Oak Ridge Health Study Document Summary Form

DOCUMENT TITLE: TASK 4-related documents from the early 1960s mostly associated with Clinch River Study, primarily subcommittee reports (18 documents)

DOCUMENT NUMBER OR IDENTIFIER: ERDMC* GB12

AUTHOR(S):

PUBLICATION DATE: primarily 1960s

DATA TIME PERIOD: Start 10/47–1/48 Stop 1963

LOCATION OF COPY (if one was made): ALA

CLASSIFICATION CATEGORY: UNK (UNC) OUO UCNI CL* *Category & Level: FRD or RD or NSI; CONF or S or TS

SITE(S) DOCUMENT ADDRESSES: K (X) Y S ORR MELT (CLIN) WOC WOL POPL EFPC PCE BEAR WATT

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3119

DOCUMENT CATEGORY

AI [DL dr dc da] (ED) ea ew es ef] EP [HO hp hr hs hw] IN IP [ST sa sw ss] TM WP

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DATE ENTERED INTO DATABASE: BY: InMagic No.

KEYWORDS: Clinch River, Watts Bar Reservoir, Tennessee River, White Oak Lake, White Oak Creek, 137Cesium, 90Strontium, 60Cobalt, 106Ruthenium, Water, Sediment and Fish Sample Results

ABSTRACT:

Most of the data presented in these reports are included in the final Clinch River Progress Reports. They are primarily progress reports or minutes from meetings from a variety of subcommittees.

One exception is the 'Radiobiological Studies of the Clinch River' by Lloyd Setter and Vamos Knobf. This study from 1948 focused on the concentration of Cs-137 in fish flesh and Sr-90 in fish bones and scales. Fish samples were collected from White Oak Lake, White Oak Creek and the Clinch River. Besides this document, all other reports were from the early 1960s.

REVIEWER: Tom Knight DATE REVIEWED: 11/13/96

GB#12

RADIOBIOLOGICAL STUDIES ON THE CLINCH RIVER

By Lloyd R. Setter and Venus Knobf

Synopsis

During 1948 studies were made of the radiobiology of fish from White Oak Lake, the creek below the lake, and the Clinch River into which the creek empties. This system receives industrial wastes from Oak Ridge National Laboratory. A total of nearly a thousand fish from four different areas were scanned. More detailed assays were made on 177 fish.

The study confirmed the capacity of fish to concentrate radioactivity in various tissues with concentration factors in bone and scales being greater than in flesh. The radioisotopes concentrated are believed to be principally cesium in flesh and strontium in bones and scales. The fish from White Oak Lake were found to have concentrated sufficient radioactivity in their flesh to provide in a single meal radioactivity equivalent to several days tolerance for ingestion. The farther downstream from White Oak Lake the specimens were collected the less radioactivity was found in fish. It is believed that fish from the Clinch River do not give rise to public health problems but fishing in White Oak Lake should be prohibited.

RADIOBIOLOGICAL STUDIES ON THE CLINCH RIVER

By Lloyd R. Setter and Venus Knobf

Purpose

This report presents the results of a radiobiological study on the Clinch River during 1948. It is concerned primarily with the radioactivity occurring in fish in the waters below the Oak Ridge National Laboratory area and the public health implications which result. The radiobiological results are also compared with the radioactivity present in the water from which the fish were collected.

Description of Area

The Clinch River is a tributary of the Tennessee River at mile Te. 567.7 and is within the area of operations of the Tennessee Valley Authority for navigation, flood control, resource development, and hydroelectric power. Between the mouth of the Tennessee River at Paducah, Ky. and the Clinch River there are eight reservoirs on the Tennessee River. Watts Bar Dam (38 miles below the mouth of the Clinch at Kingston, Tenn.) impounds a reservoir backwater from which extends up the Clinch to mile Cl. 28.7 (a few miles above White Wing Ferry Bridge). Farther up the Clinch at mile Cl. 79.8 Norris Dam impounds a tributary reservoir which is also a part of the Tennessee Valley Authority development.

White Oak Creek is tributary to the Clinch at mile 20.8. Below that point Poplar Creek enters the reservoir at mile Cl. 12.0 and the Emory River enters at mile Cl. 4.4. Backwater extends up the Emory over fourteen miles to a point above Harriman, Tennessee. Figure 1 shows the Clinch River Area.

A small dam (described in Studies of White Oak Creek Drainage System, I) at mile 0.6 on White Oak Creek impounds a small lake having a volume of 15 million cubic feet at full pool level. Inflow to this lake includes the runoff from 6 square miles of drainage area and both industrial and domestic wastes from Oak Ridge National Laboratories. Figure 2 shows the White Oak Creek Drainage System.

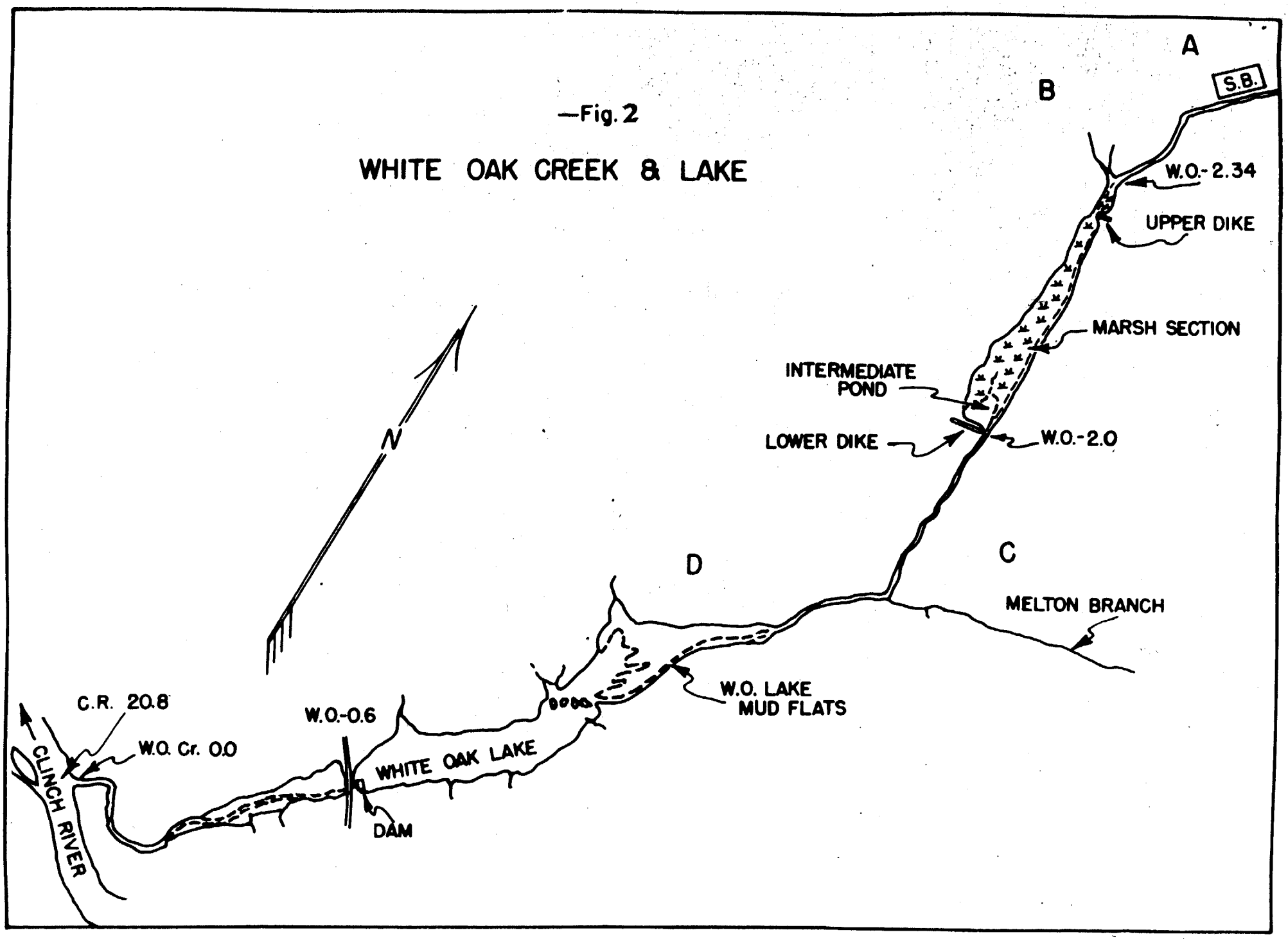
The White Oak Lake effluent is discharged during normal flows to the creek below the dam through a screen gate. Following intense rains and the consequent heavy runoff the cofferdam may also be overtopped. The effluent is probably well dispersed in the embayment below the dam and it is estimated that in this embayment dilution water from the Clinch River amounts to twice the effluent volume. The average annual discharge from the dam is approximately seven cubic feet per second and of the Clinch River 4000 cfs. However, the flow of the Clinch is extremely erratic as a result of intermittent discharges from Norris Dam upstream. During dry weather diurnal variations may have a range from as low as 200 to as high as 6000 cfs resulting in surges of flow encroaching on shores or embayments. Furthermore, there may be considerable fluctuation of the pool level of Watts Bar Reservoir. These conditions may either accelerate or prolong the period required for satisfactory dispersion of tributary inflow.

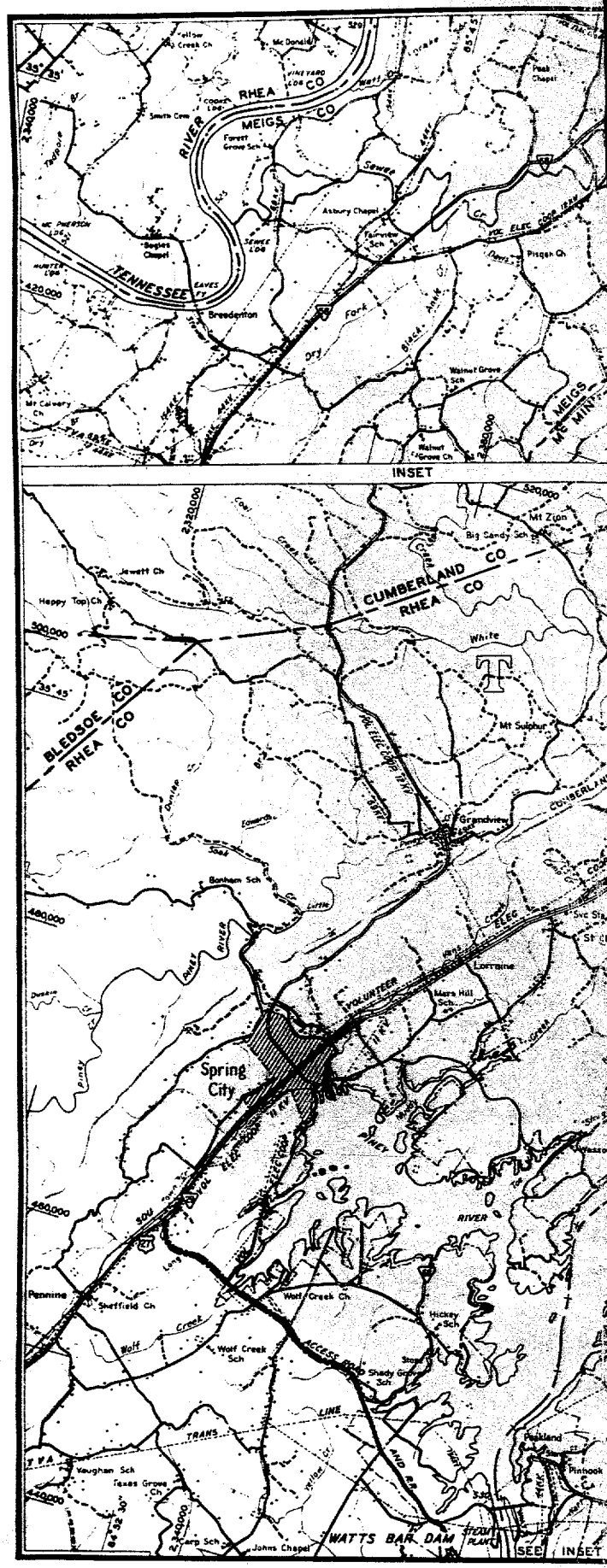
Survey Program

During the fall of 1948 a survey of the radiobiology of fish from White Oak Lake down the Clinch River to Gallaher Bridge (mile Cl. 13.3) was undertaken jointly by the Oak Ridge National Laboratory and the Tennessee Valley Authority. Personnel from the Fish and Game Branch, Division of Forestry Relations, TVA, distributed rotenone in designated

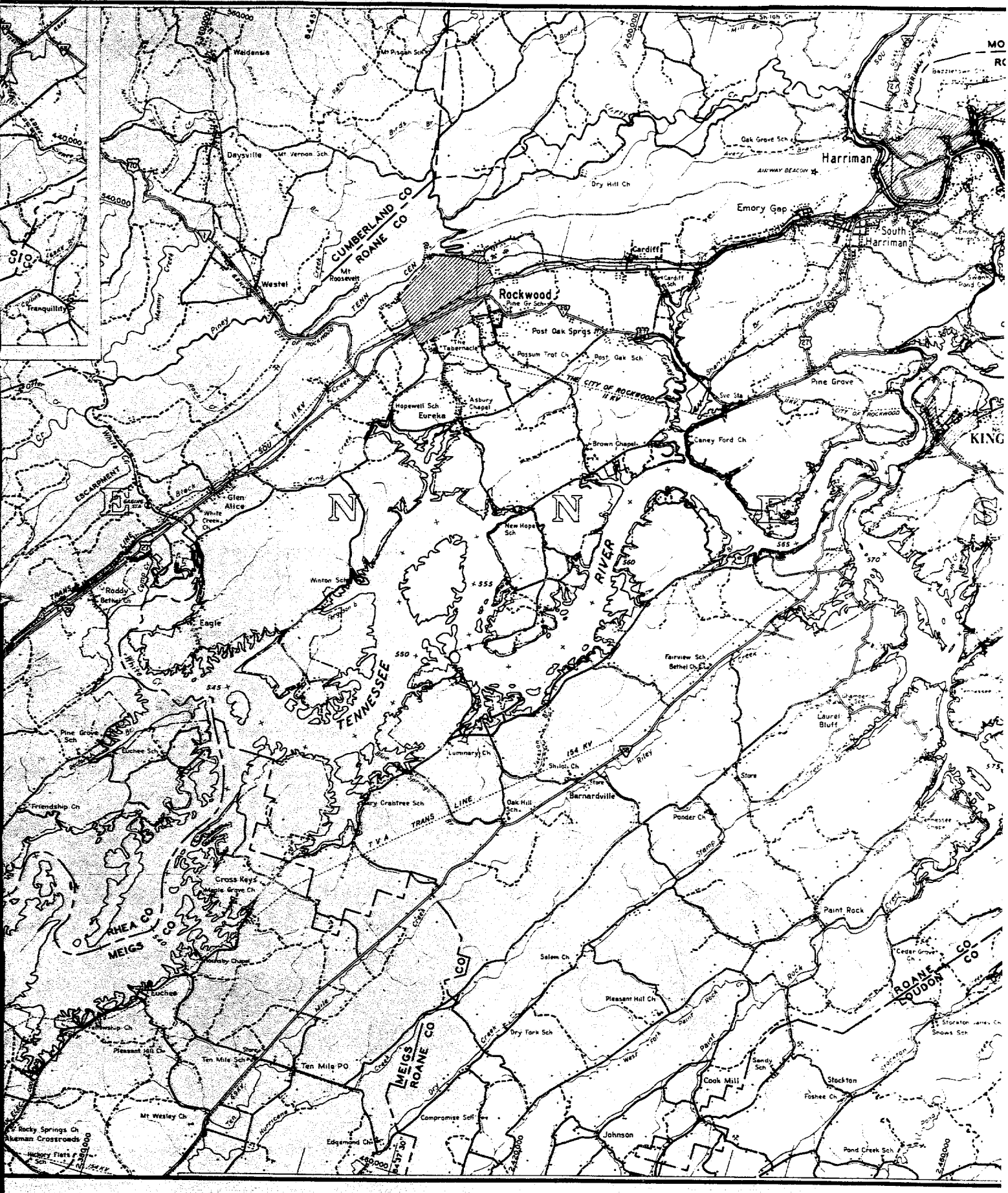
—Fig. 2

WHITE OAK CREEK & LAKE





RHEA CO
MEIGS CO
RIVER
TENNESSEE
Breedenton
Asbury Chapel
Fairview Sch
Pisgah Ch
Walnut Grove Sch
Walnut Grove Ch
Mt Calvary Ch
Smith Cem
Forest Grove Sch
Peak Chapel
INSET
CUMBERLAND CO
RHEA CO
BLEDSOE CO
RHEA CO
Mt Zion
Big Sandy Sch
Jewett Ch
Happy Top Ch
White
Mt Sulphur
Grandview
Bonham Sch
Lorraine
Mars Hill Sch
Spring City
Pennine
Sheffield Ch
Wolf Creek Ch
Wolf Creek Sch
Hickey Sch
Shady Grove Sch
Peakland
Pinhook
Vaughan Sch
Texas Grove Ch
Carp Sch
Johns Chapel
WATTS BAR DAM
SEE INSET



Harriman
South Harriman
Emory Gap
Cardiff
Rockwood
Post Oak Sprgs
Post Oak Sch
Possum Trot Ch
The Tabernacle
Hopewell Sch
Eureka
Asbury Chapel
Brown Chapel
Caney Ford Ch
Pine Grove
Oak Grove Sch
Dry Hill Ch
Mt Pisgah Sch
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Daysville
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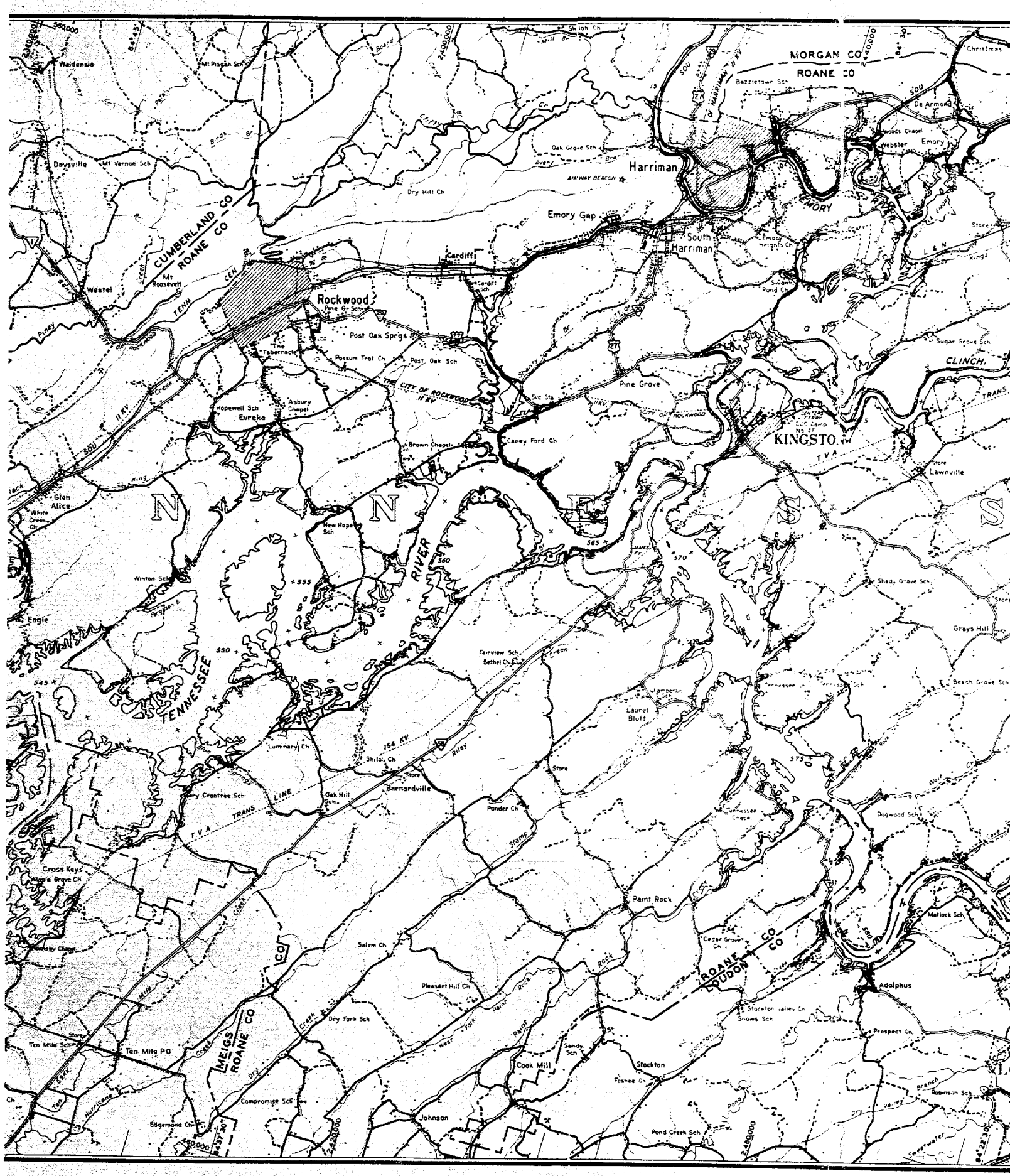
Mt Roosevelt
CUMBERLAND CO
ROANE CO
Tranquillity
Glen Alice
White Creek Ch
Roddy
Bethel Ch
Eagle
Winton Sch
New Hope Sch
TENNESSEE
RIVER
Fairview Sch
Bethel Ch
Laurel Bluff
Pine Grove Sch
Euchee Sch
Friendship Ch
Luminary Ch
Shiloh Ch
Barnardville
Oak Hill Sch
Ponder Ch
Cross Keys
Maple Grove Ch
RHEA CO
MEIGS CO
Euchee
Pleasant Hill Ch
Ten Mile Sch
Ten Mile PO
Mt Wesley Ch
Rocky Springs Ch
Akeman Crossroads
Hickory Flats Sch
Edgemond Ch
Compromise Sch
Johnson
Salem Ch
Dry Fork Sch
Paint Rock
Cedar Grove Ch
ROANE CO
LOUDON CO
Stockton
Foshee Ch
Cook Mill
Sandy Sch
Pond Creek Sch
Stockton Valley Ch
Snows Sch
MEIGS CO
ROANE CO
T.V.A. TRANS LINE
154 KV
11 KV
ESCARPMENT


MORGAN CO
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Eureka
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Winton Sch
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Salem Ch
Pleasant Hill Ch
Dry Fork Sch
Compromise Sch
Edgemond Ch
Ten Mile Sch
Lawnville
Shady Grove Sch
Grays Hill
Beech Grove Sch
Dogwood Sch
Matlock Sch
Prospect Ch
Robinson Sch
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Mt Pisgah Sch
Bezzletown Sch
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Webster
Emory
Christmas
Sugar Grove Sch
Swan Pond Ch
Emory Heights Ch
Sevier Sta
Shiloh Ch
Christ Ch
Mill Br
Brass Br
Avery Br
Piney Br
Piney Creek
Kings Creek
White Creek Ch
Riley Creek
Stamp Creek
Paint Rock Creek
Cedar Grove Ch
Stockton Valley Ch
Snows Sch
Sandy Sch
Fishee Ch
Pond Creek
Robinson Branch
Dry Valley
Hurricane Creek
Ten Mile Creek
Dry Creek
West Fork Paint Rock Creek
Wolf Creek
Cove Creek
Sugar Creek
Tennessee Chase
Hickory Chase
Maple Grove Ch
Mt Pisgah Ch
Crabtree Sch
Shady Grove Ch
Sycamore Ch
Sycamore Creek
Stockton Valley Creek
Cedar Grove Creek
Paint Rock Creek
Pond Creek
Conasauga Creek
Clinch River
Emory River
Kingston Steam Plant
Nos 37
Airway Beacon
Store
L & N
TVA
TRANS LINE
154 KV
11 KV
CITY OF ROCKWOOD
CITY OF HARRIMAN
CEN
TENN
SOU
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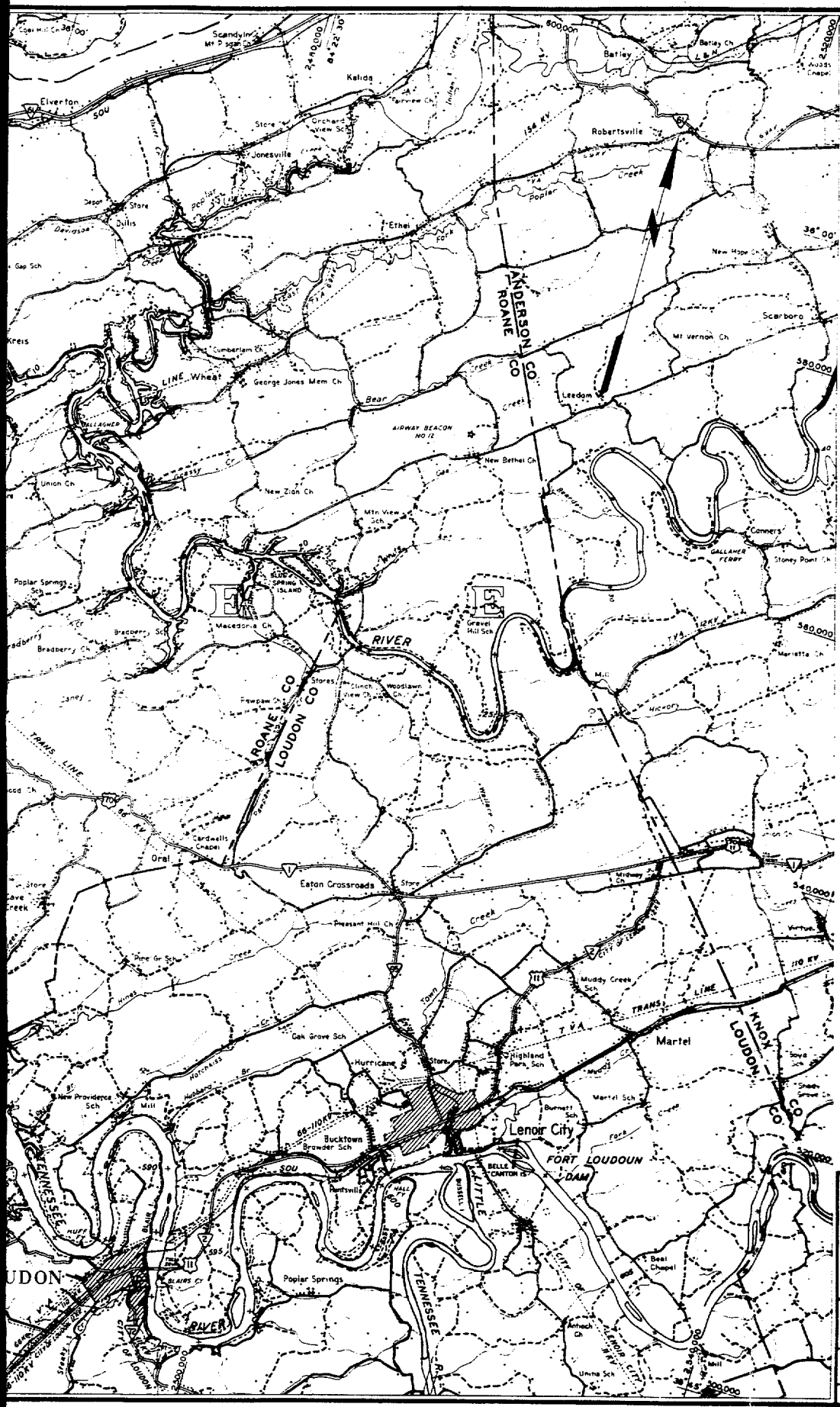
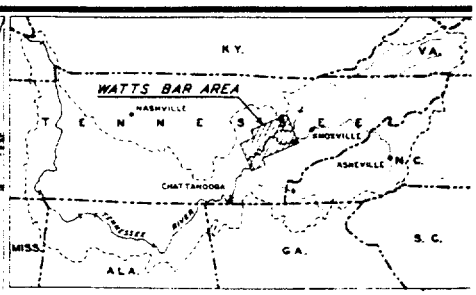




LOCATION MAP

LEGEND

- FEDERAL & STATE HIGHWAYS
- FIRST CLASS ROAD
- SECOND CLASS ROAD
- TRAIL
- RAILROAD
- POWER LINE
- CITY LIMIT
- LOUDON — COUNTY SEAT
- FERRY
- +575 — RIVER MILES ABOVE MOUTH
- MINE OR QUARRY
- CEMETERY
- SCHOOL
- CHURCH
- COMMERCIAL BUILDING
- HOUSE
- FEE PURCHASE BOUNDARY
- EASEMENT BOUNDARY

Compiled from TVA-USGS Planimetric Maps
made from aerial photos field-checked in 1939
Contour from USED-TRS Maps

NOT CLASSIFIED

MAP OF WATTS BAR RESERVOIR

ELEVATION OF POOL 741 TO 742.5

WATTS BAR RESERVOIR
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

SCALE OF MILES 0 1 2 3 4

CHATTANOOGA	JULY, 1942	9	ES	0	81D1	R. 4

areas and collected the paralyzed fish. Qualitative scanning of individual fish for radioactivity and preparation of samples for quantitative analysis was done by the Waste Disposal Research Section, Health Physics Division, ORNL. Counting room service for quantitative samples and data on radioactivity of water and mud in the environment from which the fish were collected were provided by the Area Monitoring Group, Health Physics Division, ORNL.

Collection Areas

Four areas were selected for study and are described in the order of diminishing radioactivity.

A. White Oak Lake. The fish reported from this area were not collected by means of rotenone treatment as were those from other areas. Four live carp eight to ten inches long were caught, three in the upper end in May and one in the lower end in July. Fourteen dead fish all under four inches in length were taken from the gate screen at the dam in December.

B. White Oak Creek, mile 0.0 to 0.1 (1/4 acre). Except for those shad which from their reaction time could be said to have entered the area after the distribution of the rotenone all fish which rose to the surface within four hours after treatment were collected. A total of 164 fish were taken including 56 crappie, 39 sunfish, 2 bass, 3 suckers, and 64 shad.

C. Clinch River, mile Cl. 18-19 (1/2 acre). The small embayment on the left bank at mile Cl. 18 was originally designated but yielded insufficient fish for the study. A second embayment on the left bank at mile Cl. 19 was treated to provide additional specimens. These two

embayments are considered together to be 3 miles below White Oak Creek. Here again 200 immigrating shad were discarded and the useful catch of 491 specimens contained 253 shad, 122 crappie, 34 drum, 34 carp, 17 pike, 10 buffalo, 10 sunfish, 6 suckers, 4 bass, and 1 catfish.

D. Clinch River, mile Cl. 13.3 (1 mere). Over five hundred shad were discarded as immigrants. The 271 useful fish consisted of 127 shad, 3 red horse suckers, 25 carp, 2 buffalo, 1 catfish, 59 crappie, 20 drum, 8 bass, 4 sunfish, and 2 pike.

Method of Study

Collection of Catch

Depending on the area, depth, and temperature of the water, from 25 to 100 lbs. of Derris Root (4.8% rotenone) dust in a thick water slurry was distributed over the designated area. Small boats with outboard motors were used for traversing the area and the incapacitated fish were picked up with hoop nets. The fish were washed, stored in tubs of river water and delivered to the laboratory within a few hours.

Prescanning

None of the fish from area A were scanned for the elimination of those with low levels of radioactivity. The fish from areas C and D collected October 4, 1949 were washed twice in tap water, drained, labeled with individual numbers (piece of paper tucked in the gill), and separated into lots of 10 to 12 specimens. Approximately one-half gram of scales from each fish was distributed over the cell of a mounting card in which thin sheet aluminum had been substituted for the conventional 1-in. watch glass. Heat from an infrared light was used for drying the scales after which they were covered with thin cellophane fastened to the card with

scotch tape. Samples were placed on the first shelf of a Beta counter and 2-minute counts made.

A 4-channel G-M tube beta counting rate meter (Figure 3) was devised for subsequent scanning measurements and used with the fish collected October 26, 1948 from area B. The 151 largest fish were subjected to washing, labeling, and separating as described above and then wrapped individually in cellophane. A support was provided for suspending a fish in such a position that by the operation of a lever the sensitive sections of the G-M tubes were brought into contact with the specimen from four directions. Most of the fish which registered only slightly above background on this scanner were discarded.

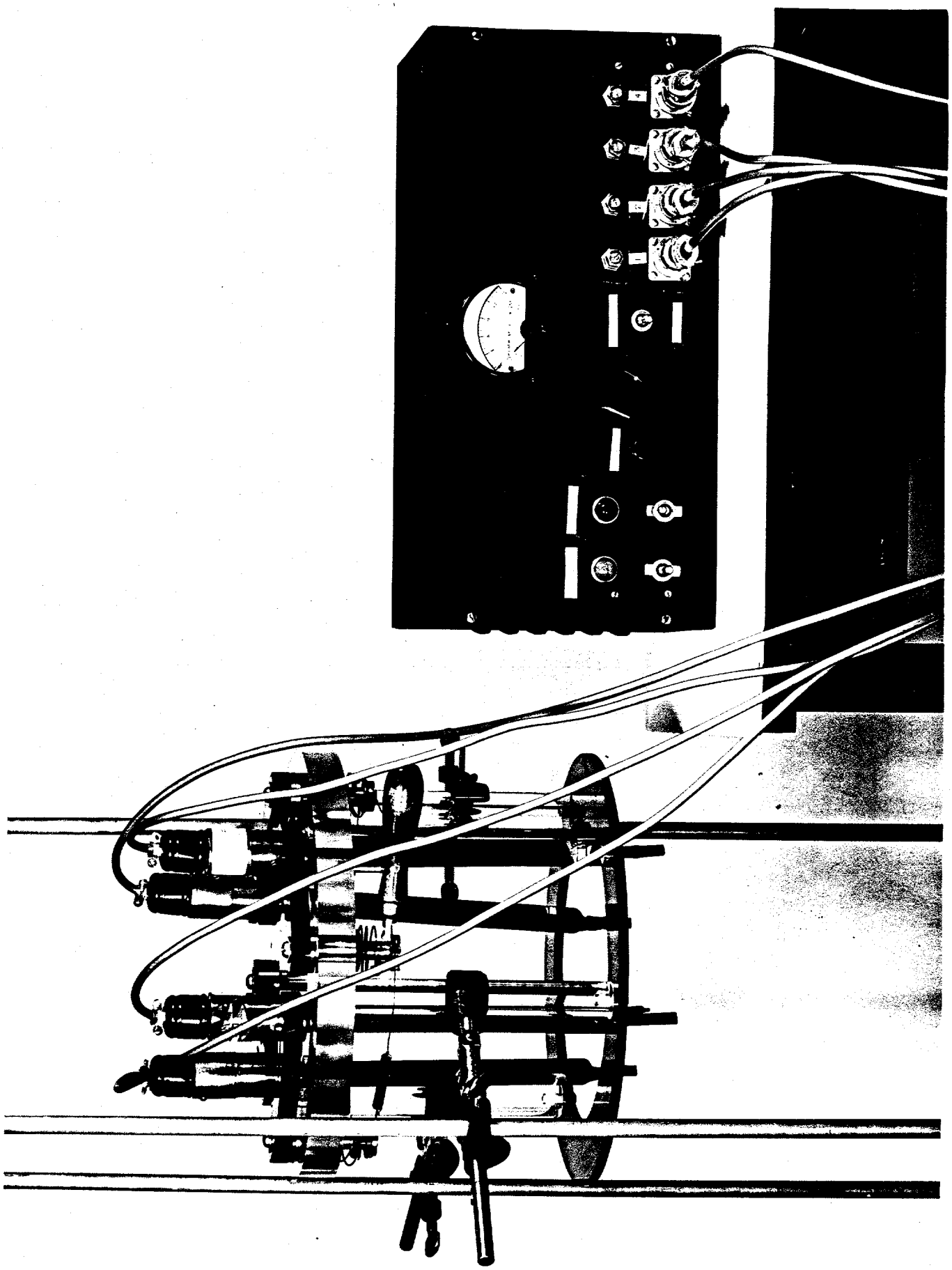
Determination of Tissues to be Quantitatively Assayed

In order to permit measurements on the greatest possible number of specimens it was necessary to limit the number of tissues from each specimen to be examined. From a public health point of view the flesh would be the most important tissue with bones and scales secondary. It was decided to limit the study principally to these three tissues. Preliminary measurements had indicated that the gills and some of the glands might contain as high a level of radioactivity as the three primary tissues so a few specimens from various locations were subjected to more detailed examination.

Preparation of Tissues for Counting

General. Porcelain evaporating dishes having vertical sides and a flat bottom of 13.8 square centimeter area were used. The dishes were numbered and their tare weights and background counts were determined prior to the preparation of samples for counting.

FIG. 3



Flesh. One side of the fish was scaled and 3 to 4 sq. in. of skin removed to permit the cutting of a 2 to 5 gm. cube of flesh from the back which was placed in the counting dish and weighed. The sample was dried and weighed and then partially ashed under infrared lamps with repeated additions of concentrated nitric acid and 2-4 drops of concentrated sulfuric acid. Complete ashing was accomplished by muffling at 600°-800°C. to free them of organic matter. To effect improved geometry for counting the ash was wetted with distilled water, crushed with a stirring rod, redistributed over the dish bottom, and redried under infrared lamps. After reweighing to permit calculation of fixed solids the dishes were delivered to the counting room.

Bone. Several vertebra (0.2 to 1 gm.) from which the flesh and side bones had been removed were placed in a counting dish and prepared in the same manner as the flesh except the partial ashing in the presence of acid was omitted.

Scales. With the aid of a knife 0.1 to 0.2 gm. of scales were removed from the specimen and placed in the counting dish. For fish having insufficient scales for a satisfactory sample parts of the fins or tail were included. Further preparation was the same as for the bone.

Counting Room Technique

The dishes were placed on the second shelf of thin window beta counters and counts made at 8 to 9% geometry. Because there were great many samples to be examined the counting time was standardized

at 2 minutes. Background for the counters ranged from 17 to 20 cpm and for the dishes 10 to 30 cpm above instrument background. Except for some large bone samples self absorption in ashed samples was very low and therefore disregarded. No correction was made for backscatter.

Computations

The data from the counting room were corrected for instrument and dish backgrounds and converted to counts per minute per gram (cpm/gm.) of fixed solids, at 10% geometry. From examination of samples from 65 fish it was calculated that the mean proportions for fixed solids were 1.63% in flesh, 27.0% in bone, and 44.0% in dry scales. When reference to original tissues was needed these proportions were used for calculating cpm/gm. original tissue from cpm/gm. fixed solids. Since at 10% geometry 22×10^4 cpm equals 1 microcurie (uc) the concentration of radioactivity in different tissues can be calculated as follows:

1 cpm/gm. @ 10% geometry equals 0.03 uc/gm. in flesh.

1 cpm/gm. @ 10% geometry equals 1.227 uc/gm. in bone.

1 cpm/gm. @ 10% geometry equals 2.0 uc/gm. in dry scales.

In some instances to avoid decimals the term millimicrocuries (muc) will be used.

Results

White Oak Lake Specimens (Area A)

The results of the radiobiological assay of fish from White Oak Lake are presented in Table 1 in the Appendix. With respect to the flesh, bone, and scale tissues it is noted that the first fifteen fish in the table (all except No. 2 collected dead from the screen at the discharge gate) gave counts ranging from about ten to over thirty

thousand cpm/gm. while the three earlier specimens had much lower levels of radioactivity. This fact only leads to speculation. Statistical comparison cannot be made since the earlier fish were all larger, were alive when collected, and were caught in the upper end of the lake over six months earlier when the level of radioactivity in the water was lower (see Table 7).

The relative concentration in different tissues of a single specimen exhibits considerable variation. Furthermore, the variation is not necessarily consistent in different fish. In general the gills and entrails (which were fairly free of digestive material) of the dead fish were found to contain a considerably higher concentration than other samples. The kidneys and stomach and intestinal contents of specimens caught alive also contained relatively high concentrations though not as high as the gills. Further discussion of relative concentration will be given in a later section.

White Oak Creek Specimens (Area B)

From a total catch of 164 the radiobiological results from 54 fish and 11 fingerlings are presented in Tables 2 and 2A. The scanning apparatus (previously described) was calibrated approximately based on observations of radioactivity in bones of the 54 fish. Scanner readings were then used for estimating the level of radioactivity for the remaining 99 fish and the estimates are given in Table 3.

The highest concentration in flesh of fish was found in a bass (No. 1, Table 2) whereas the highest level in bones and scales was found in a sunfish (No. 22, Table 2). The lowest level by species was in suckers.

Among the fingerlings assayed in toto one minnow (No. 1, Table 2A) exhibited a very high level of radioactivity amounting to 0.006 uc for only 0.6 gm. total weight. This minnow was removed from the stomach of an 8-in. crappie (No. 2, Table 2) and may have had some influence on the scanning reading for that particular fish. For comparison, a crayfish weighing 6.2 gms. removed from the stomach of bass No. 1 (Table 2) exhibited only 0.0008 uc total radioactivity. Of the fish measured by scanning only (Table 3), over 75% had levels corresponding to bone concentrations ranging from 0.5 to more than 4.1 muc/gm. of natural bone weight. The median value was 1.3 muc/gm. as compared to an average of 2.4 muc/gm. for the fish in Table 2. Thus, it appears that the scanning instrument had been of value in discarding the least contaminated fish.

