to improve the species composition and stem quality. TSI will be used in the form of precommercial thinning of overstocked hardwood stands, release mowing, discing, and spraying of herbaceous vegetation in newly planted hardwood stands, limb pruning in older stands, and improvement cuttings in older stands to regulate the bole quality and species composition. Undesirable trees and unmerchantable trees will be injected prior to regeneration following salvage or harvest cuts.

SLUDGE DISPOSAL PROGRAM. The City of Oak Ridge has requested approval to dispose of sewage sludge from the expanded West Sewage Treatment Plant on DOE land. Their initial request was for a direct transfer of land

for this purpose. Such a transfer was found to be not practicable in light of present and future land-use needs for DOE lands. Since the environmental programs at ORNL have a continuing programmatic interest in sludge disposal, it was tentatively agreed that the city's need for disposal of sewage sludge could be accommodated for a period of 5 to 10 years as part of the forestry program and environmental research programs. The acreage involved would not exceed 100 acres in any given year, and specific sites would periodically be changed as forestry-management practices and research programs required.

4. Future Land Requirements for Programmatic Research in Agricultural and Environmental Sciences

The need for retaining land and water resources is given in the following paragraphs for selected areas.

Raccoon Creek Watershed (Area VII, Overlay 7)

Raccoon Creek (area 0801) is the only stream left on the reservation that can serve as a control stream for aquatic studies. It has served as a collection site for aquatic organisms for a number of years. Within the proposed Raccoon watershed are numerous subwatersheds on the south slope of Haw Ridge, some of which have been included in the descriptions of unique natural areas.

The Raccoon Creek watershed is one of the few streams remaining on the reservation that is not heavily polluted or impacted by construction. A small but detectable amount of radioactivity has been discovered in Raccoon Creek and is being investigated to define future use of this watershed. In view of the commitment of Grassy Creek to the Clinch River Breeder Reactor site and the possible impact by EXXON (see Section 6B), the Raccoon Creek watershed must be preserved with an unimpacted watershed for aquatic studies.

McNew Hollow (Area 0913, Overlay 6)

McNew Hollow is the only marsh habitat of any significance on the reservation and represents a unique research area for the assessment of impacts on inland wetlands.

West Branch of White Oak Creek (Area VI, Overlay 7)

The West Branch of White Oak Creek will be impounded to ensure a constant water supply for experimental ponds used in aquatic research. In addition, about 40 small ponds are planned along West Branch between Bethel Valley Road and Haw Ridge.

Scarboro Embayment and Kerr Hollow (Area VIII, Overlay 7)

The Scarboro embayment and Kerr Hollow serve as a collecting site for aquatic organisms. Drainage from agricultural lands and from a small chemical dump (in a quarry) provide a different water-quality regime, and this site will be used as a future monitoring station.

Gum Branch Watershed (Area 0923, Overlay 6)

This area lies east of Walker Branch watershed on Chestnut Ridge. The Gum Branch area or subunits thereof is planned for use in future expansion of environmental programs requiring soils/geology similar to the present Walker Branch site but with different vegetation. Habitats include old-growth forest, pasture, and transmission-line corridors.

Floodplain of East Fork Poplar Creek (Area XI, Overlay 7)

This tract represents the only sizeable intact and nondisturbed floodplain on the reservation. Although it contains fertile soil, the area is not presently being used for agriculture but contains a 30-yr second-growth forest with extensive forest communities typical of east Tennessee floodplains. This site is near ORGDP and the proposed Exxon site. This tract should be retained for environmental science research in support of these energy-related technologies; however, it is recognized that the proposed Exxon rail spur borders the extreme western portion (Overlay 7, Section 8).

Influence of Environmental Contaminants on Integrated Land Use (Agriculture, Forest Management, and Wildlife Management)

As more-specific data on the movement of energy-related toxic agents through soil, plants, and animals are obtained and as the effects of these agents on agriculture, forest management, and wildlife management are identified, newer, more sophisticated experiments must be conducted to assess the effect on integrated land use as is practiced in many areas of the United States. Land that has the characteristics necessary for such studies is rare. Not only must it have the necessary qualities suitable for agriculture and forestry management with the necessary wildlife habitats but it must also permit isolation and containment for environmental control. Several such areas have been created on the reservation as a result of the area topography and the damming of the Clinch River. Such areas as the Gallaher Bend compartment are particularly suited and should be preserved for these types of study.

F MISCELLANEOUS FACILITIES (TOWNSITE AREA)

Located within the urban area of the City of Oak Ridge are eight DOE-owned sites used for administrative, support, and research services. Each of the sites is described here, and a use summary is given for each; all facilities meet DOE and GSA use criteria for agency retention.

DOE Technical Information Center—Building 1916-T-1: An 8-acre (3.3-ha) tract of land located at 100 Warehouse Road on which is situated a permanent building containing offices, printing plant, and publications distribution facilities. Also located on the site are parking areas and a government-owned rail spur.

This facility houses the Technical Information Center, organizationally an extension of DOE Headquarters, with a personnel complement of approximately 250 employees. The Center is DOE's central organization for collecting, evaluating, cataloging, reproducing, and disseminating scientific and technical information. These functions represent continuing DOE program responsibilities.

Building 1916-T-2: A 7-acre (2.9-ha) tract of land located at 205–245 Brisbane Road. This facility is used for general warehouse storage and maintenance shops by a number of DOE operating and maintenance contractors in support of approved ongoing information and educational, production, and research programs and for office space for Union Carbide Corporation, Nuclear Division, personnel involved in telecommunications and auditing.

Administrative Support Office Buildings: Two adjacent tracts of land, containing a total of 4 acres (1.6 ha), located at 231–241 Tyrone Road on which are situated two office buildings of wood frame construction. These buildings were constructed during World War II but have been rehabilitated to the extent necessary to provide for their continued use until a replacement facility becomes available.

These facilities are fully used by Union Carbide Corporation, Nuclear Division, for housing administrative offices. The primary functions carried out at this location are centralized purchasing and employment activities. Because of the centralized location to the three plants served and the unavailability of other office space, continued retention of the facilities may be required indefinitely.

Administrative Support Area: A 12-acre (4.9-ha) tract of land located immediately south of the Federal Building's main parking lot and north of Laboratory Road. This site contains two buildings of permanent construction, an antenna field, and a fenced parking area for security vehicles.

The two buildings are used by Oak Ridge Associated Universities (ORAU), a prime contractor of DOE, as laboratories, offices, and training facilities and by DOE for a records-holding area, photography laboratory, office space, and the Safeguards and Security Division's Shipment Operations Center.

The laboratories and training facilities are used primarily for the training of professional persons and college students in energy-related subjects. The ORAU facilities are used in the evenings for the Oak Ridge Resident Graduate Program of the University of Tennessee. The records-holding area is a DOE security-approved facility used for the storage of semiactive or inactive records, the use of which does not permit their transfer to a federal records center. The photography laboratory is used for the development and storage of DOE's photographs, slides, and movies and for the office of the photographer. The Safeguards and Security Division's Shipment Operations Center, which directs the off-site transportation of sensitive materials, is located in these buildings. The antenna field is maintained to provide communications capability to and from DOE's Emergency Operations Center (EOC) in the event of a disaster or national emergency. The EOC is located in the Federal Building. The secured parking area is used for the parking and protection of the Shipment Operations Center's vehicles.

DOE Research Support Facility: An 11-acre (4.5-ha) tract of land located at 456 South Illinois Avenue on which is situated an office, shop building, and a wind-tunnel research facility. This facility houses the Atmospheric Turbulence and Diffusion Laboratory (ATDL), National Oceanic and Atmospheric Administration (NOAA), which is engaged in meteorological and atmospheric diffusion research. This program conducts research supported by DOE and NOAA as an approved ongoing joint effort, provides services to other DOE contractors, and operates the Weather Instrument Telemetering Monitoring System for DOE.

The American Museum of Science and Energy: A 17-acre (6.9-ha) tract of land located at 300 South Tulane Avenue on which is situated the American Museum of Science and Energy. This facility was initially occupied in February 1975 and is operated under government contract by Oak Ridge Associated Universities. The American Museum of Science and Energy provides an opportunity for interested persons to obtain information about and increase their awareness of the national energy needs, policies, and programs. Understanding of the National Energy Plan by the public, in turn, fosters support for the energy conservation ethic and prudence in the use of energy resources.

Oak Ridge Associated Universities (ORAU) Research Support Facilities: A 3-acre (1.2-ha) tract of land located at 121–130 E. Vance Road on which is situated a permanent structure used for biomedical research.

The research facilities are used by the Division of Medical and Health Sciences, ORAU, to conduct programmatic biomedical research for DOE. Major research programs and activities involve epidemiology, biochemistry, immunology, radiopharmaceutical development, nuclear medicine, and the use of these disciplines to solve problems on occupational health and preventive medicine related to the development of nuclear energy sources.

Clinch River Breeder Reactor Project Office (CRBRPO): A 3-acre (1.2-ha) tract of land located at 55–59 Jefferson Avenue which was formerly the site of the American Museum of Atomic Energy. The facility was renovated in 1975 to become the CRBRPO. The buildings and related improvements (excluding land) were administratively transferred to the CRBRPO from ORO in 1975, and accountability will revert to ORO on completion of the project.

6

OTHER LAND-USE CONSIDERATIONS

A OUTSTANDING COMMITMENTS

1. Firm

General Services Administration

A 9.66-acre (4-ha) tract of land formerly used for CARL tenant housing was reported to GSA as excess on Mar. 31, 1978. Disposition of this tract, located on Old Edgemoor Road, is pending GSA action.