Clinch River, mile Cl. 18-19 Specimens (Area C)

The number of fish for detailed examination was reduced by pre-scanning from 491 to 70. The results from these 26 game and 44 rough fish are given in Table 4. Details are given for 12 game and 12 rough fish which exhibited substantial levels of radioactivity in all three tissues. In some of the remaining 46 fish (for which only the range of observations is given in the table) one or more samples showed inconclusive evidence of measurable contamination. It was noted that there was no apparent consistency of relative concentration in the various tissues. The average radioactivity (at 10% geometry) in the 12 game and 12 rough fish for which details are given in Table 4 was:

	cpm/gm. fixed solids	
	Game	Rough
Flesh	590	490
Bone	260	630
Scales	330	600

Gills were not routinely examined, but for the two fish for which counts were made the gills were found to contain over four times the concentration of the other three tissues.

Clinch River, mile Cl. 13.3 Specimens (Area D)

The scanning procedure eliminated most of the fish as having less radioactivity than could be estimated by the present methods. The results of processing 24 fish are given in Table 5. This table lists 6 specimens having counts ranging from 40-860 cpm/gm. fixed solids. The observations on the other 18 fish indicated doubtful radioactivity.

Radioactivity of Different Tissues of Fish

Some results of observations on three primary tissues have been mentioned previously.

Four live carp from White Oak Lake, one crappie and one bass from the mouth of White Oak Creek and one sucker from the river at mile Cl. 18 were examined in greater detail by assaying four or more additional tissues from each specimen. The results related to natural body tissue weight are given in Table 6 for information only and no conclusions are drawn from these limited data.

Radioactivity of White Oak Lake Water

The daily average, maximum, and minimum concentrations of beta radioactivity (compiled from measurements made each work day) by months in the White Oak Lake effluent are given in Table 7. The observations

ranged from a minimum of 7×10^{-6} uc/cc following storms of considerable magnitude (February, 1948) to a maximum of 185×10^{-6} uc/cc following a prolonged drought (September, 1948). The average for the year was 58×10^{-6} uc/cc. These observations were used in estimating the level of radioactivity in the water from which fish samples were collected.

Decay and absorption curves on fish tissues suggest that a major part of the radioactivity is due to strontium 89 and 90 in the bony tissues and caesium in the flesh. For this reason two sets of chemical analyses of waters are presented in Table 8 which shows that caesium accounts for 25-50% of the beta radioactivity in the lake water and strontium alone, 10%, or in combination with yttrium, zirconium, and lanthanum, 30-40%.

In addition to the radioactivity present in the water and suspended matter it is probable that the free floating plants, macroscopic animals and plankton which constitute fish food and the contaminated mud on the bottom may also contribute in varying degrees to the radioactivity of the fish.

A Comparison of the Radioactivity of Water and Fish

The radioactivity of fish samples in Tables 1 to 5 was converted into concentration related to natural tissue weight for comparison with the concentration in the water from which the fish were collected (Table 9). The concentration in the water near the mouth of the creek has been found on a few measurements to be approximately one-third of

the lake concentration. The concentration in the river was calculated on the assumption that there was complete dispersion of the creek water with the river water immediately below their confluence.

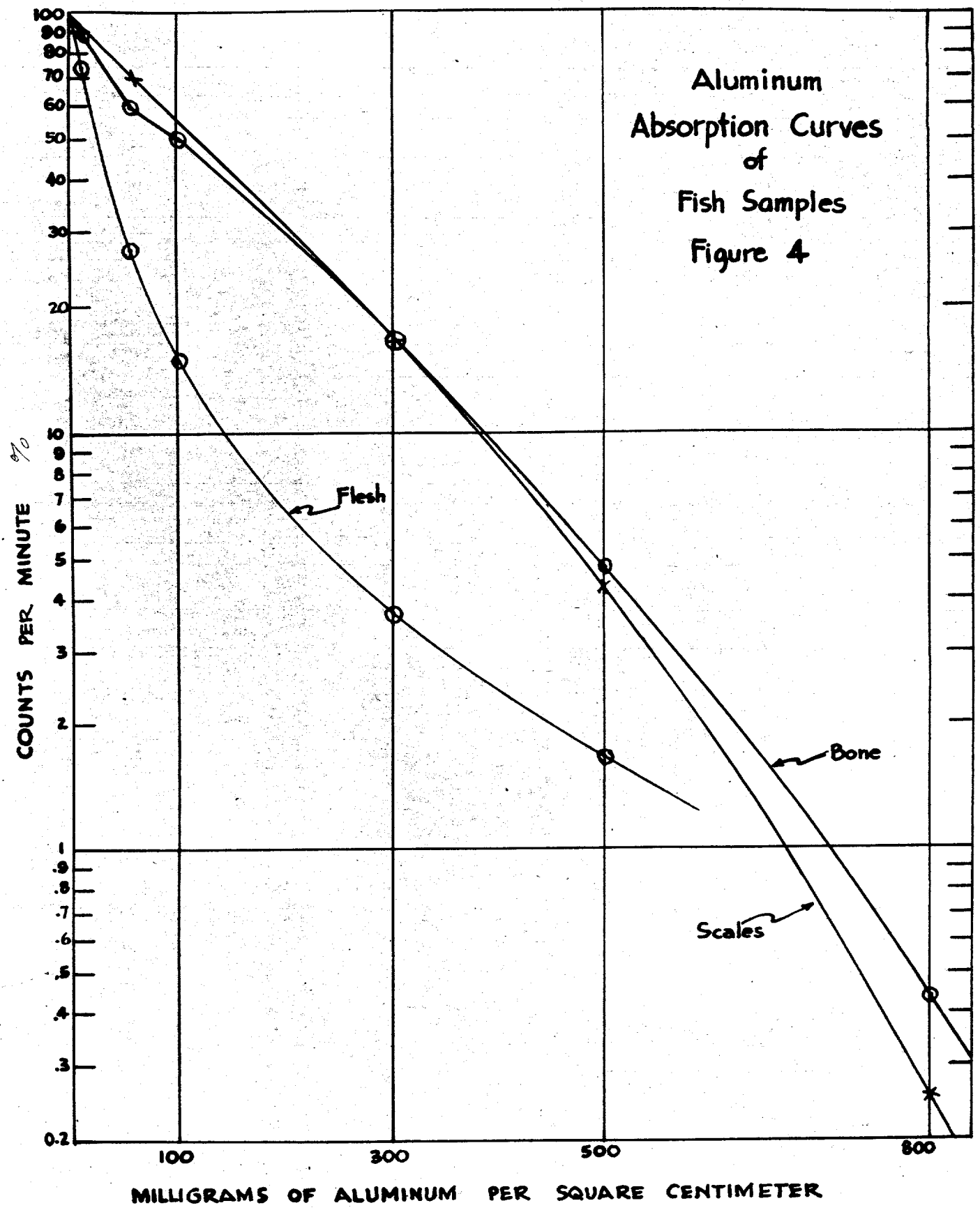
The term "concentration factor" is used here to indicate the ratio of the radioactivity measured in the fish to the radioactivity in the water from which they were collected. A summary of concentration factors based on the limited data is given below:

Area	Beta Radioactivity in Water $\mu c/cc \times 10^{-6}$	Fish: No. Included	Fish: % of Total Catch	Concentration Factor in Fish: Flesh	Concentration Factor in Fish: Bone	Concentration Factor in Fish: Scales
A. Lake	58	18	100	19	413	535
B. Creek	20	52	32	6	120	270
C. Cl.18-19	0.135	24	4.9	300	4000	7000
D. Cl.13.3	0.135	6	2.2	80	850	2150

Decay and Aluminum Absorption Curves on Fish Tissues

The aluminum absorption curves on samples of three tissues (composites after 4 months decay) are given in Figure 4. Pertinent date from these curves is tabulated below.

Composite	Initial Count @ 10% geometry	% Absorbed	Calculated Energy Value Mev
Flesh	362	30	1.7
		70	0.6
Bone	1182	60	2.0
		40	1.0
Scales	1236	80	2.2
		20	1.2


Aluminum
Absorption Curves
of
Fish Samples
Figure 4
Flesh
Bone
Scales
COUNTS PER MINUTE
%
100
90
80
70
60
50
40
30
20
10
9
8
7
6
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4
3
2
1
.9
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.7
.6
.5
.4
.3
0.2
100
300
500
800
MILLIGRAMS OF ALUMINUM PER SQUARE CENTIMETER

Decay curves on a few individual specimens were prepared (not included in this report) and the half-life determined.

	Early Half-Life Days	Extended Half-Life Years
Flesh	150	4.2
Bone	140-150	3.7 - 4.2

Preliminary analysis thus suggests that the major radioactive component in bone is from strontium 89 and 90 and yttrium and the principal components in flesh appear to be weak beta emitters of long half-life (mostly caesium plus mixtures of strontium and zirconium 95).

Discussion

Fish Habits

The feeding and foraging habits of fish found in the Clinch River are extremely complex. Fingerlings generally feed in shallow water on plankton, algae, and insects while older fish live in deeper water and may on occasion feed in shallow water. Sunfish feed principally on insects while crappie eat plankton and algae while small but after grown prefer small fish (shad). Carp, red horse, and buffale suckers are rough fish (sometimes called mudders) and rout in the bottom and shore muds in quest of plankton, vegetation, or dead animals.

Sunfish have a limited range of foraging, crappie may forage as far as 4 miles, and shad may travel longer distances. One tagged bass has been known to have travelled upstream from Norris Dam for a distance of over 120 miles in a single season.

Fish are very sensitive to changes in water elevation. If the water level falls a f/raction of an inch they may seek deeper water and if the level rises they move into embayments or small streams for protection or for food. Since the level of water in the area under consideration is subject to frequent fluctuation it is expected that the fish population of White Oak Creek is quite transient.

Studies by TVA indicate that game fishing accounts for the removal of only about fifteen percent of the population fatality whereas commercial fishing may be about twice as productive. A much larger proportion of the adult fish die of natural causes or are consumed by predators. Snakes, turtles, fish, mollusca, birds, etc. feed on dead fish. Thus the radioactive contamination of water may result in widespread distribution of certain radioactive elements on land and water by means of many simple or complex cycles of biological life. With the existing evidence it is impossible to evaluate the effect (be it beneficial or detrimental) of minute quantities of radioactive materials spread in this manner on the natural ecological balance in streams.

Tolerance Levels

From the public health point of view it is possible that the effect on health of radioactive contamination in water or food may depend on the adequacy and availability of natural stable elements for supplying the dietary needs of an individual. Should there be a deficiency of a stable element it is probable that a radioactive isotope of the same element, if present, would be absorbed to the extent of body requirements.

The maximum allowable limits[1] for ingestion of various radioactive elements have listed strontium 89 as 5 uc/day and strontium 90 as 1 uc/day. These limits were based on the assumption that adverse biological effects of radiation are due only to the resulting ionization from radioactive disintegrations and on an allowable exposure of 100 mr/day gamma or 100 mrep/day beta. There is only limited biological information as to the percentage of ingested strontium which reaches the bone or as to the rate of elimination from the bone and it was assumed that the strontium in the skeleton is uniformly distributed. More recent information[2] indicates that under certain conditions the initial retention of strontium in the gastro-intestinal tract may be nearer to 75% than the 7.5% originally assumed. Adding a factor of 10 for this greater initial retention and another factor of 10 because of the non-uniform distribution of strontium deposited in the bone the tolerance ingestion rate for Sr 90 becomes 0.01 uc/day.

Considering the tolerance to be 0.01 uc/day the results of the fish study (Table 9) indicate that a portion consisting of only 6 - 9 ~~grams~~ gms. of flesh from White Oak Lake fish could supply the daily tolerance even if it is the only source of radioactive isotopes in the diet. The corresponding quantities would be 20 - 85 gms. of fish from the mouth of White Oak Creek, 85 - 250 gms. from Cl. 18 - 19, and 170 - 900 gms. from Cl. 13.3. Compare these quantities with a small normal single serving of 120 gms. at a meal and it may be seen that one serving of lake fish would provide the equiva-

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[1] K. Z. Morgan (J. Phys. & Colloid Chem., 51, 984, 1947).

[2] K. Z. Morgan, personal advice.

lent ingestion tolerance for 13 - 25 days and one serving of creek fish of the concentration listed would provide possibly as much as 6 days tolerance. It should be pointed out, however, that the values in Table 9 were derived from the most contaminated fish taken from each area which ranged from only 2.2% of the total catch at mile Cl. 13.3 to 100% of the fish from the lake. The fish from the lake included only 4 fish collected alive but the average of those 4 was considerably less than that of the 14 dead fish with which they were grouped.

If bones were to be included in a meal, for example in a chowder, it is possible that they would contribute considerably toward the tolerance limiting quantity since it has been seen that the concentration factor in bone was over 20 times that in flesh. While this comparison of relative concentration is considered valid some limitation should be placed on the interpretation of the concentration factors previously listed. Fish migration habits preclude any definite knowledge that the fish ~~[illegible]~~ normally inhabited the water from which it was collected. The concentrations of radioactivity in all the waters except the lake effluent were assumed rather than measured. Most important, the concentration factors were calculated by considering only the most contaminated fish in the area catch and are therefore for biased samples. They do, however, represent the worst conditions that would be expected.

Conclusions

Measurable amounts of radioactivity were found in fish caught for a distance of 8.5 miles below the confluence of White Oak Creek with

the Clinch River. The level of radioactivity in fish and proportion of fish collected having substantial concentrations diminished rapidly from the mouth of White Oak Creek downstream. Human consumption of fish caught in the Clinch River does not appear to present hazards from radioactivity in the fish flesh.

These data would seem to justify the practice of prohibiting fishing in White Oak Lake which actually has been posted with "No Fishing" signs since 1944 when radioisotopes were first discharged from ORNL into the White Oak Creek system.

Recommendations

Future studies should include substantial numbers of live fish collected from White Oak Lake to more accurately determine the quality of fish which might pass through the gate and be caught by fishermen at some other location.

It would be desirable to extend fish collections upstream on the Clinch River for a distance equal to the downstream extent of the study.

Future studies on the Clinch River should include, if possible, actual determinations of the level of radioactivity in the water at the collection areas.

Acknowledgements

This cooperative study of the radiobiology of fish in the Clinch River was conducted by the Health Physics Division, Oak Ridge National

Laboratory and Tennessee Valley Authority with authorization and coordination by the Office of Research and Medicine, Oak Ridge Operations of the U. S. Atomic Energy Commission.

The overall study was directed by Roy J. Norton, Leader, Waste Disposal Research Section, Health Physics Division, Oak Ridge National Laboratory.

Field collection of specimens, including equipment and personnel, was provided by the Fish and Game Branch, Division of Forestry Relations, Tennessee Valley Authority, Dr. A. H. Wiebe, Chief. The field work was directed by Dr. R. H. Eschmeyer who also provided information concerning feeding and migrating habits of fish.

The Survey Monitoring Section, Health Physics Division, Oak Ridge National Laboratory, J. C. Hart, Leader, furnished a boat and operators to assist in fish collection, counting room service, and information concerning levels of radioactivity in the lake effluent.

Drs. K. Z. Morgan, Director, and Forrest Western, Assistant Director, Health Physics Division, Oak Ridge National Laboratory, provided technical consultation on tolerances and public health implications.

CWK:jg

11-22-49

Table 1

LEVEL OF RADIOACTIVITY IN FISH - WHITE OAK LAKE (AREA A)

Specimen No.	Species	Length (inches)	Collection Date 1948	Counts per Minute per Gram Fixed Solids x 10^3[a] Flesh	Bone	Scales	Gills	Skin	Entrails	Miscellaneous	
1	Shad	4	12/1	24.1	high	high	-	-	-	-	
2	Carp	8	July[c]	21.2	28.0	15.5	-	-	-	-	
3	Shad	4	12/1	23.9	26.6	18.3	23.5	20.4	53.5		
4	Shad	4	12/1	20.0	12.6	14.7	17.7	30.5	27.2		
5	Carp	2½	12/1	20.0	30.9	32.4	39.2	21.6	21.0		
6	Shad	3½	12/1	17.8	9.0	10.9	17.2	14.8	38.7	13.3[e]	
7	Crappie	3½	12/1	15.4	35.4	32.1	37.4	32.1	18.7		
8	Shad	3½	12/1	13.4	12.2	12.6	20.1	32.1	45.9	14.8[f]	
9	Shad	-	12/1	10.8	47.4	6.1	high	23.1	19.1	10.1[g]	21.9[h]
10	Shad	5	12/1	10.6	11.0	10.9	16.5	17.4	30.4		
11	Shad	4½	12/1	10.6	9.6	10.8	-	-	-		
12	Carp	4	12/1	-	10.2	22.3	-	16.3	-		
13	Shad	4	12/1	10.5	11.2	10.7	13.6	15.7	17.5		
14	Shad	4	12/1	9.3	10.8	11.6	-	-	-		
15	Shad	3	12/1	-	8.3	9.8	15.2	-	50.1		
16	Carp	9	5/18[d]	5.16	0.61	-	11.1	-	-	10.7[j]	13.2[f]
17	Carp	9	5/14[d]	4.66	1.23	-	19.1	-	-	9.5[k] 9.4[m]	13.6[h]
18	Carp	9	5/18[d]	3.06	1.48	-	11.2	-	-	7.2[h]	2.6[n]

a. Values have been corrected for background counting rate. 10% geometry.
b. Some fin tissue in scale sample of small fish.
c. Caught alive in lower end of lake. Kept alive in lab until 9/27. Examined after death.
d. Caught alive in upper end of lake.
e. Eyes
f. Head
g. Gonads
h. Kidneys
j. Stomach contents.
k. Intestinal contents.
m. Liver
n. Heart

Table 2

LEVEL OF RADIOACTIVITY IN FISH
WHITE OAK CREEK MI. 0.0-0.1 (AREA B)

October 26, 1948

Specimen				Counts/Minute/Gram of Fixed Solids*			
No.	Species	Length (Inches)	Weight (Grams)	Flesh	Bone	Scales	Scanning Reading
1	Bass	10-1/4	381	6800	2550	2570	7.3
2	Crappie	8-3/8	191	4110	1140	1050	5.3
3	Crappie	3-1/2	12	4060	2090	7420	2.3
4	Crappie	4	20	3480	4980	8350	5.0
5	Crappie	6-1/4	84	3180	3900	5470	11.2
6	Crappie	6-1/4	96	2340	5290	5540	12.3
7	Crappie	6-1/8	89	2160	3210	5240	11.0
8	Crappie	5-5/8	71	2150	4420	5030	10.0
9	Crappie	5-1/2	73	2050	3600	5630	10.1
10	Crappie	4-5/8	35	2010	1260	3100	4.5
11	Crappie	4-5/8	35	1670	1020	1660	2.4
12	Crappie	6-3/4	96	1600	450	270	1.3
13	Crappie	4-1/4	28	1590	970	2260	2.8
14	Crappie	4-7/8	43	1130	1400	2070	3.2
15	Crappie	6-3/8	86	1060	2160	3210	6.6
16	Crappie	3-1/2	11	920	260	640	0.8
17	Crappie	6-1/4	79	540	1160	1870	4.5
18	Crappie	6-1/4	77	510	650	740	1.9
19	Crappie	4-1/4	28	32	15	95	0.8
20	Crappie			0	170	280	0.0
20a	Crappie	5	48	430	19	330	1.1
21	Bass	5	45	48	610	650	0.9

*Values have been corrected for background counting rate, 10% geometry.

Table 2 (continued)

		Specimen		Counts/Minute/Gram of Fixed Solids*			
No.	Species	Length (Inches)	Weight (Grams)	Flesh	Bone	Scales	Scanning Reading
22	Sunfish	[illegible]	11.5	3010	10220	11860	
23	Sunfish	-	11.0	2910	3980	6680	
24	Sunfish	4-1/4	41	2680	1740	1900	
25	Sunfish	-	19.5	2460	5820	6450	
26	Sunfish	4-1/4	36	1820	2220	1890	5.5
27	Sunfish	-	14	1570	430	1920	
28	Sunfish	5-1/4	77	1440	3440	2960	8.9
29	Sunfish	5-1/8	78	1340	1420	1660	6.9
30	Sunfish	-	11.5	1320	3780	1800	
31	Sunfish	-	17.5	700	2260	340	
32	Sunfish	-	14.0	580	570	1220	
33	Sunfish	-	16.5	410	52	120	
34	Sunfish	-	19.5	260	19	0	
35	Sunfish	-	13.5	240	150	580	
36	Shad	6-3/8	71	4010	5320	6500	6.5
36a	Shad	8-3/8	167	0	150	-	4.2
37	Shad	3-1/2	-	2750	3240	5000	-
38	Shad	4-1/4	-	2560	6500	4920	-
39	Shad	8-3/8	153	2750	1280	3010	6.0
40	Shad	6-1/8	64	2610	2750	4250	7.3
41	Shad	8	126	2190	1500	2530	5.7
42	Shad	6-7/8	91	1930	1770	2610	4.2

*Values have been corrected for background counting rate, 10% geometry.

Table 2 (continued)

Specimen				Counts/Minute/Gram of Fixed Solids*			
No.	Species	Length (Inches)	Weight (Grams)	Flesh	Bone	Scales	Scanning Reading
43	Shad	4		1540	320	1230	
44	Shad	4-1/4		1450	4080	2760	
45	Shad	8-1/4	149	1330	1100	2230	4.6
46	Shad	6-7/8	91	1020	610	960	2.3
47	Shad	9-3/4	135	960	190	-	4.0
48	Shad	8-3/8	175	720	360	-	6.6
49	Shad	5	-	390	57	30	
50	Sucker	10-3/8	291	330	75	120	
51	Sucker	11-1/4	386	48	22	38	
52	Sucker	8	195	29	0	0	

*Values have been corrected for background counting rate, 10% geometry.

Table 2A

LEVEL OF RADIOACTIVITY IN FINGERLINGS*
WHITE OAK CREEK MILE 0.0 - 0.3 (AREA B)

Specimens			Counts per Minute per Gram**	
No.	Species	Body Wt. (gms.)	Body Weight	Fixed Solids
1	Minnow	0.6	2250	46000
2	Sunfish	5.7	485	8100
3	Sunfish	6.3	475	8530
4	Sunfish	5.9	330	6130
5	Sunfish	0.7	320	6780
6	Sunfish	1.0	90	2050
7	Sunfish	1.5	85	2050
8	Sunfish	8.8	52	1020
9	Sunfish	1.2	30	645
10	Sunfish	1.5	30	585
11	Sunfish	7.3	3	55

*Measured "in toto" and not by tissues.

**Corrected for background counting rate. 10% geometry.

Table 3

ESTIMATED LEVEL OF RADIOACTIVITY IN FISH
WHITE OAK CREEK (AREA B)

Scanning Reading	Level of Bone Radioactivity mmc/gm[d]		Rough[b]	Game[c]	Total
Under 1	Under 0.4		7	17	24
1.0 - 2.9	0.5 - 1.3		13	17	30
3.0 - 4.7	1.4 - 2.2		17	4	21
4.8 - 6.6	2.3 - 3.1		9	7	16
6.7 - 8.4	3.2 - 4.1		2	1	3
Over 8.4	Over 4.1		1	4	5
		Total	49	50	99

a. Range. (Background subtracted).
b. Shad.
c. Mostly Black Crappie, White Crappie, and Sunfish.
d. Millimicrocuries per gram.

Table 4

LEVEL OF RADIOACTIVITY IN FISH
CLINCH RIVER MILE CL. 18-19 (AREA C)

October 7, 1948

Specimen			Counts/Minute/Gram Fixed Solids*			
No.	Species	Length	Flesh	Bone	Scales	Gills
1	Crappie	7	1630	130	260	
2	Crappie	7	1150	440	430	
3	Crappie		850	860	1430	
4	Crappie	5-6	610	190	59	
5	Crappie	-	740	120	100	
6	Crappie	-	530	380	390	
7	Crappie	5-6	340	280	270	
8	Crappie	5-6	280	218	73	
9	Crappie	-	250	142	250	
10	Crappie	-	230	41	180	
11	Drum	-	230	158	290	1210
12	Crappie	5-6	220	149	230	
(1-12)	Ave.	[illegible]	590	260	330	
(13-26)	Game**		0 to 240	13 to 45	3 to 47	
1	Carp	-	980	540	160	
2	Carp	-	700	260	540	2640
3	Shad	-	1180	720	620	
4	Shad	-	710	840	1330	

*Corrected for background counting rate. 10% geometry.

**White and black crappie, drum, pike, and sunfish.

Table 4 (continued)

Specimen			Counts/Minute/Gram Fixed Solids*			
No.	Species	Length	Flesh	Bone	Scales	Gills
5	Shad	-	680	1550	-	
6	Shad	-	470	1680	1600	
7	Shad	-	370	320	130	
8	Shad	-	320	280	500	
9	Shad	-	260	250	280	
10	Shad	-	110	600	990	
11	Shad	-	85	200	120	
12	Shad	-	0	310	330	
(1-12)	Ave.		490	630	600	
(13-44)	Rough		0 to 166	0 to 157	0 to 250	

*Corrected for background counting rate. 10% geometry.

Table 5

LEVEL OF RADIOACTIVITY IN FISH
CLINCH RIVER MILE CL. 13.3 (AREA D)

Specimen		Counts per Minute per Gram of Fixed Solids		
No.	Species	Flesh	Bone	Scale
1	Crappie	53	75	43
2	Crappie	93	110	160
3	Crappie	120	170	250
4	Crappie	860	230	400
Average of four		280	150	210
5-17		0 to 131	0 to 32	0 to 36
1	Shad	380	460	720
2	Shad	360	78	190
Average of two		370	270	460
3-7		0 to 200	0 to 40	0 to 193

Table 6

LEVEL OF RADIOACTIVITY IN DIFFERENT TISSUES

	Counts per Minute per Gram of Tissue (10% geometry)						
Specimen No.	2	17	16	18	2[a]	1[a]	7[b]
Species	Carp	Carp	Carp	Carp	Crappie	Bass	Buffalo
Tissue examined:							
Scales	6780	-	-	-	460	1130	540[c]
Bone	7600	160	335	400	255	310	70
Gill	4580	1010	1060	1070	135	260	250
Muscle	345	76	84	50	50	83	11
Roe	-	-	-	-	49	73	-
Spleen	-	-	-	-	62	46	-
Liver	-	150	-	-	27	47	-
Kidney	-	140	-	73	14	49	-
Heart	-	63	-	25	-	-	-
Stomach contents	-	-	250	-	-	-	-
Intestinal contents	-	250	360	-	-	-	-
Bile	-	100	-	-	-	-	-
Skin	-	10	-	-	-	-	-

Carp (2, 17, 16, 18) caught alive in White Oak Lake (See Table 1).

a. Specimens 2 and 1 caught in White Oak Creek below Dam (Table 2).
b. Specimen 7 caught in Clinch River at Mi. 18.
c. Gross counts, weight unknown.

Table 7

LEVEL OF RADIOACTIVITY IN WATER
WHITE OAK LAKE EFFLUENT

1948

Period	Beta Microcuries per cc ($\times 10^{-6}$) Daily Average	Daily Maximum	Daily Minimum
January	25	43	12
February	20	40	7
March	17	28	8
April	37	63	25
May	67	99	36
June	59	87	45
July	32	45	21
August	81	113	40
September	129	185	80
October	111	143	64
November	77	106	10
December	42	58	19
Yearly average	58	-	-
Daily Max.		185	-
Daily Min.		-	7

Note: The radioactivity at the mouth of White Oak Creek was found to be about one-third that of the Lake or a yearly average of 20 microcuries per cc based on a few samples.

Table 8

CHEMICAL ANALYSIS OF RADIOACTIVE WASTES
PERCENT OF BETA RADIOACTIVITY[a]

Element	Oct. 1, 1947		Jan. 29, 1948	
	S.B.[b]	Lake[c]	S.B.[b]	Lake[c]
Cs	49.7	26.8	43.7	47.3
Ru	12.9	31.8	19.1	7.2
TRE	12.2	12.6	8.2	13.3
Zr	0.84	11.7	7.2	13.3
Y & La	9.8	10.0	5.2	11.3
Ce	0.11	1.0	2.9	1.0
Te	14.2	1.0	1.9	1.9
Ba	0.05	-	1.6	1.0
Cb	0.11	2.9	1.2	0.8
I	-	0.3	0.5	0.9
Mo	-	-	0.2	0.6
UX.	0.04	0.7	0.1	0.4
Se	-	-	0	0
Sr	0.84	11.7	7.2	13.3

a. Based on total of individual counts.

b. Settling basin effluent.

c. Lake effluent.

Table 9

LEVELS OF RADIOACTIVITY IN WATER AND FISH
A COMPARISON

	Sampling Stations			
	White Oak		Clinch River	
	Lake	Creek	Cl. 18-19	Cl. 13.3
Water (microcuries per cc) x 10^{-6}				
1948 average	58	20		0.135
Daily maximum	185	60		2.5
Fish				
Number included*	18	52	24	6
% of total catch	100	32	4.9	2.2
Average* (microcuries per 9 m.) x 10^{-3}				
Flesh	1.1	0.12	0.04	0.11
Bone	24.0	2.4	0.54	0.115
Scales	31.0	5.4	0.92	0.29
Maximum				
Flesh	1.77	0.50	0.12	0.06
Bone	58.0	12.4	2.0	0.56
Scales	64.2	23.5	3.2	1.43

*Those having highest levels of radioactivity averaged.

GB#12

AUG - 8 1960

UNION CARBIDE

INTERNAL CORRESPONDENCE

UNION CARBIDE NUCLEAR COMPANY • POST OFFICE BOX X, OAK RIDGE, TENNESSEE

To (Name) H. F. Henry
Company UCNC
Location K-25

Date August 3, 1960

Originating Dept. Health Physics Division

Answering letter date

Copy to W. H. Jordan
F. H. Bruce
~~K. Z. Morgan~~ - E. C. Struxness
J. C. Hart - D. M. Davis
HHA File

Subject Radioactivity in Clinch River Water at ORGDP Water Filtration Plant

The results of analysis of the weekly composite Clinch River samples which were collected by ORGDP personnel for ORNL at the water filtration plant intake are given in the attached table. $(MPC)_w$ values for the mixtures have been calculated and are included in the table.

Original Signed By

H. H. Abee
Health Physics Division

HHA:bab

Attachment

This document has been approved for release to the public by:

David R. Hamrin 7/12/96
Technical Information Officer Date
ORNL Site

RADIOACTIVITY IN CLINCH RIVER AT ORGDP WATER FILTRATION PLANT

Sample No.	Week Ending	Gross Beta c/m/ml [a]	Gross Alpha c/m/ml [b]	Sr Beta $10^{-8}\mu c/cc$	Ru Beta $10^{-6}\mu c/cc$	Cs Beta $10^{-6}\mu c/cc$	Ce Beta $10^{-6}\mu c/cc$	$(MPC)_w$ $10^{-6}\mu c/cc$	% $(MPC)_w$
G-16	7-17-60	0.19 ± 0.01	0.02	2.25 ± .23	.39 ± .009	0	.002 ± .001	3.46	25.8
G-17	7-24-60	0.013 ± .002	0.005	0.32 ± .17	.032 ± .003	0	0	1.92	3.2

a Gross Beta counted at approximately 9.6%. Counting efficiency based on Tl^{204} as a standard.

b Gross Alpha counted at 52% geometry.

MEMO

Date: August 18, 1960

To: H. H. Abee

Subject: Note from W. Jordan
(Activity in the Clinch)

We feel that if there is any reply to this it should come from you because you have firsthand information on this and it is your data.
I mentioned this to Mr. Hart and he said to send it to you for whatever reply you want to make to Jordan.

Roy J. Morton

RJM:ms

MEMO

Date: August 18, 1960

To: H. H. Abee

Subject: Note from W. Jordan
(Activity in the Clinch)

We feel that if there is any reply to this it should come from you because you have firsthand information on this and it is your data.
I mentioned this to Mr. Hart and he said to send it to you for whatever reply you want to make to Jordan.

Roy J. Morton

RJM:ms

Note from Jordan: To E.G.S and KEC

I note that Abee's report for Aug.3 shows the activity in the Clinch for week ending 7-17 is 26% MPE_W . Why does it vary so much? Rainfall? Does it give a clue as to the sources?

Walt J.

This document has been approved for release to the public by:

David K Hamrin 7/17/96
Technical Information Officer Date
ORNL Site

GB#12

ChemRisk/Shonka Research Associates, Inc., Document Request Form

(This section to be completed by subcontractor requesting document)

S. Flack / ~~1034A~~ OK

Requestor / Document Center (is requested to provide the following document)

Date of request 6/14/96 Expected receipt of document 4/30/

Document number none Date of document 1959

Title and author (if document is unnumbered)
Clinch River Studies (Water & Mud Study)

→ May have been previously released *

(This section to be completed by Document Center)

Date request received 7/1/96

Date submitted to ADC NA

Date submitted to HSA Coordinator 7/1/96

Second Request

(This section to be completed by HSA Coordinator)

Date submitted to CICO NA

Date received from CICO NA

Date submitted to ChemRisk/Shonka and DOE 7/2/96

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received

Signature

* Document provided to Y Moon on 4/21/95 — was formerly in H&S Doc Ctr. in K-1001

Box # 11-4-2

CLINCH RIVER STUDIES
(WATER AND MUD STUDY)

RADIOACTIVITY IN CLINCH RIVER WATER

AT GRGDP WATER FILTRATION PLANT

CRM-14.5

SAMPLE #	WEEK ENDING	GROSS BETA c/m/ml[a]	GROSS ALPHA c/m/ml[b]	Sr Beta 10^{-6} uc/cc	Ru Beta 10^{-6} uc/cc	Cs Beta 10^{-6} uc/cc	Ce Beta 10^{-6} uc/cc	MPC_w 10^{-6} uc/cc
G-1	4-3-60	0.6	<0.05	2.25	2.25	—	—	5.76
G-2	4-10-60	0.7	<0.05	2.70	2.70	—	—	5.61
G-3	4-17-60	0.2	**	1.35	0.32	—	—	5.19
G-4	4-24-60	<0.06	<0.04	1.4	*	0.18	0.04	2.02
G-5	5-1-60	<0.2	**	4.5	0.63	*	0.01	1.82

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[signature] 4/18/95

Technical Information Officer Date

Oak Ridge K-25 Site

a Gross beta counted at approximately 10.4% counting efficiency based on Tl^{204} standard

b Gross alpha counted at approximately 52.0% geometry.

* Too low to interpret.

** None detected

WCX-605 (Jan'88) 7-12 DATA SHEET

file - Water Sampling data

MEMO TO FILE

SUBJECT: Clinch River Background Levels

Per W. D. McCluen, the figures given below represent initial evaluation of the uranium content of the Clinch River bottom between the inflow of White Oak Creek and Norris Lake; they should thus be of the same order of magnitude as the uranium background of the river bottom at the ORGDP. In all cases, analyses of the water samples taken at the same points as the river bottom gave results less than 0.2 ppb of uranium, which corresponds to a value of 0.3 x [illegible] μc/cc. This may be compared to a value of 2×10^{-5} μc/cc, as a permissible limit for natural uranium in drinking water for continuous use by the general population.

For the river bottom samples, number 1 was taken some 100-200 yds. below the point of inflow of White Oak Lake, and number 2 was taken some 100-200 yds. upstream from this inflow point. Samples numbers 1 through 7 were taken [illegible] spots approximately equally distributed between point number 2 and Clinton. Sample number 8 was taken in Clinton, sample number 9 was taken approximately half way between Norris Lake and Clinton, and sample number 10 was taken [illegible] Norris Lake. All of the samples are mud or silt except the one taken [illegible] Lake, which had considerable rock. The two results given for samples [illegible] 10 represent different analyses of the same sample and do not represent [illegible] different samples.

Sample Number	Concentration ppb.	Concentration μc/ml.
1	15; 25	4×10^{-9}; 9×10^{-9}
2	50; 33	17×10^{-9}; 11×10^{-9}
3	33	11×10^{-9}
4	25	9×10^{-9}
5	17	6×10^{-9}
6	42	14×10^{-9}
7	50	17×10^{-9}
8	33	11×10^{-9}
9	25	9×10^{-9}
10	83; 67	28×10^{-9}; 23×10^{-9}

Note: In this usage, the μc is defined in accord with NBS Handbook [illegible] thus taken as about 7.4×10^{4} dis./sec.

H. F. Henry
Safety, Fire, and Radiation Con[illegible]

HFH:mh

9/22/60

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[illegible] 1/18/95
Technical Information Offi[illegible]
Oak Ridge K-25 Site

file (Env. Sampling Water & Mud)

MEMORANDUM OF CONFERENCE ~~OR CONVERSATION~~

DATE: August 15, 1960 **TELEPHONE( )** **PERSONAL(XX)**

PARTIES: (Originating) H. F. Henry, W. D. McCluen, H. J. Culbert, N. B. Schultz

(Other)

SUBJECT: Radioactivity levels in Clinch River between ORGDP and Norris Lake

DISCUSSION: A proposed study of the current radioactivity levels in the Clinch River involving water and mud sampling to be performed by the Process Engineering Division; discussed such aspects as the sampling points, quantity of sample required, multiplicity of samples, frequency of schedule, and laboratory analyses to be made.

CONCLUSION OR AGREEMENTS: Process Engineering Division (Process Laboratory Department) personnel are to collect samples of water, suspended silt (when avilable), and stream-bottom mud for analyses for uranium concentration, beta and alpha activity. Each sample is to be in duplicate, with a quantity sufficient of each sample retained for a third run as required for statistical significance. Tentative schedule: initial series of samples as soon as possible in August 1960; to be repeated in about six months during a winter month.

Locations proposed: (1) Below White Oak Creek, (2) Above White Oak Creek, (3) Gallaghar Bend, (4) Below Scarboro Creek, (5) Above Scarboro Creek, (6) Edgemore Bridge, (7) Below Clinton, (8) Above Clinton, (9) Below Norris Dam, (10) Norris Lake.

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Oak Ridge K-25 Site
4/18/95
Date

cc: A. F. Bacher

NBS:nbs

WCX-2402 (3-55)

MEMO **AVOID ORAL INSTRUCTIONS** **Date** 12/14 **19** 59

To Dr. H. F. Henry

Re: ORNL Waste Release to Clinch River

As mentioned previously, the high value of 2116 dis/min/100 ml obtained on a supposedly finished water sample does not appear to be a valid measurement of the influent water activity. Bill thinks this came from backwashing the filters. Results since this time show a steady decline as noted below:

12/4/59 - 536 Beta - dis/min/100 ml
12/5/59 - 312 " "
12/6/59 - 93 " "
12/7/59 - 273 " "
12/8/59 - 232 " "

This document has been approved for release to the public by: Technical Information Officer Oak Ridge K-25 Site Date 4/18/95

UCN-486
(1235 3-59)

AFB:la
No RC

Signed A F Becher
A. F. Becher
Safety and Health Physics

M E M O R A N D U M

To: Mr. A. F. Becher

Subject: Radioactivity of Clinch River at ORGDP

On Monday morning, November 2, 1959, the ORNL Area Monitoring Group notified ORGDP Safety and Health Physics that a radioactive leak of spent fuel elements had occurred over the weekend; subsequent newspaper releases suggested that the incident began late Friday afternoon. The gates of the dam reportedly had been closed Sunday morning to hold back what ORNL believed to be the major portion of the spill. Initial counting results of a sample of the water impounded behind White Oak Dam indicated a level of 225,000 dis./min./100 ml gross beta. The following morning the Knoxville "Journal," and that evening the "News Sentinel" as well as the "Oak Ridger" carried stories on the spill; clippings are filed in the Safety and Health Physics office. ORNL qualitative analyses indicated the radionuclides to be mainly Ruthenium and Curium, with lesser concentrations of Cerium, Neptunium, Americium, Plutonium, and Strontium; the latter being estimated at 10% of the total. Gross alpha activity of 14,000 dis./min./100 ml or about 8×10^{-5} µc/ml was attributed to Americium 40%, Curium 30%, Plutonium 20%, and Neptunium 10%. For comparison, it may be noted that the Handbook No. 69 MPL_W for 40-hour week occupational exposure is 1×10^{-4} µc Pu^{239}/ml. Early "guesstimates" of the total quantity of radionuclides involved varied widely from 5-500 curies.

ORGDP records indicated that the average beta activity in the plant sanitary water during the previous three-month period was 24 dis./min./100 ml. Using the MPL_W of 4×10^{-6} µc Sr^{90}/ml (NBS Handbook No. 69, 40-hour week occupational exposure) which is equivalent to 888 dis./min./100 ml, the 13-week MPL was computed to be 11,544 dis./min./100 ml, essentially all usable during the 13th week.

On Tuesday, November 3, 1959, about 10:30 a.m., ORNL "cracked open" the White Oak Dam, releasing impounded water to the Clinch River at about 5-10 $ft.^3$/second. Special sampling by ORGDP Utilities was started on the 4-12 shift, November 3, 1959. These results are shown graphically in figure 1 and are listed in table 1 along with the results of determinations by the ORNL "hot" lab, which apparently has a lower limit of detection of about 1000 dis./min./100 ml. Results of subsequent analyses of five duplicate samples by the ORNL "cold" lab and the ORGDP uranium measurements lab compared more favorably, averaging 459 and 486 dis./min./100 ml, respectively.

On Thursday, November 5, 1959, ORNL indicated that as of 2:00 a.m., the White Oak Lake activity level was approximately 150,000 dis./min./100 ml gross beta, or about one-fourth to one-half the peak value. At 5:00 a.m., November 5, 1959, the peak reading of 901 dis./min./100 ml was recorded at the Clinch River influent to the ORGDP sanitary water plant.

On Friday, November 6, 1959, ORNL reported that as of 7:30 a.m. the White Oak Dam was fully open, there was no backlog of radionuclides, and normal flow of White Oak Creek was re-established. At this time, the gross beta activity in

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Date

White Oak Creek reportedly was about 50,000 dis./min./100 ml, or approximately double the levels noted during "normal" operations.

Levels up to 150 dis./min./100 ml prevailed in the Clinch River influent to the ORGDP sanitary water plant through Wednesday, November 11, 1959. By Thursday, November 12, 1959, beta activity levels at this location had fallen below the ORGDP P.A.L. of 89 dis./min./100 ml (1/10th of the NCRP Sr^{90} MPL for 40-hour week occupational exposure, NBS Handbook No. 69).

It may be noted that during the period involved, the Clinch River flow remained essentially stable at about 5000 $ft.^3$/second, paralleling the average annual flow noted during 1957 and 1958, and providing the associated dilution factor of the mixed fission product waste material released from ORNL.

On Friday, November 13, 1959, sampling of sanitary water from nine system loops and end-of-line locations, including K-1001, K-25 Process Area, the pump houses, and the Powerhouse Area, indicated an average gross beta activity of 34 dis./min./100 ml, apparently reflecting the fact that there is no residual activity within the distribution system.

During an 18-hour period beginning on the 4-12 shift, November 5, 1959, hourly samples of raw, settled, and filtered water were obtained at the K-1515 Sanitary Water Plant. Lab results indicated that during water purification up to the point of filter saturation, settling alone removed an average of 53% of the total beta activity, while settling plus filtering removed about 68% of the total beta activity associated with the radionuclides present in this release, with elements such as Sr^{90} and Ru^{106} presumably remaining in solution. The need for increased frequency of washing of filters, usually performed on loss of head or 72-hour intervals, was indicated by the beta activity of the finished water approaching the beta activity of the raw water.

N. B. Schultz for
Safety and Health Physics

NBS:la

Attachments (Figure 1 and Table 1)

November 17, 1959

No RC

TABLE 1

GROSS BETA ACTIVITY IN CLINCH RIVER
ORGDP SANITARY WATER PLANT INFLUENT

DATE	11/3	11/4	11/5	11/6	11/9	11/10	11/11	11/12
C.R. FLOW (ft.^{3}/sec.)	4934	5128	5250	5260	4220	4800	5010	5300
12 Midnight		(1000)		524				
1 A.M.		9	682(0)	377				
2 A.M.		(0)		394				
3 A.M.		(500)		650				
4 A.M.		(1500)		476			33	63
5 A.M.		65 (500)	901(0)	504				
6 A.M.		(500)		411				
7 A.M.		(1000)		349				
8 A.M.				167	112		133	68
9 A.M.			556			152		
10 A.M.				59				
11 A.M.				75				
12 Noon		637	221	94				
1 P.M.								
2 P.M.				166				
3 P.M.				49				
4 P.M.			230					
5 P.M.	1	529 (1000)	408					
6 P.M.			235					
7 P.M.			417					
8 P.M.			374			40	14	
9 P.M.	19	623 (1000)	550					
10 P.M.			433					
11 P.M.	(1000)*		509					

* ORNL "hot" lab results in parenthesis.

NBS:la

11/17/59

GROSS BETA ACTIVITY IN CLINCH RIVER

ORGDP SANITARY WATER PLANT INFLUENT

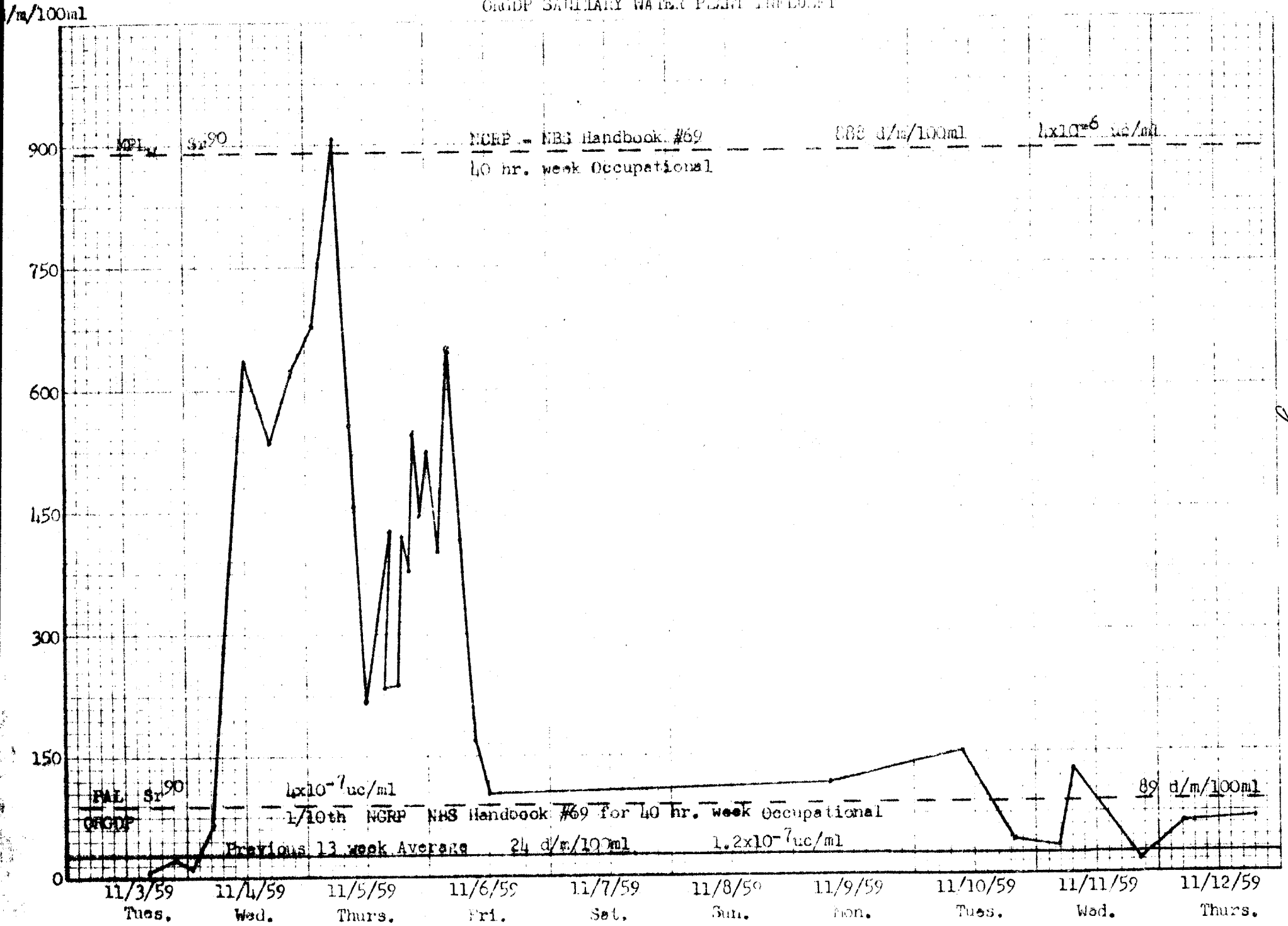

Figure 1

Material on Water and Mud in Classified File

1. Tabulation of Samples of Clinch River Water, letter dated 8-11-48 from W. J. Clossey to T. H. J. Burnett (ORNL)

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4/18/95
Date

January, 1957 – Clinch River Flow (CFS) at Scarbrough Ferry Sta.

1	12,790	(6,700)	25	4,857	(3,230)
2	12,657	(6,790)	26	3,667	(1,930)
3	12,790	(6,850)	27	5,523	(2,620)
4	10,790	(6,890)	28	5,857	"
5	6,790	(3,470)	29	11,177	"
6	957	(0130)	30	7,257	(2,540)
7	486	(2,810)	31	13,390	(6,780)
8	4,723	(6,280)			(156,100 Av 5,035)
9	5,190	(5,170)	Total – 210,416		
10	5,123	(5,630)	Monthly Average – 6,788 ft³/sec		
	5,257	(5,420)			
12	5,323	(6,220)			
13	5,790	(6,210)			
14	5,790	(6,200)			
15	5,790	(6,240)			
16	5,790	(6,950)			
17	7,123	(7,840)			
18	7,123	(7,810)			
19	6,990	(7,800)			
20	6,990	(7,760)			
21	6,923	(7,420)			
	6,390	(4,000)			
23	4,923	[illegible]			
24	6,190	(3,430)			

Ret. 28. 8390
8390 8323
8190 (8490)

27. 8190
8190 8323
8590 (8540)

26. 10,990
12390 11,923
1239 (10,540)

25. 12390
12390 16,377
24350 (12,530)

24. 13990
20190 18,123
20190 (14,270)

23. 16590
20190 18,790
19590 (16,630)

22. 19190
20790 20,257
20790 (18,720)

21. 20790
20790 20,927
21200 (20,800)

20. 20990
21200 21,130
21200 (20,970)

19. 21200
20990 21,060
20790 (20,970)

18. 20790
21990 20,997
21410 (21,030)

17. 23930
25400 24,910
25400 (23,240)

16. 25400
25400 25,470
25610 (25,500)

15. 25820
25820 25,820
25820 (25,590)

14. 26030
26030 26,100
26240 (25,690)

13. 26450
26450 26,520
26660 (25760)

12. 26870
27080 26,870
26660 (25,820)

11. 25190
24560 24,980
25190 (23,550)

10. 25820
26240 26,030
26030 (21,400)

9. 25820
26240 25,960
25820 (21,400)

8. 24770
25400 24,700
23930 (21,400)

7. 23930
23300 23,440
23090 (21,340)

6. 23090
22880 23,020
23090 (21,520)

5. 23090
23090 22,950
22670 (21,540)

tea. t- 21830

19790 19,603

17190 (20,030)

3- 12790

12390 12,990

13790 (11,990)

2. 15,990

19,190 18,257

19,590 (8,770)

1- 17,190

18,790 17,990

19,990 (8,610)

Total 581,840

Total 526,540

TVA Eqt. Avg. 18,805

Power House Avg. 20,780

Gauging Stat.

	CW 6 Yearly	Norris Disk
Jan 31	718	136.39
Feb 21 (28)	759	(28) 42.24
Mar 28	1039	(31) 240.39
Apr 30	2098	82.03
May 31	801	91.89
June 30	618	117.91
July 31	538	118.44
Aug 31	446	135.96
Sept 30	333	186.95
Oct. 31	448	180.91
Nov. 30	845	139.19
Dec. 31	1443	69.43

4.23

1544.23

4.23

365

Days 355

Total 10086

Or Cfunty

Aug. 28

	This Q.	Last Q.	This year	Last year
Avg. Beta Act.	30	14	28	39
Uran. Conc in Poplar	31	45	41	124
" " " Clich	3.6	1.5	2.8	3.4

8643

324

2

27.91

9602

344

85

355

959

~~64.83~~

20
30
31
81

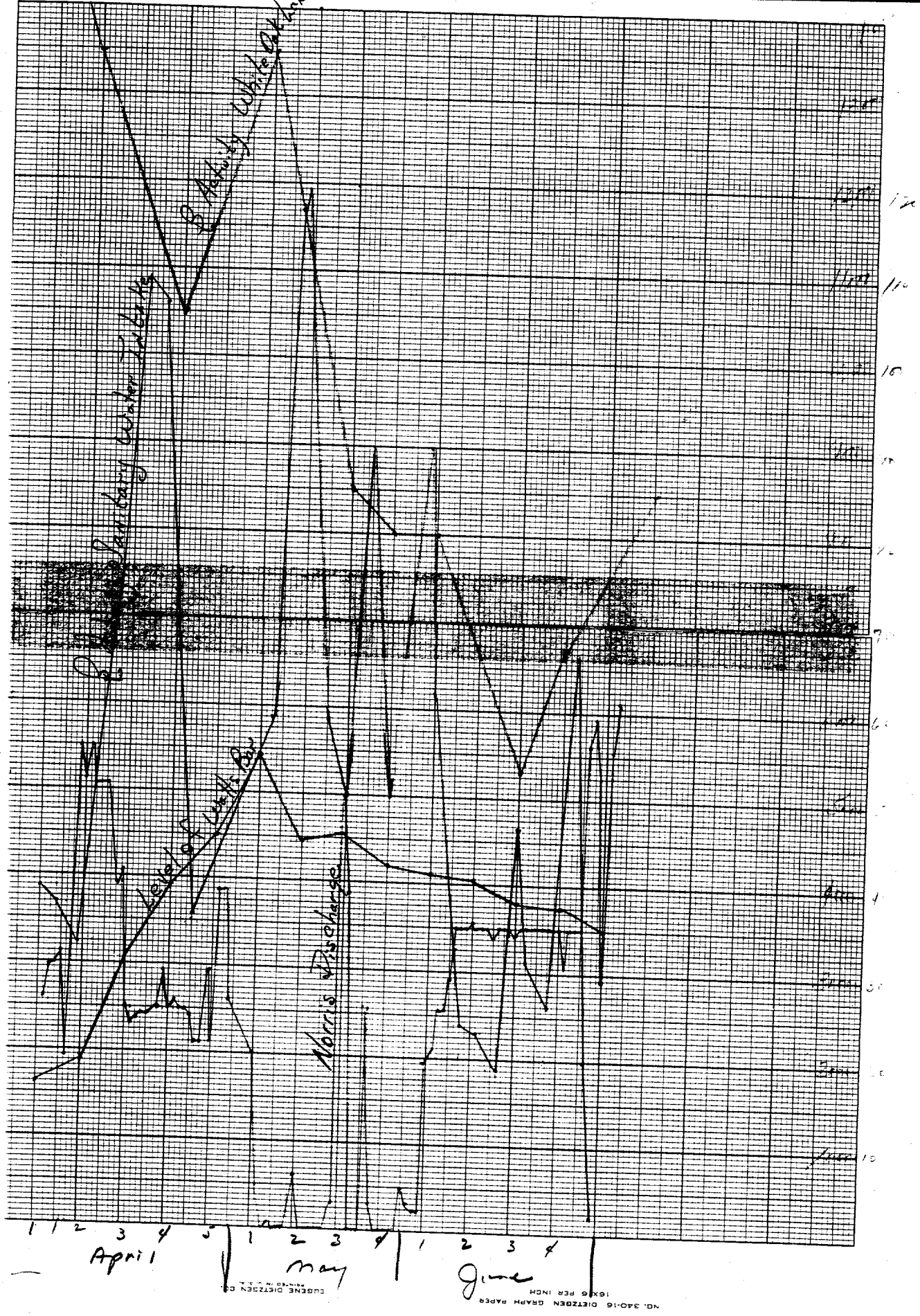
47.9

27.8

389.53

Oct-Dec.

Yearly				
[illegible] year	this year	Norris Disch.	This Quarter	Last Quarter
2.31	4.23	Quarterly Average	4.23	4.79
39	28	Average Beta Activity	27.8	14



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INTER-COMPANY CORRESPONDENCE

UNION CARBIDE NUCLEAR COMPANY

A Division of Union Carbide and Carbon Corporation

To: Mr. J. E. Rothfleisch
Building K-1401

Plant: Oak Ridge Gaseous Diffusion

Date: March 26, 1957

Copies To: Mr. J. C. Barton
Mr. H. F. Henry ✓
Mr. K. M. Jones
Dr. S. Katz
Mr. T. Kwasnoski
Mr. D. M. Lang
Mr. T. C. Whitson
Technical Division K-1005 File (RC)

Subject: Fluorides in ORGDP Area Waters, July 1956 - January 1957

KLI-4017

Submitted herewith are the results of a six months' survey, performed at your request, of fluoride concentrations in the ORGDP area waters. Semi-weekly samples were taken by the Utilities Department in the following locations: Poplar Creek at junction with Clinch River, Clinch River at K-1513 pumphouse, and the Clinch River, one mile downstream of Poplar Creek junction. The results, expressed in parts per million of fluoride ion, are presented in table I.

T. C. Whitson

T. C. Whitson

T. Kwasnoski

T. Kwasnoski

Special Analytical Services Department
Technical Division

/evo

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Irwin S. Quist 4/18/95
Technical Information Officer Date
Oak Ridge K-25 Site

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APR 1 1957
SAFETY, FIRE, AND RADIATION CONTROL

TABLE I

FLUORIDES IN OAK RIDGE GASEOUS DIFFUSION PLANT AREA WATERS

Date	CW-3 Poplar Creek at Junction With Clinch River, ppm. F^-	CW-4 Clinch River One Mile Downstream, ppm. F^-	CW-5 Clinch River at K-1513 Pumphouse, ppm. F^-
7/27/56	0.1	0.1	0.1
7/31/56	0.2	0.1	0.1
8/3/56	0.2	0.2	0.1
8/7/56	<0.1	0.2	---
8/10/56	0.2	0.2	0.2
8/14/56	0.6	0.2	0.1
8/17/56	0.4	0.4	0.1
8/21/56	0.4	0.2	0.1
8/24/56	1.7	0.1	0.5
8/28/56	0.3	0.6	1.2
8/31/56	0.3	0.2	0.2
9/4/56	0.6	1.4	0.3
9/7/56	0.7	0.6	0.6
9/11/56	0.3	0.2	0.4
9/14/56	0.1	0.1	0.1
9/18/56	0.2	0.1	0.1
9/21/56	0.2	0.4	<0.1
9/25/56	0.4	0.5	0.3
9/28/56	0.4	0.8	0.2
10/2/56	0.3	0.2	0.2
10/5/56	0.5	0.2	---
10/9/56	0.9	1.9	0.6
10/12/56	0.3	0.2	0.2
10/16/56	0.3	0.2	0.4
10/19/56	0.7	0.3	0.2
10/23/56	0.5	0.2	0.2
10/30/56	0.5	0.5	0.2

Date	CW-3 Poplar Creek at Junction With Clinch River, ppm. F^-	CW-4 Clinch River One Mile Downstream, ppm. F^-	CW-5 Clinch River at K-1513 Pumphouse, ppm. F^-
11/2/56	0.9	0.7	0.2
11/6/56	0.3	0.3	0.2
11/10/56	0.2	0.9	1.1
11/13/56	0.3	0.2	0.6
11/16/56	0.2	0.2	0.1
11/20/56	0.4	0.2	0.2
11/23/56	0.1	0.4	0.5
11/27/56	0.3	0.1	2.9
11/30/56	0.5	0.2	0.2
12/4/56	0.2	1.0	0.2
12/7/56	0.2	1.0	0.2
12/11/56	0.2	0.1	0.3
12/14/56	0.5	2.2	0.2
12/18/56	0.7	1.4	0.2
12/21/56	1.3	2.2	0.2
12/25/56	1.8	1.4	0.2
12/28/56	0.3	0.2	0.2
1/1/57	0.3	0.2	0.1
1/4/57	0.2	1.0	1.2
1/8/57	---	---	0.2
1/11/57	---	---	0.2
1/12/57	0.9	0.1	---
1/15/57	0.6	0.1	0.2
1/18/57	0.3	0.4	0.3
1/22/57	0.2	0.2	0.2
1/25/57	0.3	0.2	0.2
Av.	0.43	0.48	0.32
	52 $\sqrt{27.6}$	52 $\sqrt{25.2}$	51 $\sqrt{16.1}$

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W-5

INTER-COMPANY CORRESPONDENCE

SERT AME) COMPANY CARBIDE AND CARBON CHEMICALS CORP. LOCATION Post Office Box P OAK RIDGE, TENN.

TO Dr. H. F. Henry

LOCATION

ATTENTION

COPY TO

RECEIVED JAN 16 1950 RADIATION HAZARDS DEPARTMENT

DATE January 13, 1950

ANSWERING LETTER DATE

SUBJECT Minimum Flow of Clinch River

A letter dated January 5, from C. E. Center to R. W. Cook, concerning minimum flow of the Clinch River is quoted below. This recommendation obviously is the result of specific studies by X-10 and is consistent with our conclusions concerning the recent experiences of higher than average beta activity in the Clinch River under low flow conditions.

"Reference is made to my letter of August 26, 1949, regarding the minimum flow rate of the Clinch River. Since that time, at a meeting of the Radiation Protection Committee of the United States, Canada and Great Britain, held in Canada on September 26, the Committee recommended permissible limits on certain of the radioactive materials. Also further study has been and is still being made on the most applicable waste disposal system for Oak Ridge National Laboratory under the funds provided in Program "H".

"Until the revised waste disposal system is designed and installed, in order to keep the concentration of radioactive wastes in the Clinch River within the permissible limits recommended at the Chalk River Meeting, it will be necessary to regulate the discharge of such wastes in accord with the flow of the river. With the installation of the waste evaporator, the increase in storage space in the Tank Farm, and the use of White Oak Dam, such regulation is possible except under extraordinary conditions.

"To enable the personnel at the Laboratory to plan the disposal of the radioactive liquid waste, giving consideration to the Clinch River flow rate, it is recommended that TVA make available to the Laboratory a copy of its weekly schedule of release from Norris, or, at least, a statement of the anticipated average flow for the week. With this information, every effort will be made to maintain the average concentration of Clinch River for an extended period of time within the permissible limits. After the modification of our waste disposal system under Program "H", the knowledge of the flow rate will not be as critical as it is at the present time.

"Although the possibility of an ORNL accident in which extraordinary amounts of radioactive materials would be released is remote, the arrangement with TVA should also have provisions wherein large volumes of water could be made available to dilute the activity in Clinch River."

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If we need any information concerning Clinch River flows, particularly as related to X-10 operations, I presume you have and will continue to obtain it from X-10 rather than from any other source. If you have comments in this regard, please discuss them with me.

A P Dunlap

A. P. Dunlap
Safety and Inspection Division

APD:mgwk

GB#12

X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

To: Distribution as Listed

Date: December 16, 1959

From: Roy J. Morton

Copies To: H. H. Abee
S. I. Auerbach
T. J. Burnett
D. M. Davis
J. C. Hart
D. J. Nelson
R. J. Morton
F. L. Parker
E. G. Struxness

Subject: Discussion of Plans for Clinch River Studies

Present at a meeting in J. C. Hart's office on December 14, 1959, were Abee, Auerbach, Burnett, Davis, Hart, Morton, Nelson, and Struxness. F. L. Parker was absent because of vacation. The purpose was to discuss "Plan for Clinch River Study," dated November 9, 1959, and related questions, in preparation for a conference on this subject by representatives of the Laboratory and other interested agencies at ORNL Friday, December 18, 1959.

The discussion ranged over numerous problems of a general and also detailed nature that may be anticipated in organizing, carrying out, interpreting, and reporting this study. Only the high lights of the discussion and apparent consensus of the group will be summarized in these notes.

As to areas of interest and prospective participation by various agencies, it was agreed that the Union Carbide Nuclear Company is especially interested in work on the Clinch River from above White Wing Bridge to the mouth of the river; the Public Health Service and perhaps the Tennessee Stream Pollution Control Board might be interested in extending observations farther downstream in the Tennessee River by techniques that would give results comparable with those obtained in the Clinch River; the Tennessee Valley Authority has data and experience, particularly with respect to the silt ranges and silt deposition, in addition to its interest in hydrological and sampling studies; and the U. S. Geological Survey is competent and apparently interested in the hydrological measurements which will be essential. It was understood that all of the agencies mentioned have broader interests in the study than the outline above would suggest. The outline was made primarily to put into perspective possible participation by the various agencies which should be discussed in the conference on December 18.

Within the Health Physics Division of the Laboratory practically all work in the proposed program should be subdivided among three sections: namely, Applied Health Physics, Ecology, and Waste Disposal Research. Struxness inquired what additional work should be done by Applied Health Physics. Abee suggested that three or more cross sections of Clinch River, preferably ones on which work has been done previously, should be selected for more extensive investigation on a

year-round basis, including scanning and sampling of mud, collection and analysis of water samples, and participation in tracer tests when these are used. He commented that processing of water samples on the Health-Physics boat should be advantageous.

Struxness suggested that the recent report by W. D. Cottrell is excellent, and that as a guide the group should examine the content of this report and note what is missing in the data it provides. The group agreed that four major items missing are: (1) water analyses, (2) biological data, (3) hydrological data, and (4) delineation of seasonal changes. Hart commented that the Area Monitoring Program could be increased considerably for purposes of improved control of radioactivity, but that major increases for the benefit of the research investigation could not be justified by Applied Health Physics under its present budget arrangement and allocation of manpower.

Hart raised questions and there was much discussion concerning the feasibility of water sampling in the river in such a way as to obtain representative and valid measurements of radioactivity dispersed in the river. It was pointed out by several that to be meaningful water sampling must be related to other measurements and interpreted with judgment based on all available knowledge of conditions in the river. Also, it was agreed that sampling at White Oak Creek will be most informative (before radioactivity is dispersed) and that the pattern of dispersion might have to be estimated from other measurements; for example, temperature, water velocities, changes in biota, etc. Nelson explained briefly a statistical approach to help in selecting sampling points at which analysis of water would be most informative. It appeared to be the consensus that although it involves serious difficulties water sampling is an essential part of the study. Nelson and Abee were designated to consider carefully the problems and possible procedures and to work out recommendations regarding water sampling.

Auerbach raised the question of cost and available funds. It was commented that the "Plan for Clinch River Study" included an estimate of cost ($150,000) for FY 1961, but it was agreed that this estimate may not be complete or realistic and that it should be given further study and review after plans for the river study are more definite. Struxness suggested that it is realistic to estimate analytical costs for the whole project and to use available funds for analyses to the best advantage wherever needed. There were several suggestions as to how analytical costs can be kept within bounds.

Several other points were discussed, but no very definite conclusions were reached. Points discussed included:

(1) Processing of Data by IBM Methods.-- It was agreed generally that Applied Health Physics data, as well as data from the other groups, should be processed but that probably separate scheduling and programming would be best. Further study for grouping of data and design of cards will be necessary.

(2) Allocation of Work (among the various groups that may wish and find it possible to participate in the work program).-- No conclusion can be reached on this until after the extent and nature of the participation by the several interested agencies has been determined.

(3) Reporting of Results.-- With regard to the responsibility and timing for the preparation and release of reports on various aspects of the study, it was agreed that this is very important and will require further study. In general, it will not be advisable for all parts of the study to wait for reporting until the end of a two- or three-year period when over-all conclusions may be possible. Some phases will be at a stage for reporting earlier than others.

The desirability of having a "Steering Committee" for help in planning and for general guidance of the study was discussed. It appeared to be the consensus that such a committee would be helpful and perhaps essential, provided that: (1) the number of members should be small, and (2) each representative should be technically competent in the specialized work of his agency and also prepared to represent and clear with his own agency particular questions or problems that may arise. Also, it was agreed that the committee should be constituted so that its deliberations and conclusions would be closely correlated with the direction of the work program.

Finally, with regard to the conference on December 18, it was believed that some orientation discussion will be needed. For this it was decided that: (1) K. Z. Morgan should discuss the historical background of the discharges of radioactivity to Clinch River; (2) H. H. Abee should explain the background of investigations and monitoring work on the Clinch River; and (3) F. L. Parker should review briefly the proposal; that is, "Plan of Clinch River Studies" previously distributed.

Roy J. Morton

RJM:jmd

Draft
Balter/mm
10/28/59

Draft letter to:

USPHS
USGS
Tennessee State Health Dept. (TVA)

Subject: CLINCH RIVER STUDY

Dear _____:

During the past year there have been several discussions on the desirability of conducting a comprehensive stream investigation of the Clinch River below the Oak Ridge National laboratory. The purpose of the study would be to obtain engineering information on the physical, chemical, and biological aspects of a flowing, fresh water ecosystem which is receiving low-level liquid radioactive wastes.

The type of program envisioned for this river study should be of basic interest to several agencies outside of the AEC (ORNL), namely, the USPHS, the USGS, the TVA, and the Tennessee State Department of Public Health. It appears that each group has a different, yet complementary interest in a stream survey of this type, and it is hoped that the various scientific and engineering disciplines of each organization could be utilized in carrying out a well-planned and coordinated program. The study is to be conducted as part of the waste disposal development program being sponsored by the Division of Reactor Development, AEC. The AEC Division of Biology and Medicine will also support part of the project.

MEMO ROUTE SLIP
Form AEC-93 (Rev. May 14, 1947)

See me about this.	For concurrence.	For action.
Note and return.	For signature.	For information.

TO (Name and unit)	INITIALS	REMARKS
F.L. Parker H.P. Division Bldg 3504 ORNL	DATE	As per our telephone conversation

TO (Name and unit)	INITIALS	REMARKS
	DATE	

TO (Name and unit)	INITIALS	REMARKS
	DATE	

FROM (Name and unit)	REMARKS
A. Schoen Res. and Dev. Div. ORO	

PHONE NO.	DATE
4289	11/2/59

USE OTHER SIDE FOR ADDITIONAL REMARKS

U. S. GOVERNMENT PRINTING OFFICE : 1957—O-422007

Enclosed is a copy of a tentative program plan as prepared by the ORNL. In order to effectively plan and carry out this program, it is suggested that a steering committee be selected, consisting of one member from each of the agencies mentioned above. The purpose of this letter is to obtain 1) your overall thoughts or suggestions on the value of such a survey with your approval or disapproval of the project, 2) your comments on the enclosed program outline and 3) your representative on the aforementioned steering committee.

We are anxious to initiate work on this project and realizing the time required for program planning, it is suggested that a steering committee organizational meeting be tentatively set for December 15. At this time the extent of each agency's participation would be discussed and comments on the proposed study would be reviewed with the objective of formulating a program plan. It is hoped to distribute several reports on the Clinch River as prepared by TVA and ORNL for consideration by the agencies involved prior to the steering committee meeting.

Your suggestions and comments on the proposed program are requested - by December 1, 1959, if possible.

Sincerely yours,

JAL

Enclosure:

DEC 9 - 1959

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
UCC
POST OFFICE BOX X
OAK RIDGE, TENNESSEE

November 23, 1959

U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Dr. H. M. Roth

Gentlemen:

Subject: PROPOSED ECOLOGICAL RESEARCH ON THE CLINCH RIVER AND FORECAST OF NEEDS.

The purpose of this letter is to outline the objectives, proposed program and needs of the Clinch River Ecological Study. The general aspects of the biological, physical, and chemical research on the Clinch River to be done at the Laboratory are contained in a letter and memorandum of November 13, 1959 from J. A. Swartout to H. M. Roth.

Previous biological investigations on the Clinch River have been limited to a single study of the uptake and concentration of radionuclides by fish (Knobf 1951, ORNL 1031) and algae (Lackey 1957, ORNL 2410). Routine monitoring by the Applied Health Physics group indicates the uptake and concentration of radioactive wastes on bottom sediments (Cottrell, W. D., ORNL CF 55-10-125, ORNL 2847; Garner, J. M. and O. W. Kochtitzky 1956, J. Sanit. Engr. Div., Proc. Am. Soc. Civil Engrs. Pap. 1051).

The general objectives of the ecological phase of the Clinch River study will be to determine: (1) the biological and closely related physical and chemical mechanisms which affect the distribution and fate of radionuclides in the flowing water environment; (2) the factors which contribute to the downstream transport of radioactive materials; (3) the equilibrium conditions below the confluence of White Oak Creek and the Clinch River and the rate of progression of this equilibrium in a downstream direction; (4) suitable methods for rapid assaying of the consequences of a nuclear accident contaminating a river, including development of techniques for the radiobiological assay of aquatic environments.

The river will be considered as separate compartments of flowing water with dissolved and particulate organic and inorganic materials, organic and inorganic bottom sediments and organisms for analysis of uptake rates and equilibria. This approach will provide information necessary to determine the capacity of the

environment to absorb radioactive wastes and mechanisms of downstream transport. The basic information on stream ecology and radioactive pollution will be applicable to similar warm-water streams, particularly those in eastern U. S.

The ecological studies on the Clinch River will be conducted in a series of interrelated phases. It is anticipated that the work program will provide data applicable to concurrent and succeeding phases so that it will be possible to obtain a more complete understanding of the river as an ecological system. The work program for the next three years has been designed to permit the gradual development of field and laboratory investigations in a logical sequence dependent upon the availability of manpower, equipment and funds for radiochemical analyses.

Preliminary field work in FY 1960 will be directed toward the selection of study transects in the Clinch River so that random sampling methods may be used for bottom-dwelling organisms and sediments. A central composite sampling design patterned after those of G.E.P. Box will be used to test for homogeneity of the water mass in river cross sections. Members of the Mathematics Panel will be consulted to assure that reliable statistical methods will be applicable to all field and laboratory data. Periodic chemical analyses (Ca, Sr, CO_3, HCO_3, Cs, K, Fe, nitrogen compounds, etc.) of the river water will be started to characterize the aquatic environment. These data will be necessary to interpret uptake and cycling of radioactive isotopes under natural conditions.

Because the last survey for contaminated fish was made 11 years ago the Tennessee Fish and Game Commission and TVA will be approached this year to aid in a fish survey. If their help is obtained and sufficient funds for radiochemical analyses are available, another survey will be made this year.

Initial laboratory studies in FY 1960 will be concerned with determining the role of heterotrophic microorganisms in the uptake and cycling of radionuclides such as Sr, Cs, Ru, Co, and Zr-Nb. It will be necessary to compare uptake and release of the various isotopes from sterile and non-sterile media to separate the biological action of the microorganisms from the physical sorption. Investigations will be made of uptake by uncontaminated organic matter from contaminated solutions and release of radionuclides from contaminated organic matter into uncontaminated solutions. The role of microorganisms in the food chain is not known. It is possible that they become food for microorganisms feeding on organic detritus and it may be assumed that they release radionuclides from organic matter by decomposition but rate processes are not known.

By FY 1961 it will be possible to direct a major effort toward determining the budget of photosynthetically produced organic matter (primary producer trophic level) in the Clinch River. This level is considered the primary concentration point from which radionuclides enter the food chain. Since a portion of the organic matter is produced within the stream (autochthonous) and some is derived from the surrounding watershed (allochthonous) it will be necessary to distinguish between these two sources.

The autochthonous primary production will be determined by diurnal changes in the dissolved oxygen content of the river water mass (Odum, H. T., 1956, Limnol. and Oceanogr. 1:102-117). The diurnal oxygen determinations will be done at least

once a week throughout the year and twice a week during the summer. The hourly changes in oxygen concentration will be correlated with the hourly changes in incident light intensity, light extinction in the water, phosphate, nitrate, and chlorophyll and with environmental factors of water temperature, current velocity and day length. These data will be entered on IBM cards for a multiple regression analysis to evaluate the effect of these factors on the primary production in the river.

The allochthonous primary production in the river, consisting largely of leaves, may be determined by direct measurements on the quantity of leaves accruing to the river. The addition of allochthonous organic matter from a small stream will be measured by screening Melton Branch and relating the quantity of leaf material washed into the screen to its watershed. The degradation of leaf materials will be studied in samples of organic detritus from bottom sediments and samples of particulate detritus in the flowing water. The particulate detritus will be separated from the river water by millipore filtering and centrifuging. It will be possible to account for algal cells in the particulate fraction either on the basis of chlorophyll content or through direct microscopic examination and measurement of algal cells. The difference between total particulate material and algal cells will be the non-living detritus.

In FY 1961 preliminary investigations will be made to determine the chemical composition of aquatic organisms for biologically important stable isotopes and body burdens of radionuclides. Particular attention will be paid to Sr, Ca, Co, Cs, K, and I. Studies of the food habits of organisms will be started so that each species may be placed in the proper position of the food chain. Organisms ingesting sediments are especially interesting because it is probable that the digestive processes within the guts of these organisms will change the capacity of the sediments to adsorb radionuclides.

By FY 1962 a large-scale field and laboratory operation is contemplated which should provide information on body burdens, uptake and excretion rates for the more important radionuclides present in aquatic organisms. Previous work will provide population estimates and then it will be possible to calculate species turnover rate for each radionuclide of importance. It should also be possible to locate indicator organisms which may be used to assess immediately the consequences of a radioactive spill involving the release of significant amounts of radioactivity into the environment.

Visiting investigators, particularly university personnel, are anticipated during the summers. Many of these people will have research programs outlined but others will be open to suggestion. Several short-term studies are listed which may be conducted by these individuals.

1) What is the role of emergent aquatic insects in removing radionuclides from water and transporting these to the terrestrial environment? The transport may occur through the insects dying on land (mayflies and caddis flies) or being eaten by insectivorous birds which subsequently defecate over land (Peredelskii, A. A. and I. O. Bogatyrev 1960, Izv. Akad. Nauk. Biol. Sec. No. 2, 186-192).

2) What is the budget of a particular element (Sr for example) in a reach of the river? By determining the quantity of an element entering and leaving a

certain segment of the river a gross estimate could be made of export or storage under the conditions existing.

3) What is the capacity of suspended river sediments to adsorb various radionuclides? The radioisotopes in solution may be added to river water and a partition coefficient between the dissolved and particulate phases could be determined.

4) What would be the effect of river fertilization on photosynthesis in a stream such as the Clinch River? Phosphates and nitrates are usually limiting factors for algal growth in aquatic environments. The ORNL adds significant amounts of nitrates, so added phosphate should produce a rapid growth of algae. Such a method may prove useful in coping with the removal of radionuclides from large volumes of wastes--either in the river or holding basins--since algae have been shown to concentrate some isotopes 100,000 times or more.

5) What is the effect of current velocity on photosynthesis by algae? The general statement is made frequently that current enhances algal growth either by supplying nutrients or by removing waste products. It is possible in the laboratory to vary concentrations of nutrients in the medium and current velocity so that there is a constant flux of nutrients past the organisms grown on a glass tube. By using an experimental design for optimum conditions it will be possible to evaluate the effect of current. A similar study is possible on the respiration of consumer organisms such as caddis flies or Diptera.

Assistance in attaining the objectives of the program may be obtained through cooperation with the U. S. Geological Survey, TVA, Tennessee Stream Pollution Control Board and the U. S. Public Health Service.

Estimated manpower needs and costs are as follows:

FY 1960	1 man year	$ 30,000	
FY 1961	2 man years	70,000	(including analytical chem.)
FY 1962	3 man years	100,000	(" " ")

The costs for FY 1960 and FY 1961 would be a proportional part of the over-all Ecological Research (AEC 6480) budget for those years.

Sincerely yours,

J. A. Swartout
Deputy Director

JAS:SIA:db

cc: C. E. Center
W. H. Jordan
K. Z. Morgan
E. G. Struxness
S. I. Auerbach (20)
F. L. Parker
J. C. Hart
D. J. Nelson

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
UCC
POST OFFICE BOX X
OAK RIDGE, TENNESSEE

November 13, 1959

NOV 23 1959

U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Dr. H. M. Roth

Gentlemen:

Subject: PROPOSED CLINCH RIVER RESEARCH PROGRAM

The Staff of the Laboratory's Health Physics Division has prepared a draft of a proposal outlining a comprehensive stream investigation of the Clinch River below the Oak Ridge National Laboratory. The purpose of the study would be to obtain information on the physical, chemical, and biological aspects of a flowing, fresh water ecosystem which is receiving low-level, liquid radioactive wastes.

We believe this proposal would be of interest to other agencies which have some jurisdictional or other interest in this area. We suggest that it would be in the interest of the Atomic Energy Commission to circulate this proposal among these agencies and to invite their critical comments, suggestions and possible participation.

Sincerely yours,

J. A. Swartout
Deputy Director

JAS:SIA:ms

Enclosure

cc: C. E. Center
W. H. Jordan
K. Z. Morgan
E. G. Struxness
S. I. Auerbach
F. L. Parker ✓
J. C. Hart

GB#12

X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

January 14, 1960

To: K. Z. Morgan

Copies: R. J. Morton
F. L. Parker
R. L. Bradshaw
S. I. Auerbach
D. J. Nelson
H. H. Abee
T. J. Burnett
R. M. Richardson

Enclosed you will find a draft of the minutes of our December 18 meeting on "Plan for Clinch River Study." Will you study these minutes and offer comments as to their validity and representation of what was actually said?

We are particularly anxious that these minutes be prepared in final form as accurately as possible. Be especially careful to review and if necessary revise your own comments. If you will then return this draft with suggested changes, we will prepare a final draft and distribute copies to you who were in attendance.

Thank you.