2. Tentative

City of Oak Ridge

The City of Oak Ridge is considering the road redesign of Laboratory, Lambuth, Bus Terminal, and Administration Roads in the area southwest of the Federal Building. DOE review was requested of two alternatives for the redesign of Administration and Laboratory Roads. DOE preferred a straight extension of Administration Road from the west single-lane employee parking area to Laboratory Road. This would eliminate the present L-shaped curve in the road. DOE advised the City that they anticipated that an easement for road redesign would be granted on request.

Tennessee Valley Authority

In 1973, TVA requested, and Headquarters subsequently approved, the transfer of Clark Center Recreation Park and adjoining lands to TVA for development as a regional public park. Actions were taken to specifically define the area to be transferred, which totals 965 acres (391 ha). A radioactive-contamination survey was made, which revealed no unusual findings, and negotiations were begun to effect transfer under authority of the TVA Act of 1933. In 1976, negotiations were suspended, and the proposed transfer is still pending.

B EXXON NUCLEAR COMPANY, INC.

On Feb. 6, 1975, the Exxon Nuclear Company, Inc., wrote the ERDA Administrator requesting the position of ERDA as to the availability of an approximately 2500-acre (1012-ha) site on the Oak Ridge reservation. Exxon expressed interest in the land "on a purchase, lease, or other arrangement" basis for "the purpose of spent-fuel reprocessing, spent-fuel storage, and interim waste storage." A contract was entered into with Exxon on Mar. 8, 1977, calling for conditional sale of the plant-site area and lease of the remaining buffer area.

The Exxon request for 2500 acres (1012 ha) was to provide for a plant site of about 185 acres (75 ha) and a buffer area (Overlay 11). A pipeline corridor north of Bear Creek Road westerly to the Clinch River and a railroad right-of-way would also be required.

On Mar. 8, 1978, the Nuclear Regulatory Commission notified Exxon that, based on the decision to terminate the Generic Environmental Statement Mixed Oxide (GESMO) fuel proceedings, it was ceasing its review of Exxon's spent-fuel storage and reprocessing application. Since that time all work at the site and on the Exxon application has ceased.

C COMMUNITY INTEREST IN DOE LAND

As the owner of approximately 62% of the land within the City of Oak Ridge, DOE can anticipate recurring questions and expressions of interest concerning its holdings. Changing or expanding community needs, which frequently involve land, can generate proposals by the city for alternative uses of portions of DOE land. To a lesser extent such interest may also be expressed by the state, Anderson and Roane counties, and private individuals or organizations. In the past, community expressions of interest in DOE land for industrial purposes or for improved highway connections were the expected outcome of a policy established by the Atomic Energy Commission in December 1962.* At that time the AEC approved a

*Memorandum: A. R. Luedecke, General Manager, to Managers of Operations et al., Cooperation in Industrial Development Efforts of Communities, Dec. 6, 1962.

policy of cooperation in the industrial development efforts of Oak Ridge and Richland, which, among other things, announced AEC's willingness to consider the availability of its land, on a case-by-case basis, in the buffer areas* for purposes not incompatible with its operations and program requirements.

A policy of cooperation with the city and the two counties has been confirmed by the DOE in carrying out the purposes of the Atomic Energy Community Act of 1955, as amended. On the basis of a report prepared by a DOE Working Group on Community Assistance, the Secretary of Energy, in January 1979, made a decision concerning future DOE policy regarding financial assistance to the communities at the atomic energy facilities. A key aspect of the decision relates to the achievement of self-sufficiency by the communities, which is to be realized by the reduction, or perhaps the ultimate termination, in DOE financial assistance. To encourage the realization of this objective, the DOE report expressed the view that DOE land might be made available for industrial and residential uses. Future transfers of DOE land for community purposes may need to give consideration to the self-sufficiency objective.

The city's land-use studies, together with recent actions affecting land, provide basic data concerning the land available for residential, commercial, recreational, and industrial purposes, particularly within "urban Oak Ridge," which is defined as the minimum geographic area plus that part of the city (Oak Hills, Country Club, etc.) situated in Roane County up to the DOE property line. Approximately 4000 acres (1619 ha), or 30%, of the total area in this "urban Oak Ridge" consist of open and undeveloped land (exclusive of public- and semipublic-use land). Additional acreage can probably be obtained by shifts to alternative uses, as could occur, for example, in the cases of land owned by the Sportsman Association and part of the Oak Ridge Country Club, if the demand for housing increased sufficiently. The 4000 acres (1619 ha) cited above are in addition to an estimated 1500 acres (607 ha) of open space owned by the city (principally greenbelt with steep slopes) in the urban area and are also in addition to the 3500 acres (1417 ha) of non-DOE land south of Pine Ridge (Haw Ridge, UT arboretum, landfill, etc.). Not all the 4000 acres (1619 ha) are easily developable since an estimated 1900 acres (769 ha) involve slopes of 20% or more. Development of some of this hillside may be feasible, although probably at considerable cost.

The city has been improving its parks and recreation facilities inside the urban area. This effort is not expected to involve requests for DOE land. The possibility of future requests for such purposes depends on the increase in population density in the community and also on whether the residential neighborhoods are permitted to extend beyond the present DOE line, west along the Turnpike. Outside the urban zone but within the city are the larger recreation areas, Clark Center Recreation Park and, potentially, Haw Ridge with 850 acres (344 ha), which appear to be more than adequate for Oak Ridge requirements unless metropolitan usage creates congestion. Nearby facilities outside the city offer other recreational resources convenient to the residents.

About 252 acres (102 ha), or 6.3%, of the 4000 acres (1619 ha) are private property zoned for industrial purposes. The greater part of this land is situated in the Midway area where rail and utilities are readily available. There are, in addition, about 30 acres (12 ha) of vacant city and TVA land for industrial uses in the urban area. Outside the urban area the city is developing the Valley Industrial Park of 125 acres (51 ha), has designated the 30-acre (12-ha) Union Valley former landfill for industry, and has access to about 96 acres (39 ha) of vacant land in the Clinch River Industrial Park (TVA). Taken together, this represents approximately 525 acres (212 ha) of undeveloped industrial land (private and public) inside the city, although 200 acres (81 ha) has been identified as the site for the centrifuge manufacturing plant to be built by the Boeing Engineering and Construction Company. Several sites on public land are presently under option to industrial interests. The city foresees the need to establish another municipally-owned industrial park around 1982, depending on progress in realizing private investment in the Valley Industrial Park.

Although there seems to be adequate land (exclusive of DOE land) for most community requirements, it would appear that the city and other community interests view all the land within the corporate limits as their proper sphere of planning for Oak Ridge development. Their explorations of possible future land uses, particularly with respect to potential industrial sites, are not inclined to stop at the DOE boundary line.

In an active community environment, ideas for improvements or development are frequently being conceived, nurtured, tested, and sometimes brought to fruition. Such ideas may originate from many different sources, although their fruition often involves city support or participation. Some ideas that might be termed as points of interaction (actual and potential) between DOE and others with respect to DOE land are:

1. Perimeter pressures: Hartland Estates and Country Club Estates.
2. Industrial sites on DOE land suitable for building construction, especially on the part of enterprises whose activities would be compatible with DOE programs.
3. Bethel Valley Road as freeway from I-40 to I-75 via White Wing, which would raise the possibility of requests for industrial sites along the route.
4. In connection with item 3 above, realignment of White Wing Road and improved intersection at Bethel Valley.

*Buffer areas as used in this context means all land areas between the plant complexes.

5. An airstrip. Although present interest is centered on land owned by the University of Tennessee, DOE land continues to be involved.

6. Landfill sites.

7. Disposal of city sludge on DOE forestry lands, a plan for which is being developed with DOE approval.

Some of these points of interaction reached the stage of a request for the transfer of specific portions of DOE land. These requests and their impact on DOE programs are discussed in Section 6A. Other points, however, still represent only ideas or possibilities that at some future time might become sufficiently tangible to turn into requests. In cases where a request for land or easements involves potential conflicts with DOE program requirements, there would need to be a careful evaluation in arriving at an appropriate agency position. Obviously, DOE's broad responsibilities will affect its determinations concerning the availability of DOE land.

Annexation of adjoining areas is a municipality's traditional means of obtaining more living space or of broadening its economic or social base. In the case of Oak Ridge, annexation as an alternative to requesting land from DOE requires surmounting the natural barriers provided by the Clinch River and Black Oak Ridge, which still contribute to the isolation of the community deliberately sought during World War II. Present service and financial resources would be strained to leap these barriers as the demand for services and facilities began to rise. As long as adequate vacant, undeveloped land is available in the present urban area, there appears to be little incentive for the city to pursue annexation except to meet circumstances for which particular sites are proved to be necessary.

Since local land resources for both the city and DOE are not unlimited, it is incumbent on both to encourage effective land management and to give responsible consideration for each other's requirements.

7

HEALTH AND SAFETY REQUIREMENTS

A BACKGROUND FOR BUFFER ZONES

It is standard practice for nuclear facilities to have buffer zones around their perimeter. The size of buffer zones, although not clearly specified by regulation, should be consistent with the "as low as reasonably achievable" concept where personnel exposure to radioactive and/or toxic materials may be involved. Buffer-zone requirements for reactors are outlined in the *Code of Federal Regulations,* Title 10, Part 100.[1] These regulations establish 300 rems to the thyroid and 25 rems to the whole body as the maximum radiation doses permitted at the edge of the exclusion boundary (buffer zone) for 2 hr following a maximum hypothetical accident.