Original signed by E. G. Struxness

E. G. Struxness

EGS:ms

MINUTES

MEETING ON "PLAN FOR CLINCH RIVER STUDY"

OAK RIDGE NATIONAL LABORATORY
Building 2001-Conference Room
December 18, 1959 - 9:30 AM

INTRODUCTION

E. G. Struxness, acting as chairman, called the meeting to order. He welcomed and introduced those present (see attendance list, page 13) and outlined the purpose of the meeting as follows:

1. Acceptance of plan for proposed Clinch River Study.

2. To determine the interest of agencies represented in the study and their possible participation in the work program.

3. To consider need of and organize a Steering Committee to guide and implement the study program.

STATEMENTS BY ATOMIC ENERGY COMMISSION REPRESENTATION

W. G. Belter conveyed regrets from J. A. Lieberman of the Environmental and Sanitary Engineering Section of the AEC in Washington for not being able to attend the meeting. With regard to the proposed program, he said the Sanitary Engineering group of AEC is much concerned with the effects of waste disposal on our environment and that about 40% of the budget of this group is for environmental studies, of which 30% is in the program at Oak Ridge. He said this should be a cooperative and joint undertaking for a comprehensive study of the Clinch and Tennessee Rivers, and that he hoped all agencies represented in the meeting would be able to take part in the estimate of manpower and financial limitations involved. The fate of radioactivity in both the Clinch and Tennessee Rivers must be determined in order to guide control measures and future releases to the Clinch River.

The Laboratory has conducted an extensive monitoring program exemplified in the recent report by the Applied Health Physics Section on radioactivity in the Clinch and Tennessee Rivers. He said the proposed study is not a monitoring program but the basic information and data from monitoring will aid in determining the capacity of these streams to assimilate wastes and in improving control procedures.

All groups here have relatively different but complementary interests. For this reason it will be desirable to organize a Steering Committee; a small group for guidance of the program. There should be one technical representative from each agency who will have the authority to act for his agency in planning the program. He said that it will be helpful if each agency can decide how it will participate and to what extent it will be able to make its facilities available for the study as a preliminary basis for allocation of work. He said the AEC in Washington has allocated a certain amount of funds for work on this project this year and the Public Health Service has personnel available to do planning and field work of this program. After the committee is selected perhaps we can have discussion on uniformity of preparation and collection of samples. This no doubt will be a problem and will require more definite ideas as to how the preliminary work will be done.

C. S. Shoup emphasized the mutual nature of the proposed program. He said the study should include participation by several agencies through contributions of data they now have on special aspects of the program and also by active help in obtaining new data. When agencies or groups participate actively and make a definite contribution they have greater interest and the program is more successful. It is important to collect information now in files and perhaps prepare an overall report of what we now know of the Clinch.

As to assignment of personnel, he said that AEC ORO can arrange for people from other agencies and commissions to work in the Laboratory.

For reporting results of the study he said they had found that it is best to issue reports through the regular reporting system of ORNL. This has advantage in that the reports get the TID 4500 distribution to all atomic energy sites and can be purchased by others who have an interest in the information. The issuance of reports as ORNL publications does not preclude the opportunity for a particular agency to publish details of the work in its special area with approval as separate releases.

RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS

H. H. Abee summarized the area monitoring program of the Health Physics Division and the data collected concerning releases of radioactivity to the river. He pointed out that in the Clinch River study we are concerned primarily with contamination by low-level radioactive waste water and potential seepage from disposal of solid and intermediate liquid waste to the ground. He referred to available health physics reports and described the system of sample collection and analyses for control purposes and showed slides to illustrate these data. (Discussion followed)

Q. Wallen: What kind of analyses are made on samples collected at White Oak Dam?

A. Abee: Three composites are made:

12-59

1. Daily composite on which gross beta and gamma is determined;

2. Weekly composite on which alpha determinations are made; and,

3. Monthly composites on which radiochemical analyses are made for some 5 or 6 of the most important radionuclides.

Q. Wallen: How do you determine the effect of discharges from White Oak Creek upon radioactivity in the Clinch River?

A. Abee: It is assumed that discharges from the creek are completely dispersed in the river water and the calculated concentration is considered in relation to the MPC_W value. This is the concentration for drinking water which will allow an individual to drink the water for 50 years without any detectable damage to the person.

Q. Schultz: Is the concentration checked by sampling in the river?

A. Abee: No, it is not. Concentrations in the river are so low and analyses so complicated that control is based on a straight mathematical calculation using

a dilution factor.

Q. Schultz: Is any allowance made for biological concentration in the river?

A. Abee: No, because our knowledge is not sufficient. We do make one check by river sampling at a ferry near the mouth of the Clinch River. By contract with the ferry operator a daily grab sample is composited to about 20 gallon in three months and analyzed quarterly to determine the average of the important nuclides: For example: 1956 through 1958; the average was about 7.5 x 10^{-7} micro-curies per ml at the sampling point.

T. J. Burnett commented that based on the radiochemical analyses this value is about 30% of the MPC_w.

H. H. Abee said the river monitoring surveys have been confined primarily to concentration of radioactive materials in the suspended matter which settle and form bottom sediments. Since early 1951 sediment surveys have been made down the Clinch and Tennessee Rivers to Chattanooga and beyond. Results have been reported by Garner and Kochtitzky and recently by Cottrell. The surveys include bottom scanning with "Flounder" instrument and also by collecting sediment samples.

Q. Schultz: Do you have alpha and beta counts?

A. Abee: No. The underwater instrument can detect primarily gamma radiation.

In discussion of results of analyses Abee referred to his slides showing data at the various cross sections downstream. In response to a number of questions about methods of analysis and levels of activity found, E. G. Struxness commented that much description and summaries of this information are contained in the record of the Congressional Hearings held by the Joint Committee on Atomic Energy in Washington, January 28 to February 3, 1959.

PROPOSED CLINCH RIVER STUDY PROGRAM

F. L. Parker reviewed the Plan for Clinch River Study, copies of which were distributed before the meeting began. He said it is necessary that we determine the exact fate of radioactive materials. The plan represents the Health Physics Division rather than a single section in the Health Physics Division. Most studies are concerned with meeting MPC standards for a flowing stream. This may not be the best approach but we do know there is contamination by potentially hazardous nuclides. We need to arrive at a more rational MPC figure. The primary need is to get a budget of radioactive material in the river. To do this we must take more water and sediment samples, particularly downstream, and make alpha as well as beta gamma determinations. We want to correlate levels in the sediment with distribution in the water.

Q. Wallen: How far down in sediment do you go?

A. Auerbach: No sediments have been taken.

Parker: Sediment sampling is planned probably at depths to 6".

Nelson: It is planned to go downstream and determine the movement of sediment through the stream to see how suspended matter moves downstream.

Q. Wallen: What will be used for tracer?

A. Parker: For sediment, a radioactive material, possibly Sc-46. Two tracer tests were run ~~this past~~ two summers. (Discussion of tests followed)

Q. Wallen: Will there be models used?

A. Parker: Not this year. Models cannot reproduce completely the conditions in the field. For example, with models we could obtain hydrologic data and measure dispersion and sediment transport but models would not provide biological data. (Suggested that Rex Elder of TVA comment from his experiments with hydrologic models)

Elder: My primary work is in the model field. I have had only two discussions with Frank about models. Cannot do a good job with models in the situation here. Dollars in 7 figure amounts probably would be necessary to simulate the extremely complex flow pattern in the lower 20 miles of Clinch River. The stream below ORNL could not be located in a more complex river situation than this. It is at a point where the flows run into the backwater from Watts Bar Dam. The prediction of flows then becomes highly complex during summer months because of stratification. Releases come down the Tennessee River and will be reflected in the movement of water in the Clinch River. It is complicated by the fact that from 5 to 30 days in a row we may have 4, 6, or 7,000 cfs during day time, power plants of TVA may shut down almost completely at night, then start to pick up at 5 or 6 in the morning, increase to capacity, then drop off toward evening and back to light load again. With these things going at about 4 plants affecting flow in this area, it is not uncommon to have negative water slopes and still have good discharges going downstream.

Q. Wallen: Is there any need to use models to define the water slopes?

A. Elder: No, unless your budget is ample and there is need to elucidate a particular facet which proves too difficult to work out in the field. (Elder commented that models would be suitable for working on restricted facets of the hydrology of the stream, as Parker suggested.)

S. I. Auerbach: The ecological problem in the Clinch River can be epitomized as follows: 1) As ecologists we are interested in obtaining basic biological knowledge from streams such as the Clinch River. 2) As Health Physicists we are interested in improving the status of operational monitoring in the Laboratory environs, including the Clinch River. 3) We believe we can contribute information necessary to understanding the fate of radionuclides released to the river.

The basis for programs of ecology and biology in radiological river studies is meager. Less than 1/2 dozen atomic energy installations have had good biological sampling programs of which Hanford and Chalk River are outstanding.

The status of work in biology on the Clinch River has been extremely meager. A survey was made with the aid of TVA and the Fish and Game Commission of the State of Tennessee. They collected a total of 700 fish from White Oak Lake and the Clinch River. The radioanalyses done at that time was gross beta. Based on Sr content found in the White Oak Creek fish, and using the MPCs at that time, they calculated that of the fish from White Oak Lake a person would have to eat 14 pounds of fish per day to get the maximum permissible dose and at river mile 13.3, 36 pounds per day. This survey was done about

12 years ago. Since that time, MPCs have changed and more activity has been deposited in the river. The only other study at this Laboratory was done by Professor James Lackey, which was collection and examination of plankton in the river below White Oak Creek. Dr. Lackey found the Clinch River water above White Oak Creek to contain negligible plankton. The water from Norris Dam is discharged at the bottom and the flows to mile 28 or 29 are cool and free running. We add nutrient materials in addition to radioactive materials which supports increased biological activity below White Oak Creek outfall.

There is another complicating factor--the proposed Melton Hill Dam. This installation will be both a hydroelectric and navigation dam. Its construction and subsequent operation will alter conditions in the river below the dam. We have a number of years before this dam is in operation.

To develop an understanding of the role of the flora and fauna in determining and affecting the fate of radionuclides in the river we should get started on the proposed program at the earliest possible time. There are four major steps in our program: 1) Characterization of the biota some distance above and below White Oak Creek outfall; 2) information regarding the biological productivity; 3) information on the specific radionuclides present, and, 4) synthesis of total system relationships as we can put them together--chemical, physical and biological. More detailed discussion on the phases of the ecology program will be given by D. J. Nelson.

D. J. Nelson: Initial work will be concerned with a characterization of the environment from the biological and chemical standpoint. Physical information will become available from the engineering studies. One of the first questions concerns the source of photosynthetically produced organic matter found within the stream. There are two sources. 1) That which originates within the stream. This primary production will be estimated by the diurnal oxygen curve method.

Q. Schultz: How often do you propose to sample?

A. Nelson: Once a week and twice a week during summer time.

Q. Wallen: What hours of the day and what will you measure?

A. Nelson: 24 hours per day or before sunup till after sundown. Since we are going to be on the stream we anticipate making measurements of other environmental parameters such as PO_4, chlorophyll, temperature, light intensity, etc.

Q. Wallen: How are measurements made?

A. Nelson: When sufficient data are accumulated a multiple regression analysis will be attempted to evaluate the effect of each factor and combination of factors on the primary production within the stream.

PO_4 and NO_3 frequently are limiting factors for photosynthesis in aquatic communities. Since the Laboratory wastes include large amounts of NO_3, one could add PO_4 as fertilizer to the stream and determine what effect it has on photosynthesis. A technique such as this might present a method for treatment of large volumes of waste which might occur as the result of an accident. In streams you find large amounts of organic matter such as leaves which are derived from the watershed. It is possible that half of the organic matter at the photosynthetic level in the stream is derived from the

watershed. (Discussion) We should determine the quantity of organic matter originating on the watershed and what its role is in the food chain. In effect we would have the budget of photosynthetically produced organic matter in the Clinch River. The allochthonous organic matter is known to concentrate radionuclides. Whether the concentration is due to physical sorption or the metabolism of heterotrophic microorganisms such as bacteria is not known. Some laboratory experiments are being conducted with sterile and non-sterile mixtures of river water and leaf material to separate the physical and biological factors which concentrate radionuclides on the non-living organic matter. There is a great deal of organic matter in the bottom sediments and radionuclides associated with it may enter the food chain through the feeding activities of the bottom-dwelling organisms.

Another phase of the Clinch River studies will deal with biogeochemistry and with particular reference to those elements which are released in the radioactive effluent from the Laboratory. A recent paper in Limnology and Oceanography by Nicholls, Curl, and Bowen from Woods Hole and MIT emphasizes that some elements are actively concentrated or excluded by different organisms. They concluded that each element will be found concentrated by some organism in the spectrum of life. The work will include stable and radiochemistry, the determination of body burdens and eventually uptake and excretion rates. The studies will be associated with work on the food chain. We will be able to find the quantity of the various radionuclides in the biota, which elements are mobile and which are conserved.

Q. Wallen: What exactly do you plan to do?

A. Nelson: Plan to start on photosynthesis this spring and carry it a full year and pick up information on the organic matter coming into the stream and also on chemical nature.

Chairman Struxness said that the previous discussion of past work on the river and the plan for the proposed study leads logically to comments by others as an extra order of business. He called for a discussion of the hydrologic parameters.

Godfrey stated that these had been pretty well covered. He indicated that the level of the program almost rules out any extensive model studies.

Elder said that a statement previously made that there are no drinking water supplies taken from this reservoir is not entirely correct. During low flows in the river the cold Clinch River water will flow along the bottom up the Emory River and find its way into the Harriman water supply intake and after warming up will flow back along the surface to the Clinch River.

Parker: The water is monitored at the K-25 plant which has the first downstream water supply taken from Clinch River below ORNL.

Jones: The Kingston water supply which is usually from springs may be affected when water shortage causes intake from the Tennessee River. The Kingston water intake is located a short distance upstream from the mouth of the Clinch and under some conditions there may be an upstream of Clinch River water to the Kingston intake.

Kochtitzky substantiated the fact that under these conditions of up stream flow of the Tennessee River, Kingston might use Clinch River water.

Burnett: A possible concern of the agencies represented here is stream pollution control and we have provided that. The amounts released from White Oak Lake bed area are monitored for protection of the public and can be controlled temporarily by closing White Oak Dam.

(The TVA representatives emphasized that reservoir operations do affect river conditions although information may not be quantitative.)

Elder: There are figures on the effect of Melton Hill Dam. The Melton Hill project will affect the releases in this area to some extent. The fluctuations will be larger and of shorter duration.

Belter proposed that Parker summarize what is to be done in the next six months.

Parker recalled meetings two years ago. Summary of work to be done: investigation of literature, determine the most important hydrologic features to be studied, try to determine what would be the most effective way of studying hydrologic effects.

Q. Belter: Do you anticipate compiling this data? What time would be involved?

A. Parker: The program will progress as data is obtained.

Friend asked if TVA data on mixing were adequate and what would be expected of the PHS.

Struxness: As to what ORNL can do for the next six months: We are negotiating for a man to do hydrologic studies which makes it difficult for us to know what we will do on hydrologic aspects, except tie together what we have in our files on the tracer tests.

Auerbach: On biological aspects for next 6 months: Cottrell's report: Applied Health Physics people have measured the activity in the sediment at specified TVA silt ranges. These provide us a useful guide-line in which to start a biological characterization of the river. We have requested our Laboratory management to purchase a large type of laboratory boat, a pontoon type houseboat, in which we can maintain a crew and sampling facilities. We propose, together with Mr. Abee, to start out at these silt ranges and do one silt range a week on three or four ranges or once a month at each silt range. We think by March we could go into the river and start the silt range samples.

Q. Wallen: What do you mean by characterization of the river?

A. Auerbach: Start work to determine the specific radionuclides in the organisms. Abee's group will be collecting samples at various cross sections, which will be additional.

Wallen commented that this omits two important aspects; namely, fish and plankton.

Auerbach said the aid of Tennessee Fish and Game Commission would be enlisted for sampling the fish and the water samples will be collected by Abee's group which will aid in plankton studies.

Abee: Proposal for next six months: Applied Health Physics program will not have facilities for the next 6 months but hope to integrate the two programs in order to make cross section measurements the year round to see how seasonal variations affect bottom sediments.

Struxness: Asked Wallen to comment on the proposal since he seems to feel that it is too ambitious.

Wallen: I have strong objection to the ecology program as written. I do think the objectives are very broad. At Hanford, with ten people, they have been unable to do in five or ten years what is planned here. It will take a lot of people we do not have and it seems the two parts of the program are contradictory. The objectives are too general. We need to rewrite the proposal, be more specific and make it more of a job description. As now written, it would mean that you either hire 5 people or reduce the program to include one person.

Struxness: We recognize the proposal is very broad and very general. In February and March of each year we have to describe the proposed investigation for AEC Form 189 budget submission to be done in the first year and also in the second year. We are not in position at the moment but hope to be in February. I agree it is an idealistic proposal and difficult at the moment for a Steering Committee to have anything to go on. This is one of the most important studies that the Laboratory has ever undertaken. We would like for it to be as thorough and comprehensive as we can make it. We want you to have interest and responsibility to come in and help. I think the agencies represented here should come in, as well as other agencies. With the AEC alone it would flop. We can make adjustments with the money from the AEC. No increases expected in the next two fiscal years. We are not expecting to come to the agencies with too large a proposal. There may be need for additional funds but we will do our level best to justify it.

Belter: There have been certain funds allotted for fiscal year 1960. Going back to Steering Committee. It is needed to try to find out where to get started.

Schultz: To get the proposal better lined up, you should bring in the best limnologists and discuss this thing. Six months is not much time if you can get people together and really work together. It is early to start with samples.

Struxness: I agree that we should lay plans before starting on the river. More fission products up to now have been released to this stream than at any other place and less has been done to understand it. We have a situation that is changing. We who are interested in health protection are very much interested in the river program and we must get it underway.

Friend: I think the Steering Committee should be set up in order to set up the program.

Kochtitzky: A detailed work plan is needed to show respective agencies what time, personnel and money will be required before they are willing to commit their agencies.

Schoen: I think it should be left to the Steering Committee as to work plan and how we would be involved in it.

LUNCH

STATEMENT ON THE HISTORY AND PHILOSOPHY OF LABORATORY OPERATIONS WITH RESPECT TO THE CLINCH RIVER

K. Z. Morgan commented on the recent serious accidents and meetings on the subject. He stated that the field of Health Physics is relatively new. He briefly reviewed the

history of Health Physics and the development of the radiation protection committees, specifically the National Committee on Radiation Protection and the International Commission on Radiological Protection. In discussing the history of the White Oak Lake and Clinch River usage by ORNL, Morgan showed how the maximum permissible exposures have been successively reduced over the last 17 years. He emphasized that there is little liklihood that the present maximum permissible concentrations will be increased; rather, the chances are that they will be decreased in the future.

Struxness commented that Morgan's discussion exemplifies why we are concerned about the Clinch River. He suggested that each representative make a statement of the interest and possible participation of his agency. He stated that it would not be a firm committment.

STATEMENTS ON THE INTEREST AND/OR ACTIVE PARTICIPATION OF OTHER AGENCIES IN CLINCH RIVER STUDY PROGRAM

S. Leary Jones: The State of Tennessee is interested and I feel that the study must be made. It is possible in the state program to shift emphasis from what is now being done; for example, from bacterial studies to studies on this objective. Details will come out after the Steering Committee gets underway. Apparently monitoring is being done. I would like to see a certain amount of monitoring start now at Chattanooga. The people are quite concerned about the Strontium 90 that is in the water supply. We have had a number of letters about this problem because there is no solid basis for assurance that it is perfectly safe. He illustrated how much trouble public concern may cause by reference to a relatively minor incident of pollution by a paper mill which almost forced the company to leave the state. He said he would like to see this program tied in with TVA reservoir operation studies. It is hard to say how this should be set up. This should be correlated with plans developed by the Steering Committee. We have eight people in our group who will be very much interested in this work. We have three biologists and I would like to send one of them (Mulligan) to ORNL to work on this problem.

Struxness: We do not have proof but strongly suspect that the Strontium 90 at Chattanooga does not come from Oak Ridge, but we cannot prove it. Our Laboratory management and the AEC are quite aware of the public relations problem that we may have to face. This is another reason why we must do the best we can and answer the questions that we are sure might be asked.

F. E. Gartrell: We are interested to see that the hydrologic and chemical data accumulated through the years by TVA is used both in planning and carrying out this study. We have not given any attention to the matter of radioactive material. We have felt the need to accumulate radiologic data and have some plans to do so, and I feel that with a study of this kind getting underway it would be a good time for us to initiate some studies of our own. Participation proposed, in addition to developing staff competency, would provide guide-lines as to the kind of sampling needed to be done by TVA on a long-term basis. The question of the best way to operate TVA reservoirs in the event of an accidental spill has been given a lot of attention. But we have not gotten down to specific cases or worked out details. We are concerned about radioactive wastes in TVA water supplies which we have responsibility for operating. We are concerned with effect on fish and game as well as the effect on water quality.

As far as being in a position to participate in a program of this kind, we have lots of competence and skills but to what extent we can make them available is something

we would have to work out with personnel in our organization. We have a small staff but the details of studies that have been made in the past 2 1/2 years may have applications and some of the basic data would be useful. We have extensive survey facilities but these facilities are costly. The amount of dollar contribution that we could make might not be very encouraging in undertaking a study of this magnitude. I feel that I certainly would recommend to TVA management that TVA participate in this study. The details of our contribution would have to be worked out later when your work program has been defined.

A. G. Friend: We are very much interested in the project. We have at the present time the funds and the personnel. The budget next year we do not have and what we can do next year I do not know. We are in pretty good shape for the remainder of this fiscal year.

Struxness: Would your participation be on the biological side or equally on the hydrological side?

Friend outlined what was done on the Mohawk River Study. He stated that something of that nature could be contributed.

E. G. Godfrey: I cannot speak for the USGS and I am going to ask Mr. Cragwall to make the statement. First, however, I would like to speak of our interest in this program. The USGS has been working with AEC on waste disposal problems. They have been actively participating in a number of programs with various local groups such as KAPL and Savannah River. We have in the past participated in studies here in Tennessee. As far as participating in this study it would have to be worked out with Mr. Cragwall.

J. S. Cragwall: We are very interested in the project and feel we have skills to be of assistance to you and we can always participate to the extent that funds may be made available. If these are not available, we will cooperate in furnishing technical skills to the best extent we can.

J. E. Munzer: We are definitely interested in all types of field work which we can do on a contract basis. The contracts will run from a week or two to 3 months. We are definitely interested in this operation.

Struxness: TVA and USGS already have information on the hydrological aspects and are definitely interested in this study, especially the USGS. We will look more or less to them for the guidance and actual performance of measurements made on the river. The PHS, plus the Stream Pollution Control Board, as well as the group represented by Mr. Munzer, have almost the same interests as the Health Physics Division. These groups would in some ways enter into the study of biological and radiological determinations. One of the big parts of this study will be analyses. We all agree we need hands and need to get out on the river. We have large and well equipped laboratory and analytical facilities at ORNL.

Morgan: Are you planning to get enough money for this?

Struxness: We must consider this in looking at reality in collection of samples and analyses of samples. We are fooling ourselves if we say we can do this study over a period of 5 years. Someone will have to put out a good sum of money for these analyses.

Friend: PHS has two methods; 1) refined, and, 2) a quick and dirty method, which is cheaper.

Struxness: Another thing that complicates organization in carrying out this cooperative program is that some of us are interested in the practical and some in the scientific aspects. As to responsibilities for source of support, one group might support the biological phases and another support the engineering-hydrologic portion.

Some of you are more concerned about the TVA system from K-25 to some point on downstream. Some of us are more concerned with the stretch immediately below the outfall of White Oak Creek. Over all of us hangs the public relations problem associated with this program. The AEC will have to begin educating the public.

Shoup: Our public information people are aware of this meeting and the plans for a cooperative effort. They are prepared to issue a press release when the program gets into operation.

Struxness: You fellows who are interested hold an important part in orienting and informing your colleagues back home. It is unfortunate that this meeting could not have been held 16 years ago. (Mr. Struxness asked for comments from the attendance concerning the proposal that a Steering Committee composed of representatives from the various participating agencies be appointed to coordinate the overall direction of the river studies. He said that this involved the type of committee, its functions, and procedures of reporting results.)

ORGANIZATION OF CLINCH RIVER RESEARCH STEERING COMMITTEE

Gartrell: The release of all information should be formal, through the Steering Committee and should be cleared through this group. We should think about who will be the representatives in the committee. Since ORNL has the biggest stake in this program it would seem to me that Struxness would be a logical choice to head up the committee in view of the fact that he heads the ORNL waste disposal and engineering group.

Shoup: It seems that all the agencies participating would be the ones who would be represented on the committee and would have one member from each agency on the committee.

Struxness: I am interested in knowing whether this Steering Committee is an advisory committee or is it a working committee.

Gartrell: I think it should be a working committee not just advisory. The representative from each agency would clear with his own group. The committee should make the decisions as to the direction of the program. It is different from a typical river advisory board.

Struxness: It should be a working committee which would see that the work is done. The chairman of the Steering Committee should be at Oak Ridge and would be really the local coordinator of the program.

Gartrell: Due to the fact that you have these various groups under your jurisdiction, it would seem logical that you should be chairman.

Steering Committee members were elected as follows:

E. G. Struxness, Chairman
S. Leary Jones
A. G. Friend
E. G. Godfrey
F. E. Gartrell

J. A. Lieberman - ex officio
I. E. Wallen " "
A. A. Schoen " "

Burnett: If this is to be both an advisory and working committee would you need a larger committee?

Struxness: I believe we agree the Steering Committee is large enough to represent the group here. We can start on this basis and may see fit to change it later.

Shoup: Does this mean that alternates may be on the committee for particular problems?

Struxness: On behalf of the AEC and ORNL, we are anxious to have representatives on the Steering Committee who have something to say about this program.

Morton: There should not be alternate members on the committee. If this committee is going to have definite responsibilities, the members must accept their responsibilities for decisions. They can bring their staff support to committee meetings, or accept assignments and work them out themselves in their own group and with their own agency.

Shoup: I think you are right. I used the wrong terminology.

The meeting was adjourned at 3:50 PM.

After the meeting was adjourned the first meeting of the Steering Committee was set up for Thursday and Friday, January 21 and 22, 1960.

ATTENDANCE LIST

USAEC

I. E. Wallen (DBM-ESB - Washington)
Vincent Schultz (DBM-ESB - Washington)
W. G. Belter (DRD - Washington)
C. S. Shoup (ORO- Oak Ridge)
A. A. Schoen (ORO- Oak Ridge)

USGS

E. P. Mathews (Surface Water Branch - Knoxville)
J. S. Cragwall, Jr. (Surface Water Branch - Chattanooga)
E. G. Godfrey (" " " ") WASHINGTON
B. J. Frederick (" " " ")
R. M. Richardson (Ground Water Branch - ORNL)

USPHS

A. G. Friend (Taft Sanitary Eng. Center - Cincinnati)
J. E. Munzer (Regional Office - Atlanta)

TVA

F. E. Gartrell (Health and Safety Div. - Chattanooga)
O. W. Kochtitzky " " " " ")
Rex A. Elder (Norris Lab. - Hydrologic Data Div. - Norris)

State Stream Pollution Control Board

S. Leary Jones (Nashville)
W. H. Martin (")

ORNL

K. Z. Morgan (Division)
E. G. Struxness (Division)
R. J. Morton (Waste Disposal)
F. L. Parker (" ")
R. L. Bradshaw " ")
S. I. Auerbach (Ecology)
D. J. Nelson (")
H. H. Abee (Applied Health Physics)
T. J. Burnett " " ")

Final

GB#12

MINUTES

MEETING ON "PLAN FOR CLINCH RIVER STUDY"

OAK RIDGE NATIONAL LABORATORY
Building 2001-Conference Room
December 18, 1959 - 9:30 AM

INTRODUCTION

E. G. Struxness, acting as chairman, called the meeting to order. He welcomed and introduced those present (see attendance list, page 13) and outlined the purpose of the meeting as follows:

1. To discuss the plan for proposed Clinch River Study.

2. To determine the interest of agencies represented in the meeting and their possible participation in the work program.

3. To consider need of and organize a Steering Committee to guide and implement the study program.

STATEMENTS BY ATOMIC ENERGY COMMISSION REPRESENTATION

W. G. Belter conveyed regrets from J. A. Lieberman of the Environmental and Sanitary Engineering Section of the AEC in Washington for not being able to attend the meeting. With regard to the proposed program, he said the Sanitary Engineering group of AEC is much concerned with the effects of waste disposal on our environment and that about 40% of the budget of this group is for environmental studies. It is hoped that the proposed comprehensive study of the Clinch and Tennessee Rivers will be a cooperative undertaking with all of the agencies represented at the meeting being able to participate to the extent of manpower and financial limitations. The fate of radioactivity in both the Clinch and Tennessee Rivers must be determined in order to guide waste disposal control measures and future releases to the Clinch River.

The Laboratory has conducted an extensive monitoring program as exemplified in the recent report by the Applied Health Physics Section on radioactivity in the Clinch and Tennessee Rivers. He said the proposed study is not a monitoring program or a stream pollution survey, but the basic information and data developed will aid in determining the capacity of these streams to assimilate large-volume, low-level wastes and thereby improve waste management procedures.

All groups here have relatively different but complementary interests. For this reason it will be desirable to organize a Steering Committee; a small group for guidance of the program. There should be one technical representative from each agency who will have the authority to act for his agency in planning the program. He said that it would be helpful if each agency could decide how it will participate and to what extent it will be able to make its facilities available for the study as a preliminary basis for allocation of work. He said the AEC in Washington has allocated a certain amount of funds for work on this project this year and the Public Health Service, under an interagency agreement with the Commission, has personnel available to do planning and field work in this program. After the committee is selected, it would be desirable to begin discussions on the establishment of representative stream sampling stations, uniform sample collection, analytical procedures to be used, etc. In this manner, it is hoped that exploratory field work can be initiated as soon as possible.

C. S. Shoup emphasized the mutual interest of the various agencies in the proposed program and said the study should include participation by several agencies through contributions of data they now have on special aspects of the program and also by active help in obtaining new data. When agencies or groups participate actively and make a definite contribution they have greater interest and the program is more successful. It is important to collect information now in files and perhaps prepare an overall report of what we now know of the Clinch.

As to assignment of personnel, he said that AEC ORO can arrange for people from other agencies and commissions to work in the Laboratory.

For reporting results of the study he said they had found that it is best to issue reports through the regular reporting system of ORNL. This has advantage in that the reports get the TID 4500 distribution to all atomic energy sites and can be purchased by others who have an interest in the information. The issuance of reports as ORNL publications does not preclude the opportunity for a particular agency to publish details of the work in its special area with approval as separate releases.

RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS

H. H. Abee summarized the area monitoring program of the Health Physics Division and the data collected concerning releases of radioactivity to the river. He pointed out that in the Clinch River study we are concerned primarily with contamination by low-level radioactive waste water and potential seepage from disposal of solid and intermediate liquid waste to the ground. He referred to available health physics reports and described the system of sample collection and analyses for control purposes and showed slides to illustrate these data. (Discussion followed)

Q. Wallen: What kind of analyses are made on samples collected at White Oak Dam?

A. Abee: Three composites are made:

1. Daily composite on which gross beta and gamma is determined;

2. Weekly composite on which alpha determinations are made; and,

3. Monthly composites on which radiochemical analyses are made for some 5 or 6 of the most important radionuclides.

Q. Wallen: How do you determine the effect of discharges from White Oak Creek upon radioactivity in the Clinch River?

A. Abee: The probable concentrations are calculated values, based on dilution factors. It is assumed that discharges from the creek are completely dispersed in the river water and the calculated concentration is considered in relation to the MPC_w value. This is the concentration for drinking water which will allow an individual to drink the water for 50 years without any detectable damage to the person.

Q. Schultz: Is the concentration checked by sampling in the river?

A. Abee: No, it is not. Concentrations in the river are so low and analyses so complicated that control is based on a straight mathematical calculation using

a dilution factor which represents the ratio of river flow and creek discharges for the particular period of time.

Q. Schultz: Is any allowance made for biological concentration in the river?

A. Abee: No, because our knowledge is not sufficient. We do make one check by river sampling at a ferry near the mouth of the Clinch River, some 16 miles downstream. By contract with the ferry operator, a daily grab sample is composited to about 20 gallon in three months and analyzed quarterly to determine the average of the important nuclides: For example: 1956 through 1958; the average was about 7.5×10^{-7} micro-curies per ml at the sampling point.

T. J. Burnett commented that based on the radiochemical analyses this value is about 30% of the MPC_w.

H. H. Abee said the river monitoring surveys have been confined primarily to concentration of radioactive materials in the suspended matter which settle and form bottom sediments. Since early 1951 sediment surveys have been made down the Clinch and Tennessee Rivers to Chattanooga and beyond. Results have been reported by Garner and Kochtitzky and recently by Cottrell (ORNL-2847). The surveys include bottom scanning with the "Flounder" instrument and also by collecting sediment samples.

Q. Schultz: Do you have alpha and beta counts?

A. Abee: No. The underwater instrument can detect primarily gamma radiation.

In discussion of results of analyses Abee referred to his slides showing data at the various cross sections downstream. In response to a number of questions about methods of analysis and levels of activity found, E. G. Struxness commented that much description and summaries of this information are contained in the record of the Congressional Hearings held by the Joint Committee on Atomic Energy in Washington, January 28 to February 3, 1959.

PROPOSED CLINCH RIVER STUDY PROGRAM

F. L. Parker reviewed the Plan for Clinch River Study, copies of which were distributed before the meeting began. He said it is necessary that we determine the exact fate of radioactive materials. The plan represents the Health Physics Division rather than a single section in the Health Physics Division. Most studies are concerned with meeting MPC standards for a flowing stream. This may not be the best approach but we do know there is contamination by potentially hazardous nuclides. We need to arrive at a more rational MPC figure. The primary need is to get a materials balance of radioactive materials in the river. To do this we must take more water and sediment samples, particularly downstream, and make alpha as well as beta gamma determinations. We want to correlate levels in the sediment with distribution in the water.

Q. Wallen: How far down in sediment do you go?

A. Auerbach: No sediments have been taken.

Parker: Sediment sampling is planned probably at depths to 6".

Nelson: It is planned to go downstream and determine the movement of sediment through the stream to see how suspended matter moves downstream.

Q. Wallen: What will be used for tracer?

A. Parker: For sediment, a radioactive material, possibly Sc-46. Two tracer tests were run this past summer. (Discussion of tests followed)

Q. Wallen: Will there be models used?

A. Parker: Not this year. Models cannot reproduce completely the conditions in the field. For example, with models we could obtain hydrologic data and measure dispersion and sediment transport but models would not provide biological data. (Suggested that Rex Elder of TVA comment from his experiments with hydrologic models)

Elder: My primary work is in the model field. I have had only two discussions with Frank about models. Cannot do a good job with models in the situation here. Dollars in 7 figure amounts probably would be necessary to simulate the extremely complex flow pattern in the lower 20 miles of Clinch River. The stream below ORNL could not be located in a more complex river situation than this. It is at a point where the flows run into the backwater from Watts Bar Dam. The prediction of flows then becomes highly complex during summer months because of stratification. Releases come down the Tennessee River and will be reflected in the movement of water in the Clinch River. It is complicated by the fact that from 5 to 30 days in a row we may have 4, 6, or 7,000 cfs during day time, power plants of TVA may shut down almost completely at night, then start to pick up at 5 or 6 in the morning, increase to capacity, then drop off toward evening and back to light load again. With these things going at about 4 plants affecting flow in this area, it is not uncommon to have negative water slopes and still have good discharges going downstream.

Q. Wallen: Is there any need to use models to define the water slopes?

A. Elder: No, unless your budget is ample and there is need to elucidate a particular facet which proves too difficult to work out in the field. (Elder commented that models would be suitable for working on restricted facets of the hydrology of the stream, as Parker suggested.)

S. I. Auerbach: The ecological problem in the Clinch River can be epitomized as follows: 1) As ecologists we are interested in obtaining basic biological knowledge from streams such as the Clinch River. 2) As Health Physicists we are interested in improving the status of operational monitoring in the Laboratory environs, including the Clinch River. 3) We believe we can contribute information necessary to understanding the fate of radionuclides released to the river.

The basis for programs of ecology and biology in radiological river studies is meager. Less than 1/2 dozen atomic energy installations have had good biological sampling programs of which Hanford and Chalk River are outstanding.

The extent of work in biology on the Clinch River has been extremely meager. A survey was made with the aid of TVA and the Fish and Game Commission of the State of Tennessee. They collected a total of 700 fish from White Oak Lake and the Clinch River. The radioanalyses done at that time were for gross beta. Based on Sr content found in the White Oak Creek fish, and using the MPCs at that time, they calculated that of the fish from White Oak Lake a person would have to eat 14 pounds of fish per day to get the maximum permissible dose and at river mile 13.3, 36 pounds per day. This survey was

done about 12 years ago. Since that time, MPCs have changed and more activity has been deposited in the river. The only other study at this Laboratory was done by Professor James Lackey, which was collection and examination of plankton in the river below White Oak Creek. Dr. Lackey found the Clinch River water above White Oak Creek to contain negligible plankton. The water from Norris Dam is discharged at the bottom and the flows to mile 28 or 29 are cool and free running. In addition to radioactive materials, we add nutrient materials which support increased biological activity below White Oak Creek outfall.

There is another complicating factor--the proposed Melton Hill Dam. This installation will be both a hydroelectric and navigation dam. Its construction and subsequent operation will alter conditions in the river below the dam. We have a number of years before this dam is in operation.

To develop an understanding of the role of the flora and fauna in determining and affecting the fate of radionuclides in the river we should get started on the proposed program at the earliest possible time. There are four major steps in our program: 1) Characterization of the biota some distance above and below White Oak Creek outfall; 2) obtaining information regarding the biological productivity; 3) obtaining information on the specific radionuclides present, and, 4) synthesis of total system relationships as we can put them together--chemical, physical and biological. More detailed discussion on the phases of the ecology program will be given by D. J. Nelson.

D. J. Nelson: Initial work will be concerned with a characterization of the environment from the biological and chemical standpoint. Physical information will become available from the engineering studies. One of the first questions concerns the source of photosynthetically produced organic matter found within the stream. There are two sources; 1) That which originates within the stream. This primary production will be estimated by the diurnal ozygen curve method.

Q. Schultz: How often do you propose to sample?

A. Nelson: Once a week and twice a week during summer time.

Q. Wallen: What hours of the day and what will you measure?

A. Nelson: 24 hours per day or before sunup till after sundown. Since we are going to be on the stream we anticipate making measurements of other environmental parameters such as PO_4, chlorophyll, temperature, light intensity, etc.

Q. Wallen: How are measurements made?

A. Nelson: When sufficient data are accumulated a multiple regression analysis will be attempted to evaluate the effect of each factor and combination of factors on the primary production within the stream.

PO_4 and NO_3 frequently are limiting factors for photosynthesis in aquatic communities. Since the Laboratory wastes include large amounts of NO_3, one could add PO_4 as fertilizer to the stream and determine what effect it has on photosynthesis. A technique such as this might present a method for treatment of large volumes of waste which might occur as the result of an accident. In streams you find large amounts of organic matter such as leaves which are derived from the watershed. It is possible that half of the organic matter at the photosynthetic level in the stream is derived from the watershed. (Dis-

cussion) We should determine the quantity of organic matter originating on the watershed and what its role is in the food chain. In effect we would have the budget of photosynthetically produced organic matter in the Clinch River. The allochthonous organic matter is known to concentrate radionuclides. Whether the concentration is due to physical sorption or the metabolism of heterotrophic microorganisms such as bacteria is not known. Some laboratory experiments are being conducted with sterile and non-sterile mixtures of river water and leaf material to separate the physical and biological factors which concentrate radionuclides on the non-living organic matter. There is a great deal of organic matter in the bottom sediments and radionuclides associated with it may enter the food chain through the feeding activities of the bottom-dwelling organisms.

Another phase of the Clinch River studies will deal with biogeochemistry and with particular reference to those elements which are released in the radioactive effluent from the Laboratory. A recent paper in Limnology and Oceanography by Nicholls, Curl, and Bowen from Woods Hole and MIT emphasizes that some elements are actively concentrated or excreted by different organisms. They concluded that each element will be found concentrated by some organism in the spectrum of life. The work will include stable and radiochemistry, the determination of body burdens and eventually uptake and excretion rates. The studies will be associated with work on the food chain. We will be able to find the quantity of the various radionuclides in the biota, which elements are mobile and which are conserved.

Q. Wallen: What exactly do you plan to do?

A. Nelson: Plan to start on photosynthesis this spring and carry it a full year and pick up information on the organic matter coming into the stream and also on chemical nature.

Chairman Struxness said that the previous discussion of past work on the river and the plan for the proposed study leads logically to comments by others as an extra order of business. He called for a discussion of the hydrologic parameters.

Godfrey stated that these had been pretty well covered. He indicated that the level of the program almost rules out any extensive model studies.

Elder said that a statement previously made that there are no drinking water supplies taken from this reservoir is not entirely correct. During low flows in the river the cold Clinch River water will flow upstream along the bottom of the Emory River about 12 miles and find its way into the Harriman water supply intake and, after warming up, will flow back along the surface to the Clinch River.

Parker: The water is monitored at the K-25 plant which has the first downstream water supply taken from Clinch River below ORNL.

Jones: The Kingston water supply is usually from springs, but when the spring flow is inadequate a filter plant with intake on the Tennessee River, a short distance upstream from the mouth of Clinch River, is used to supplement the municipal supply. The Kingston system may be affected when water shortage causes intake from the Tennessee River, because under some conditions there may be an upstream flow of Clinch River water to the Kingston intake.

Kochtitzky substantiated the fact that under these conditions of upstream flow of the Tennessee River, Kingston might use Clinch River water. Furthermore, the Kingston Steam

Plant of TVA has special diversionary facilities to deliver Clinch River water to the plant intake on the Emory River.

Burnett: A possible concern of the agencies represented here is stream pollution control and we have provided that. The amounts released from White Oak Lake bed area are monitored for protection of the public and can be controlled temporarily by closing White Oak Dam.

(The TVA representatives emphasized that reservoir operations do affect river conditions although information may not be quantitative.)

Elder: There are figures available on the effect of Melton Hill Dam. It is proposed to construct Melton Hill Dam on the Clinch River a short distance above the mouth of White Oak Creek. Water released from Norris Dam some 55 miles farther up the river will be reused to generate power at Melton Hill. The starting and stopping of turbines at Melton Hill will be reflected in the flow at White Oak Creek much more quickly than similar operations at Norris in the past. Furthermore, because of the short distance to White Oak Creek the peaks of high and low release will not be flattened as much as flows from Norris were before the construction of this intervening dam.

Belter proposed that Parker summarize what is to be done in the next six months.

Parker recalled meetings two years ago. Summary of work to be done: investigation of literature, determine the most important hydrologic features to be studied, try to determine what would be the most effective way of studying hydrologic effects.

Q. Belter: Do you anticipate compiling this data? What time would be involved?

A. Parker: The program will progress as data is obtained.

Friend asked if TVA data on mixing were adequate and what would be expected of the PHS.

Struxness: As to what ORNL can do for the next six months: We are negotiating for a man to do hydrologic studies which makes it difficult for us to know what we will do on hydrologic aspects, except tie together what we have in our files on the tracer tests.

Auerbach: On biological aspects for next 6 months: Cottrell's report: Applied Health Physics people have measured the activity in the sediment at specified TVA silt ranges. These provide us a useful guide-line in which to start a biological characterization of the river. We have requested our Laboratory management to purchase a large type of laboratory boat, a pontoon type houseboat, in which we can maintain a crew and sampling facilities. We propose, together with Mr. Abee, to start out at these silt ranges and do one silt range a week on three or four ranges or once a month at each silt range. We think by March we could go into the river and start the silt range samples.

Q. Wallen: What do you mean by characterization of the river?

A. Auerbach: Start work to determine the specific radionuclides in the organisms. Abee's group will be collecting samples at various cross sections, which will be additional.

Wallen commented that this omits two important aspects; namely, fish and plankton.

Auerbach said the aid of Tennessee Fish and Game Commission would be enlisted for sampling the fish and the water samples will be collected by Abee's group which will aid in plankton studies.

Abee: Proposal for next six months: Applied Health Physics program will not have facilities for the next 6 months but hope to integrate the two programs in order to make cross section measurements the year round to see how seasonal variations affect bottom sediments.

Struxness: Asked Wallen to comment on the proposal since he seems to feel that it is too ambitious.

Wallen: I have strong objection to the ecology program as written. I do think the objectives are very broad. At Hanford, with ten people, they have been unable to do in five or ten years what is planned here. It will take a lot of people we do not have and it seems the two parts of the program are contradictory. The objectives are too general. We need to rewrite the proposal, be more specific and make it more of a job description. As now written, it would mean that you either hire 5 people or reduce the program to include one person.

Struxness: We recognize the proposal is very broad and very general. In February and March of each year we have to describe the proposed investigation for AEC Form 189 budget submission to be done in the first year and also in the second year. We are not in position at the moment but hope to be in February. I agree it is an idealistic proposal and difficult at the moment for a Steering Committee to have anything to go on. This is one of the most important studies that the Laboratory has ever undertaken. We would like for it to be as thorough and comprehensive as we can make it. We want you to have interest and responsibility to come in and help. I think the agencies represented here should come in, as well as other agencies. With the AEC alone it would flop. We can make adjustments with the money from the AEC. No increases expected in the next two fiscal years. We are not expecting to come to the agencies with too large a proposal. There may be need for additional funds but we will do our level best to justify it.

Belter: There have been certain funds allotted for fiscal year 1960. Referring back to a Steering Committee, we believe it is desirable to select this group now in order that detailed plans for the study can be developed as soon as possible.

Schultz: To get the proposal better lined up, you should bring in the best limnologists and discuss this thing. Six months is not much time if you can get people together and really work together. It is too early to start with samples.

Struxness: I agree that we should lay plans before starting on the river. More fission products have been released to this stream than to any other and less has been done to understand it. We have a situation that is changing. We who are interested in health protection are very much interested in the river program and we must get it underway. As mentioned previously by others, there is need to improve and expand the river monitoring program. The proposed river study will help by providing information and justification for more definitive monitoring.

Friend: I think the Steering Committee should be set up in order to set up the program.

Kochtitzky: A detailed work plan is needed to show respective agencies what time, per-

sonnel and money will be required before they are willing to commit their agencies.

Schoen: I think it should be left to the Steering Committee to draft a work plan and to determine how we would be involved in it.

LUNCH

STATEMENT ON THE HISTORY AND PHILOSOPHY OF LABORATORY OPERATIONS WITH RESPECT TO THE CLINCH RIVER

K. Z. Morgan commented on the recent serious accidents and meetings on the subject. He stated that the field of Health Physics is relatively new. He briefly reviewed the history of Health Physics and the development of the radiation protection committees, specifically the National Committee on Radiation Protection and the International Commission on Radiological Protection. In discussing the history of the White Oak Lake and Clinch River usage by ORNL, Morgan showed how the maximum permissible exposures have been successively reduced over the last 17 years. He emphasized that there is little liklihood that the present maximum permissible concentrations will be increased; rather, the chances are that they will be decreased in the future.

Struxness commented that Morgan's discussion exemplifies why we are concerned about the Clinch River. He suggested that each representative make a statement of the interest and possible participation of his agency. He stated that it would not be a firm committment.

STATEMENTS ON THE INTEREST AND/OR ACTIVE PARTICIPATION OF OTHER AGENCIES IN CLINCH RIVER STUDY PROGRAM

S. Leary Jones: The State of Tennessee is interested and I feel that the study must be made. It is possible in the state program to shift emphasis from what is now being done; for example, from bacterial studies to studies on this objective. Details will come out after the Steering Committee gets underway. Apparently monitoring is being done. I would like to see a certain amount of monitoring start now at Chattanooga. The people are quite concerned about the Strontium 90 that is in the water supply. We have had a number of letters about this problem. They have been difficult to answer because there is no solid basis for assurance that it is perfectly safe. He illustrated how much trouble public concern may cause by reference to a relatively minor incident of pollution by a paper mill which almost forced the company to leave the state. He said he would like to see this program tied in with TVA reservoir operation studies. It is hard to say how this should be set up. This should be correlated with plans developed by the Steering Committee. We have eight people in our group who will be very much interested in this work. We have three biologists and I would like to send one of them (Mulligan) to ORNL to work on this problem.

Struxness: We strongly suspect that the Strontium 90 at Chattanooga does not come from Oak Ridge, but we cannot prove it. Our Laboratory management and the AEC are quite aware of the public relations problem that we may have to face. This is another reason why we must do the best we can to answer the questions that we are sure might be asked.

F. E. Gartrell: We are interested in participating in the proposed study. We would expect that the vast amount of the hydrologic and water quality data accumulated through the years by TVA would be useful both in planning and in carrying out this study. In our studies to date we have not given any attention to the matter of radioactive material.

However, we have felt the need to accumulate radiological data and have some plans to do so. I feel that with a study of this kind getting underway it would be a good time for us to initiate some activities in this field. Participation in the proposed study, in addition to developing staff competency, would provide guide-lines as to the kind of sampling that might need to be done by TVA on a long-term basis and would provide preimpoundage baseline data for the Melton Hill project. The question of the best way to operate TVA reservoirs in the event of an accidental spill has been given a lot of attention, but so far we have not gotten down to specific cases nor have we worked out administrative details that would be involved. We are concerned about radioactive wastes in TVA drinking water supplies which we have responsibility for operating, such as the ones at the Kingston power plant and Watts Bar Dam. We are concerned with effects on fish and game as well as the effects on water quality which might adversely influence future developments in the Valley.

As for participating in a program of this kind, TVA has lots of competence and skills but to what extent we can make them available is something we would have to work out with the various TVA organizations that might be involved. We have a small stream pollution control staff which devotes some time to research. Studies that have been made in the past 2-1/2 years may have applications in the Clinch River study and some of the basic data might be useful. TVA has extensive survey and mapping facilities and hydraulic laboratories. I feel that I certainly would recommend to TVA management that TVA participate in this study. The details of our contribution would have to be worked out later when your work program has been defined. The size of the contribution that we possibly could make might not be very encouraging in undertaking a study of this magnitude.

A. G. Friend: We are very much interested in the project. We have at the present time the funds and the personnel. The budget next year we do not have and what we can do next year I do not know. We are in pretty good shape for the remainder of this fiscal year.

Struxness: Would your participation be on the biological side or equally on the hydrological side?

Friend outlined what was done on the Mohawk River study. He stated that something of that nature could be contributed.

R. G. Godfrey: I cannot speak for the USGS and I am going to ask Mr. Cragwall to make the statement. First, however, I would like to speak of our interest in this program. The USGS has been working with AEC on waste disposal problems. They have been actively participating in a number of programs with various local groups such as KAPL and Savannah River. We have in the past participated in studies here in Tennessee. As far as participating in this study it would have to be worked out with Mr. Cragwall.

J. S. Cragwall: We are very interested in the project and feel we have the skills that will be of assistance to you. We can participate to the extent that funds and manpower are made available. Within these limitations we will cooperate in furnishing hydrologic information and technical skills to the greatest extent possible.

J. E. Munzer: (Regional Radiological Health Consultant, Region IV, speaking for Division of Water Supply and Pollution Control, U.S.P.H.S.) The Division is definitely interested in all types of field work relating to water pollution, and has done many of these in cooperation with State and other Federal agencies, usually in the case of the latter, on

a contract basis. Such surveys have been for a few days duration to several years. With reference to the Water Quality Network stations, one of which is located at Chattanooga, Tennessee, five groups of tests are performed: 1. General Chemical Analysis, 2. Carbon Filter Analysis, 3. Bacteriological Analysis, 4. Plankton Count, 5. Radioactivity. (Results of the first year of operation will be found in Public Health Service Publication No. 663, National Water Quality Network.)

Struxness: TVA and USGS already have information on the hydrological aspects and are definitely interested in this study, especially the USGS. We will look more or less to them for the guidance and actual performance of measurements made on the river. The PHS, plus the Stream Pollution Control Board, as well as the group represented by Mr. Munzer, have almost the same interests as the Health Physics Division. These groups would in some ways enter into the study of biological and radiological determinations. One of the big parts of this study will be analyses. We all agree we need hands and need to get out on the river. We have large and well equipped laboratory and analytical facilities at ORNL.

Morgan: Are you planning to get enough money for this?

Struxness: We must consider this in looking at reality in collection of samples and analyses of samples. We are fooling ourselves if we say we can do this study over a period of 5 years. Someone will have to put out a good sum of money for these analyses.

Friend: PHS has two methods; 1) refined, and, 2) a quick and dirty method, which is cheaper.

Struxness: Another thing that complicates organization in carrying out this cooperative program is that some of us are interested in the practical and some in the scientific aspects. As to responsibilities for source of support, one group might support the biological phases and another support the engineering-hydrologic portion.

Some of you are more concerned about the TVA system from K-25 to some point on downstream. Some of us are more concerned with the stretch immediately below the outfall of White Oak Creek. Over all of us hangs the public relations problem associated with this program. The AEC will have to begin educating the public.

Shoup: Our public information people are aware of this meeting and the plans for a cooperative effort. They are prepared to issue a press release when the program gets into operation.

Struxness: You fellows who are interested hold an important part in orienting and informing your colleagues back home. It is unfortunate that this meeting could not have been held 16 years ago. (Mr. Struxness asked for comments from the attendance concerning the proposal that a Steering Committee composed of representatives from the various participating agencies be appointed to coordinate the overall direction of the river studies. He said that this involved the type of committee, its functions, and procedures of reporting results.)

ORGANIZATION OF CLINCH RIVER RESEARCH STEERING COMMITTEE

Belter: The release of all information should be formal, through the Steering Committee and should be cleared through this group. We should think about who will be the representatives on the committee. Since ORNL has the biggest stake in this program it would seem to me that Struxness would be a logical choice to head up the committee in view of the fact that he heads the ORNL waste disposal and engineering group.

Shoup: It seems that all the agencies participating would be the ones who would be represented on the committee and would have one member from each agency on the committee.

Struxness: I am interested in knowing whether this Steering Committee is an advisory committee or a working committee.

Belter: I think it should be a working committee not just advisory. The representative from each agency would clear with his own group. The committee should make the decisions as to the direction of the program. It is different from a typical river advisory board.

Struxness: It should be a working committee which would see that the work is done. The chairman of the Steering Committee should be at Oak Ridge and would be really the local coordinator of the program.

Gartrell: Due to the fact that you have these various groups under your jurisdiction, it would seem logical that you should be chairman.

Steering Committee members were elected as follows:

E. G. Struxness, Chairman	J. A. Lieberman - ex officio
S. Leary Jones	I. E. Wallen " "
A. G. Friend	A. A. Schoen " "
R. G. Godfrey	
F. E. Gartrell	

Burnett: If this is to be both an advisory and working committee would you need a larger committee?

Struxness: I believe we agree the Steering Committee is large enough to represent the group here. We can start on this basis and may see fit to change it later.

Shoup: Does this mean that alternates may be on the committee for particular problems?

Struxness: On behalf of the AEC and ORNL, we are anxious to have representatives on the Steering Committee who have something to say about this program.

Morton: There should not be alternate members on the committee. If this committee is going to have definite responsibilities, the members must accept their responsibilities for decisions. They can bring their staff support to committee meetings, or accept assignments and work them out themselves in their own group and with their own agency.

Shoup: I think you are right. I used the wrong terminology. Staff support as needed will be the correct means to lend strength to the Committee's work.

The meeting was adjourned at 3:50 PM.

After the meeting was adjourned, the first meeting of the Steering Committee was set up for Thursday and Friday, January 21 and 22, 1960.

ATTENDANCE LIST

USAEC

I. E. Wallen (DBM-ESB - Washington)
Vincent Schultz (DBM-ESB - Washington)
W. G. Belter (DRD - Washington)
C. S. Shoup (ORO - Oak Ridge)
A. A. Schoen (ORO - Oak Ridge)

USGS

R. G. Godfrey (Surface Water Branch - Washington)
E. P. Mathews (" " " Knoxville)
J. S. Cragwall, Jr. (Surface Water Branch - Chattanooga)
B. J. Frederick (Surface Water Branch - Chattanooga)
R. M. Richardson (Ground Water Branch - ORNL)

USPHS

A. G. Friend (Taft Sanitary Eng. Center - Cincinnati)
J. E. Munzer (Regional Office - Atlanta)

TVA

F. E. Gartrell (Health and Safety Div. - Chattanooga)
O. W. Kochtitzky " " " " ")
Rex A. Elder (Norris Lab. - Hydraulic Data Div. - Norris)

Tennessee Stream Pollution Control Board

S. Leary Jones (Nashville)
W. H. Martin (")

ORNL

K. Z. Morgan (Division)
E. G. Struxness (Division)
R. J. Morton (Waste Disposal)
F. L. Parker (" ")
R. L. Bradshaw " ")
S. I. Auerbach (Ecology)
D. J. Nelson (")
H. H. Abee (Applied Health Physics)
T. J. Burnett " " ")

AGENDA

HEALTH PHYSICS DIVISION
OAK RIDGE NATIONAL LABORATORY

MEETING ON CLINCH RIVER RESEARCH PROGRAM
December 18, 1959

Bldg. 2001, Conference Room

Chairman, E. G. Struxness

Time	Title and Speaker
9:30	Introduction
9:35	Statements by Atomic Energy Commission Presentation -- W. G. Belter, Division of Reactor Development (Washington) C. S. Shoup, Biology Branch (Oak Ridge Operations)
10:00	Radioactivity in Silt of the Clinch and Tennessee Rivers -- H. H. Abee, Oak Ridge National Laboratory, Health Physics Division
10:30	Proposed Clinch River Study Program -- F. L. Parker, Oak Ridge National Laboratory, Health Physics Division S. I. Auerbach, Oak Ridge National Laboratory, Health Physics Division D. J. Nelson, Oak Ridge National Laboratory, Health Physics Division
11:15	Discussion of Proposed Clinch River Study Program -- Conference Participants
11:45	Statements on the Interest and/or Active Participation of Other Agencies in Clinch River Study Program -- Leary Jones, Tennessee Stream Pollution Control Board Frank Gartrell, Tennessee Valley Authority Al Friend, U. S. Public Health Service Richard Godfrey, U. S. Geological Survey
12:30	LUNCH
2:00	Statement on the History and Philosophy of Laboratory Operations with Respect to the Clinch River -- K. Z. Morgan, Oak Ridge National Laboratory, Health Physics Director
2:30	Organization of Clinch River Research Steering Committee
3:00	Adjournment

12/18/59

(1)

Purpose of meeting

I more or less general acceptance of ORNL proposal

II attempt to get commitments on interest & possible active participation

II form steering committee

Better

WD & effect on environment (purpose of group)

40% of total budget — environment

30% of total funds in Oak Ridge

Questions

where is the activity going?

how long to get there?

not monitoring!

not stream pollution survey!

Allocation of work with various agencies

conc @ W.O.D. 10^{-5} $\frac{\mu c}{cc}$

" " clinch 10^{-7} - 10^{-8} $\frac{\mu c}{cc}$

Centers Ferry - 7.5×10^{-8} $\frac{\mu c}{cc}$ 1956 - 1958 measured

MPC 2.4×10^{-7} $\frac{\mu c}{cc}$

Nonis ~ 10 cps γ

above WOL 2-4 cps γ

needed

12/18/59

Daily gamma scan of effluent
" " "
& beta determinations of Sr
Chalk River (Opfel) (von)

apt

characterization of biota
productivity
census of biota
synthesis

A A A A A

Dan Nelson —
photosynthesis in Chuck R.
algal productivity
sample once a week

perhaps name not well chosen but mission is not clear

1931 1 r/week MPC
1934-1949 0.5 r/week
1949- 0.3 rems/wk
1956 0.1 rem/wk

Leary Jones - interest of state "Study must be made"

State servants a monitoring system set up daily, weekly, & upstream & downstream

3 biologists - would actually learn more than contribute - (Mulakey)

Frank Gartrell

Hydrologic data & water quality data available

Effect of TVA water control on water quality

no work on R.A.W. will do not

staff competence

Effect of accidents on TVA operations

R.A.W. on TVA water supplies & Fish & game resources

appreciability of Mitchells work to Nelson's work

cal Trieid

very interested

have funds, time equipment

same as on Kaps - Gamma Scan + Sr 90 analysis

Dick Godfrey - SGS

will furnish skills to non extent possible

(bulletin [illegible]

radiological

chemical

carbon filter)

physical & hydrological guidance & measurements
USGS & TVA

other groups would [illegible] TVA, SPCB, AEC
on chemical & Biological State G&F

8/11 Lab — analytical work, sophisticated radio-chemical analysis, —

8

E. G. Struxness
Leary Jones
Al Friend
Dick Godfrey
Frank Gantrell
Joe Lieberman (Ex officio)
Gene Wollan (Ex officio)
Art Schoen (Ex officio)

GB#12

MINUTES

OPEN MEETING - "CLINCH RIVER STUDY" STEERING COMMITTEE

OAK RIDGE NATIONAL LABORATORY
Building 3504-Conference Room
January 21, 1960 - 10:00 AM

Meeting #1

ATTENDANCE LIST

I. E. Wallen - USAEC - DBM-ESB - Washington
W. G. Belter - USAEC - DRD - Washington
A. A. Schoen - USAEC - ORO - Oak Ridge
R. G. Godfrey - USGS - Surface Water Branch - Washington
F. E. Gartrell - TVA - Health and Safety Division - Chattanooga
S. Leary Jones - Tennessee Stream Pollution Control Board - Nashville
Price Wilkins - Tennessee State Fish and Game Commission - Nashville
E. G. Struxness - ORNL - Health Physics Division
R. J. Morton - ORNL - Waste Disposal
Frank Parker - ORNL - Waste Disposal
S. I. Auerbach - ORNL - Ecology
D. J. Nelson - ORNL - Ecology

Chairman Struxness: I passed out to you some material that could be used as a basis for discussing our business along the lines suggested in my letter to you. I characterize this material as the best thoughts we have here at this site, at this time, on; 1) the objectives of the study, and, 2) the work that we should get underway immediately. Where we were uncertain regarding the participation of certain agencies, we ask questions or make suggestions. I would like to open for discussion the material covered on the first sheet--the overall objectives. The subject of overall objectives of this study is now under consideration.

Belter: I want to express the regrets of Al Friend of the Public Health Service for not being able to be here this morning. An allergic reaction to an inoculation necessitated his taking a plane back to Cincinnati. Friend mentioned that his group at Cincinnati is ready to do field work on the Clinch River or the Tennessee River at the direction of the committee and they are ready to start field work within a period of a week, two weeks, or so, depending on just what aspects the committee decides the PHS should do. He would be willing to come down next week with his aquatic biologist, Henderson, and work out details with the Laboratory. We are actually going ahead with the survey program. So whatever phases or aspects the committee decides the PHS should do, they are willing to go to work in the field almost immediately. This is for the record.

Struxness: As you will recognize from these objectives, this study is not a stream pollution survey. I think the committee should recognize this and if there are any questions about this aspect of the study we should discuss them now.

Belter: Much of the information that will be obtained in this survey will be of direct interest to, and bearing on, stream pollution, but it is primarily a research and development project. You will be determining the fate of radioactivity and this information will have interest from a stream pollution standpoint. But the study is not the typical stream pollution survey. It will be much more detailed than that type of a survey.

Struxness: I would like to start the discussion by posing this question to the group. Is there any uncertainty or lack of knowledge regarding the radioactive material in which we are primarily interested? In Item 1 under chemical and physical objectives we refer to the chemical and physical fate of radioactive materials.

Godfrey: Are you referring to specific nuclides or gross radioactivity?

Struxness: We are speaking of gross radioactivity but we are thinking of specific nuclides. We are primarily interested in Strontium-90, Cesium-137, Ruthenium-106, Cobalt-60, and the transuranic alpha-emitting isotopes. However, in relative importance, we think that the transuranics do assume some lower order of priority than the fission products.

Belter: Al Friend of PHS has always mentioned in discussions that the survey should deal with specific nuclides, primarily. In other words, we are interested in the fate of Strontium-90, Cesium-137, Ruthenium-106, in this river system.

Struxness: There is one other element or isotope that we might discuss briefly because of the visits of Gene Wallen and Sam Shoup to Y-12 and K-25. Did you detect any need for concentrating specifically on uranium?

Wallen: I think we could not ignore uranium.

Struxness: I asked the question for another reason. Since our last meeting the people in Y-12 have learned of this proposed study in the Clinch River. Quite independently they have been looking at the industrial wastes released from Y-12, and they were wondering if there should be some coordination or some broadening of our objectives possibly to include in this overall study the problem of chemical wastes released to the east fork of Poplar Creek. This waste includes uranium.

Godfrey: I understand from Phil Mathews that they are also considering coming across the ridge into Bear Creek with some of their waste and that it does contain only chemical waste.

Struxness: Yes. For those of you who are not familiar; Bear Creek drains from this direction back into Poplar Creek and for years they had been releasing, primarily in the east fork of Poplar Creek, these chemical wastes; however, also for years they have located, at the west end of the Y-12 area, storage pits or seepage pits into which they have released chemical wastes containing small concentrations of uranium. I am not familiar with the operation at the present time but I was quite familiar with it a few years back and the type of wastes released to these seepage pits were such that you would expect almost anything to end up in the seepage pits including a good amount of organic solvents, also the concentration of uranium running on the order of 5 ppm. The reason for that is that back in the early days, and even to date, uranium has been considered a very valuable product. The operation in Y-12 is geared to very high recoveries of the material going into the plant and the minimization of material coming out.

Schoen: This is true also at K-25 in that the economics involved in uranium recovery keep uranium releases to a minimum. In most cases, the factors of safety added on by the dictates of the economics are more than adequate to protect against uranium

pollution of streams.

Struxness: The Y-12 production plant was started during the war years under pressure to get into production rapidly, and at one time during the war there were 27,000 employees in the Y-12 plant. Because of routine analyses of the water in this plant as well as analyses of effluents leaving the plant, we found concentrations of the order of 100 ppm of uranium in the sewage treatment plant. We found similar concentrations in the east fork of Poplar Creek. They quickly did a survey of the plant and corrected some of the cross connections and I am sure that since that time they have been alert to such possibilities.

Belter: Under No. 2 of the chemical and physical objectives, would it be possible to make measurements on Poplar Creek, and maybe below K-25, to determine the quantities of waste flows that are being discharged to the Clinch in the same way as curie content will be measured at the outflow of White Oak Creek? Would it be possible perhaps to revise the objectives here to include the measurement of these two potential sources of pollution?

Struxness: In answering that question there are some practical facts that we must consider. The compartmentalization within the Y-12 plant, and similar compartmentalization at K-25, will make coordination with those plants difficult.

Belter: Does the Applied Health Physics group take into consideration these other possible sources of pollution or is their responsibility limited to ORNL wastes?

Parker: They measure total influence upon the main stream. They do not measure outflow from each individual stream itself.

Belter: Would it be desirable for this survey to actually measure the outflow of these creeks?

Struxness: As to whether it is possible to include within the scope of this study a study of the east fork of Poplar Creek, Bear Creek, and so on, the answer is "yes". However, the work would have to be coordinated with another complex organization from which it is difficult to get information because of the security compartmentalization.

Belter: Do you envision any real difficulty in trying to do this Bear Creek and Poplar Creek work as a part of the overall study?

Struxness: There is no difficulty--it is a matter of taking time to brief and confer with the Y-12 and K-25 people.

Godfrey: Frank, you I believe made the statement to the effect that Y-12 does not monitor the east fork of Poplar Creek itself.

Parker: The Laboratory does not.

Godfrey: Does Y-12 monitor east fork?

Struxness: I am quite certain there is a minimum amount of sampling and analysis of the effluent from the Y-12 plant in Poplar Creek. Furthermore, there is some

selective sampling at points upstream from the gaging station within the Y-12 area.

Belter: Would the committee feel it desirable to invite a representative of Y-12 to come to one of these sessions in order to determine their feelings or interest in this program? I feel that the study would be relatively incomplete if such work is not included. I think we ought to have this information on a detailed basis otherwise what we have is strictly White Oak Creek discharge and we leave ourselves open to the question, "what about the other plants in the Oak Ridge area?"

Morton: Mr. Chairman, I happen to know there were seven or eight sampling stations in and around K-25; they have good analytical chemistry labs, and I suspect they still have a sampling program. We never see the data but we probably could obtain and use it if we could show need.

Schoen: They are definitely sampling. The question is whether they are doing this in accordance or in sufficient detail to give us the information we would need to make a thorough evaluation of what contribution the Oak Ridge facilities are making to the river system.

Belter: Are they doing any type of biological sampling?

Struxness: They are not to my knowledge doing any biological sampling. It is primarily water analysis.

Belter: I would be interested in the views of other members of the committee regarding the bringing of some of the other Oak Ridge facility people into these discussions.

Struxness: I would suggest that if we invite Y-12 people we should include in the invitation K-25 staff also. Furthermore, I suspect that these people would want some time to prepare. Therefore, it might be the subject of a later meeting of the committee. Pass it this time and consider taking it up at the next meeting.

Belter: I think we should get the quantitative data and I am wondering how the committee reacts to the suggestion that the chairman should contact both the Y-12 and K-25 people and invite them to present this data in the next quarterly meeting. We could give them time to prepare and also give them the background on this study. The committee could then decide on the application of the program to these plants.

Struxness: From my conversations with the Sanitary Engineer in Y-12, I know now that he would be quite pleased to be invited and present this information. I am quite sure that K-25 would be too.

Belter: Would he represent the feeling of the Y-12 management?

Struxness: Yes. I would like to dismiss further discussion on this particular aspect at this time and say that I will get in touch with both installations and extend this invitation and ask them to give us a prepared statement at the next steering committee meeting.

Struxness: Any other comments now on the objectives, or discussion. Frank, do you have any question about Item No. 4 under chemical and physical?

Gartrell: No, I don't have any question about it. I would just have put that No. 1 if I had been listing.

Belter: The question which concerns you, Dick, is this in cooperation and conjunction with USGS?

Godfrey: Well, the objectives that are listed here under chemical and physical are the same objectives that we are working towards in other studies in other places.

Belter: Do you have any studies right now going on on these objectives on the Clinch or the Tennessee?

Godfrey: Yes, in fact last week we ran some tests on a small tributary to the Clinch in Virginia. It was a rerun of a test we ran last June but the stream had base flow four times as great as we had last June. We were not successful in attempting to rerun the test on the Clinch but the Poplar Creek one was a real good set of data.

Belter: This work that you have done upstream--this wouldn't have any direct relationship or bearing on these studies?

Godfrey: Only in the basic understanding of the mechanisms.

Gartrell: With regard to point 4--the objective is stated, but it seems to me equally important to identify the limitations of this particular stream. There may be some serious limitations on an overall basis that you may have to handle in many ways before you can take into account the detailed way in which this hydrologic system operates. You may identify some limitations and, of course, with most stream pollution control problems of this kind you have to deal with different stream situations--periods of low flow and periods of high temperature in the water; consequently it may be necessary that we concern ourselves with identifying those limitations too.

Struxness: That is of prime interest to ORNL. In management's view this is No. 1.

Gartrell: Then the Melton Hill Dam will regulate the flow of the Clinch at White Oak Creek. The type of operation that you will have at that dam will change what you have now. There would be periods of time when there would be no flow at all at White Oak Creek whereas when you cut Norris off it is a matter of hours before it flows out at the mouth of White Oak Creek. Melton Hill project, however, when you cut it off the flow will be cut off and that's it. When they cut it back on, any waste accumulated in the Clinch River from White Oak Creek will travel as a slug of waste whereas now anything that is carried into the stream is averaged out over a period of 24 hours or so. You may find yourself getting 10, 12, 15 hour accumulation of waste from White Oak Creek and in an operation of 3 or 4 hours at the Melton Hill project you would get this slug of waste moving down rather than having dilution during a period of 24 hours.

Belter: Actually if it was authorized this year it would be at least two years

before operation of this facility and by that time we should have considerable field data on the Clinch, at least the present survey.

Gartrell: These dam constructions begin when they start putting in roads and excavating and then the conditions of the river are going to be disturbed tremendously.

Belter: What is the earliest possible construction date of this project?

Gartrell: It will start this fall.

Belter: This fall. Six months time!

Parker: Representative Baker said ten days after authorization, which could be the tenth of July possibly. Actually that is the reason why we took the general survey as No. 1 on our list--because when they are moving dirt it will be difficult to get a background basis on which to operate in the future.

Belter: A question on the chemical and physical objectives under No. 1, general survey. There is allotted 15 man months in the field. Would all of this be from ORNL or would ORNL provide just the laboratory work? How about the field work?

Parker: The field work also would be ORNL. This would be a combination of the work now being carried out by the Applied Health Physics group, as well as our own group.

Struxness: Walt, you are getting into the second part. I wonder if we now have reached the point where we can pass on the general objectives. I, too, agree with Frank Gartrell's comment on No. 4 and I would like to include that in restating objective No. 4 under chemical and physical for clarifying the report. Can we pass on to the next subject of our discussion?

Gartrell: I would like to make one additional comment. In the earlier discussion there was some mention of possibilities of extrapolating the data to give information that would be of value for estimating the capacity of a stream to a universal basis. I notice there is no reference to that and I think that is good. I would like to see this as a good practical study for achieving the objective, but if you had the other objective in mind--why I think you would be doing quite a different study. I hope the universal facet of it was omitted intentionally, not just through oversight, so it will not come back into the picture later on.

Struxness: We directed our attention to that very specific point, Frank, and this is omitted not by accident. We are now thinking strictly in terms of this stretch of the river.

Gartrell: That's fine. I wanted to be sure of that.

Struxness: The second order of business is to discuss the specific work project and the amount of effort that we will apply in each of these, and consider when such work might begin. As listed in the proposal, we would cover the biological work first. I would now entertain statements or comments from Stanley and Dan in regard to these proposals.

Nelson: This proposal is designed to give us some information on the river as quickly as possible with particular regard to the kinds of organisms present. The proposal is quite general and we will measure only gross gamma activity at this stage. In a specific survey we would measure activity of specific isotopes and do exact radiochemical work. We have had Dr. Morgan list the isotopes that he considered to be of primary importance and they are the ones mentioned a few minutes ago; namely, strontium, cesium, ruthenium, and transuranics. We will have to do a good bit of exploratory work on the detection of transuranics in our biological samples. About the only way we can measure these is by alpha analysis and this is a problem in itself. The advent of Melton Hill Dam is another problem because this is very definitely going to change the characteristics of the river; particularly in the vicinity of the mouth of White Oak Creek. If the dam is approved we might find that we would have to alter Part B on the more specific survey but, in the meantime, I think we could go ahead with Part A and get as much information as we could over the broad stretch of the river and see what developments occur in connection with the dam.

Belter: Question, Dan. Would it be possible to determine radionuclide content of the organisms by gamma analysis?

Nelson: This could be done.

Auerbach: I will just clarify that. Our reason for putting it the way we did was because the gross gamma measurement would give us the quickest and easiest way of locating the radioactive organisms. If we have assistance we could push B-2 up to Part A.

Belter: The reason I mention this is that with respect to assistance, this is an area in which perhaps the USPHS could assist manpowerwise and perform some necessary field work and also, perhaps, some of the laboratory work since they are set up to do multichannel analyses, etc. This is one thing that Friend mentioned before leaving. He made the suggestion that he come down with his aquatic biologist, Henderson, to think in terms of what areas they could serve. Then you can arrive at a decision as to what stations ought to be sampled and they can work very closely with your group and with the Applied Health Physics group to accomplish the field work.

Nelson: Walt, we have a fish survey outlined on the next page. I think it is unfortunate that Al Friend isn't here so we could discuss these specifically, but in any case on this general survey the samples would not be discarded and would be available for future analysis.

Belter: I am just thinking of making more manpower available. In the case of the PHS, perhaps 4 members of a survey team might be assigned to do a fair amount of field work within the next few weeks and to utilize this available manpower under the direction of the Survey staff. I think this is something that the committee might consider as a means of getting the field work started.

Schoen: Are you saying that this 4-man team is ready to get started within two weeks?

Belter: That is what Friend has said. One week is what he indicated at the time

of the last meeting. If the committee decides what should be done, Friend's team is ready to start within one week. They recently completed the field work they were doing at KAPL on the Mohawk River. Since that time they are doing the analytical work in Cincinnati but have reached the stage now where they are ready to go out and do more field work.

Auerbach: Do you, taking your words literally, feel that the PHS group would be amenable to following a pattern of sampling that has biological research implications?

Belter: Very, very much so. Much of the work they did on the Mohawk was biological.

Struxness: My impression of what you say, Walt, is that here immediately we can integrate 4 men into the program.

Belter: Right.

Struxness: They are looking for a good study project?

Belter: That is exactly correct.

Would it be desirable, Ed, to have Stan go up to the map and show where these sampling stations are envisioned at the present time and maybe initiate some discussion on these?

Nelson: As you can see from that outline, I have roughly indicated areas to be sampled. Mile 23 on this map would be at this point and we would want to get one sampling station above here. I have indicated a minimum of one sampling station between Poplar Creek and White Oak Creek. Another sampling site would be between Poplar Creek and the mouth of Emory River. I think it would be advisable to go down the Tennessee River and pick up one station.

Belter: Any thoughts on where this station would be in the Tennessee?

Nelson: Well, I would say as short a distance downstream as conveniently possible to eliminate excessive traveling time. If we had the personnel available, and this is where PHS could assist, I think it would be advisable to go up the Tennessee River and locate one station to get effects of the effluent upon the Tennessee River itself. In addition, another sampling site between Emory River and Poplar Creek and another one between Poplar Creek and White Oak Creek would be useful. This would give us a total of 7 sampling sites. I think these sampling sites should be sampled frequently. I have indicated twice each month. This is on the basis of experience at Hanford where they have found that samples which are not taken regularly are of little value. All you get is an odd reading here or there which is impossible to interpret.

Godfrey: Amen.

Belter: I am wondering, does Leary Jones have anything to suggest at this time on the sampling frequency of twice a month? Would there be any way, Leary, where the Stream Pollution Control Board could help in this sampling program?

Jones: I don't know how much on the actual sampling we are going to help. We've got a small staff and there is no more money for the next year and a half, and there will not be any increase for three and a half years. We will help what we can.

Belter: Is there any possibility, Leary, of integrating into their normal program when they would be in the vicinity perhaps of some of these stations that are on the Tennessee, or of using them for sampling in connection with their regular duties?

Jones: Their regular duties wouldn't cover that area. On the biological work, your problem is not sampling. The major problem is identification of your material. You can sample enough in one day to keep you busy in the lab a month.

Schoen: In that regard you indicated at the last meeting you had some interest in perhaps sending a biologist to ORNL to more or less familiarize himself with the techniques involved and it sounds now like you've got your men all committed to other work.

Jones: Yes, I talked too much last time. As for putting him here full time, we could not. All these new industries are coming in and we are so far behind on those that it would be embarrassing if we published information as to how far behind we are. We will squeeze in all the time we can on the Clinch River Study.

Struxness: I would question about integrating now--Leary's man and the Public Health Service men and others--into the effort here on site. Question directed to you, Stanley. I assume if the PHS group comes down here they have to settle in some locale in the Laboratory or in our facilities. Do you have room, for instance, for four people and the equipment they would bring with them?

Auerbach: Yes, providing they have transportation. We can provide some freezer capacity with the possibility of some increased freezer capacities for storing. One other point pertinent to Mr. Jones' discussion is the fact that our laboratories at Y-12 are in a restricted zone and if there is a possibility that even one of your men will come at infrequent times for periods of a week or so we might consider getting a man under clearance.

Jones: We don't have our biologist cleared.

Struxness: The problem there, Leary, is because that is a different plant. For such a man to plan to spend any time he should be cleared and that takes a minimum of 90 days.

Auerbach: The PHS people have clearance?

Belter: They are all cleared.

Struxness: If these 4 people come next week, I don't know where we would put them.

Auerbach: Some of them would be out in the field.

Belter: They would be out in the field and perhaps staying at the hotel. That has

never been a problem.

Auerbach: We can accommodate them in our place, certainly until summer.

Struxness: Frank, do you have any biologists?

Gartrell: No, but I'll ask whether or not summer biologists could be worked into a program of this kind. We had a young college professor for the past two summers on some other assignments and we might make some arrangements to get him for summer months, providing we can get some money and if he hasn't signed up somewhere else. However, he wouldn't get here until sometime after the first of June and would be due to leave Labor Day. He is a very competent person and he has worked on plankton studies with us. We think quite highly of him and I think he would fit in very well.

Belter: Is he coming in this summer again?

Gartrell: That's right.

Nelson: Could we get some information from some of the routine operations your fish and game people are planning this summer and this winter. We need background information and this would have to come from above Norris Dam in the reservoir. TVA is planning a fish survey on the Clinch River above the Melton Hill Dam site and this would also provide us with some information and specimens of value.

Gartrell: I have talked to our Fish and Game Branch about fish population studies. Their practice is to work with the State fish and game people. They would cooperate on any work that the State fish and game people did. I am sure if you needed some collections in Norris Lake you could probably arrange to get help from our people.

Nelson: One item is that they have this rough fish removal program up there.

Wilkins: Along that line, will one set of fish samples serve for your background material?

Nelson: This would help.

Wilkins: Or do you need to get them monthly also?

Nelson: Ideally it would be nice to get them monthly. I think analysis of a large number of specimens from Norris plus a large number from the Clinch River would be a tremendous job. Statistically this fish problem is going to be very difficult.

Belter: I have a question for Price Wilkins. Is there any possibility of obtaining, shall we say, a biologist from the Game and Fish Commission, for limited service who could actively participate in this program either during the summer or during any other time?

Wilkins: There is always a possibility but we are in much the same position as Leary. We only have two men in all of East Tennessee. One is assigned to this district. He would be able to come in at times to help with a fishery survey, especially if it were extensive enough to require extra men, extra gear, extra boats.

I am sure we could work that out.