Buffer zones are regarded as controlled areas free of permanent occupancy so that prompt and easy evacuation can be effected following accidents with serious off-site health impact. The size or radius of buffer zones varies with the relative hazard of the particular facility. For minimally contained reactors, proper buffer zones may range to 10 miles (16 km) or more. For very-low-hazard nuclear facilities, such as isotopes laboratories, fuel-fabrication facilities, nuclear hospitals, etc., no buffer zone at all may be required. A buffer zone often is permitted to have occasional occupancy and may be dual-use property, including agricultural, forest-management, or research uses. However, emergency capability and plans exist to evacuate buffer areas on short notice.

DOE facilities are subject to safety analyses to determine potential off-site effects of accidents and buffer-zone requirements. For reactors, safety analyses spell out in great detail the potential hazard inherent in the buffer zone and the mandatory requirement for buffer-zone maintenance. For other nuclear and nonnuclear facilities, the documentation of need for buffer zones is not generally so complete. However, for many nuclear facilities, such as transuranium-handling facilities and fuel-reprocessing plants, the need for buffer zones is at least as great as that for most small reactors.

B URANIUM-ENRICHMENT FACILITIES

1. Oak Ridge Gaseous Diffusion Plant

The inherent design, process variables, and quality-assurance provisions required in the uranium-enrichment process also effect a high degree of containment for uranium. This, in conjunction with the fact that only low ^{235}U assay UF_6 is handled at the ORGDP, would not indicate the requirement for an extremely large buffer zone. However, the philosophy of a hazard analysis is to assume the failure of certain lines of containment. For the ORGDP, the potential for large releases of uranium involves ancillary feed, withdrawal, and sampling operations where UF_6 is heated in large cylinders with capacities up to 14 tons. The following considerations involving routine environmental releases and the maximum postulated accident support the minimum 1-mile (1.6-km) buffer-zone radius established for the ORGDP.

Routine Environmental Releases from the ORGDP

Routine radioactive effluents from diffusion-plant operations are well controlled. Perimeter (buffer zone) airborne concentrations of uranium are routinely controlled at levels approximately 1% of present DOE standards.

Data from a vegetation sampling program indicate that this minimum buffer zone is necessary to meet the State Air Pollution Control Commission regulations on ambient concentrations of fluorides. Although areas in the outer part of the buffer zone do not exceed these guidelines, areas near the perimeter fence would, in some instances, have been in violation had the buffer zone not been established.

Maximum Postulated Accident

The most important consideration supporting the minimum buffer zone described is the potential for a catastrophic failure of an anhydrous hydrofluoric acid (AHF) storage tank or rail car. The AHF is highly toxic and can readily become airborne when released from containment resulting in severe environmental effects.[2] Since up to 250,000 lb (113,400 kg) may be in storage or process at the ORGDP, accident analyses have been performed with the assumption that significant quantities could be released

from containment.[2] Resultant concentrations of HF in air, based on diffusion equations, support the requirement for the 1-mile (1.6-km) buffer zone.

2. Gas-Centrifuge Operations

The sophistication of design, quality-assurance provisions, and operating parameters, not unlike the ORGDP, are such as to preclude the requirement of a large buffer zone for gas-centrifuge operations as such. However, the feed and withdrawal operations involving the handling of UF_6 in large cylinders will be essentially the same as now required at the ORGDP. Hence the potential for UF_6 releases from the auxiliary operations is considered equivalent to that for gaseous diffusion operations. Thus the requirement for a 1-mile (1.6-km) buffer zone is indicated to be consistent with that described for the ORGDP.

Since gas-centrifuge technology is yet to be applied to large-scale operations, including component production activities, the operating experience valuable to accident analysis is not available. Therefore conservative assumptions involving equipment failure, future operating parameters, and inventories must be made. These factors and the potential for release of certain materials peculiar to the manufacture of centrifuge rotors substantiate the need for the buffer zone as stated.

C OAK RIDGE RESEARCH FACILITIES

1. Oak Ridge National Laboratory

Buffer zones or exclusion areas are reasonably well defined for the ORNL area, particularly for the reactor facilities where extensive documentation is required. For both the High Flux Isotope Reactor (HFIR) and the Oak Ridge Research Reactor (ORR), the radius of the buffer zone is controlled by whole-body radiation exposure since iodine filtration systems are incorporated into these reactors. The buffer-zone area for the HFIR [100 Mw(t)] is 1¾ miles (2.8 km) and for the ORR [45 Mw(t)] is 1 mile (1.6 km).

Both the Tower Shielding Facility (TSF) and the Health Physics Research Reactor (HPRR) require fairly large buffer areas because they are operated in an unshielded condition. Fences act as the buffer-area edge for these unshielded reactors to provide control of personnel occupancy. The TSF has an irregularly shaped buffer zone with a radius ranging from ¾ to 1¼ miles (1.2 to 2.0 km). The buffer-zone radius for the HPRR ranges from ½ to 1 mile (0.8 to 1.6 km). Overlay 12 consolidates the buffer zones for the ORNL reactors and fills in 1-mile (1.6-km) buffer zones for facilities such as plutonium and waste-treatment facilities. More specific facts and data regarding buffer zones in the Oak Ridge area follow:

Tower Shielding Facility

The boundary of the general exclusion area for the TSF, which is enclosed by an antipersonnel chain-link fence, is the basis for the exclusion boundary used in the TSR safety analysis report.[3] Four gamma-ray sensitive detectors are located at points along the exclusion fence. The gamma-ray dose rates at the four monitoring stations are continuously recorded on a strip chart in the control room. The Tower Shielding Reactor No. 2 is operated such that the dose at the nearest point of reasonable access is limited to 500 mrems/year. This is 4085 ft (1245 m) from the reactor near Melton Hill Dam.

The maximum postulated accident for the TSF postulates that the reactor has been dropped and all water has been lost from the pressure vessel. Studies of exposure doses at the enclosure boundary as a function of core-melting fraction for various power levels and modes of operation were made to determine the operating limits on power. Radioactive-cloud concentrations downwind from an instantaneous point source were estimated with two different dispersion models and for different atmospheric conditions. For example, the ^{131}I activity, which would be released if 3.6% of the core melted following 1-Mw(t) operation, would result in a 300-rem thyroid dose at a distance of 1 km. Thyroid dose is limiting at this facility and indicates that the power level must be restricted to about 1-Mw(t) operation. Loss of any of this exclusion area would severely restrict TSF operation.

Health Physics Research Reactor

The HPRR is capable of producing self-limiting prompt-critical bursts with yields of the order of 10^{17} fissions. The facility is designed to safely handle the postulated maximum credible accident of 10^{19} fissions. The enclosure boundary, which again is an antipersonnel chain-link fence, is within the ORNL buffer zone (see Overlay 12). The west portion of this boundary is common with the TSF boundary.

Personnel that use either the TSF or the HPRR exclusion area enter at the appropriate gate if the particular facility is not operating. They will not be given the key to the gate in the common fence unless both facilities are shut down. Neither facility will be allowed to start up until this employee's accountable badge has been returned.

Information presented in the HPRR safety analysis report[4] (p. 75) indicates that a maximum credible burst of 10^{19} fissions would result in total fission products that, assuming 200 sec for the airborne material to travel to the nearest access point 3000 ft (914 m), would conservatively give an external dose not greater than 15 rads at this point. Again, all the indicated exclusion area should be retained.

High Flux Isotope Reactor

The HFIR is a 100-Mw(t) reactor designed primarily for producing relatively large quantities of transplutonium elements. The maximum credible accident, as given in the HFIR safety analysis report,[5] is postulated to be an

extensive meltdown of the reactor core concurrent with a failure of the primary containment sufficiently severe to allow some of the fission products to escape directly into the building but not violent enough to grossly rupture the reactor vessel or the high-pressure piping.

The controlling factor in the HFIR exclusion boundary dose is the total-body dose from noble gases. This is because an overall decontamination factor of 2000 has been applied to iodine.

At 1¾ miles (2.16 km) downwind from the HFIR, the total-body dose in 2 hr is calculated (pp. 25-26 in the safety analysis report) to be 25 rems. Thus the HFIR exclusion area is considered to be a circle having a radius of 1¾ miles (2.16 km) which essentially reaches Melton Hill Lake at the nearest points (see Overlay 12).

Oak Ridge Research Reactor

The ORR is a research reactor designed and built for use as a general-purpose research tool. The current power level is 30 Mw(t). The ORR safety analysis report[6] uses 45 Mw in analyzing the maximum credible accident. As in the HFIR, the total-body dose dominates over the thyroid dose. The total-body dose of 25 rems from 2 hr exposure is calculated (p. 15, Ref. 5) to occur at a distance downwind of 1.06 miles (1.7 km). This distance allows for the combined gamma and beta total-body dose and results in a circular exclusion area having a radius of 1 mile (1.6 km).

A larger exclusion area for the HFIR as compared with the ORR results from a number of differences in analysis. Principal among these are the larger power and the increased building leakage rate of the HFIR relative to the ORR. The extensive shielding at the ORR and HFIR avoids restrictive buffer zones during normal operation.

Iodine Release from Chemical Processing Facilities

There are five stacks at ORNL that, from time to time, emit small quantities of radioactive material to the atmosphere.[7] These stacks are located at different points within the laboratory, have different emission characteristics, and serve a variety of equipment and processes. A total permitted annual release for all the stacks taken together has been set at 52 Ci of ^{131}I per year. The iodine release rates of the ORR and the HFIR are several orders of magnitude below their respective operating limits of 1.28 and 0.67 μCi/sec. As such these reactors do not contribute much to the total release rate. Alternatively, chemical operations, such as the High-Level Analytical Laboratory, the Transuranium Processing Plant, and the Isotopes Division processing facilities, contributed about 21 Ci of ^{131}I total in 1967; presently they average about 2 Ci per year.

The effective-area perimeter used in the effluent study is discussed in Report ORNL-TM-3187;[6] it is included in the buffer zone. Accidental releases of radioactive effluents from chemical operations are also discussed in Ref. 6. The validity of the computer program used was investigated by comparing calculations of the annual average ground-level concentration from the five ORNL stacks with measurements for each of nine established sampling points in the vicinity of ORNL. In general, the calculated values agreed with the measured values within a factor of 2. Concentrations tend to be stronger in the east and west directions in agreement with prevailing wind patterns.

2. Comparative Animal Research Laboratory (CARL)

The buffer zone for this facility is a fenced area enclosing an array of unshielded radiation sources (while in use) that are used to irradiate large animals (see Overlay 12). Severe operating controls are imposed since the size of the buffer zone is limited by the lake reservoir. Currently, tentative plans exist for the use of transuranic materials in animal research programs at CARL. The quantities involved and the exact nature of the research have yet to be defined, and hence buffer-zone requirements for this program are not included here. It must be recognized, however, that an expanded buffer zone may be required in the future should research programs at CARL include transuranics in significant quantities.

D Y-12 OPERATIONS

Operations at the Y-12 Plant include enriched-uranium fabrication, uranium recovery, and plutonium handling. Also included is a variety of research and developmental programs involving the use of toxic and hazardous substances. Although rigid controls through design, monitoring, and procedural methods exist to minimize plant impact on the environment, a nominal 1-mile (1.6-km) buffer zone (see Overlay 12) is considered necessary. This is consistent with the ORNL buffer-zone requirement for similar transuranium facilities. The need for a buffer zone is further supported by the fact that Y-12 operations are flexible and subject to decisions by outside design groups involved in defense programs. Although it is not a certainty that future operations will require an expanded buffer zone, there is always the possibility when operations are subject to change to meet defense requirements.

E RADIOACTIVE- AND CHEMICAL-WASTE BURIAL

With exception of the radioactive-waste burial area northwest of Y-12 along Bear Creek, all major radioactive- and chemical-waste treatment and burial areas (see Section 5D) are included in existing buffer zones (see Overlay 12). Buffer-zone criteria and requirements for commercial radioactive-waste burial operations are not defined; however, depending on the geology of the area, type of materials buried, etc., a reasonable exclusion area appropriately

fenced is generally accepted as adequate. This is needed to effect any required monitoring, access, and expansion of operations. The fenced perimeter around the Y-12 Bear Creek waste-burial operations thus constitutes an acceptable exclusion or buffer area for current operations. Future operations could require an enlarged perimeter.

References

1. *Code of Federal Regulations*, Title 10, Chapter 1, United States Atomic Energy Commission (April 1967), Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.
2. Environmental Statement Expansion of U. S. Uranium Enrichment Capacity, Draft ERDA-1543, June 1975.
3. L. B. Holland and J. O. Kolb, Tower Shielding Reactor II, Design and Operation Report, Vol. 2, Safety Analysis, USAEC Report ORNL-TM-2893, Oak Ridge National Laboratory, Oct. 7, 1970.
4. M. I. Lundin, Health Physics Research Reactor Hazards Summary, USAEC Report ORNL-3248, Oak Ridge National Laboratory, Sept. 10, 1962.
5. F. T. Binford, T. E. Cole, and E. N. Cramer, The High Flux Isotope Reactor Accident Analysis, USAEC Report ORNL-3573, Oak Ridge National Laboratory, April 1967.
6. F. T. Binford, The Oak Ridge Research Reactor—Safety Analysis, USAEC Report ORNL-4169 (Vol. II), Oak Ridge National Laboratory, March 1968.
7. F. T. Binford, T. P. Hamrick, and Beth H. Cope, Some Techniques for Estimating the Results of the Emission of Radioactive Effluent from ORNL Stacks, USAEC Report ORNL-TM-3187, Oak Ridge National Laboratory, Oct. 1, 1970.

8
MAPS

PREVIOUSLY EXCESSED
GOV'T. PROPERTY

ORGDP

IND. SITES

C R B R
SITE

HNL (ORNL)

Y-12

SITE-X
(CITY)

HAW RIDGE
(CITY)

BASE MAP
OAK RIDGE LAND USE STUDY

- DOE – ORO RESERVATION BOUNDARY
- PREVIOUSLY EXCESSED GOV'T. PROPERTY
- CLARK CENTER RECREATION PARK
- DOE OWNED TRACTS IN CITY OF OAK RIDGE

REVISED 6-30-75

REV-7-17-19

ADMINISTRATIVE GRID NORTH
34° 12' 51" W
TRUE NORTH
MAGNETIC NORTH
0°

APPROXIMATE MEAN DECLINATION, 1974
ANNUAL CHANGE 0° 05'

DECLINATION OF GRID 34° 12' 51" W OF TRUE NORTH
GRID INTERVAL 5000 FEET

POLYCONIC PROJECTION
1927 NORTH AMERICAN DATUM

1 3/4 1/2 1/4 0 1 2 3 MILES

1000 750 500 250 0 1000 2000 3000 4000 5000 YARDS

1000 0 2000 4000 6000 8000 10000 12000 FEET

CONTOUR INTERVAL 20 FEET, DATUM IS MEAN SEA LEVEL

S-16A
JUNE, 1974

PREVIOUSLY EXCESSED GOV'T. PROPERTY

IND. SITES

SITE-X (CITY)

CRBR SITE

HAW RIDGE (CITY)

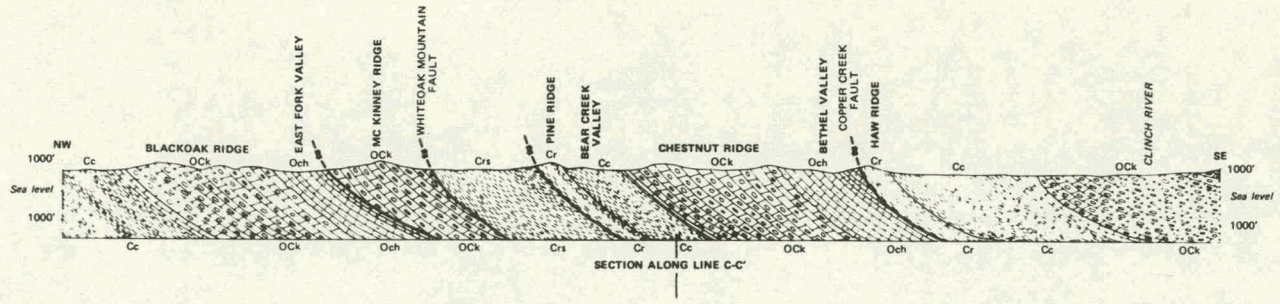
BASE MAP
OAK RIDGE LAND USE STUDY

- DOE – ORO RESERVATION BOUNDARY
- PREVIOUSLY EXCESSED GOV'T. PROPERTY
- CLARK CENTER RECREATION PARK
- DOE OWNED TRACTS IN CITY OF OAK RIDGE

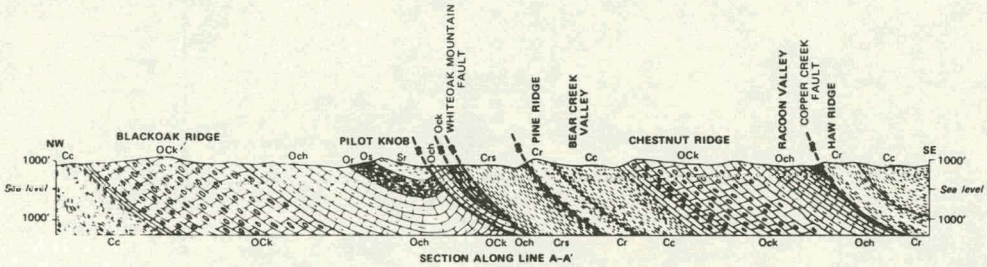
REVISED 6-30-75

REV-1-17-14

Overlay No. 1 Geology Map



SECTION ALONG LINE C-C'



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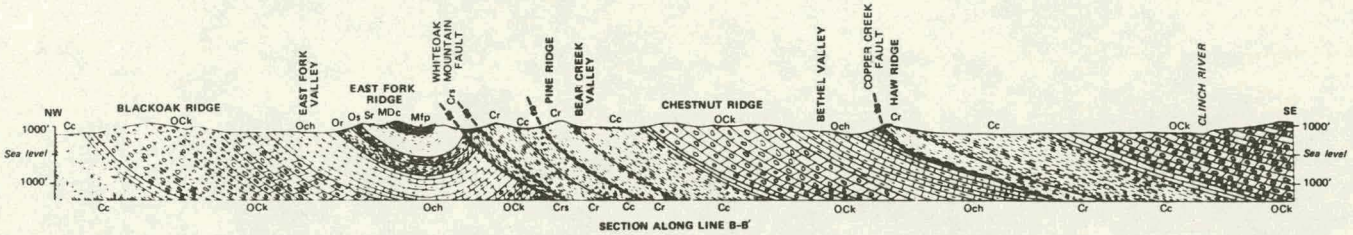


SECTION ALONG LINE B-B'

LOWER MISSISSIPPIAN — Mfp — *MISSISSIPPIAN*

Fort Payne Chert

Limestone, extremely siliceous, weathers to beds of dense blue-white to white chert, less than 80 feet in thickness.