Jones: Price, how about your conservation officers. Could they help with fish collection? I know they are tied up day and night on law enforcement but heretofore you have been able to pull them off for a day at a time and they usually have the boat equipment and usually know where the fish are.

Wilkins: That would be especially true in low backwater on Watts Bar. They could provide at least boats in that area.

Jones: One of our troubles in the State is that we are up to our ears in routine enforcement. We have no research program although the law says we can set up research studies.

Auerbach: I think the committee should consider postponing the fish survey until later because it will be the major biological engineering operation of this survey. Several hundred fish would have to be butchered, filleted, and digested in hot acid. It is an operation of considerable magnitude.

Struxness: Should the committee consider asking the PHS and the Fish and Game Commission to take this on as a package? They organize it, they conduct it, and we will concentrate our efforts on the bottom fauna survey?

Belter: This would be for all stretches of the river--upstream, downstream--the Tennessee, the Clinch?

Wilkins: I don't think you can count on that much Game and Fish participation, on a routine monthly basis. If you have something big coming up, such that you need one extensive set of samples, I am sure we can pull enough men in to help to get those, but to have this thing recurring monthly would just take more time than we are prepared to give.

Schoen: It would seem to me that what might be done is to use the Public Health Service in the fish study and to plan the sort of sampling that is necessary to elicit the information needed for the study, particularly with 4 people from PHS being available now to start work. Since these people are available now it would be a shame to forego this opportunity to get started even on a limited basis.

Auerbach: I suggest that the PHS come on down. We would work out a bottom sampling program while they were here getting fish samples.

Wilkins: Are you thinking in terms of specimens of all Tennessee River species or two or three representative species?

Struxness: Of course, Nelson never did get a chance to answer that question.

Nelson: I think we should investigate all species and perhaps give particular attention to game fish.

Wilkins: In other words we should begin with the more representative animals.

Nelson: That is true. We should know the species of fish in the stretches of the

Clinch River.

Auerbach: I am concerned that the number of fish samples being discussed is getting beyond our capacity for radioanalysis. In bringing up the fish survey in the first place, from our own biological point of view, we have mentioned it not because we feel in a position to do any biological work with fish populations--it is a tremendous job and Fish and Game and fishery research groups have been working on the biological aspects of fish populations for many years. The importance of the fish survey is related to the immediate radiation hazard. For this reason we put it in the program as a separate but related study, not necessarily a part of the biological program that we have proposed for the next year.

NOTE: Following this statement there was considerable discussion on the various technical aspects of the frequency of fish sampling, sample preparation, methods of radioanalysis, and time required to obtain significant radioactivity measurements.

Struxness: Well, I think we have a pretty good idea of at least the scope of the proposed biological work.

Belter: Before you leave this subject on the fish survey maybe we should get in contact with Friend and relate to him our discussion and also the suggestions on the frequency of sampling and have Friend come down here next week and discuss it in detail with Auerbach and Nelson. See what Friend and his biologists think about this and how they can fit this work into their program.

Struxness: Maybe they could get started on this study this first quarter of 1960.

Auerbach: Walt, I gather from what you say that the PHS is going to be in a position to work this team in FY 1961.

Belter: Right now they are primarily concerned about the last of fiscal '60. What we want to make sure of now is that they are utilized in the last five months or so of this fiscal year. We are hopeful, as far as the next fiscal year is concerned, that they will continue but this is not finalized at all at this stage. In the last five months they are definitely available and might think in terms of getting two quarters of data, if that meets with the committee's approval. I would suggest that the PHS fellows get together with Stan and Dan of Health Physics, State Fish and Game Department, and TVA Fish and Game. It is desirable to get a program that can be outlined, at least on the fish survey.

Struxness: Now in view of the passing time, I think we should get on to the discussion of the chemical and physical part of this study. The proposed scope is included on the last sheet of this proposal.

Belter: Before you leave the general survey of bottom organisms, is there any part of this work here that perhaps either the Public Health Service or the Stream Pollution Control Board could assist in?

Auerbach: Certainly, in the general survey.

Belter: This is the other item I want us to mention to them. They can also assist

in this area.

Auerbach: The bottom survey is planned to be done the rest of this fiscal year and will be our main effort the rest of the year.

Struxness: This is the main effort of the ORNL staff. Any work that these folks do should be more or less under the direction of and coordinated with the ORNL effort.

Belter: My point and idea is that perhaps the ORNL effort could only just cover a certain part of the Clinch and maybe is not going to go further downstream than the Tennessee. Perhaps the PHS could do work at the same time that ORNL is working in the Clinch. I think this is another item that could be decided in a discussion with Stan and Dan. I want to make sure that Friend is apprised of this work listed under Roman numeral I. There might be some possibilities here for them in addition to the fish survey.

Nelson: They could help and also do some gamma analyses for us.

Belter: Friend is primarily interested in gamma analyses.

Auerbach: Would this also be in the next fiscal year?

Belter: Yes. This is fine, Stan. There are two good general research areas here. The general survey part and the fish survey part where the PHS can be started.

Nelson: I should mention there is nothing in the proposal on plankton.

Belter: I have a question on that, too. This plankton work may be another area where they (PHS) can assist. They actually collect samples of sediments and plankton. They could be working for Frank in addition to your group.

Struxness: Shall we then get on to the discussion of the proposal on the last page--the chemical and physical work of the study?

Parker: There are two reasons for doing the general survey. First, we need a background measurement of what is actually in the Clinch now if we want to develop a materials balance. We are interested in the contamination that goes into the river and what happens to it once it gets there and how it passes on downstream. Second, if Melton Hill Dam does go in then it is likely it will upset the whole system and will cover a good deal of the bottom sediment with new sediment. If we do not complete this general survey before that happens--once that does occur we will have, essentially, a fresh, new stream at the bottom to start out with. There will not be very much to start working on in the river, as there will be so much sediment going down the stream. Before the actual general survey starts we might want to get out and make measurements of some of the more active river cross-sections to establish a statistical analysis and determine how many stations will be required to distinguish between sediments at the surface and below the surface. This should all be done before the general survey, so that at the time of the general survey we will be able to proceed directly down the stream. Having the general survey, if we then can determine what goes out of White Oak Creek (discharges from K-25 in the past have been very low) we will be able to start the

preparation of a materials balance. The general survey will enable us to set up a number of cross-sections downstream to measure the movement of the radioactivity out of this reach of the river. It may be possible to just have one at the end of the reach. I think from our point of view we will look primarily at the Clinch and Emory River. A good place for the Public Health Service men would be on the Tennessee River as the public health significance would be there. To make the most of all this data and the data that is already available, we of course would need to have velocity and temperature profiles of the river system. This is one of the things that we measured last summer with the Health Physics fellows and the assistance of the USGS. They helped train these fellows and gave them experience on what it is like to run a river survey--experience in running the temperature probes and the velocity gages at the same time that we ran the radiation probes with the result that we have good background information a short distance downstream from White Oak Creek. We would like to extend this, of course, to the whole river and we hope that this would then allow us to make full use of the data that is already in the files on the activity from the bottom sediments. A good deal more analysis could be done on the information in the files of the Applied Health Physics group, but we need this sort of information to do it. We hope the USGS will be able to cooperate in that effort. Then finally we want to get on to a research type program to determine where and how the material is taken up by the sediments. To do that we propose to go upstream and take some bottom sediment and suspended sediment samples and run a series of trial tests with actual wastes and with some of the pure isotopes and eventually run those in a flume and determine the rates of uptake as well. We hope that we can get some assistance from the USGS on the determination of the type of clay minerals, ion exchange capacity, and that sort of thing.

Godfrey: Which group are you thinking of?

Parker: The Petrography and Geochemistry Branch. The other part would be Surface Water Branch for temperature and velocity measurements. That in a nutshell is about what we hope we can accomplish in the next year and a half; providing we have assistance, primarily from USGS. I think that the work that the PHS could do on the Tennessee River would tie in very neatly with the materials balance work that we could do on the Clinch and the Emory. I think it would also relieve the minds of the people down in Chattanooga, too, if they were working down there as well.

Belter: When you say on the Tennessee, Frank, do you mean strictly on the sediments and biota or also the water?

Parker: Water as well. We'll be doing water samples during the general survey. When coming to Part III, preparing the materials balance of the activity, I think we will find that the major amounts of activity do move in the sediments and we can cut down on the water samples and depend a good deal on the sediment samples. That is prejudging what we hope to find out in the general survey. There is not very much more we can do about the water except measure it. This will tie in with the Applied Physics program. We will use, at least at the start, the same cross-sections that Applied Health Physics people have been using up to now, so we shall be able to have some correlation with all the data that is in the files. After an analysis of the general survey has been completed, we may want to change some of our stations. In that case they may want to change some of theirs, too.

Belter: Have you thought, Frank, about the frequency of the sampling program? Much of what Applied Health Physics has done especially on silt has been done on an annual basis. What are you thinking of here--on a quarterly basis or monthly to begin with?

Parker: To begin with it will most likely be summertime before we can do the general survey. That will take, say, all summer just getting the general survey completed. To determine a materials balance, I would say monthly would be about the minimum for taking the suspended and bottom sediment samples. If the general survey should work out well then we could reduce the number of samples we would have to take and might only have to take one cross section.

Belter: Did I understand you right, Frank, that as far as the general survey is concerned it wouldn't start until this coming summer?

Parker: Well, preparations for this have already started but preliminary work must be done to decide the type of samples that must be taken in the general survey.

Belter: What I was wondering about was samples for this quarter. Might we not attempt to suggest any frequency but try to take so many during this next three months in conjunction with the Applied Health Physics routine sampling program.

Parker: There is no routine sampling program on the river now except water samples taken at Center's Ferry. I think it is really a question of equipment and manpower. I can't see going up there and taking samples just to be taking samples.

Belter: That is right. I agree with you on that.

Parker: Whereas, if we do this preliminary study for the general survey we will have some idea where the places are and the type of samples that are to be taken. Until we do that I don't know how valuable samples would be.

Godfrey: We've got whole buildings full of meaningless samples.

Parker: That's right.

Belter: Well, Frank, how about the number II item as far as taking samples from White Oak Creek?

Parker: I would say a minimum of once a week, compositing daily samples and measuring once a week. This is very dependent at the present time on the reconstruction of the White Oak Dam which is in progress. Because of the accidents here it has not been completed though it was scheduled for completion by this time. Until that is done there isn't any point in trying to get the materials balance because we're not sure of the flow.

Belter: When do you anticipate, hope, or expect to get this started?

Parker: Which one?

Belter: This number II part. Will that be next summer, too?

Parker: Why, as soon as the dam is completed which should be rather soon I should think. We can start that right away.

Godfrey: I have a couple of questions for Parker or Gartrell, I'm not sure at this point. I have never seen any data about how the suspended silt load varies with discharge in the Clinch. I'm sure that there is a hydrograph which says when the water discharge is increased somewhere in the neighborhood of ten-fold. The sediment at the same time will go up perhaps one hundred-fold. Are you going to try and do sampling over a range of discharge?

Parker: Well, we hope to do at least quarterly the bottom sediments on this materials balance and, because of the way TVA operates their reservoirs, in a sense we will be at different stages during these periods of time.

Gartrell: I think this will vary with the season. Some of the things will vary slowly and there will be very little change when we're using water that will have been stored for several months in Norris. In the wintertime with Norris low and when between floods, then you have an increased silt load. I don't know specifically what kind of data we have, but I'm sure (I'm like you--I've got a building full of samples) we could find out quite easily what is available along that line.

Godfrey: I know it is a complicated situation with Norris and its seasonal pattern and of course this is trapping a good portion of the sediment. It looks to me like there would be more in wintertime when Norris is pulled down. There will be more suspended sediment available.

Gartrell: Well, Norris gets muddy in the wintertime. It freezes up there in Norris Lake just like any river lake in the wintertime, but in the summertime it is nearly always clear. I'm sure that Dan ought to be able to get enough information of that kind and we can probably add some, too.

Jones: We should have an indication of that at the Clinton water plant. They ought to be running daily turbidities. I say "ought" because I'm not sure. A turbidity would not necessarily be sediment, but it should be an indication and there is a gage somewhere near there which could be tied in with the silt load.

Parker: I think, of course, we'll want to get together with the TVA people that have had lots of experience on measuring sediment before we get very far along. I think the USGS has also contributed a great deal on the movement of sediments and silt.

Gartrell: On this item IV, I asked Rex Elder for any information we might have on temperature and velocity distribution in the channel and in this same section of the river that I referred to, from the mouth up to K-25. He says that they have velocities and temperature distribution data for wide means of flow conditions for different seasons of the year and the data hasn't been worked up in final reports in forms to be distributed, but you would be welcome to use all the data but to actually work it up would take several man-months. I imagine it would take about the number of man-months you have here to do the total job but he does have lots of information of that type. It might be that he has already done field work for this phase.

Godfrey: Frank, did you say that was just up to K-25?

Gartrell: That is as far as we may have to cover because all the data we could possibly use is from K-25 on down.

Belter: Maybe, Dick, you could check with your Geochemistry and Petrography Branch. Seems to me they are doing some sediment studies but I don't know where it is.

Godfrey: At Colorado State University. There are two programs that are concerned with what Frank is driving at here. I'm sure that the Geochemistry people in Washington and also perhaps Parker and John Heim and his crew in Denver would be interested. They have been working in this area. Whether they have touched upon exactly what Frank is interested in or not is something I'll have to find out.

Belter: I do think this would be worth following up on, Dick.

Well, Frank, what do you think you will be doing in the next two or so months?

Parker: Two things. One would be preparing the equipment for the general survey and the second, getting out on the river and taking enough samples to determine exactly what samples we will take on this general survey. For instance the question of whether we can composite mud samples all the way across the river, which is what is being done now. They take several samples at each cross-section and make a composite and measure only the composite. I think this should be tested to see whether this is actually a legitimate operation. I'm sure it is good enough for the monitoring information they need, but for the materials balance we might want to make sure that it is actually the preferred way to do it. We would also want to check to see whether we should weight the channel samples more than we should weight the ones at the edges along the same cross-section. I also question where the samples should be taken. Right now they are taken by an Eckman mud sampler. We might actually want to use a coring device to see whether better samples can be obtained in that manner and perhaps shear them off at different levels and measure the activity. I think this is the sort of information we should develop in the next couple of months at the same time we are working to get equipment. Stan and Dan are hoping to buy a boat and we hope that we can get that equipped and any other equipment needed for work during the summer. I think all we can expect to do in the next couple of months is to find that information and get the lab set up to handle some samples when we get them.

Godfrey: I might say that Phil Mathews and Joe Cragwall would be very happy to work with you in helping to get whatever equipment you need.

Parker: Actually most of the stuff that the USGS uses seems to be homemade.

Godfrey: Yes, nobody else wants it.

Parker: Phil also mentioned his department has a fancy, new temperature measuring device.

Godfrey: We could round up some more of those if needed on a short term loan basis.

Belter: I have one more question for Frank Gartrell. What do you think, Frank, about your agency's participation in the study? You will be supplying Parker with

all the available velocity and temperature profile data that you have up to K-25, and possibly a biology professor for the summer who may come to work on this program?

Gartrell: That is a possibility. And if you get the sampling program refined, possibly the sanitary engineering staff would be able to assist in the sampling program. But until we know exactly what the sampling program is going to be, I'm not in much of a position to promise any further.

Belter: When you say sampling program are you thinking about Leary's suggestion of once a quarter fish survey or would there be any possibility of manpower?

Gartrell: I think that possibly TVA Fish and Game would help with that, but I had in mind either the sampling program that Frank was talking about which would interest the Stream Pollution Control staff, or the transport of radioactive materials through the river system. We're interested in the portion that is transported in solution in the water and also that which is transported in silt. Having that interest I think that the Stream Pollution Control staff will perhaps be interested with that stage of the sampling. It might be that they would want to include some sampling even on beyond Watt's Bar further downstream, but I'm sure that they would be interested in the early stages of the sampling up in the Clinch and getting the sampling procedures worked out and deciding what is the best way to do the sampling. They might later on extend the sampling on their streams.

Parker: They certainly have had much experience in this field which we haven't. Of course we would like to work closely with them to establish our program.

Belter: Well, that is three potential areas where TVA could participate or cooperate in the study.

Gartrell: I think there is another way they could be helpful and that is in getting the long term forecasts as to what the flow conditions are likely to be within the next weeks or months, and you might be guided in the rates of sampling by the forecast of the operating conditions. The sampling might be in a period when they are having little or no flow from Norris Dam. (Laughter) You need to have some idea of what flow conditions are likely to be if you want to get some different samples, because you certainly don't want to sample in identical conditions several times. That would just be a matter of providing you forecast information.

Belter: One other question we could ask Price Wilkins; is there any other area, after all these discussions we have had so far, where the Game and Fish Commission could enter into this program aside from perhaps supplying some manpower on a one- or two-day basis per quarter? Is this suggestion favorable to your group or do you see any other areas where you might perhaps enter into this program?

Wilkins: It would be better if someone with more authority than I have were here to answer that question, but in general I would say that once you have established your work routine and know what day you want to collect, you know what your minimum standards are, then, if you want to come back and ask that question again, it may very well be that we can help. But right now you may be putting me in a position of asking me how I would run your project. After you have started then come back to us and see where we can be of some help.

Belter: I'm sure you realize at this stage that it is too much of a general run into this thing. Much of this initial work is more of a probing nature, general survey type. Frank Parker has mentioned here and Stan, too, much of the beginning work is really a general survey in nature and you have to do this first before you can think in terms of what specific directions you want to go in the program.

Godfrey: I have a question, Frank. On your data necessary for your materials balance on the Clinch, do you have any idea as yet what frequency of operation you will need to have?

Parker: I would think it would turn out to be mostly sediment carrying most of the activity downstream, which information we hope to develop during the general survey. If this is the case, I think that perhaps once a month--or once a week would be actually what would be required. I believe this would be another thing to be considered. We will try it in the field and see what works out best.

Godfrey: I have some reservations about the sediment carrying all the activity.

Gartrell: I have been thinking the same thing.

Parker: For one thing, the volume of water is a factor.

Godfrey: Actually there is very little sediment in the Clinch, particularly upstream.

Gartrell: Very limited. If you want to put it on a pound per pound basis it is a very small proportion of the mass going down the river.

Parker: The uptake qualities of silt is phenomenal, and if you try jar tests or even if you make it in the field you find that the amount taken up is just enormous.

Godfrey: This is true. This is why I'm not going to make any bald statements. I'll just keep my little reservations right over here in the corner.

Parker: As I said previously, I am prejudging this. It all depends upon the general survey to help us find this information.

Belter: One other general question I have. About two or three months ago when discussion was being initiated there was some mention made of the existing reports that were either in the process of preparation or some which were coming out like Gartrell's silt study report and the question then was whether there were any actual Applied Health Physics reports coming out from this routine monitoring data. I understand much of it has been filed. I believe there was some indication that some of these reports might actually be published. I was going to raise the question--have any things developed in the last month or so which would indicate whether some of these reports are about ready to come out? I think we asked Frank Parker the same thing, if some of these tracer study reports, which I guess you have two in various stages of production right now, how do those stand, Frank? Maybe Stan or Ed can answer the other question.

Parker: The data from the tracer tests is all worked up. The question now is interpreting and writing it up. I think we can include this in one report because

these summer tests were qualitative and not quantitative. Actually it lends some additional bearing to the tracer test--I think they should put in this report.

Struxness: I can answer the second part of your question. The Applied Health Physics Section has been requested by AEC to prepare for distribution on the standard distribution lists an annual Applied Health Physics report. The report for 1958 is about ready and may even now be in Reproduction. The report for 1959 is also well along toward completion but I checked on it a day or two ago and because of the recent accidents they haven't been able to do a thing recently.

Belter: The reason for my question on this is perhaps utilization by the committee members and their various agencies of the reports planning.

Schoen: Much of the environmental monitoring data is published in an unclassified form. In many cases, of course, in production plants the environmental monitoring data was included in the operational monthly report. Much of this operational information is classified.

Belter: McCone's presentation last spring to the National Press Club Association in Washington D.C., where he made the statement that all the environmental data as far as AEC installations were concerned, should be disseminated to the public--this is more or less one of the follow-ups of scientific information. It has been initiated more or less, at least the fallout data has been issued in three quarterly reports up till now. And now Dr. Western is coming out with one in which is summarized all environmental data and fallout data. Environmental monitoring data is published more or less on a routine quarterly basis. This is disseminated locally. Leary Jones indicated the possibility of participating in this fish survey thing--one or two days once a quarter or something like that. Another thing I was thinking of--the possibility of one of your biologists or so working into this program somehow or another, again depending on whether you can spare a man to work with Dan Nelson. Seems to me he would be very useful. How long a period? What time--summertime or what?

Jones: It is hard to comment on something that occurs once a quarter. We can afford enough personnel to handle that as long as we know as much as a month ahead. It is this routine week-in and week-out business that is complicated, and I will do some figuring. We want to be in on it. We want to help as much as we can on this. Tying one up for six months, we can't do it.

Belter: What I'm wondering about is the possibility like Frank Parker mentioned a moment ago--maybe the work will be intensified this summer. There might be a place here where one or two people from the State Health Department or from the Stream Pollution group could work with Frank's group on some of this general survey work.

Jones: Summer is our worst time.

Struxness: We have a problem in summer, too, of providing space and facilities for the summer research participants. Also the activity of the ecological section is intensified. It could be a real problem for Auerbach, too. Our problem is just to find a place to put them if they get here. In September they return to their home stations and we do have room.

Wilkins: If you decide that quarterly fish samples are enough and will be what you need, we will tentatively schedule a man. I'm sure we can and Fish and Game in TVA can--that will give you at least four, probably over a two day period.

Godfrey: I want to ask Frank another question about this. As you well know, Frank, there is quite a little effort involved in getting a number of temperature and velocity profiles. You were thinking of about how many sections and were you thinking over a range of conditions to fill in what TVA might not have?

Parker: I was thinking particularly of our quarters at a number of representative stations taking the profiles--and there you would have high and low condition for the year every time we got the samples. This would be information we would have to use to fill in with information we have on file.

Godfrey: Were you thinking of the areas--have you given any thought to the areas of species that are not affected by the density current from Norris Dam that Rex Elder was talking about last time, and installing these temperature gages?

Jones: I want to refer again to this general survey. The reason I'm asking specific questions is that I have to go back and explain the program to our biologist. You need manpower on that?

Nelson: Yes.

Jones: When you collect your bottom samples will you identify each of the bottom organisms? Separate those and then take them in and measure radioactivity?

Nelson: This would be the idea.

Jones: Could that material be sorted away from here and then be sent back?

Nelson: There is no reason why it couldn't be handled in that fashion.

Jones: How important is shipping time?

Nelson: I am concerned about sorting and handling organisms. We will be dealing with species which ingest mud and silt. This being the case the silt in the digestive tract will tend to be radioactive. I think it would be desirable to allow these organisms to clear their guts of anything of this nature, otherwise we will not know whether we are measuring the radioactivity of tissue and organs or gut contents. Consequently we would take the samples, sort the organisms as quickly as possible, let them clear their digestive tract, kill and preserve the bodies, and preserve the liquid and the organisms for radioanalysis.

Jones: Samples collected will arrive in Nashville by next morning by bus. You are going to have to keep the animals alive until then. Will we run into a problem on shipping that you wouldn't have in a lab?

Nelson: I am not sure but I believe we could hold them in the refrigerator until the next day and sort them. This is a problem.

Jones: At this stage you have to take it point by point. We will explore this

aspect when I get back. We could do the sorting more cheaply in Nashville.

TVA, during this period, will hold a constant flow of water.

Wilkins: You mean it is constantly fluctuating? (Laughter)

Belter: Well, I think, Ed, that pretty well summarizes most of the agencies' comments and suggestions where they might be able to aid in the program. I guess, Dick, you probably want to check with the G and P people on number V.

Godfrey: And see what possible help we could get from the members. Joe and Phil have indicated their willingness to cooperate trying to get this on paper. That will be on number IV.

Belter: I think that about covers all the groups. I think it extremely unfortunate that Friend couldn't be here.

Jones: But they contributed.

Gartrell: Yes. They contribute the river and we the manpower. (Laughter)

Belter: Well, we've already discussed everything two or three times mostly trying to get this manpower operating out in the field. He said again today just before he left for the airport that from that standpoint I should just pass a little information on so that they can see results as far as next week is concerned.

Jones: Maybe what we ought to do is get this map out, work up an outline and say this is what we decided you are supposed to do. He might be able to do it. (Laughter)

Struxness: I suggest that we have sat long enough for one day. We seem to have all of the ideas pertinent to the proposal. I suggest that we break up and you can go back to the hotel and recover some of your energy for the evening.

Belter: Unless Stan, Dan, or Gene--do you have anything else?

Struxness: We'll be back here at nine o'clock in the morning and we can leave everything here as is.

Meeting adjourned at 3:30 PM

MINUTES

EXECUTIVE MEETING - "CLINCH RIVER STUDY" STEERING COMMITTEE

OAK RIDGE NATIONAL LABORATORY
Building 3504-Conference Room
January 21, 1960 - 3:45 PM

ATTENDANCE LIST

I. E. Wallen - USAEC - DBM-ESB - Washington
W. G. Belter - USAEC - DRD - Washington
A. A. Schoen - USAEC - ORO - Oak Ridge
R. G. Godfrey - USGS - Surface Water Branch - Washington
F. E. Gartrell - TVA - Health and Safety Division - Chattanooga
S. Leary Jones - Tennessee Stream Pollution Control Board - Nashville
E. G. Struxness - ORNL - Health Physics Division
R. J. Morton - ORNL - Waste Disposal

Struxness: For the sake of our record, I will identify this tape as the executive session of the first Steering Committee Meeting. I would like to summarize the discussions as I see them and proceed from there to the main emphasis of our meeting earlier today. First of all, we seem to be in agreement on the objectives of the Clinch River Study. Secondly, we are in general agreement as to the nature and extent of the initial work leading to a generalized characterization of the river. Thirdly, the main uncertainty stems from problems having to do with money and manpower.

From the point of view of the Laboratory, we will have two full time professionals on the river study: Frank Parker, Dan Nelson. We have already assigned one technician, Ed Eastwood. He will work as directed, either in the laboratory or out on the river, for Frank Parker. He has had fifteen years of experience with TVA in work of this sort. He is a very conscientious, very capable, hard-working technician. These are the only ORNL permanent assignees.

In addition, we have the equivalent of eight-tenths of a man-year in the Applied Health Physics Section. I want it clearly understood what this eight-tenths man-year really constitutes. It is this. In the summer seasons past, the Applied Health Physics Section has had three men on the river to conduct the annual bottom survey--to collect the samples, prepare the water and the sediment samples for analysis, and work up the data taken on this annual survey of the river. This work is summarized in the Cottrell report.

One further fact regarding ORNL personnel. We are still interested in employing Nick Matalas of the USGS. We missed on the first offer of employment, but there will be a second offer and there is some chance that we may succeed. If we are successful, I doubt that he will get here much before June or July. If we are not successful in getting Nick, we have in mind one or two others we will try to get. We will try to get a man who is well qualified for this particular study.

In addition to these permanent Health Physics Division staff members, we have an unknown amount of manpower support in the Analytical Chemistry Division. I'm hard pressed at this time to total this up and give an exact number, but it could

represent something on the order of two man-years or three man-years.

Schoen: Do you mean having available two or three people each week on a rotating basis all during the summer?

Struxness: In the Analytical Chemistry Division we keep one man, one analyst, busy preparing the samples. That represents one man-year of effort and, in addition, these prepared samples are then routed to the laboratory and analyzed.

That constitutes a hard look at the manpower at ORNL. At the moment we have no money to support more men than those I have named. As it appears today, it is not likely that we will get much support from cooperating agencies other than PHS.

Morton: Mr. Chairman, you did not mention Stanley's group in terms of manpower.

Struxness: I named Dan Nelson. At the moment we don't have a supporting technician for Dan Nelson, and I don't want to imply that we even have the money to support one. I'm being just as practical as I can in respect to manpower. My impression is that the manpower to do what we have set out to do will require more manpower than ORNL has to offer at the present time.

Wallen: How much time will Eastwood have to give to this?

Struxness: Full time.

Belter: One question, Ed. I mentioned to you at noon the possibility of Applied Health Physics needing more people to do the job that ought to be done, that needs to be done as far as this study is concerned. If it could be put down on paper--maybe a half a man-year or another man-year--the committee can decide what they should be doing. I'm not saying that there is a possibility of getting funds to support this, but at least it is worthwhile exploring. Maybe there is a possibility of reshuffling money from the 4,000 program to do it.

Struxness: I'd like to talk to that point for a moment. At our first meeting I was quite concerned about Leary's statement. He said or implied that what we were doing on a routine basis wasn't even a minimum monitoring program. I discussed this with the Applied Health Physics people after the meeting and they, too, agreed that this was perhaps true. We, in the course of these discussions, concluded that to improve the routine monitoring program, would perhaps require two more man-years, two man-years in addition to the present eight-tenths man-year effort. This meant that we had to supply this out of our Waste Disposal funds (4000 program) or we would have to go to the AEC to get additional money. I mention this, Walt, so that Leary understands we did listen to his statement last month and we have thought about it. We must have something on the order of thirty to thirty-five thousand dollars to build this minimum monitoring program up to where it should be.

Belter: What would you say--two more man-years or two man-years total?

Struxness: Two man-years total.

Belter: They've got about .8; we need another 1.2 man-years effort.

Struxness: They tell me that this amounts to thirty to thirty-five thousand dollars.

Belter: Another question, Ed. Have they mentioned specifically how this effort would be directed if this manpower were made available? In what areas would they increase emphasis? Would this mean the bottom sediment study would still be an annual affair or might they try and do it quarterly? What other areas were they thinking of perhaps expanding?

Struxness: They feel that this annual survey of the river bottom is necessary. They would like to continue it. They don't want to interrupt it, particularly this year, because the Laboratory has released more activity to the river in the last six months than is normal.

Belter: Yes. I wasn't thinking, Ed, of interrupting it. I was just thinking in terms of increasing frequency.

Struxness: They agree to the suggestion that they should do more about sampling river water. They want to extend the water sampling and improve the analysis techniques as well. They also believe that they should be doing more extensive work on the river bottom through this stretch of the Clinch.

Belter: Is the paper work, Ed, going through on this thing? I mean for the request for additional funds.

Struxness: We've talked about that and find that this is part of a big package. So, after this meeting or the next several meetings, when we get a clearer picture of exactly what manpower ORNL has or should have and what money they have, then we will submit the whole package to AEC in a program letter. We do not want to pull this item out as something separate.

Belter: Actually, Ed, I was thinking that if we wait until the next meeting, you realize we are getting into the last quarter. For all practical purposes this will be something you would perhaps think of in terms of '61 rather than '60, because anything that is submitted in April or May, by the time the paper work is actually through, leaves little or no time for actual work. That is why I asked whether there was any request going through at the present time; if something was being submitted in conjunction with the Mid-year Review, there might be time for at least three or four months of work.

Struxness: Well, we might in the remainder of this fiscal year make some internal adjustments--look now at our financial plans and our operating expenses.

Belter: This is the thing I would like to encourage, Ed, if possible, getting the Applied Health Physics to think in term of "R" and "D" work, not just routine monitoring.

Schoen: Applied Health Physics is an overhead function and the cost of this operation is a question for the entire Laboratory, so we would never see this.

Struxness: Remember, I'm under instructions from the Laboratory Director, too. He wants to see the whole program proposal--costs and manpower. I can say that our

Laboratory Director and Assistant Laboratory Director are very interested in this project purely from a research point of view. They are equally interested from the point of view of public relations and sound practices, so they want to evaluate the whole proposal. They are waiting to see how this whole program shapes up. If I were to go to the policy committee now with a request to hire two technicians, I wouldn't get to first base. They would say, let's wait and see the whole thing.

Schoen: I was merely using this discussion to point out that any additional funds which might be used to support specific individuals could easily be assigned to this organization rather than Applied Health Physics.

Struxness: Yes. We would be paying the salaries of these two people in the Applied Health Physics Section.

Schoen: Right.

Belter: This is okay. This would actually mean there would be two more people in Applied Health Physics that would be working on this enlarged program, working more on this "R" and "D" basis rather than just routine operation. This would mean more manpower applied to this study.

Struxness: There is one other general impression that I have today, and that is that it is too early to expect the TVA, the USGS, the Game and Fish Commission, the Stream Pollution Control Board or the State Health Department to decide what they are going to do. I think our plans cannot be firmed up until we have a meeting with Al Friend.

Schoen: Right.

Belter: Then much of the work that Friend and his survey team will do will be of this general survey nature to begin with and will be more or less of a probing thing trying to find out in which direction specific data will be obtained.

Struxness: I will prepare a memorandum report to you describing the results of the discussions with the PHS group and include a plan of exactly what we propose to do and who will do it. Then you folks can figure out what you might possibly be able to do.

Belter: Ed, you say you will come out with a memorandum after the PHS people have been down here next week. We will go on the assumption that sometime next week Friend can come down for detailed discussion with Auerbach and Nelson to determine just exactly what they are going to do on this first go around. After that you will come out with a letter more or less summarizing the plan of attack and you will circulate it for the committee's general consideration.

Struxness: I have to do that anyway, you see, because of the requirement that the Laboratory policy committee wants to examine the total program as soon as we are in a position to tell them. This is not extra work and it is information you people should all have.

Jones: This is another thing that will actually come out of this whole survey; particularly when we are talking about increasing what I would call monitoring of

wastes. Actually, that is a research problem in that no one really knows now how to monitor a stream of this type. I'm not sure. You all may know now from your work.

Schoen: My reaction to that, Leary, is we don't know. That is one of the reasons for this study. This survey will perhaps show that infrequent and random samples are so erratic we need to collect twice as many or three times as many samples of a given type.

Belter: We need a greater emphasis on certain phases, I think, where we are doing nothing now. I mean on the analysis end of it specifically. To draw one specific example. Frank was asked about the question of sediment samples, and he didn't know exactly how many were in a particular cross-section, whether he should put more emphasis in the main channel, more emphasis in the bank and overbank area, how he should composite them, whether he could composite them, what he would lose by compositing them, and other questions.

Schoen: The environmental monitoring program and the routine monitoring has not incorporated biological sampling; principally because nobody has told them what or where the indicators are, what sort of things to sample. That I think might be anticipated in connection with the routine monitoring operation eventually.

Jones: We've got two plants at Bristol on very small streams. A biologist goes in there routinely about every six months. We know, from the samples he collected, there has been nothing toxic in six months. We may be able to go in and make a monthly biological survey and tell pretty well whether we have been within limits on the average throughout the past twelve months. Maybe once a quarter, if they store up on some kind of basis, we might follow just by this survey alone.

Struxness: I have heard so often that many like to participate in stream surveys by taking samples and running analyses and filling up rooms with data and then doing nothing with it. We want to stress that however effective and extensive our analytical techniques may be, we must attempt to do some synthesizing too. These data must be meaningful in the end.

Jones: I think that would be very important. It would be an extremely valuable contribution if, ten years from now, we have information on all streams of the minimum amount of waste being released. How can you set up a monitoring program on all Tennessee state streams? Frightening thing to look forward to if it includes the same amount of work that it involves now. We have wasted a tremendous amount of time, too, on samples. A lot of it we will never write up; it will be lost and the next guy will have to go back and do the same thing over again. We're repeating the same thing that Streeter did on the early Ohio River work. Part he wrote down and part he never did.

Struxness: As far as I can see this is about all our committee can do today.

Belter: I think you are right, Ed. It was unfortunate that Friend wasn't able to be here for this discussion. When he comes down here next week and you have your discussion with him, we will get a better idea as to determining where we get off the ground on initial field work. I think everybody realizes that the initial work can be of this general, probing, survey type until we can really pin this thing

down.

Godfrey: All very good questions and questions that have never been faced up to.

Gartrell: Would it be appropriate for a board member to make arrangements for a meeting of our technical people who might be assigned to the study? I had in mind possibly Milo Churchill, Christian, Frank Parker, Nelson and I getting together sometime to talk about the details of the study. Unless we get Milo Churchill interested in this activity, he is going to be reluctant to devote time and effort to this study in preference to some other things that he has in mind.

Struxness: That is not only appropriate; it is your responsibility.

Gartrell: I want to clear up that point because I think that is the way we want to operate. Once we get a working relationship worked out, then one can work directly with the ORNL staff member on the same thing, the interpretation of data and all that sort of thing. I wouldn't want to have all that stuff handled through me.

Belter: I think this is the only way you can do it, Frank. Have these little specific working groups, like TVA together with Parker on a certain phase of the study. The same way with Dick on the work that the USGS will coordinate with Parker.

Godfrey: We will be happy to come out from Knoxville and sit down with Frank and his crew.

Belter: Right. In the same sense the PHS will get together with the ORNL group to talk about biological work. You can't help but have these small working groups. Whatever arrives out of those working discussions will very likely be worthwhile to report in memorandum reports to the committee. Especially if there is something significant that comes out of the discussion. I think the committee ought to be informed of this to let them know what has happened. Then, when the next quarterly meeting comes around, this is something that would be discussed in detail by somebody familiar with the plan.

Struxness: There is one thing that is peculiar to the biological aspects of this study that I hope our committee will respect. Our ORNL biologists, and our biological supporters in the AEC, are extremely interested in the research aspects of this program. I would hope that the guidance on biological aspects of this study would come through the biologists in the AEC and the ORNL biologists. We like to think that every scientist and engineer working in the program will pay attention to the specific objectives as well as the overall objectives. We are extremely desirous of making this a sophisticated study.

Belter: I wholeheartedly agree with that, Ed. I was wondering whether Leary or Gene might have some comment to make on this.

Struxness: At the same time we shouldn't forget that there are practical aspects in the study too. The thought occurred to me that perhaps at the next meeting we ought to have the Y-12 representative and the K-25 representative tell us of their waste releases.

Schoen: As long as we are thinking about the next meeting, it would be appropriate to consider planning a schedule for the next meeting.

Struxness: Let's fix a date for our next meeting.

Belter: My impression of the need for a meeting is in line with the suggestion this morning. I think we have talked this out enough now and except for the uncertainty introduced in our discussions today by the absence of Al Friend, I feel confident now on where to go and when and how, once we know what Al's potential is. That approval I can get from him when our Annual Report comes around. So, I don't really see any need for meeting any sooner than three months.

Struxness: I suggest that our next meeting should be in April. Is there any particular preference as to the days of the week?

Godfrey: I would like not to have the meeting in the middle of the week for obvious reasons, but I have no preference as to one end or the other. One other thing. As to the program being firmed up and the role of GS firmed up, this will give us more time to plan for the next fiscal year and arrange for people.

Belter: How about the suggestion of the seventh and eighth of April?

Struxness: The seventh and eighth would be the first Thursday and Friday in April.

Schoen: That really gives us only two months to get something done.

Belter: Well, at least it gives us two months to try and get something started. There will be enough developments after two months.

Schoen: I think the point Dick makes about the planning for the next year is real appropriate because you will be in the midst of budget problems for the next fiscal year, too.

Struxness: Any objections then to April 7th and 8th, Thursday and Friday? Good. Again we will plan to get our business over with in a day and a half. Or, as we did today, if we can get it over in a day, we'll do that too. Allow the extra day, if needed. April 7th and 8th will be our next meeting.

(rescheduled to April 21)

MEETING ADJOURNED

1/21/60 GB#12

STRuxness
Nelson
Wallen
Belter

Jones -
other work
in lab
whilom
work on

Price Wilkens (Tenn State Trout Biologist)

Parker
Morton
F. E. Gartrell

Martin
Leary Jones
Godfrey
Auerbach
Schoen

Ed - not Stream Pollution Survey
Belter more complete than but
much the same
break for reading of notes
Wallen can not ignore it

Struxness Y-12 wants to look at cesium releases

Belter - Y-12 + Ke 25 participate? - give a report
of their doings

Fish Survey - PHS 2 (1/4 surveys)
Forecast
TVA on sediments movements

Barker on sediments,
Elder temp & vel data < K25

CLINCH RIVER STUDIES

Over-All Objectives

Biological

1. To determine the biological mechanisms which affect the distribution and fate of radionuclides in the Clinch River system.

2. To obtain sufficient characterization of the biological populations, their chemical and physical environment, as well as quantitative information on the processes operating therein so as to provide a valid basis for evaluating the effect of radioactivity as an environmental factor.

Chemical and Physical

1. To determine the chemical and physical fate of radioactive materials currently being discharged to the river.

2. To determine and understand the chemical and physical mechanisms of dispersion of radionuclides released to the river.

3. To evaluate the direct and indirect health hazards of the current disposal practices in the river.

4. To evaluate the over-all usefulness of this river for radioactive waste disposal purposes. limitation

CLINCH RIVER STUDIES

Biological Objectives
FY 1960-61

I. Survey of Bottom Organisms

A. General Survey

Objective: To determine kinds, relative abundance and gross gamma activity of bottom organisms from CRM 25 to TRM 560 (30 mi.). This survey is needed to describe the river bottom fauna and to insure that representative sampling sites are chosen for the study which is to follow.

Operational: Gross gamma activity will be measured in the organisms collected.

Agency: ORNL; 0.5 - 1.0 manyear; to begin immediately and to be finished in 3-6 months. Could State Stream Pollution Control Board assist this effort?