UPPER DEVONIAN — MDc — *DEVONIAN*

Chattanooga Shale and Maury Formation

Shale, black, bituminous, fissile, disconformity at base, 25 feet in thickness.

LOWER SILURIAN — Sr — *SILURIAN*

Rockwood Formation

Siltstone, shale, sandstone, brown, tan, and yellow, thin beds of hematitic limestone in upper half, 690 feet in thickness.

Contact
Dashed where approximately located

Fault
Dashed where approximately located

Strike and dip of beds

35
normal

vertical

Syncline
Showing trace of axial plane

UPPER ORDOVICIAN — Os

Sequatchie Formation

Limestone, silty and shaly, maroon, maroon and green, and gray; calcareous maroon siltstone, 360 feet in thickness.

UPPER ORDOVICIAN — Or

Reedsville Shale

Shale, with thin limestone lenses in lower half, tan to orange-brown, with black stains, about 200 feet in thickness.

MIDDLE ORDOVICIAN — Och

Chickamauga Limestone

Limestone, shaly and silty, cherty; dense to crystalline, gray to gray-blue; fossiliferous; thin to medium beds; disconformity within formation and at base, about 2200 feet in thickness.

LOWER ORDOVICIAN — OCk

Knox Group

Dolomite, cherty; dense to crystalline; light to medium gray; thin to massive beds, 3000 feet in thickness.

UPPER CAMBRIAN

MIDDLE CAMBRIAN — Cc

Conasauga Group

Shale, siltstone, with thin limestone layers in lower two-thirds, massive limestone in upper third, 1500 feet in thickness.

LOWER CAMBRIAN — Cr, Crs

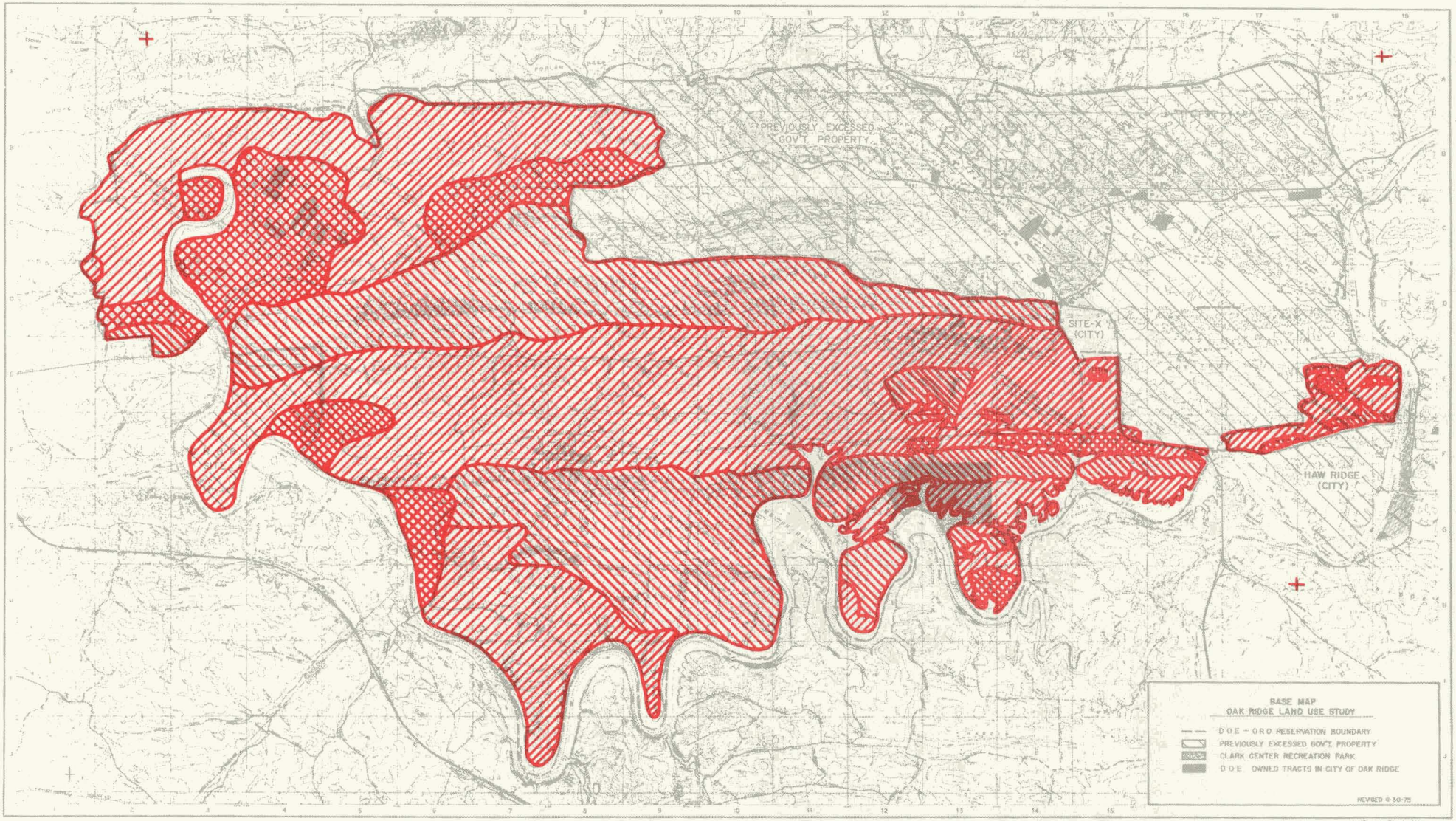
Rome Formation

Cr, siltstone, shale, sandstone, variegated, thin to medium, even beds; primary structures common, over 800 feet in thickness. Crs, shale, pure to silty; minor amounts of sandstone; chalcedonic chert cobbles strewn on surface, thickness unknown.

ORDOVICIAN

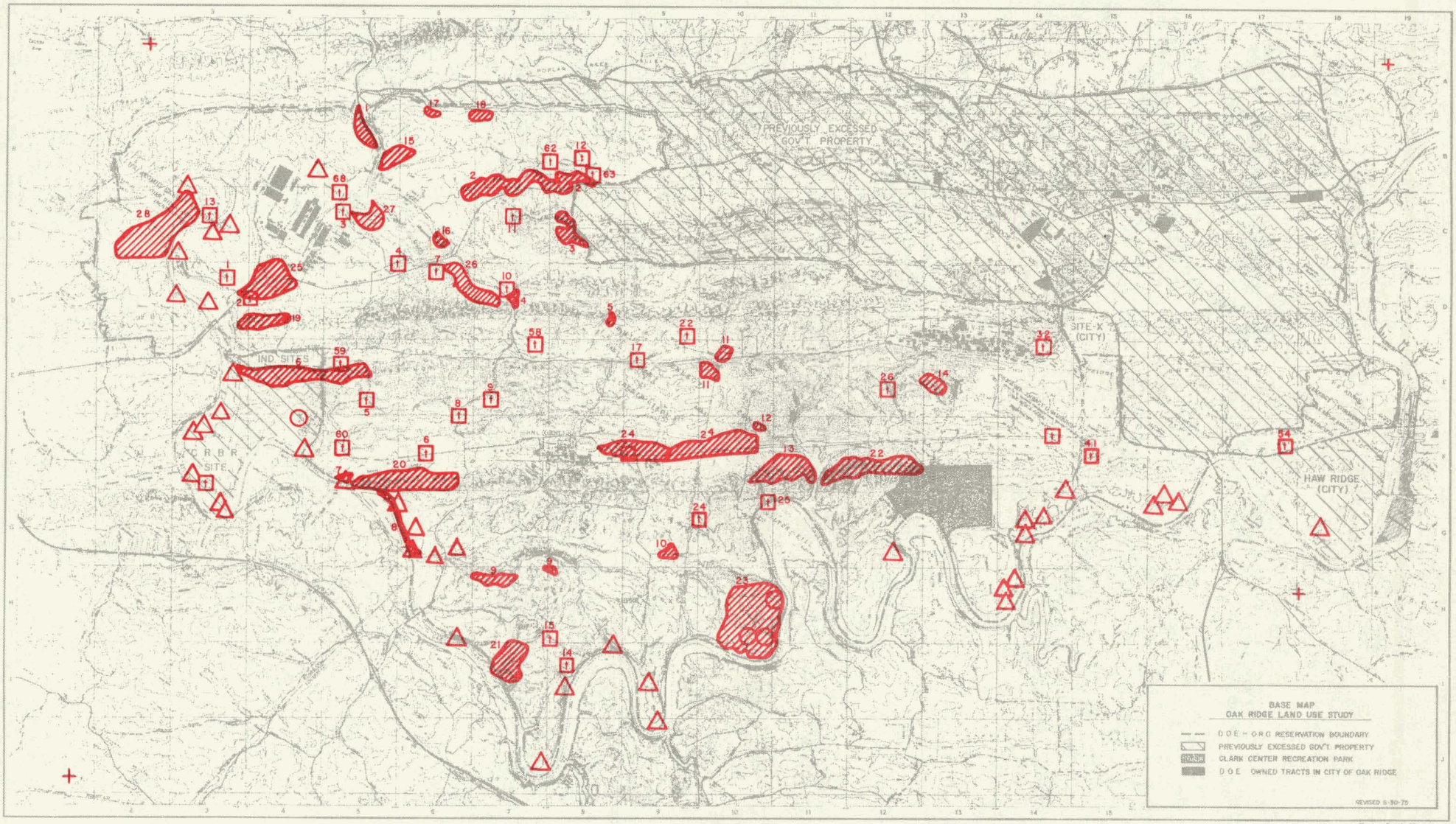
CAMBRIAN

Overlay No. 2 Flood Hazard Potential



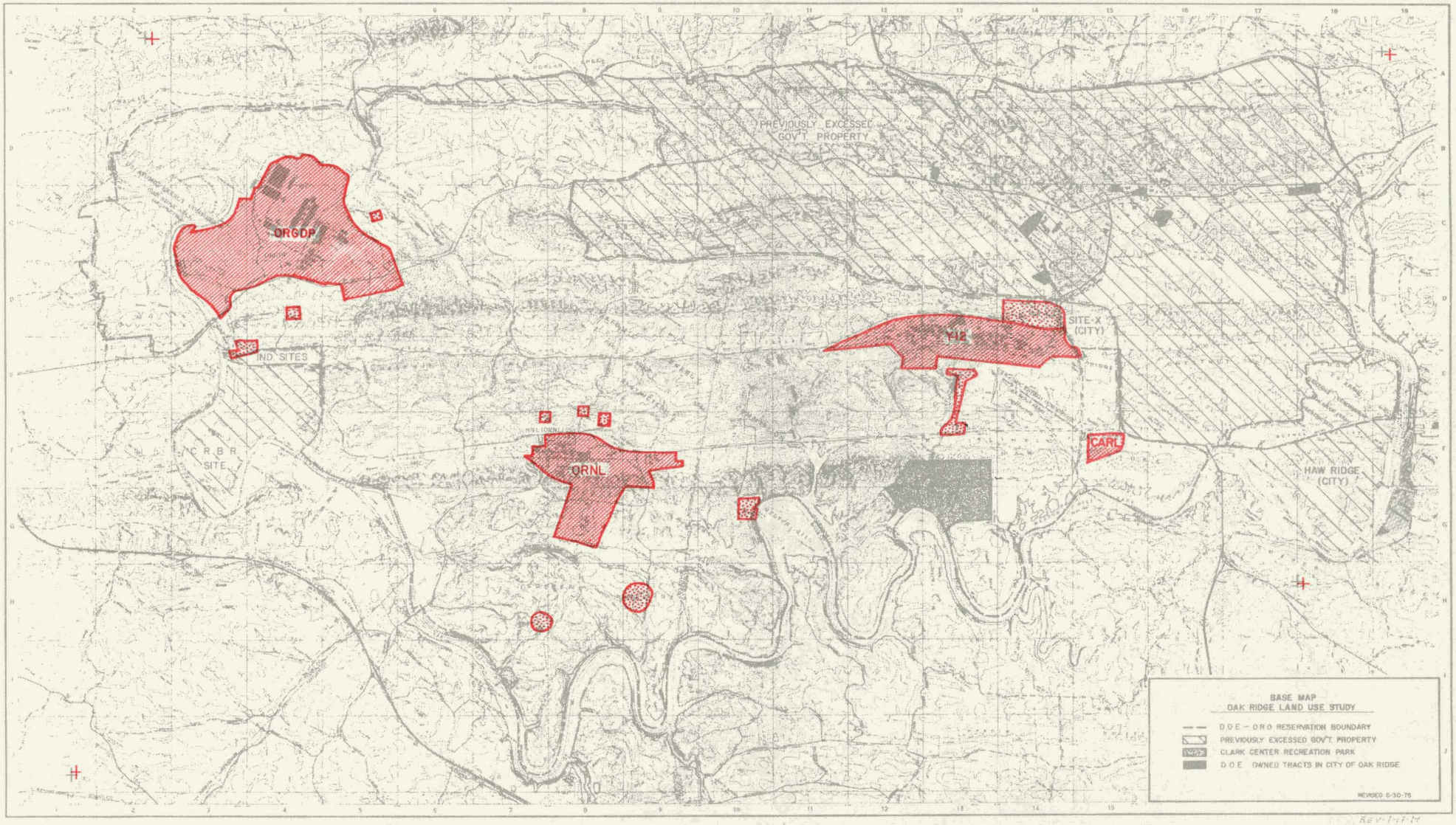
Overlay No. 3 Land Type Suitability for Agriculture

Type 1 Type 2 Type 3



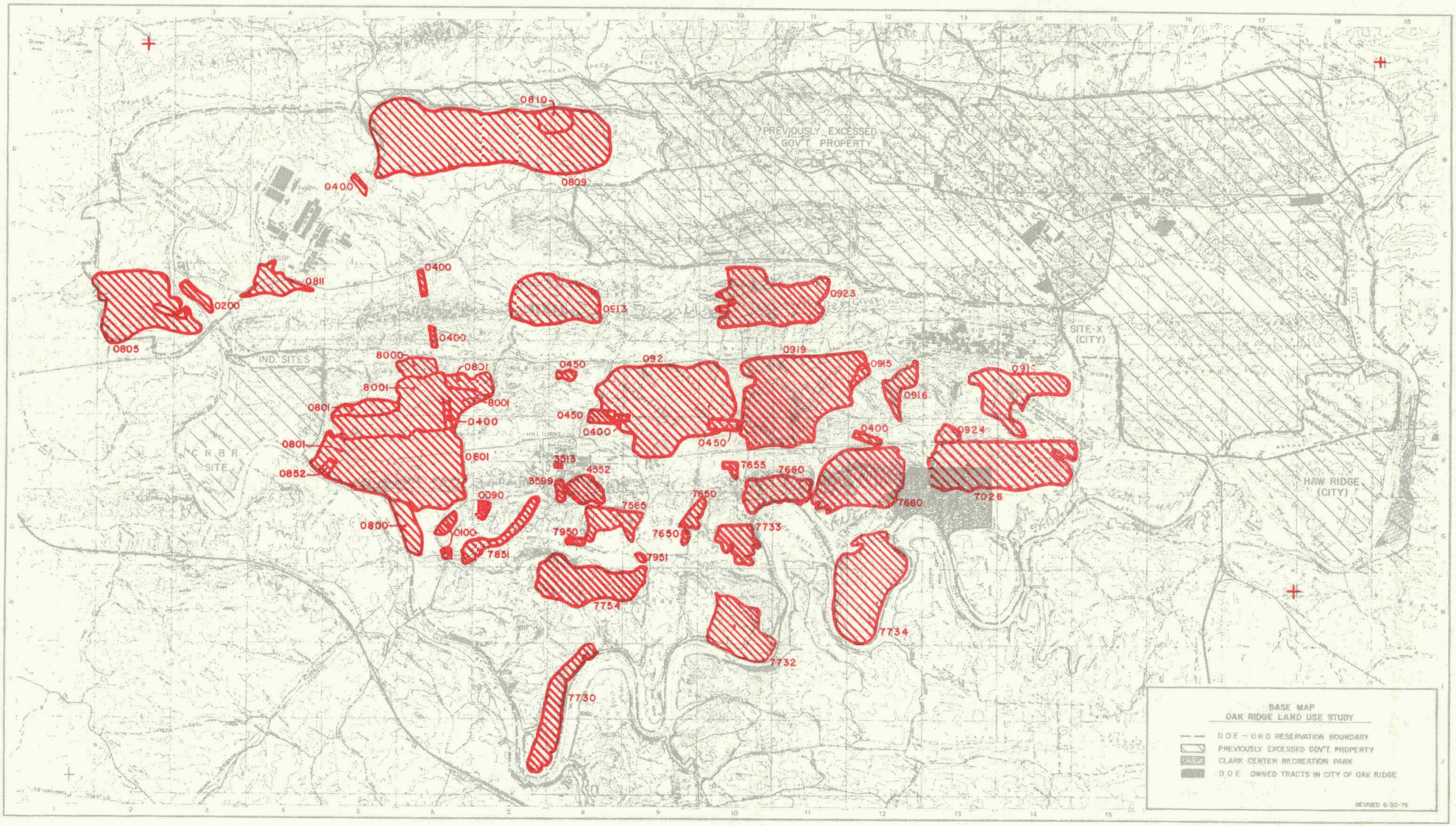
Overlay No. 4. Unique Natural and Cultural Areas.