B. Survey using specific sampling sites through a seasonal cycle to indicate which radionuclides are significant biologically of those which are known to be important from the standpoint of environmental contamination.

Objectives: 1. To determine the seasonal abundance of each species of organisms at each sampling station.

2. To determine the radionuclide content of organisms by gamma scans, Sr^{90}, and alpha analyses.

Operational: 1. Select a minimum of four sampling stations: Clinch River upstream from the mouth of White Oak Creek; Clinch River between White Oak Creek and Poplar Creek, Clinch River between Poplar Creek and Emory River, and Tennessee River downstream from the mouth of the Clinch River. (Specific sampling sites will be chosen on the basis of the general survey and to coincide with Applied Health Physics' sampling sites if feasible).

2. The stations will be sampled twice each month.

Agency: ORNL; 2.5 manyears; to begin following completion of the general survey. Could State Stream Pollution Control Board assist this effort?

Correlative Information Needed:

1. Sediment Analysis

   a) mechanical -- sand, silt, clay, organic matter

   b) radionuclide content

2. Food Habits of Organisms. (ORNL)

II. Fish Survey

Objective: To determine quantities and kinds of radionuclides being accumulated by the various species of fish in the Clinch River. (Obtain background data from fish caught above Norris Dam).

Operational: Sample the fish populations at least once a month. Do radioanalyses of fish flesh, bone, and liver by gamma scans, Sr^{90}, and alpha analyses. Could State Game and Fish and/or TVA Fish and Game Branch and USPHS cooperate to accomplish this project?

Desirable Correlative Information:

Tagging to determine fish movements.

CLINCH RIVER STUDIES

Chemical and Physical

FY 1960 and 1961

I. General Survey of the Sediments and Waters of the Radioactive Material in the Clinch and Emory Rivers to Obtain Background Values.

15 man months field.
15 man months laboratory ORNL.

II. Measurement of the Curie Content of the Outflow of White Oak Creek. + Poplar + K-25

2 man months.

III. Prepare a Budget of the Activity in the River Systems. Based upon the General Survey Use Select Cross Sections to Measure the Net Curie Outflow from the System.

4 man months.

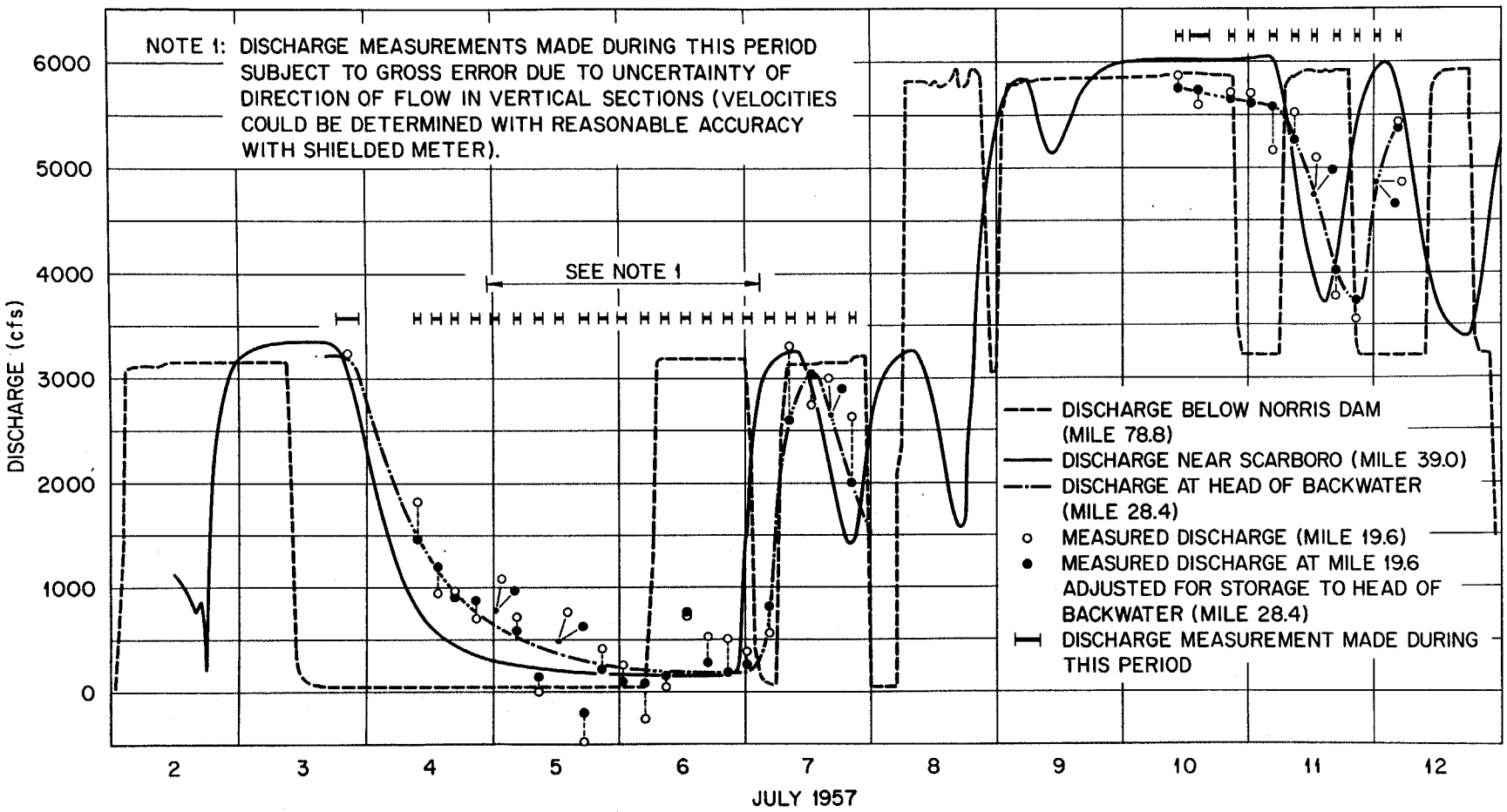
IV. Obtain Velocity and Temperature Profiles of the River System.

4 man months (USGS ?).

V. Laboratory - Sediment and Suspended Sediment Isotope Uptake Tests in Jar and Flume.

12 man months (USGS Petrograph).

UNCLASSIFIED
ORNL-LR-DWG 34239

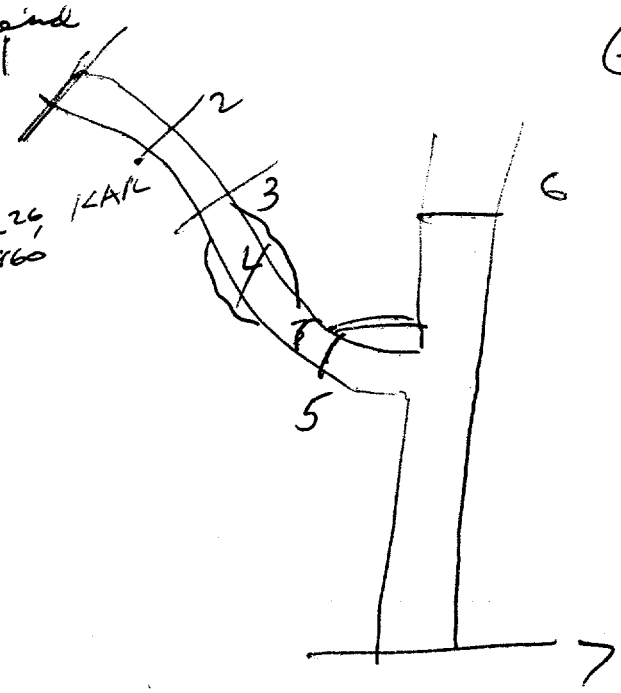


DATA BY U. S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
SURFACE WATER BRANCH

Clinch River Discharge Hydrographs
(Mile 78.8 to 28.4)

GB#12

Discussions with Freund & Henderson on US PHS role in river survey Jan 26, 1960 KAK



Fish

filamentous algae

Plankton

Bottom mud sampler

core sampler

crayfish

snails

water chestnut, cypress

minnow seines & gill nets

30 species of fish caught
20 species processed

3

carp

skin
scales
flesh
bones
liver
viscera
Intestines (contents included)

Sr^{90} & Gamma Scan

goldfish higher in Ca
algae " " Ca

used Petersen Dredge Co, Cs, Sr

in muds % organic matter

disc 1 — discussion of Mohawk Study & River work — discussion of fish study

disc 2 — discussion of bottom sediments

turbid water #30 - #31 Whatman & Millipore

~~poor~~ results using mixed bed for water concentration — call Herman about this data — used Cation resins — H.G.

al suggests semi-annual report from the steering committee

Side B #1

nothing living on the bottom

Our report in general is about what they agree to do

Stan Broad Basic Biological Research problem - but hazard data needed as well

1 Bottom fauna

2 - fish population (contamination uptake)

Bridge - fish collection OK analysis difficult for them

a setting have so few people

fish study & details of the fish study

NO.2
Side A

Select species
fish discussion
Stan random collection of fish al (yes ready to do this)
gillnets & minnow seins

Bottom samples — good rate of flow
nice prismatic channel — even flows
target for bottom samples — no
shallow water areas

mag flys
caltis fly & water mites
when full
description of river condition & system
lower areas — no rapid water movement

al "standard method of analysis "needed"
prefer to take samples back to Cinci

100 minutes per sample for pulse height
Cesium uptake expect in fish analysis
thallium 204 as background
worms identification
use Chang

Frank handle particulate activity in water

No 2 Side B

concentrating sediments by centrifuge
use plankton nets for samples
" centrifuge (does not lose smaller size samples)
200-600 cc/min high speed centrifuge.
trouble with millipore filter - no volume throughput

30 Whatman - use for free ppt &
follow by millipore
some evaporation - tried dowex on Co
cycle - not too hot - on cation resin
tried mixed bed - to get the - results
not yet available
2 gal/day from water samples
get little from water samples but
~~most likely~~ perhaps because so little there
tea dried spinach in bags @ each
station & they showed up a lot
of activity ~~so~~ though they were in contact
with water for 10 days & more surface area

better time to only collect fish
want to collect some of the other stuff
at the same time
get the gutts cleaned out before use the
organisms

#0 2 Side B

fish ~~lost~~ activity much more rapidly than they take it up.

Don fish do ~~all~~ only bone flesh & liver

al if you gather fish — run all the parts separately

ash fish — dry ash — if lot of fish

~~m~~ muffle to ash above 350°c

Cs 450°c —

try not to ash but frequently necessary to do so

carbonaceous sample but does reduce volume

after initial recovery what?

sample at the same place each time

cross section for biology not the best or

cross section for hydraulic

No 3 Side A

30 mile stretch of river
all the way to the Ohio eventually
mig own trans & 3-4 people
place to put samples
2 weeks in the field - composite water samples
red tape, facilities
boats available
Dam on water with them most of the time

4 stations - contingent upon determining
that these are the best
initial biological survey - objective
fish - select stations above & below WOC

How do we handle the results
el - should be up to the steering
committee - only way to do this
S.S. should put out semi-annual
report to keep informed the group

#3 Side B

go on a range & do a specific study
can't do mechanical analysis PHP
are samples in sediment showed no difference
water samples @ each station @ 1 pt.
run on dry cells - recip pumps
2 gall/day

stratification
start in two weeks
lot of space available @ Stan's
Stan we want more intensive effort on few things
Al take a little bit of everything to see
What is taking place
Stan what is significance of it all
Al - our field of interest bottom muds
know little about it
Dan - lot of organic matter in bottom muds
Al - facilities set up for public health
Stan - work with Stream as ecological system
1/4 mile intensively rather than whole river
see if they could do some gamma scans for us

#4 Side A

al - before attempt to survey - let other
agencies know if they want
can you do? wish to do?
preliminary survey by al & us
get help from Wilkins & Fish Hours People
Ed bound to report to Steering Committee results of
meeting
next meeting discussion of pollutants
from K25 + Y-12
Y-12 to present their problems next
steering committee meeting
al - we should do preliminary survey +
then tell others what else should be done
Ed - make sure each gets out what they want
no stream pollution survey - hydrologic
and should be as comprehensive as biological
al - set up for public health
would set up samples & Chattanooga at
our suggestion - would do more to
elevate years of TVA + heavy ones
would take mid samples at our suggestion
PHS politics

4 B

PHS politics

local management afraid of what they find in the river – mistake to hide things

official breaking up of meeting

Dept of Conser. for collection permit

multiple conversations, difficult to interpret

discussion of Hanford setup

1 What Dan has been doing – name of TVA group at Homi
2 Names of VHS & other visitors (Singleton
3 Ed – Date of meeting & names of speakers from Y-12 & K-25
4 Tommy – check casting temperatures for Cs & effect of Rn

River Conference TVA
Knoxville, 2/23/60

2/23/60

① GB#12

1) TVA would participate as part of their seen programmed activities

② fits into plans for TVA stream group on transport of activity in water & silt

③ Gartrell, Davidson, Kochtitsky, Elmore — Chat TVA
Parker, Auerbach, Nelson, George Lauff (U of Mich) — ORNL
Elder, Frey Knox, Engstrom — Miller, Chance, Hasselbach — Norris
Nelson — fish studies

① fish movements
② " species & population

statistical
partition between water & silt phases
sediment movement
sediment load & distribution

laboratory study to determine role of uptake

tracer studies

LRM 5.5 — 6 depths temp meas
3.3
2.2 — also temp measurements @ edge of main channel
mouth of enorm
ERM 1.8 (1953 +)

scarboro charts & temp charts
@ 2"/hr are available for analysis

~~Feb~~ to April 1 for steady flow

sampling with Milo on how may
variability

same active assistance from Milo's group

GB#12

MINUTES
OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
April 21, 1960

Meeting #2

ATTENDANCE

COMMITTEE MEMBERS

Present:

E. G. Struxness, Chairman (ORNL)
A. G. Friend (USPHS)
F. E. Gartrell (TVA)*
R. G. Godfrey (USGS)
S. Leary Jones (Tenn. SDPH & Str. Pol. Control Bd.)
J. A. Lieberman (USAEC - Wash., ex officio)
Vincent Schultz (USAEC - Wash., ex officio, vice I. E. Wallen)
A. A. Schoen (USAEC - ORO, ex officio)

Absent:

F. C. Durand (Tenn. Game & Fish Commission)

VISITORS AND STAFF PRESENT

S. I. Auerbach (ORNL)
W. G. Belter (USAEC - Wash.)
G. Bruscia (ORNL - temporary, Italy)*
Milo A. Churchill (TVA)
C. Henderson (USPHS)
Hugh F. Henry (ORGDP)
M. Howell (USPHS)
W. H. Jordan (ORNL)*
W. H. Martin (Tenn. SDPH)
Roy J. Morton (ORNL)
D. J. Nelson (ORNL)
F. L. Parker (ORNL)
R. M. Richardson (USGS - ORNL)
N. B. Schultz (ORGDP)
C. S. Shoup (USAEC - ORO)*
A. Sorathesn (ORNL - temporary, Thailand)*
A. H. Story (USPHS)
T. Tamura (ORNL)*

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*Attended afternoon session only.

The meeting was called to order at 9:30 a.m. by the chairman, E. G. Struxness. The Chairman welcomed members of the group and expressed appreciation to those who had traveled to the Laboratory to attend the meeting. After announcements regarding certain details of arrangements, he called attention to the agenda which was to be followed (see attached). He said it was expected that both the open session and the executive meeting of the Committee could be completed today, but that in any event business of the Committee would be concluded by noon, April 22.

Dr. Hugh F. Henry of the Oak Ridge Gaseous Diffusion Plant (ORGDP) had been invited to meet with the Committee and discuss radioactive releases from ORGDP.

Dr. Henry distributed a sketch map of the general ORGDP Area (see News Release, 4/18/60, attached), and pointed out the sampling stations on Poplar Creek and the Clinch River. The principal radioactive material handled at this plant is uranium, which is primarily an alpha emitter with beta-gamma-emitting daughters. In general, the equilibrium beta-gamma fields are the maxima attained. However, the daughters of uranium are not volatile and remain behind in the process after uranium is volatilized as UF_6, with higher resultant fields. Small amounts of fission products come from handling of spent fuel from reactors which has been decontaminated in fuel reprocessing but contains some fission products. It was noted that from the nature of the operation, discharges of radioactive materials at this plant are not comparable with those from operations dealing primarily with irradiated reactor fuels and fission product materials. Losses of uranium are kept to a minimum, the standard limit being less than 1 ppm uranium in waste water.

The principal discharge of waste water is through a storm sewer, the location of which was pointed out. Some waste water is accumulated in a holding pond from which it flows to Poplar Creek. Asked about release of U^{235}, Dr. Henry said that the specific activity of enriched uranium is higher than normal uranium which enables checking of the waste water. Essentially no U^{235} is released, and the counts from uranium in the waste are due to U^{238}. Asked about Ra^{226}, Dr. Henry replied there was no indication that this was above background. A control concept used is to control the uranium and maintain the low specified limits with the result that the daughter products will also be taken care of.

With regard to sampling, continuous composite liquid samples are taken in Poplar Creek and the Clinch River as indicated on the attached map (see News Release, 4/18/60); in addition at the water plant (potable) there is a continuous sampler for analysis of the raw water from the Clinch River, this location being about 8 miles below the mouth of the White Oak Creek. Water samples at other points in Poplar Creek and in Clinch River above and below ORGDP are taken periodically as checks. Mud samples are taken periodically; for example, at each of the water sampling sites and at the point of waste discharge a grab sample is taken once per quarter. In the streams no mud sampling dredge or other sampler is used, and mud is taken by dip-sampling, avoiding debris. It was brought out that the continuous water samples are not proportional to stream flow; they are taken at a constant rate continuously.

The results of analyses of water and mud samples during 1959 were reviewed, as tabulated in the attached News Release. Records of the monitoring program go

back to about 1949. It was noted that for mud no MPC value is specified. A chart was shown comparing gross beta activity in the raw water at the water plant with the nonoccupational MPC value for Sr^{90} in water for the past several years. Experience, in general, has been that the gross-beta level is around 10% of the MPC based on Sr^{90} alone and much less than that based on the mixture of radioisotopes actually present. Asked about build-up of activity in the mud in a waste holding pond, it was stated that this is checked once a year and that little, if any, activity is released to it now. No data on the results were at hand at this meeting.

The Chairman thanked Dr. Henry and Mr. N. B. Schultz of ORGDP for making this information available to the Committee. There was comment that, in connection with actual work on the river study, there will probably be need to consider specific data or to make field observations concerning conditions in the ORGDP Area or in Poplar Creek above.

The Chairman said that people at the Y-12 area were invited to discuss discharges from that plant, but they requested more time and will discuss this subject at a later meeting.

In the next discussion, A. G. Friend described the work done in February 1960 by personnel of PHS sanitary Engineering Center in Cincinnati. A preliminary report on this work was distributed (copy of report attached to these minutes). ← NO

This preliminary survey, made February 9-15, 1960, included collection of samples of water, bottom muds, fish, miscellaneous aquatic fauna, plankton, and filter sand from the Chattanooga Water Treatment Plant. These were taken from seven sampling stations at selected points from above Norris Dam on the Clinch River and at Fort Loudoun Dam on the Tennessee River to Chattanooga. In addition, samples were taken from three different locations on Bear Creek in the Oak Ridge area. A total of 230 analyses of samples or components of the same field sample were made. It was explained that the report has not been finally checked and is in preliminary form in other respects. It is made available for the use of the Committee, but releases or quotations from it should be reserved until it is in more nearly final form.

Friend summarized the survey briefly and, with assistance from Henderson, Howell, and Story, answered questions about it.

In discussing Table 2, Radionuclide Concentration in Water etc., Friend commented that 33 μμc/liter is used as the MPC value for drinking water. White Oak Creek samples showed 2800 + μμc/liter of Sr^{90}; and the trend of concentration was found to decrease downstream, except that it increased from a minimum of 0.4 μμc/liter (background at Fort Loudoun Dam), and 1.5 μμc/liter at Watts Bar Dam, to 4.4 μμc/liter in the raw water at Chattanooga. Jones explained that the Chattanooga figures are based on quarterly composites of weekly samples. He said that the last quarter-year of data for Chattanooga showed in the neighborhood of 1.4 μμc/liter. Schultz (AEC) asked about analytical and counting errors. Friend replied that the concentration of radionuclides is low, but with present methods they can be detected and measured. He commented that the Chattanooga Water Treatment Plant is estimated to

remove about 18% of the Sr^{90}. Lieberman asked why the increase as you go downstream; for example, is activity desorbed from the mud back into solution? Friend said he did not know. Struxness said there are indications that the Sr^{90} is in solution - only 18% removal at Chattanooga Water Plant. Also, a recent review at ORNL of data on White Oak Lake Bed indicates transport of strontium in solution, while cesium is transported on the sediments. Schultz asked whether the PHS will assign confidence limits to the data? Friend said, yes. Parker commented that the results of sampling in White Oak Creek and downstream should be correlated as to relative times of sampling and time of water flow - "may be sampling different water" than that analyzed from White Oak Creek.

Friend summarized the data on analyses of mud samples. These also showed higher concentrations at Chattanooga. Those below Watts Bar Dam were low - samples may not have been very good because of scouring below the dam.

Friend showed a series of charts of results of analyses of fish taken at seven locations. Henderson commented on the data in Table 5, Table 6, Table 7, etc. Friend said that in most cases the activity was from natural sources. He said some small fish were taken from Norris Reservoir, but there is no table in the report showing these data. Fish from White Oak Lake, about 6 inches long, 51 in number, are covered in Table 9. Schultz asked whether the intestinal contents were separated. Henderson replied that the whole alimentary tract was removed (separated). All other viscera were left to be assayed with the flesh, bones, and scales. Lieberman asked what the trend of activity in fish was as collection was farther downstream. Henderson replied that the picture is not very clear, but bottom feeders are picking up radioactive materials, as shown, for example, in Table 19. He emphasized, however, that we cannot attach too much importance to one series of fish samples.

Friend commented on the tests of filter sand from the Chattanooga Water Plant, shown in Table 23.

Struxness reminded the group that this first round of sampling was expected to serve as a basis for more definite planning; that is, develop a better pattern of sampling. He asked what conclusions had been reached regarding this. Friend and Henderson pointed out that the data had not been analyzed and studied fully. Lieberman pressed the point that opinions and observations should be recorded, and purposely we should add to or change plans for both sampling and analyses.

After a short intermission, the Chairman called upon D. J. Nelson to discuss "Studies on Clinch River Fish, Mollusks, Bottom Organisms, and Detritus." He distributed a brief report, "Cooperative Fish Studies by ORNL and TVA - March 23 to April 1, 1960," (see report attached) and a one-page attachment, dated April 13, 1960.
No

Nelson reviewed the results of the fish study shown in the tables. He said the data do suggest that activity in fish from the Clinch River is slightly higher than in those from Douglas Reservoir. Schultz (AEC) discussed sampling errors, especially sampling variations, and commented that variations may be one to three orders of magnitude. Nelson thought this too much and that one order of magnitude more reasonable if care is used in sampling. There was general discussion of sampling errors. It

was asked whether controlled exposures of fish, for example, in a cage, might be feasible. Nelson said that controlled laboratory experiments would be more reliable, but we are not set up to do this here. Such work is being done at Hanford and by the PHS. Lieberman thought we must get (as a frame of reference) data on certain questions; for example, rate of uptake, differences in species, size, etc., and fish movement. It was agreed that studies of this kind should be made for the Clinch-Tennessee River system. Also, a review of literature on fish movement and the reports of TVA studies on these rivers should be done.

Nelson indicated on a map the extent of studies of bottom organisms made and planned. He commented, "In the river bottom we have a tremendous reservoir of organic matter" - much leaf material provides organic matter; also, leaves with relatively high radioactivity have been found. Schultz (AEC) inquired whether there will be enough radioactivity in aquatic organisms for radiochemical analysis. Nelson thought there will be no trouble except for the laborious job of separating the organisms. Auerbach commented that from ORNL operations leaves are contaminated and get into the river. Therefore, sampling of water alone misses leaf transport to the stream and suggests that we must look at leaves and leaf material on the bottom of the stream. Nelson said that some clam and mussel shells from Indian mounds of the same species as in the river now have been obtained; and that Ca-Sr ratios are being determined in these shells, those from the river, and human bones.

Nelson mentioned a planned study to determine movement of radionuclides by bottom organisms. Lieberman raised the question of the importance of biological transport as compared with direct transport by the water in solution. There was no answer to this question. Henderson asked whether the river inventory is a continuing study. The answer was that it is the initial inventory of the Clinch River system and after this we will be concerned with the income and outgo of radioactive materials and their route in the River.

Struxness asked what is now indicated for a plan of future work. In his reply Nelson outlined what we would like to study: (1) fish movements in the river, (2) bottom organisms, and (3) molluscan data that are of interest (at least to us in this survey).

The meeting was recessed for lunch at 12:25 p.m.

Afternoon Session

Reconvening the meeting at 1:30 p.m. the Chairman called on F. L. Parker who discussed "Sediment Transport in the Clinch River and Discrimination Factors."

Parker summarized on the blackboard data regarding sediment in parts per million moving past the mouth of White Oak Creek and also an estimate of pounds per year for the 5-year period, 1955-59. He also listed the percentages of radioactivity on the silt in the composite samples collected at Center's Ferry, which were analyzed for Co^{60}, Zr-Nb^{95}, Cs^{137}, Ru^{106}, Ce^{144}, and Sr^{90}. These percentages varied from 5%

for strontium to 67% for cesium. The percentage distribution of the radionuclides from Center's Ferry analyses were listed and also the activity in curies. The distribution of activity according to season for 2 years of the period was shown.

Note: Further details of the data presented by Parker are given in the tables attached at the back of these minutes, "Sediment Transport and Related Data."

NO

The bed load was discussed by Churchill, Lieberman, and others. Although determinations of transport are not adequate, it appeared to be the consensus that the bed load is not an important factor. Churchill said that in his opinion bed-load measurements should not be done because: (1) bed load is not very significant in transport of radioactivity, and (2) such determinations are very complex and difficult to make.

T. Tamura of ORNL discussed "Affinity of Clinch River Sediments for Radioactive Nuclides." He acknowledged that the work reported was done at ORNL by Aroon Sorathesn of Thailand and Guiseppe Bruscia of Italy, whom he introduced to the Committee.

NO

Tamura distributed Table IV, V, VI, and VII (see tables attached). He explained that the studies were made using the jar-test technique and that the four tables being discussed were from the report on the entire study submitted by Sorathesn and Bruscia.

This was primarily a study of the characteristics and sorptive properties of uncontaminated sediments collected from the bottom of Clinch River. For comparison tests were run concurrently on the standard clays - illite, kaolinite, montmorillonite, and vermiculite, as shown in the tables. The process isotopes were Cs^{137}, Co^{60}, Sr^{85}, and Zr-Nb^{95}. Schultz asked about the mechanism of sorption to explain time dependency shown by data in the tables. Tamura discussed at some length the structural properties of the clays and the mechanism of sorption that predominates. Friend asked about chemical conditions, techniques, etc. Tamura explained these and commented that further details would be available in the report when it is completed and released.

Lieberman inquired what differences would be expected if river water had been used in the experiments instead of distilled water. Tamura said very little except slight reduction in the sorption of strontium because calcium in the river water would make the K_d lower.

Struxness asked Parker and Tamura what the preliminary study has shown. In reply they noted: (1) variability in sediment and concentration after heavy rains suggest that in the Clinch River Study we must be sure to sample after rains rather than strictly on a time basis; and (2) a smaller percentage of activity than was expected was found to be associated with the sediments which suggest the need for more sampling and analysis for dissolved activity in the water.

The Chairman invited reports by anyone present of changes in situation with respect to money, manpower, etc., but there were no reports. Lieberman commented that budget hearings are in progress.

There being no further business the open meeting was adjourned at 2:30 p.m. Members of the Committee were requested to be available for the executive session at 2:45 p.m.

ATTACHMENTS

1. Agenda, Steering Committee Meeting, 4/21/60
2. Objectives of Clinch River Study
3. News Release - Environmental Sampling, ORGDP, 4/18/60
4. Preliminary Report - Samples by PHS, February 1960
5. Fish Studies, ORNL and TVA, 3/23-4/1/60
6. Sediment Transport and Related Data by F. L. Parker
7. Percentages of cesium, cobalt, strontium, and zirconium-niobium sorbed by clays - 4 tables

See version from K 1034-A (J. Bailey) for attachments

Minutes prepared by Roy J. Morton

AGENDA

CLINCH RIVER STUDY STEERING COMMITTEE MEETING

April 21-22, 1960

Time	Title and Speaker
Thursday, April 21 - Building 2001	
9:00	"Radioactive Releases from ORGDP" -- H. F. Henry, Oak Ridge Gaseous Diffusion Plant
10:00	"Clinch River Studies" -- A. G. Friend, USPHS
11:30	"Studies on Clinch River Fish, Mollusks, Bottom Organisms, and Detritus" -- D. J. Nelson, ORNL
12:30	LUNCH
2:00	"Sediment Transport in the Clinch River and Discrimination Factors" -- F. L. Parker, ORNL
2:30	"Affinity of Clinch River Sediments for Radioactive Nuclides" -- T. Tamura, ORNL
3:00	Executive Session
Friday, April 22 - Building 3504	
9:00	Executive Session (if necessary)
12:00	LUNCH
	Optional -- 4500 Auditorium
1:00	"Public Reaction to Houston's Kellogg Incident and Atomic Waste Fears" -- R. S. O'Leary, Houston Post

OBJECTIVES OF CLINCH RIVER STUDY

The purpose of the study of the Clinch River below Oak Ridge National Laboratory is to obtain fundamental information on the physical, chemical, and biological dynamics of a flowing, fresh water ecosystem which is receiving large volumes of low-level radioactive wastes. Information from a broadly conceived fundamental and applied program will have important implications for two major world-wide problems resulting from large-scale environmental contamination. These are:

1. What is the over-all diluent capacity of fresh water environments for an increasing continuous input of large volumes of low-level radioactive wastes?

2. What is the long-term indirect impact of radioactive contamination of such environments?

Objectives

This program has four general objectives, namely:

1. to determine the fate of radioactive materials currently being discharged to the river,

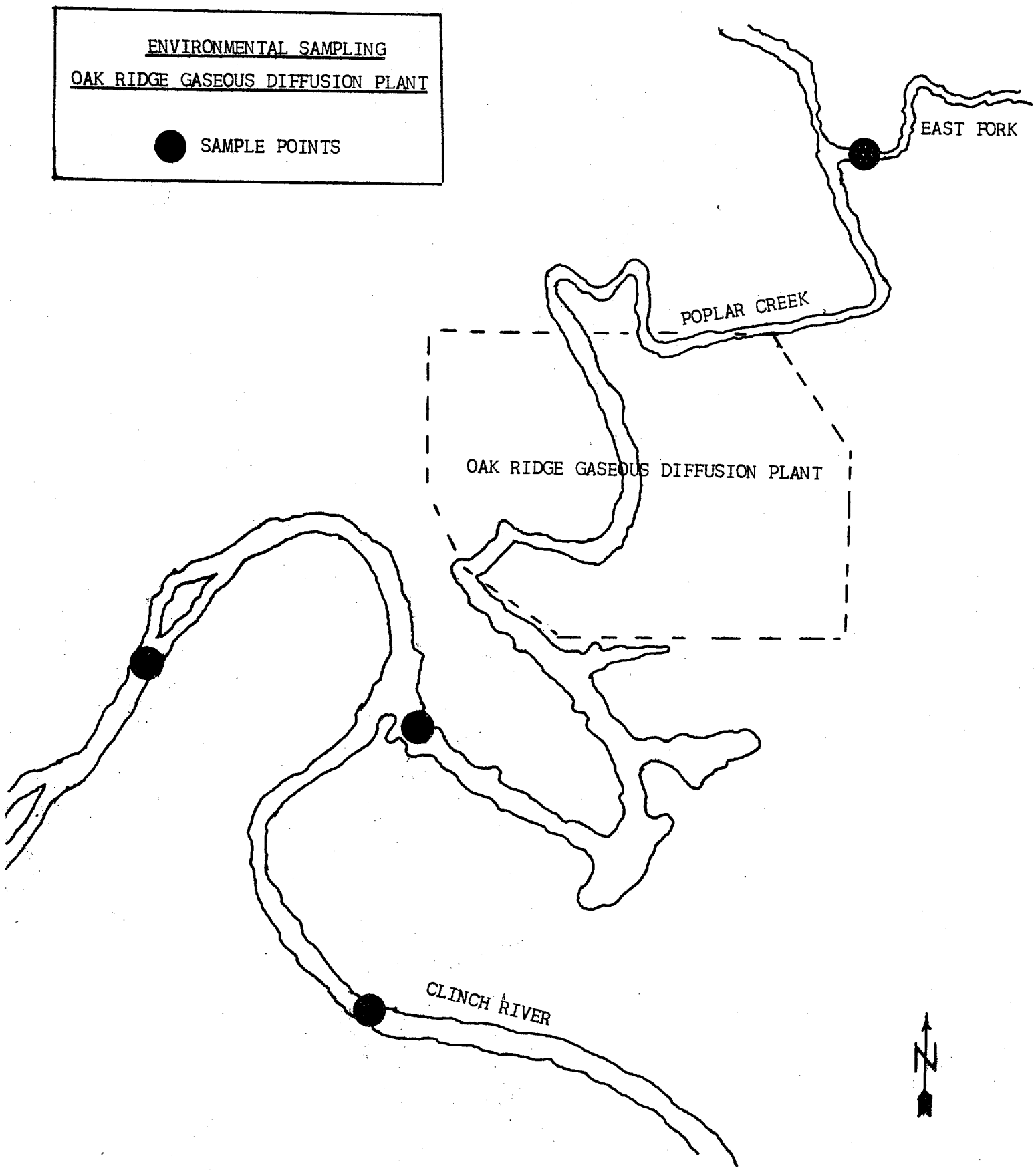
2. to determine and understand the mechanisms of dispersion of radionuclides released to the river,

3. to evaluate the direct and indirect health and hazard aspects of the current disposal practices in the river,

4. to evaluate the over-all usefulness of this and similar rivers for radioactive waste disposal purposes.

News Release

April 18, 1960



ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

Period 1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/cc \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissible (MPC)	Av. Pl. Exp./MPC
Local Streams (Water)							
Poplar Creek	Uranium Concentration						
Upstream		52	3.7	8.7	6.2	2000	0.31%
Downstream	"	52	0.5	1.0	0.6	2000	0.03%
Clinch River							
Upstream	"	52	0.08	0.2	0.1	2000	0.005%
Downstream	"	52	0.1	0.3	0.3	2000	0.015%
Poplar Creek	Total Beta Activity						
Upstream		52	14.0	22.0	18.0	2000	0.9%
Downstream	"	52	11.0	32.0	22.0	2000	1.1%
Clinch River							
Upstream	"	52	13.0	96.0	39.0	105*	37%
Downstream	"	52	10.0	136.0	50.0	105*	48%

Normal Sampling Frequency: Continuous sampling; composited over one week.

* Measured mixture of radionuclides.

ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

Period 1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/g \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissible (MPC)
Stream Bottom (Mud)						
Poplar Creek	Uranium Concentration					
Upstream		4	400	6,900	3,200	None Specified
Downstream	"	4	1,300	4,500	2,500	
Clinch River						
Downstream	"	4	300	1,300	700	
Poplar Creek	Total Beta Activity					
Upstream		4	7,200	28,600	18,000	None Specified
Downstream	"	4	12,900	21,200	18,500	
Clinch River						
Downstream	"	4	15,800	79,200	45,500	

Normal Sampling Frequency: Grab sample, once each quarter at each location.

MINUTES
EXECUTIVE MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
April 21, 1960

The Executive Session was convened by the chairman, E. G. Struxness, at 2:45 p.m., with the following members present: W. G. Belter (ex officio), A. G. Friend, F. E. Gartrell, R. G. Godfrey, S. Leary Jones, J. A. Lieberman (ex officio), Vincent Schultz (ex officio, vice I. E. Wallen), and A. A. Schoen (ex officio). Member F. C. Durand was absent. Roy J. Morton attended to serve as secretary.

The Chairman raised the question of what should be done with the preliminary reports presented in the open meeting earlier today. After discussion it was agreed that copies of the preliminary reports should be attached to the minutes of the open meeting with the notation that they were of a preliminary nature, distributed for the use of the Committee with the understanding that the material is not to be released or quoted openly without approval from the agency that prepared the report. Schultz commended the several individuals who did the preliminary work and those who presented the reports at the open meeting.

Several members of the Committee requested extra copies of the minutes for use by members of their staff. It was agreed that these should be provided, and the secretary made note of the extra copies requested.

Struxness inquired as to the status of the press release on the Clinch River Study which was submitted sometime ago. Lieberman stated that this release had been reviewed and some revisions made by the AEC in Washington and that the final version should now be enroute from the Washington office to AEC-ORO. There were comments from members of the Committee who had received the original draft of the release. Gartrell received a copy. Friend said that PHS in Cincinnati and Washington received copies; some individuals of PHS in Washington thought that public health was not emphasized sufficiently. Lieberman said that some in the AEC felt that the release as drafted left the implication that this was the first time anything has been done on the Clinch River. The AEC Public Information people in revising the draft wanted to make it clear that this is a research study; monitoring already is being done.

Jones said he had heard that a writer in Washington is anxious to write an article on releases of radioactivity at Oak Ridge. After discussion, it was the consensus of the Committee that it is desirable to get out the release on the Clinch River Study to forestall irresponsible releases about the river.

Struxness asked for discussion of something that may be a problem; namely, some biologists feel that this is just another stream pollution survey. Schultz said he saw no objection to the type of data being collected. He has talked with Friend and Auerbach about it. Different groups have different interests, and their

work will not be of identical character. With respect to monitoring functions, Lieberman emphasized that this Committee should not approve or disapprove conditions in the river. Other members of the Committee appeared to agree. Lieberman commented further, restating the purposes of the study and that we must have the biologists' help. If they are able at the same time to exploit their own interests, there is no objection. We must aim to be practical to the end that answers will come out of this study, even though this is achieved by survey rather than intensive study techniques. Friend said that PHS is not set up to study particular organisms intensively - must use survey techniques. Jones suggested that the objectives of the study should be restated in or attached to these minutes. This was agreed.

Struxness mentioned a letter of which he had knowledge that tended to discourage support for work on the biological aspects of the study by the Biology and Medicine Division of AEC. Schultz said that he was interested in this comment and that he will inquire into it further.

Lieberman emphasized again that we must get help from other agencies, for example, TVA. Gartrell said that if the Committee will state a particular thing to be done, TVA can probably manage to get it done.

Struxness commented that hydraulics and hydrology were not discussed much in the open meeting. There were a number of suggestions aimed to improve coverage of these aspects. Lieberman asked whether "hydraulic data" is an area in which TVA can co-operate with USGS. At least "could the TVA and the USGS collaborate on: (1) what to be done, and (2) who to do it?" Gartrell said that sampling should be fitted into the hydraulic pattern of the streams. Lieberman asked what do we have to do to establish a working mechanism for co-ordinating sampling and hydraulics? Gartrell suggested detailed discussions between the USGS and the TVA Hydraulic Data Division of which A. S. Fry is head. Gartrell said that he can and will arrange for these discussions. Examples of questions suggested to be discussed were:

(1) Based on the knowledge now available, is it reasonable to set up times when it would be simpler to do various parts of the study?

(2) What is necessary to set up a system of recorded hydraulic data that will aid in guiding other parts of the study?

Struxness suggested that the question of how many gages are needed is a part of this problem. Lieberman made a Motion that by the time of the next meeting Gartrell and Godfrey be asked to study the need for gaging and submit recommendations as to what gages are needed and how the information from them is to be made available. The motion was amended to ask Gartrell and Godfrey to do this within a month, if possible, and report to the chairman of this Committee. The motion was approved.

Schultz cautioned that the sampling program must not be biased by selecting low flows only; it is essential that all conditions be represented. Gartrell said

that the "wave" and "slug" behavior is quite complicated as flow is cut on and off at the dams. Lieberman said that he would like to hear this discussed in detail at some meeting of this Committee. There was general discussion, and it was the consensus that we need for TVA not only to provide the flow data but also to help interpret its meaning in terms of this study.

Schultz commented that this type of information (hydraulic) is not so important in sampling of the kind the PHS did in February (mainly survey), but is more important for studies such as Auerbach and Nelson are doing; they are trying to explain "why." There was general discussion of the difficulty of getting definitive ecological knowledge in a highly variable situation. Schultz said that this is true, but we should do the best we can, taking advantage of related information, such as hydraulic data, discussed earlier.

Lieberman mentioned the problem from use of various units and suggested that a small committee be formed to consider what units should be used. Schultz thought that this is too much of a problem to undertake as a part of this study. Struxness suggested that each agency should select and state what units they prefer to use, and these can be converted by other agencies to their own units if necessary.

Friend said that the PHS would like to make another survey sometime in the early summer, for example, June. Struxness said that this is desirable to show seasonal differences. He requested that in the next survey efforts be made to: (1) notify ORNL people in advance and have more discussions, and (2) consider the possibility of splitting samples more systematically than was done in the last survey.