Natural ▨ Cemeteries ⊡ Ruins ○ Archeological △



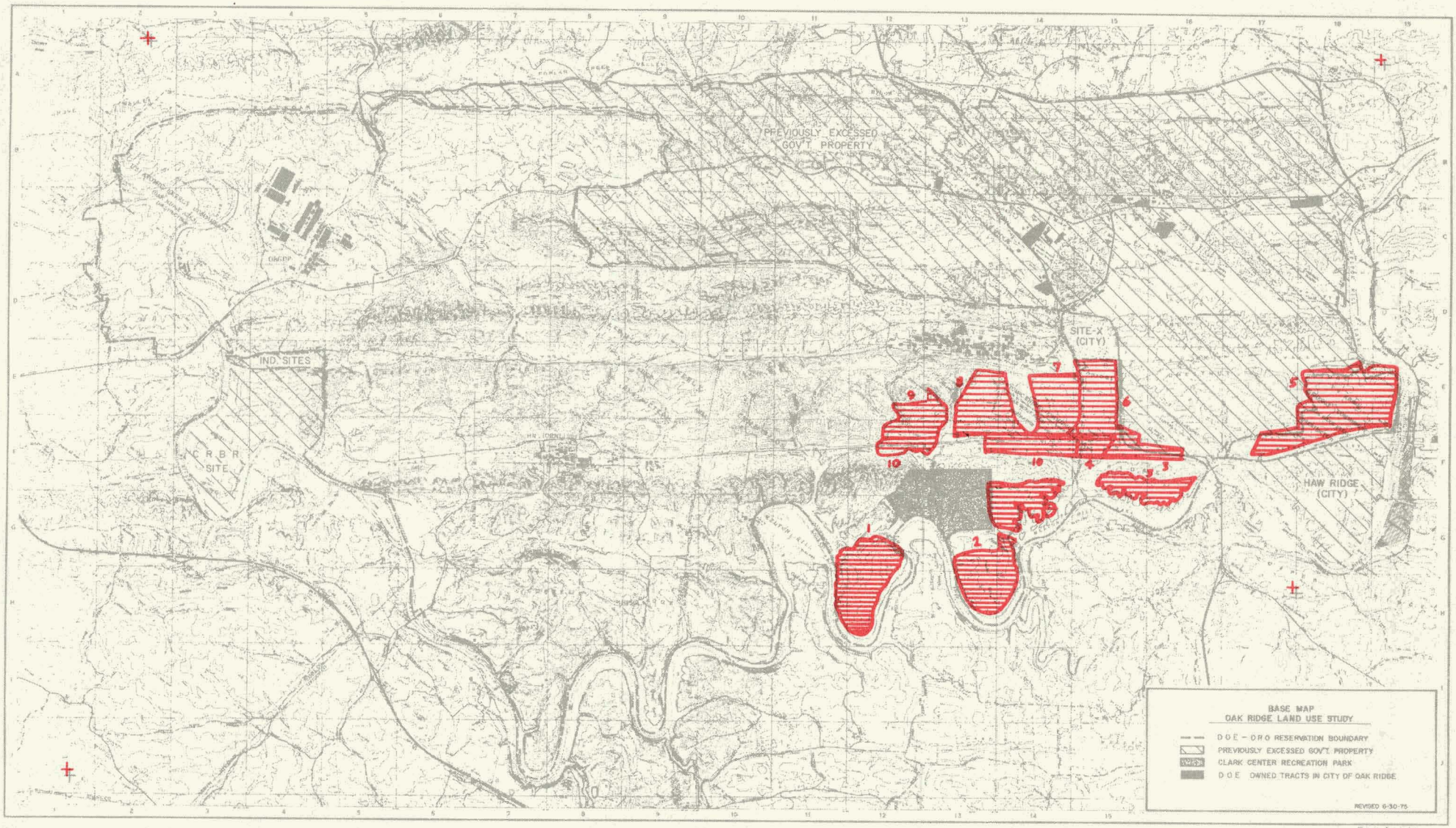
Overlay No. 5 Plant and Research Area Complexes

Main Plant Area ▨ Plant Support Areas ▨

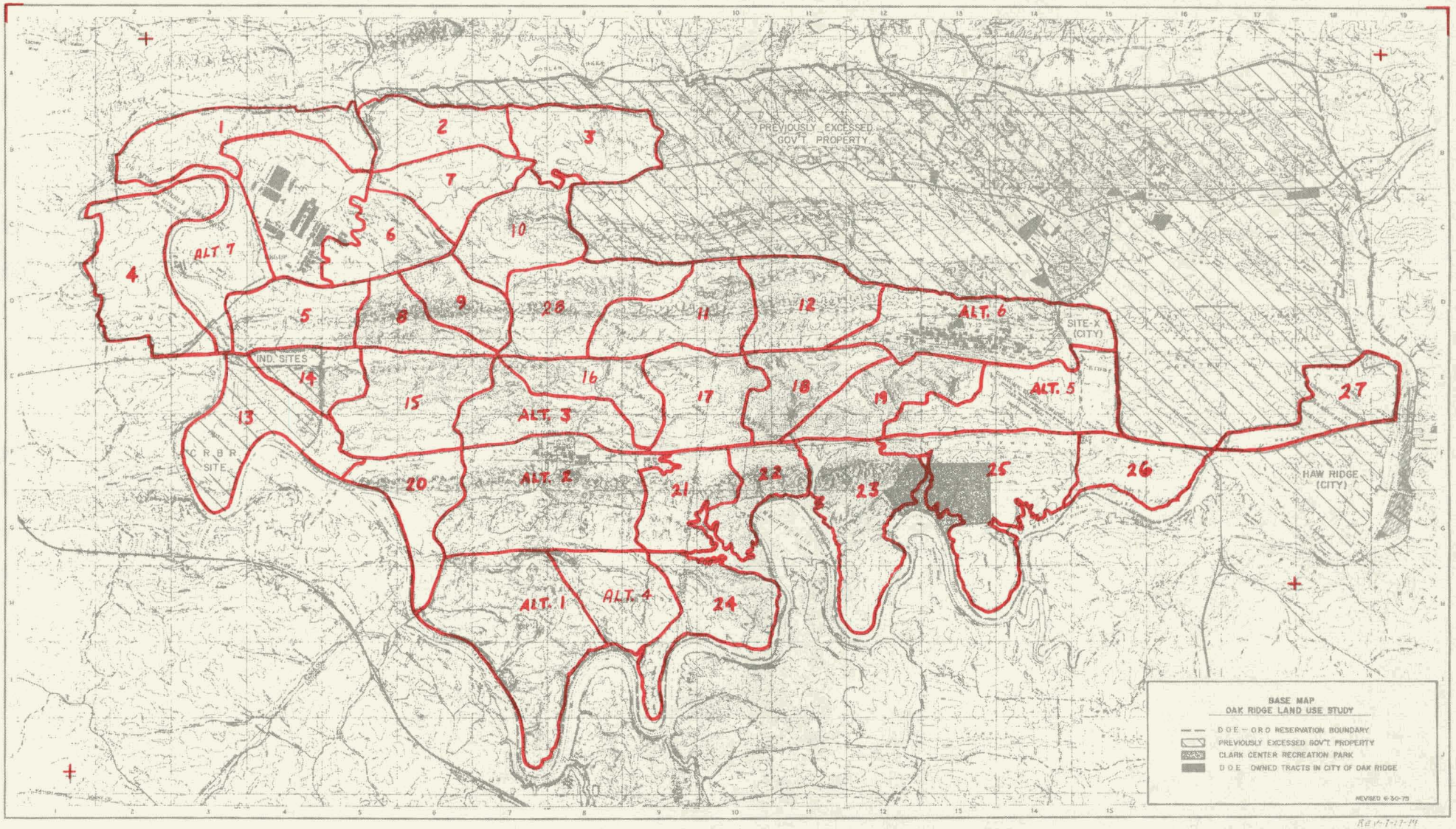


Overlay No. 6 Terrestrial Research Areas

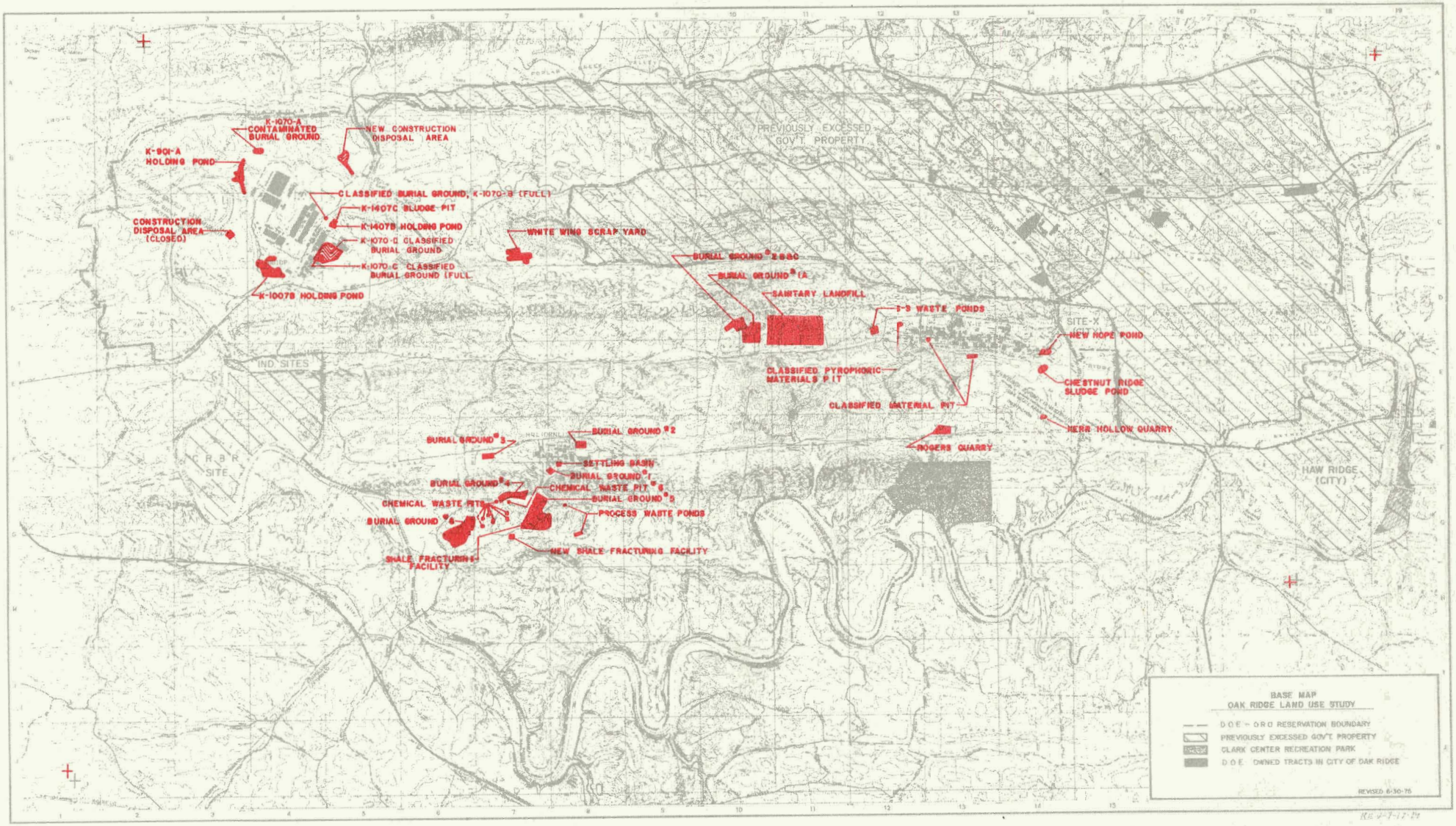
Overlay No. 7 Aquatic Research Areas



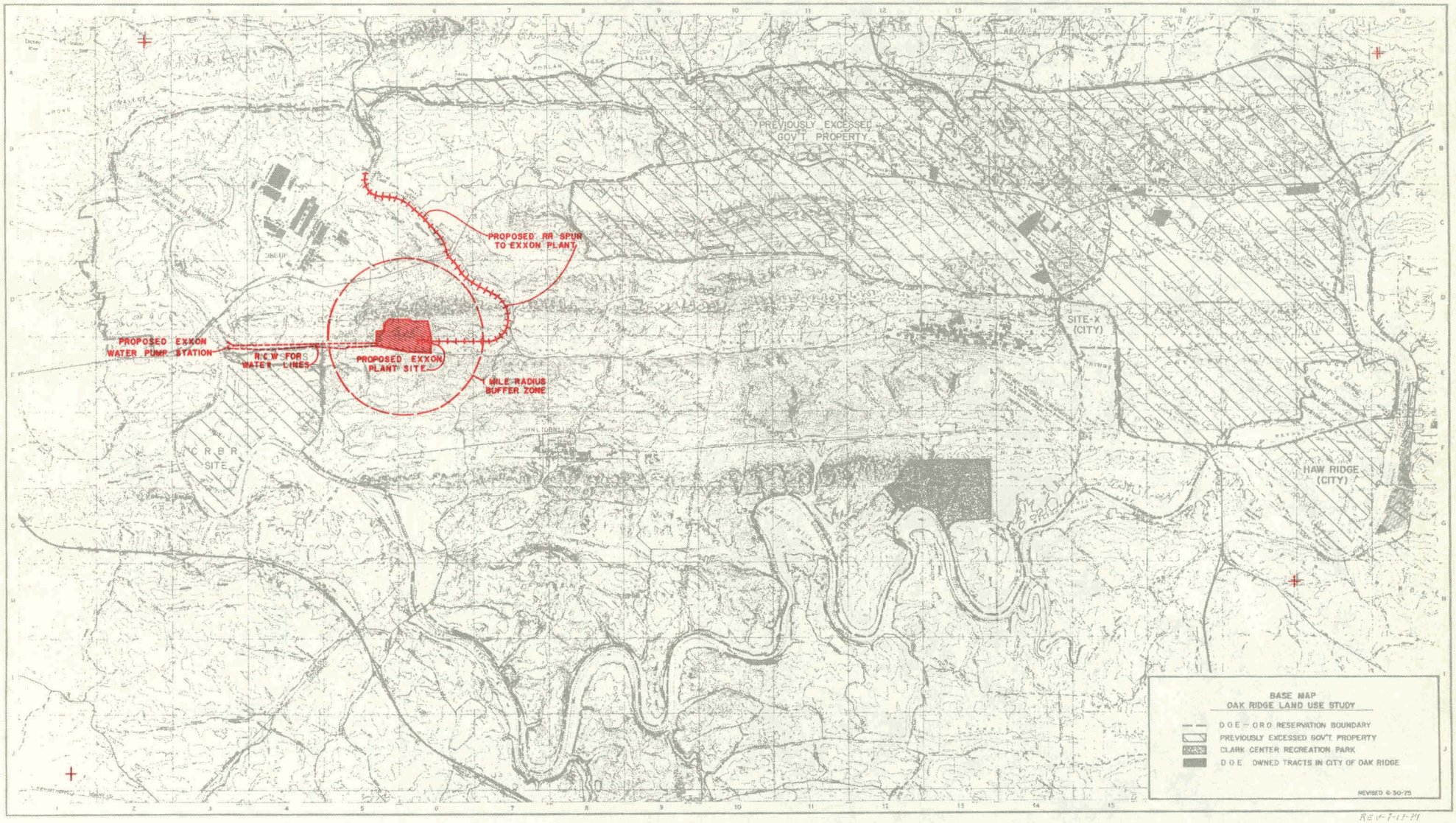
Overlay No. 8 C A R L Programmatic Land



Overlay No. 9 Forest Management Tracts

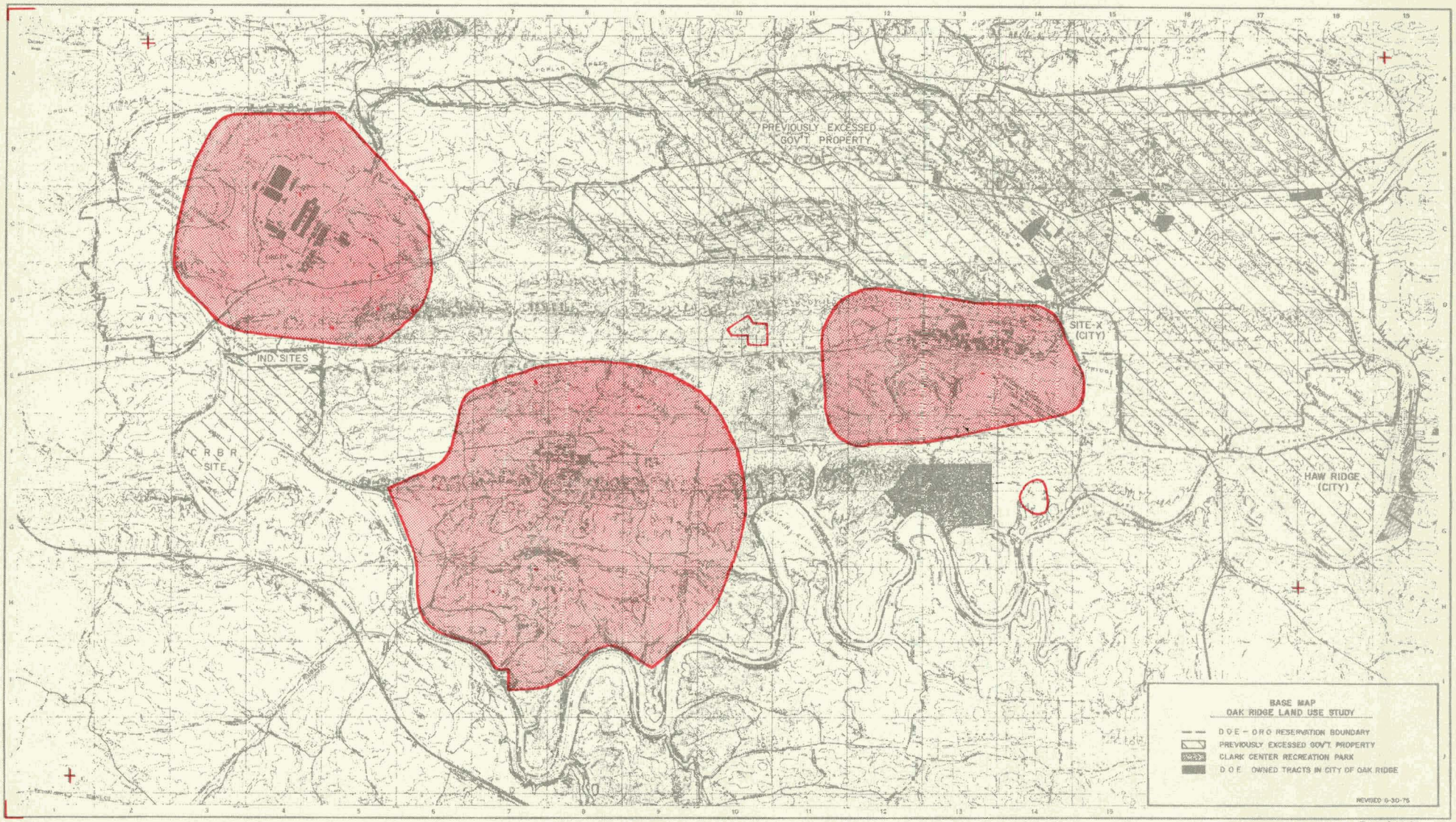


Overlay No. 10 Waste Management Areas



REV-7-11-74

Overlay No. II Proposed EXXON Site



Overlay No. 12 Minimum Buffer Areas for Health and Safety