Next Meeting

Thursday and Friday, August 18-19, 1960, were selected as the dates for the next meeting.

The Committee was adjourned at 4:15 p.m.

(apparently postponed until Sept. 1960)

Minutes prepared by Roy J. Morton.

AGENDA

CLINCH RIVER STUDY STEERING COMMITTEE MEETING

April 21-22, 1960

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Thursday, April 21 - Building 2001	
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1:00	"Public Reaction to Houston's Kellogg Incident and Atomic Waste Fears" -- R. S. O'Leary, Houston Post

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POST OFFICE BOX X
OAK RIDGE, TENNESSEE

MEMORANDUM

December 29, 1960

TO: Clinch River Study Steering Committee

FROM: E. G. Struxness

Meeting #3

SUBJECT: Minutes of Committee Meetings September 22, 1960

(have none of the handouts/attachments)

Minutes of the open meeting and also of the executive session September 22, 1960 have been completed and one or more copies are enclosed. Extra copies are being sent to Committee members who requested them during the meeting last April.

If you find errors in the minutes or misrepresentation of your remarks I shall appreciate it if you will advise me as soon as convenient. A corrected copy of the minutes can then be made ready for consideration and approval at the next meeting.

In accordance with the decision of the Steering Committee (see minutes of executive meeting page 1, paragraph 2), each member of the Committee will receive shortly a rough draft of the status report on the Clinch River Study. This will be submitted for your general approval and comments on the basis of which the final draft can be completed and prepared for publication.

The program of water sampling and analysis proposed by the Committee on Sampling and Analysis (see minutes of executive meeting page 4, paragraph 3) has been established. The first analytical results from this program will be forthcoming sometime during the first quarter of 1961.

A little later I will write to all members of the Steering Committee and request suggestions as to the most desirable dates and agenda for the next meeting.

Ed

E. G. Struxness, Chairman
Clinch River Study Steering Committee

EGS:RJM:ms

Enclosures (2)

Distribution: All Committee Members, Others Attending Meeting 9/22/60, K. Z. Morgan, W. H. Jordan, R. J. Morton

MINUTES
EXECUTIVE MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Building 2001 - Conference Room
September 22, 1960

The Executive Session was convened by the Chairman, E. G. Struxness, at 2 p.m., with the following members present: M. A. Churchill (vice F. E. Gartrell), J. S. Cragwall, A. G. Friend, Glenn Gentry, S. Leary Jones, W. G. Belter (ex officio, vice J. A. Lieberman), Vincent Schultz (ex officio), and A. A. Schoen (ex officio). Messrs. C. Henderson and L. P. Wilkins also attended the session; and W. J. Boegly, Jr., attended to serve as secretary.

The Chairman raised the question of what should be done with the reports presented to the Committee to date. Should these reports be made into a status report on the Clinch River Study? After discussion, it was agreed that, although the existing data is preliminary and of a scouting nature, a status report based on this information is needed. It was further agreed that E. G. Struxness should prepare a draft of the proposed report and send it to members of the Steering Committee for review and comments. A final draft will then be prepared and submitted to the ORNL Review Committee for publication as an ORNL report.

Jones commented on a telephone call he had received from a reporter inquiring about the Clinch River Study. This reporter had heard that the reason for this study was a complaint from the Tennessee Stream Pollution Control Board. Jones pointed out that this was not the case and felt that the reporter had been misinformed. The general point made was that the Steering Committee must let the public know what is being done as soon as

possible. A general discussion of the original press release and why the delay in its release followed. Struxness pointed out that this Committee has little control over press releases and suggested that AEC people in Washington might assist us by seeing that members have a chance to comment on press releases and are informed as to when such releases will be made. Schultz commented that this discussion emphasized the need for a status report on the Clinch River Study. The Committee agreed. Belter pointed out that as soon as the people at any installation start a study of the environment it seems that everyone assumes they have done something wrong and are trying to find out what the situation is. This is not a problem at AEC installations only but is common to all industry.

Jones raised the question of additional water sampling stations on the Clinch River system. About 3 years ago, after the water quality station was established at Chattanooga and the resulting data showed comparatively high activity, the possibility of other stations at various points on the river was discussed by the Tennessee Department of Public Health. The idea was tabled at that time. However, the subject has come up again, and stations at the Clinton River Intake, the Clinch River at Roane Ferry, and the Clinch River at Kingston have been suggested as locations for water quality stations. Jones felt that these stations might be useful in determining the river budget. He pointed out, however, that this would cause an overlapping with work of USPHS groups, since these samples would be analyzed for radioactivity only. Jones also commented that the Tennessee Stream Pollution Control Board has set up about seven sampling stations on various rivers, not including the Clinch River, and will be glad to submit data for comparison of the Clinch River and other Tennessee

rivers. Belter inquired as to how much water quality data is currently available for past periods in TVA and Tennessee Stream Pollution Control Board files. Jones said some data is available; mainly, pH, alkalinity, turbidity, and color. Churchill commented that TVA has made some mineral analyses on reservoirs, based on monthly grab samples.

It was pointed out by Struxness that in addition to fission-product analysis we will also need mineral analyses; and since ORNL will soon release phosphates, and are currently releasing nitrates, analyses for these minerals should be undertaken. He also pointed out that additional water quality work should be done by agencies involved in the Study if possible, instead of bringing in new groups.

Jones suggested that the Clinch River Study Committee select sampling stations and then see if we have facilities for analyses available among the groups involved. Furthermore, if we find that we have enough stations available to determine the budget, no additional stations will be required. However, if we need more stations, Struxness or the Tennessee Stream Pollution Control Board can request other help in maintaining sampling stations and doing analytical work. Churchill suggested sampling at TVA dams on the Clinch River system since personnel are available at all times of the day. He pointed out, however, that still more sampling might be needed to define the budget. Cragwall inquired whether we are thinking of mineral, radiochemical, suspended solid, or other analyses; if so, could all of this be done by one group? Churchill suggested that sampling stations at Norris Dam, Center's Ferry, Fort Loudoun Dam (or the Visking Corporation Plant), Watts Bar Dam, and Chickamauga Dam might be considered. He further felt that it would be possible to obtain proportional samples of

the type discussed in the Open Meeting at all of the sampling stations at TVA dams. These samples would be grab samples with the volume made proportional to flow. It was pointed out that at Center's Ferry the sample should be taken as near the bottom as possible, since this is the portion of the stream which can be considered as Clinch River water. Friend would handle the analysis of weekly composite samples. The sample size would be approximately 2 gallons per day. The upstream station to be used will be decided by Churchill and Friend.

Struxness pointed out that these samples will be overlapped by four samples being taken by ORNL. These are at the Oak Ridge Water Plant Intake, White Oak Creek at the Dam, K-25 Cooling Water Intake, and the sampling station above Kingston Steam Plant (Center's Ferry, CRM 4.5). Belter inquired as to what analyses will be run on these samples. A strontium-90 determination, gamma scan, and complete nuclide analysis will be run by Friend. Jones will provide mineral analyses. The frequency of analysis for each mineral will be determined by the variation found in each mineral. If the concentration of a mineral is fairly constant, this mineral will be run less frequently. Jones requires about one gallon for analysis.

The Chairman appointed a committee, composed of Friend, Churchill, Jones, and Cragwall, to design and implement the water sampling and analysis program for the Clinch River Study. They will also work out arrangements for shipping and analysis.

Gentry commented that when collecting fish and game samples, collectors must have a permit. These have been supplied to interested persons in the Clinch River Study. It is also desirable that the personnel doing the sampling contact local Fish and Game officers when working in any area.

Struxness requested a list of the officers to be contacted. Gentry also commented that fish are available from Cherokee Lake if anyone desired live fish. The Chairman was requested to contact Gentry if anyone wishes live fish, and he will see that fish are made available. In general discussion of the Fish Tagging Program, Churchill pointed out that for intermittent studies TVA and state officials could probably help. However, when we propose continuous studies of fish population, it becomes impossible for these agencies to provide personnel for long periods of time. Gentry agreed and commented that for a number of days he could supply personnel for assistance in a fish program. He also commented that this work should be scheduled well in advance so that personnel can be made available. Struxness will request from Dan Nelson (Ecology) a statement on what he plans to do and when, and Struxness will contact Gentry and Churchill for assistance.

Churchill raised the question of what is to be done about sediments and sediment analyses. Struxness suggested that since we have not decided what to do with the Clinch River cores at this time, it might be best to leave the sediment analyses for later. Churchill inquired as to whether coring was being done below Watts Bar Dam. Struxness said that nothing as yet was being done by ORNL below Watts Bar. Cragwall asked whether suspended sediments were important at this time. If not, the subject should be left for later discussion. Struxness commented that studies indicate that cesium-137 will be contained in the silt; however, since first order of priority should go to determining strontium-90 concentrations, sediment analysis should be left until later. Furthermore, preliminary analyses have indicated that little activity is present in suspended solids. After discussion, it was decided that suspended solids and sediment analysis should be left for further discussion at a later Committee meeting.

Jones suggested that Struxness prepare a list to show who is taking samples, where they are being taken, who is analyzing, and what type of analysis is being done. Also, this list should show how the samples are being taken and the volume per sample. This information could be made into a type of flow sheet, showing responsibilities for sampling and analysis. If this were then reproduced and sent out to the Committee, with revisions when necessary, this list would help prevent duplication of sampling and analyses.

Struxness mentioned the Health Physics Division Information Meeting to be held in October. All members of the Clinch River Study Steering Committee should have received invitations. If not, he extended a special invitation to all present to attend this meeting. He has been asked to present a 10-minute discussion of the Clinch River Study if this is satisfactory with the Committee. The Committee saw no objection.

The minutes of the last meeting were approved. No date was set for the next meeting of the Steering Committee. The meeting was adjourned at 4:30 p.m.

Minutes prepared by W. J. Boegly, Jr.

MINUTES

OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE

OAK RIDGE NATIONAL LABORATORY
Conference Room - Building 2001
September 22, 1960

Joe Pine and Ann Glen suggested we review Bill Boegly's notes (they are not indexed)

The meeting was called to order at 9:30 a.m., September 22, 1960, by Chairman E. G. Struxness with attendance as listed on page 8 of these minutes. W. J. Boegly, Jr. acted as secretary at this session. Minutes of the previous meeting were approved as written. The Chairman raised the question of whether previous minutes should be approved at each meeting or whether we should dispense with formal approval. It was agreed that minutes of each meeting be approved at the succeeding meeting.

The first item for discussion was a clarification of the aims and objectives of the Clinch River Study. The representative of the Biology and Medicine Division, AEC, Washington, D. C., raised a question relative to the scope and objectives of biological research in the Clinch River program. Struxness said that he felt the objectives of the Clinch River Study include location of the activity released to the river, determination of how the activity is moving, and an understanding of how the ecosystem in the river operates. In the final analysis we hope to achieve knowledge related to the possible hazard of material released to the river. For example, in this country nuclear facilities (research, production, reactors, fuel materials, etc.) have been approved on the basis of detailed analyses of possible hazards (hazard summaries). The hazard summary described the area and the facility and predicted the "maximum credible accident". This is the maximum release, due to the worst accident, with a prediction of what hazards would result. Generally, these may be written before, or after, the site has been selected. No doubt it would be best if the hazard summary was prepared prior to selection of the site. Past experience has shown that the significant hazards at these installations have been due mainly to smaller but more probable accidents, not to the "maximum credible accident". Furthermore, hazard summaries do not take into account the long-term importance of routine waste releases. By and large sites are not selected primarily to meet waste-disposal requirements.

According to Struxness, hazard summaries should include an analysis of the effect the installation will have on the site, the effect the site will have on the installation, and what is involved

in assuring the local population that the site is well chosen. In this light, the Clinch River Study will provide information that will be useful in further site selection studies. It also will give confirmatory information from actual experience.

In general, the three basic aims of the Clinch River Study are (1) to provide a detailed inventory of the activity in the River - how much, where it is and how it is moving; (2) to determine whether the activity constitutes a hazard; and (3) to study the biological parameters and interrelationships that influence the conditions of radioactivity in the River. As yet, we do not have a co-ordinated program. In general discussion following these comments, it was pointed out that possibly the program has not progressed far enough to be able to say whether we are going in different directions or not. Later, as we gain more information, we may be better able to decide what co-ordination will be necessary.

The Chairman suggested that if there were no objections to the above outlined plan of attack the Clinch River Study will continue according to this plan. No objections were made.

As agenda for the meeting, the Chairman suggested that progress reports be made by A. G. Friend, P. H. Carrigan, M. A. Churchill, D. J. Nelson, T. Tamura, and H. H. Abee.

Friend commented on his "Report on Clinch River Samples Collected February 9-15, 1960, by Personnel of the U. S. Public Health Service," which had been distributed. He pointed out that all information collected thus far is in this report. Attention was called to page 19 of the report in which it is indicated that cobalt, cerium, and cesium seem to pass out of the water phase rapidly; whereas ruthenium and strontium stay in the water phase for long travel times down the river. Also, on page 39 of the report the last two sentences in the last paragraph should be deleted. Struxness pointed out that the data on page 19 will be correlated with the data to be presented later by Tamura. A question was raised as to whether sampling is being done at proper points, in view of the apparent decrease in activity at Watts Bar Dam and the subsequent increase downstream. Before replying, Churchill asked where the samples were taken, and Friend reported that they were taken below the dam, in the winter, when the water was quite turbid. Churchill pointed out that there are, actually two basic systems of sampling. The first is to sample continuously and get data for a whole period. The second system is to follow a mass of water and sample this mass at various times and locations. He commented that the present sampling scheme assumes a constant waste source and constant dilution so that we only obtain a measure of what is at the sampling point at the sampling time, and not necessarily the same material at each station. It was asked whether TVA data on the time of flow should

be used in determining sampling time and station. Friend noted that this was an 18-day composited sample; however, Churchill pointed out that this was still not a long enough period. Until time-of-flow data is used and the same mass of water is being sampled, samples will not represent the true fate of the fission products. Struxness reported that in a meeting yesterday it was agreed that the USGS and TVA would select sampling points and times. Schultz pointed out that even though the analyses should not be compared from station-to-station, the samples from the station are correct in the relative nuclide concentration. Henderson commented that the USPHS did sample silt in the TVA silt ranges as was suggested at the last meeting.

A general discussion on the question of water sampling and analysis followed. Some of the more pertinent comments are summarized below.

Churchill: Sampling the Clinch River above Watts Bar Dam is a highly complicated process if we are to be sure that only Clinch River Water is being sampled. In the summer Norris Dam releases cold water into the Clinch, and this cold layer dips down below the warmer Emory River water and forms a layer nearer the bottom. Thus, to be sure that samples represent the Clinch River we must make temperature measurements and certain chemical tests. Actually the sampling point is not important; the sampling depth is. During the winter months the temperature of the water in both rivers is about the same, and a condition of uniform flow exists. In reply to a question, Churchill stated that the change from one condition to the other is not abrupt but occurs over a period of months. In general the mixed layers will occur from middle March to fall.

Jones: If it is necessary to continually make temperature measurements and calculations to determine sampling depth and sampling times, doesn't this restrict the sampling?

Churchill: It will be necessary to have someone near the sampling stations more or less continuously if we are to sample on the basis of time-of-flow calculations.

Struxness: Is data recorded so that we can go back and compute flows for samples already taken?

Churchill: We do not have temperature records; therefore, exact information cannot be given. If the Committee thinks this is essential, we must set up temperature measuring stations now.

Friend: If samples were taken below Watts Bar Dam, could TVA calculate the percentage of Clinch River water and Tennessee River water in the samples?

Churchill: This could be done, but it would be a complicated calculation.

Struxness: It is essential that we immediately find out what is happening to the strontium-90 in the river. How are we going to trace it downstream? Shouldn't we give first priority to continuous sampling and later consider slug sampling? We are doing continuous sampling at ORNL primarily to be sure we keep track of Sr^{90}.

Belter: How about Ru^{106} since the MPC value has been decreased?

Struxness: Ruthenium is not a critical nuclide. When we weight the relative hazard of Sr and Ru in the ORNL situation we find that Sr^{90} has more weight in the MPC than Ru and all the other nuclides put together.

Cragwall: Has the USPHS collected continuous samples at Chattanooga?

Friend: Only for the past few days.

Churchill: Previous data available is apparently based on composite samples. TVA probably would be willing to collect samples in the tailrace of Chickamauga Dam and adjust the sample volume to give a composite that is proportional to flow. (Tailrace is best for sampling as shown by previous TVA sampling studies).

Friend: What about samples at Watts Bar Dam? How much volume could you collect?

Churchill: Sampling could be done at Watts Bar also. The volume collected could be any amount desired. Would the USPHS or someone be able to analyze these samples?

Friend: We could analyze these samples if they were taken.

Churchill: Could USPHS supply the sample containers and take care of the shipping?

Friend: USPHS can furnish the containers.

Cragwall: How long will the continuous samplers operate without maintenance?

Friend: Approximately 24 hours (2 gallons) before the sampler shuts off automatically.

Cragwall: If maintenance of sampling stations could be done weekly, the USGS could probably help.

Friend: Instead of sampling the mud for radioactivity, wouldn't it be easier to sample the water and determine the difference in activity and assume that it is in the mud?

Churchill: We will need silt surveys to determine the amount of silt at various points even if we know what is in the silt.

Cragwall: Isn't the last 15 years a sediment problem? All the water has now gone past Chattanooga, and the only activity remaining is in the silt.

This ended the discussion of Friend's report. The Chairman announced that the next report would be made by P. H. Carrigan and would be a summary of the ORNL program of water and silt sampling. A summary statement was distributed.
do not have

The following items not in the printed statement were covered by Carrigan:

1. An additional continuous sampler was installed on the discharge at White Oak Dam. Sampling commenced in June, 1960, but no detailed compilation has been made of the data to date.

2. Cores taken were 1-inch in diameter, six to ten cores per cross-section, and cross-sections approximately 1 1/2 miles apart, depending on the river cross-section. Actually there is not very much silt to sample. Radioactivity has been found to a depth of 8-inches in some locations.

3. A continuous discharge gaging station at White Oak Dam was installed July 1, 1960; a continuous recorder station at CRM 19.1 is not yet in operation. Also we hope to install an electromagnetic current meter at CRM 19.1.

Churchill: inquired whether the core samples actually go to the bottom of the river bed, since frictional drag could plug the sampling tool and even though the sampler may have penetrated 3 feet the core inside might represent only the upper 1 foot of sediment. Carrigan pointed out that he was not at ORNL when the samples were taken; however, he understood that no trouble of this sort was observed. Cragwall questioned whether we could get a sediment budget by taking samples at stations 1 1/2 miles apart. Carrigan commented that we probably cannot obtain detailed information in this fashion. Cragwall agreed, and pointed out that considerable sediment could be in the meanders and bends, and this must be measured to get total sediment volume. Carrigan hoped to have a sonic-depth device in the future to measure silt depths.

The next topic for discussion was the work of the Ecology group at ORNL (presented by D. J. Nelson). Churchill commented that W. T. Lammers was loaned to the Ecology Group this summer to make flowing-material studies and will work on plankton next summer.

The following items covered by Nelson were not in his printed statement which was distributed:

1. Item I, No. 5 of the Objectives set forth in the April 21, 1960 Steering Committee Meeting (Cobalt-60 Uptake by Crayfish) has been completed by C. W. Wiser, but this information has not yet been reviewed.

2. Item I, No. 6 (Organisms and Detritus in Bottom Sediments and Radioactivity Content) has not been started.

3. Nelson said that he felt clams (fresh-water mussels) might be a good indicator for the strontium-90 content in water due to the passage of rather large quantities of water through the clam and the filtering action of the clam.

4. In describing the live fish boxes, Nelson pointed out that no initial counts were made on the fish before the test. It was also pointed out that on page 13 of the summary, Table 5, numbers listed under the title, "Fish in Upper and Lower Boxes", represent the number assigned to each fish and not the number of fish in the boxes.

After general discussion of the Ecology report, the Chairman introduced T. Tamura, who discussed sediment studies and handed out a short summary of this work. In addition to the summary, Tamura presented the following information:

do not have

1. In Table 3, the numbers under the column "River Sediments" represent mile 6.0 and 7.0; and the 150 or 450 are feet measured from the left bank.

2. He pointed out that the pH of the samples containing river sediments fall in the optimum range for cobalt removal, resulting in excellent removals.

3. After all analytical work is completed, a particle-size separation and mineralogical analysis of the sediment fractions should be performed. Also, a peroxide digestion of the samples should be performed, if and when we know the effect of the digestion process on the inorganic phase of the sediment.

The Chairman then introduced H. H. Abee of the Applied Health Physics Section of ORNL to discuss the surveys made this summer by his group.

In summary he pointed out that mud samples were collected every mile downstream of the Tennessee River to Guntersville, Alabama and on the Clinch River. The results were 15% to 30% higher than last year. This is based on a preliminary analysis of the data and is subject to revision. He felt this increase might be due to the releases occurring in the past year. In general, the ruthenium concentration below White Oak Creek has increased by some 10 to 100 times as compared with last year. This is probably due to a leak in one of the ORNL waste pits which is releasing ruthenium to White Oak Creek.

Struxness pointed out that the words, "Official Use Only - Not for Release", should be put on all material that was handed out at this session. He requested all members present to add these words to their material.

There being no further discussion, the Chairman adjourned the meeting at 1:00 p.m.; and thanked those in attendance for their time and interest.

RJM:WJB:ms

ATTENDANCE LIST

H. H. Abee (ORNL
W. G. Belter (Reactor Development-AEC)
W. J. Boegly, Jr. (ORNL)
P. H. Carrigan (USGS-ORNL)
M. A. Churchill (TVA)
J. S. Cragwall, Jr. (USGS)
D. M. Davis (ORNL)
A. G. Friend (USPHS
Glenn Gentry (Tenn. Game & Fish Commission)
L. Hemphill (ORNL)
C. Henderson (USPHS)
S. Leary Jones (Tenn. State Dept. of Public Health & Stream Pollution Control Board)
W. H. Martin (Tennessee Stream Pollution Control Board)
J. E. Munzer (USPHS)
D. J. Nelson (ORNL)
R. M. Richardson (USGS-ORNL)
A. A. Schoen (ORO-AEC)
Vincent Schultz (Biology & Medicine-AEC)
E. G. Struxness (ORNL)
T. Tamura (ORNL)
L. P. Wilkins (Tenn. Game & Fish Commission)

GB#12 4/a

Nelson

MINUTES
OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Health Physics Lecture Room (R-207), Building 4500
April 25-26, 1962

Meeting #4

The meeting was called to order at 9 a.m. by Committee Chairman E. G. Struxness. The open meeting was conducted as an information meeting with presentation and discussion of reports and summaries of progress in a morning and afternoon session, April 25, and a morning session, April 26. The sessions were attended wholly or in part by all members of the steering committee and 25 other participants in the Clinch River Study or closely related projects (See attached attendance list.). Most of the speakers distributed prepared reports or summaries of data which served as a basis for discussion and later will provide the main source of material for status report No. 4.

In his opening remarks, the chairman emphasized that this is a most important meeting. During more than 2 years since the study was initiated, a tremendous amount of work has been done and much data accumulated. It is urgent now that these data be assembled and analyzed as thoroughly as possible in order to interpret the information and plan for completion of the various phases of the study. The major purpose of this, the fourth information meeting held by the steering committee and staff of the study, is to acquaint all who are involved in the study with the activities and progress to date. This should help in more specific planning for further work.

The chairman emphasized the necessity for concluding the Clinch River Study in a satisfactory way and within a reasonable time, perhaps another year or two. He emphasized that the study cannot be concluded satisfactorily until the effect of Melton Hill Dam and its operation can be observed, which means that we should visualize the end of the study about 2 years from now. Certain phases, such as the ecological and biological studies and the collection of additional hydraulic data, when needed, may have to continue beyond that time. In the meantime, however, we must continue to collect all data that are essential for definite conclusions regarding the basic objectives of the study. These objectives, outlined in status reports No. 1 and No. 3 on the Clinch River Study, were reviewed briefly. During this meeting and subsequently, we must do all we can to determine where we stand and what remains to be done and then formulate definite plans to complete the study.

In concluding his remarks, Struxness commented on plans for the open and executive meetings during the next 2 days. He commended the work and cooperation by the participating agencies and expressed confidence that sound, realistic, and practical plans for the remainder of the study will be worked out. He referred to the agenda and called for reports and discussions, which were given as summarized below.

1. Area Monitoring of Clinch River. H. H. Abee of the ORNL Applied Health Physics Section used slides to show analyses completed since the last steering committee meeting. He explained the area-monitoring program and discussed the results of sampling and analysis of water and sediments in White Oak Creek and the Clinch River. The 1960 study on Tennessee River silt was extended downstream all the way

to the mouth of the Tennessee River, near Paducah. It was agreed that the analytical data from this silt survey should be included in status report No. 3, which is scheduled for release in about 2 months.

2. Management and Control of Liquid Wastes at ORNL. E. J. Witkowski of the ORNL Operations Division was introduced by the chairman for this discussion with the comment that he has administrative responsibility for the wastes released to the river and also has been responsible for many changes and improvements that have been made in the control and reduction of waste releases from ORNL during the last couple of years.

In a brief paper, illustrated by slides, Witkowski described the system for collection, segregation, treatment, and monitoring of liquid wastes produced in the Laboratory area. He said that an important improvement has been acceptance by Laboratory management of responsibility for safe disposal of radioactive wastes and the placing of responsibility for proper use of the waste-disposal system upon those who produce wastes. The basic approach of the Operations Division is to obtain detailed current information about the wastes that are released from various sources in order to trace back unusual releases to particular individual sources. This is done by having monitoring tanks outside buildings at each significant source and by measurement of flow and sampling at manholes through which waste lines carry the various liquid wastes. The aim of the Laboratory is to reduce the discharges to White Oak Creek to levels below MPC_w. Treatment processes are being studied and designed; individual sources of wastes are being segregated more efficiently into high- and low-level components for proper handling; monitoring stations downstream on White Oak Creek provide continuous records of contamination levels; an emergency waste retention basin has been provided into which unusual or accidental releases can be pumped; and information about conditions throughout the waste system is transmitted immediately to the waste-control center. Witkowski emphasized the importance of having specific, current information about releases from each significant source of waste so as to show who is misusing the waste system. The Operations Division works constantly with those who use the system to encourage better control of waste discharges. Another approach is the program to provide additional treatment facilities for the liquids before they are discharged to White Oak Creek.

3. Study of White Oak Creek Drainage Basin by T. F. Lomenick (ORNL). Between the system in the ORNL area described by Witkowski and the program of area monitoring from White Oak Dam downstream discussed by Abee, the White Oak Creek Drainage basin is being studied intensively to define more exactly the sources of wastes and their movement from the point of origin to White Oak Creek and into Clinch River. Lomenick read a paper and showed slides of the White Oak Basin studies and answered questions about the relative magnitude and importance of liquid wastes from the several sources. Witkowski commented that the present discharge of radioactive contaminants from the sanitary sewage system is a carry-over from an earlier accidental escape of activity from a liquid waste line into a sanitary sewer.

4. Hydrologic Measurements and Analyses. A composite paper containing tables, graphs, and discussion was distributed, and the various measurements and data were discussed by P. H. Carrigan, J. P. Monis, and B. J. Frederick of the U. S. Geological Survey.

P. H. Carrigan - "Effect of Power Releases from Norris Reservoir on Flow and Radioactivity Levels in Clinch River"; "Effect of Power Releases from Melton Hill Reservoir on White Oak Lake Levels"; "Proposed Investigation in Bear Creek Basin." have this one only (BC has)

There was discussion of these three reports. The chairman invited comments, particularly from any of five members of the ORNL Engineering and Mechanical Division regarding the effect of power releases from Melton Hill Reservoir on White Oak Lake levels. C. L. Fox responded briefly.

J. P. Monis - "Data Collection and Analyses Program." The operation of surface-water gaging stations in support of the Clinch River Study was summarized. Activities of the USGS, during the period since the last report to the steering committee, were outlined. It was explained that the collection and analyses of water samples mentioned in the outline was to obtain background data on quality of water and radioactivity in the suspended sediments.

B. J. Frederick - "Radiotracer Study in Clinch River, February 1, 1962." In a short paper, supplemented by a table and several charts, Frederick described the radiotracer study during a steady discharge in the Clinch River at 20,000 cfs and compared the results with the study at a discharge of 7990 cfs on August 30, 1961. During discussion Frederick explained that the actual duration of time for passage of the cloud of activity shown in the charts was longer than indicated, because levels below 1 μμc per ml could not be measured with the detection instruments. Asked why the radioisotope, gold-198, was selected as the tracer, Frederick stated its advantages: (1) it is cheaper than any other available radioisotope except tritium; (2) it has a relatively strong gamma ray for easy measurement; (3) it has a relatively high MPC_w - easy to operate below this level; (4) the half life is favorable. He said that in the case of water containing much suspended silt, sorption of the gold-198 by the silt might be a disadvantage. Churchill cautioned that the picture of dispersion shown by this short-term (slug-type) release of tracer must not be applied to a longer-term release.

The meeting was recessed for lunch at 12:05 and reconvened at 1:30 p.m.

5. Study of Density-Gradient Separation of Particulate Matter from River Water by W. T. Lammers. Lammers distributed copies of his paper which was reviewed briefly. It described further work on this technique and tests of new gradient materials. This was followed by general discussion.

6. Data from PHS Environmental Surveys

A. G. Friend - "Sediment Samples Collected in May 1961." Friend distributed copies of his report with tables of data and also a summary of methods of analysis which had been found useful. Friend commented on the tables of data from bottom-sediment sampling in Clinch and Tennessee Rivers during a survey in June 1961 and read a paper prepared by Dr. Andrew. The paper discussed the cross-sectional variation of activities of four radionuclides in bottom sediments from 27 cross sections on the Clinch and Tennessee Rivers, collected in June 1961; a relationship of nuclide activity to the particle-size distribution of the bottom sediments as they reflected stream hydraulics; and the longitudinal variation in radioactivity and its relationship to dilution.

D. B. Porcella - "Fish Samples Collected in May and December 1961 and March 1962." This report was postponed to follow the report of the Subcommittee on Aquatic Biology, Thursday morning, April 26.

The chairman remarked that the reports up to this time were in a sense "preliminaries," and that the final series of reports, four in number, would describe

the work and present the conclusions of the subcommittees of the steering committee. He requested that each report be in two parts: first, the work and information of the subcommittee, and, secondly, a discussion of program evaluation, including opinions of the subcommittee members and others who wished to participate.

We have Progress Report No. 4

7. Report of Subcommittee on Water Sampling and Analysis by M. A. Churchill, Chairman. Churchill distributed a summary of activities of his subcommittee and explained that progress report No. 3 will be issued in late May or early June 1962. He showed a map of the regular sampling stations, seven in number. In a series of slides, mass curves of individual radionuclides at the several sampling stations were shown. These curves had been replotted to take into account the time of water travel between stations, which helped to explain some discrepancies in the earlier graphs.

Churchill pointed out that much more strontium-90 passes the stations at Watts Bar and Chickamauga Dams than could be accounted for by releases through the Clinch River. Asked by Struxness how the subcommittee explained this, Churchill said that several possibilities had been suggested, for example, sampling error, anaerobic digestion, etc., but that the subcommittee still thinks that the excess comes down the Tennessee River from above the mouth of the Clinch River.

The subcommittee explained that duplicate samples are being taken and analyzed at Cincinnati and at ORNL, but that no reports on these samples are available as yet. There was a discussion of the need for down-river sampling to the mouth of the Tennessee River. Ruthenium-106 is measurable all the way down, although low - 35 μμc per liter - at Hale's Bar Dam and lower farther downstream. A need for greater precision of analysis was suggested, and Parker said he was in favor of this for research information. Churchill said that his subcommittee was doubtful whether the expense of special sampling (larger and longer composites), followed by special analyses, is justifiable. Apparently, it is not justifiable on the basis of hazards alone.

Have none of these.

8. Report of Subcommittee on Bottom-Sediment Sampling and Analysis by P. H. Carrigan, Chairman. A report, entitled, "Scope of Activities and Responsibilities of Subcommittee on Bottom Sediments of the Clinch River Study," was distributed and summarized by Carrigan. During discussion, several suggestions were made for revising this report before it is included in status report No. 4. Parker believed that there is need for bottom-sediment sampling farther upstream (above the mouth of White Oak Creek). Friend agreed. Kochtitzky said that the TVA workers are extending their survey up to White Wing Bridge. In continued discussion of sampling farther upstream, Cragwall and Schultz raised questions as to whether the analytical data (at a low level of concentration) could be interpreted. It was pointed out that radioactivity counting statistics are not good and that the distribution of activity is affected by complex hydraulic behavior between White Oak Creek and White Wing Bridge. At the end of the report Carrigan commented on, and there was discussion of, a new type of sampler (the Swedish Foil Sampler) on which information is being obtained by the subcommittee.

The meeting was recessed at 4 p.m. to reconvene at 8:30 on the morning of April 26.

The open meeting was called to order by Chairman E. G. Struxness at 8:40 a.m., April 26, 1962.

9. Report of Subcommittee on Aquatic Biology

We have Progress Report No. 2

"Progress Report No. 1 - Subcommittee on Aquatic Biology, Clinch River Study" by S. I. Auerbach, Chairman. The report of this subcommittee, distributed by Auerbach, was in two parts: (1) Scope and Outline of Work and (2) Progress Report No. 1. The two parts of the report were summarized in this order.

There were numerous comments on the Scope and Outline of Work (of which all had copies). Struxness noted that two or more agencies work on the same activity and asked whether coordination is maintained. Auerbach said adequate coordination is maintained. Schultz commented that overlap is inevitable. There was general discussion of the scope and duration of biological studies, now included in the Clinch River Study. Friend said objectives should be spelled out in more detail. Schultz said ecology must go beyond the objectives of the Clinch River Study. Gartrell sees the biological studies as a screening process. Auerbach said this is true, but we have settled down to emphasis on fish. Struxness would like to see the outline in more detail - now too general. Auerbach said the outline is related closely to the information listed for use of the Safety Evaluation Subcommittee. Struxness said we should limit the outline to what is being done for the steering committee, not the whole ecology program. Jones said duplication is needed. Also it should be spelled out to show what duplication there is, as well as to explain the absence of it.

The sense of a general discussion was that the statement of scope and the outline of work should indicate which work is for the Clinch River Study and which is for the long-range ecology program. Auerbach said this is difficult, since many ideas for the ecology program come out of the river study. Struxness said we must reconcile plans for ecology studies with completion of the Clinch River Study. It is implied that all work in the outline will be completed, but we cannot wait for this to be done before we complete the Clinch River Study. Specifically, the steering committee is interested in (1) fish food chains and (2) concentration in fish. Schultz and Auerbach commented that work on these phases is going on now, but completion is not guaranteed. Struxness said the subcommittee should outline what is going on that is primarily for the study, not things that are supported for other reasons. All agreed and it was concluded that this should be done. Struxness listed on the blackboard points of primary interest: (1) fate in water, (2) fate in suspended material, (3) fate in bottom sediments, and (4) fate in simple food chains to man.

Friend commented that we should also study mechanisms of transfer from one to the other phase. Schultz said that as he and Auerbach interpret "mechanisms" this will take years (that is, fundamental, not empirical information). Friend asked when we will relate the data to the MPC values; that is, the Federal Radiation Council requirements. Schultz said that this steering committee is interested in man. The biologists are interested in effects; for example, on fish.

Auerbach continued with a review of progress report No. 1 of which all present had a copy. There was considerable discussion of the section of the report on human use of aquatic natural resources, particularly commercial fish and game fish. It was explained that of commercial fish, quillback, buffalo, and carp are shipped to northern market centers, while paddle fish and catfish are sold locally within Tennessee for human food. It was the consensus of the group that the harvest of game fish is of greatest interest, since there are limits to the extent of study of radionuclides in fish that can be included in the Clinch River

Study. The opinion was expressed that the amount of game fish harvested in probably as great as that of the commercial fisherman, and Gentry commented that about 429,000 fishing licenses are sold annually in Tennessee.

see p.3

D. B. Porcella - "Fish Samples Collected in May and December 1961 and March 1962." This report covered analyses of samples collected by PHS during the three environmental surveys mentioned above. There was discussion that certain of the parameters mentioned in the report, for example, the length-weight relationship, are of interest to fisheries' biologists, but not of importance in the Clinch River Study. Churchill said that the criterion, whether to study a particular factor, is whether or not knowledge of this factor will help to define the relationships of activity discharged to the river and the potential exposure of man.

Other sections of the report of the Subcommittee on Aquatic Biology were summarized as "preliminary" reports by D. J. Nelson as follow:

(1) "Additional Data on Strontium in Clams"
(2) "Biological Half Life of Cesium in Fish"
(3) "Radioactive Strontium in Fish Used for Human Food"

There was considerable discussion of the data presented by Nelson, particularly his formula for relating the strontium in fish tissues to the strontium concentration in water, from which he aims to develop a more generally applicable basis of estimate. He explained the method, based at present on analyses for strontium in the flesh and bone of white crappie. The studies upon which these sections of the report were based are continuing.

We have Progress Report No's 2 and 3

10. Report of Subcommittee on Safety Evaluation, presented by R. L. Hervin, alternate, in the absence of C. P. McCammon, Chairman. In his summary Hervin referred to copies of the progress report which had been distributed. He said that this is not a working group for direct collection of data. However, a preliminary survey of available information indicates that most of the major aspects of safety can be evaluated fairly well by use of the data on concentrations of radionuclides in water which are or will be available. For the next progress report, the subcommittee expects to have estimates of potential hazards by exposure in the GI tract of man and animals, in the blood stream, and in critical organs, and also of potential hazards from swimming.

Struxness asked whether we should not at an early date consider the hazards in relation to ORGDP. Hervin replied that this will be the next consideration of the subcommittee. As chairman, Struxness invited A. F. Becher to comment about his interests as a representative of ORGDP. Becher mentioned interest in the water supply and the radioactivity in the treated water which he said ORGDP laboratories are analyzing. Churchill asked Hervin what water-sampling stations are of most interest to the subcommittee. Hervin replied that the subcommittee wishes to consider water concentrations under the worst conditions; that is, in the Clinch River fairly near to the ORNL discharges. Struxness suggested that the subcommittee should recommend aspects on which further study is needed so that data can be collected. He thought that the subcommittee should be especially interested in the population at K-25, irrigation along banks of Clinch River, and possibly the Kingston water supply. Hervin replied that from preliminary examination of data Kingston appears to be minor in importance. Also he said that an inquiry had revealed no irrigation of crops along the Clinch River. Parker said that if additional information is needed we should start collecting it in order to have it in time. Hervin

said that the subcommittee feels they have enough information for this year's work; namely, on drinking water and swimming hazards.

During further discussions Struxness mentioned a new water-sampling station at ORGDP and asked Churchill whether analyses of the treated water would be helpful. Churchill said that this may not be profitable. He considers it unnecessary unless we can show that there is a hazard in the raw water. Look first at the raw water. Cragwall asked whether the safety committee will evaluate the capacity of the river; that is, how much increase in contamination is permissible. Opinions were expressed both in favor of and not in favor of analyzing the treated water at ORGDP. Schultz warned that we must not expand to collect "marginal" information. We must consider cost and effort required. Churchill agreed and said again that we should consider first whether there is a "hazard" in the raw water at ORGDP.

The chairman closed the discussion on safety evaluation. He introduced F. L. Parker, who discussed the final topic in the open meeting; namely, "Future Plans."

Parker commented informally, giving his impressions regarding the present status of the study and his opinions as to important needs during the next year or two. Since his return to ORNL, after an absence of 1 1/2 years, he has been impressed with the progress made toward the stated objectives of the study. He reviewed the five objectives and commented briefly upon them. The purposes of the study thus stated are much broader than the scope of the discussion this morning.

He summarized some data he had collected, regarding releases to the Clinch River, and estimates of the radioactivity now present in the river system. As a reasonable approximation, he estimated that there is probably 100 curies of cesium-137 in the upper horizons of the bottom sediments out of about 1800 curies released, taking into account reduction by radioactive decay. There is probably a maximum of about 17 millicuries of strontium-90 in the biomass. This amount of strontium-90 is insignificant, compared with the strontium-90 in the water phases of the stream. Therefore, Parker emphasized that, from the viewpoint of safety, we are concerned most particularly with water concentrations and transport of radioactivity. He said that studies on small simple streams may help to interpret the data with respect to Clinch River conditions.

With regard to radionuclides in the river and the exposure of people, Parker observed that we have no measurements of alpha emitters and suggested that some data on potential alpha exposures should be obtained. With regard to objectives, Schultz observed that it is no disgrace to change objectives and suggested that the steering committee should re-examine and restate the objectives of the study.

Suggested objectives for the near future were outlined by Parker:

1. The safety of the river system as now operating should be appraised, and the safety evaluation subcommittee should be able to complete its work on this within a year.

2. Some additional sampling for information on undefined aspects is needed; for example, the importance and potential hazards, if any, of irrigation of crops.

3. The feasibility and importance of determining the body burden of radionuclides in workers at ORGDP should be considered seriously.

4. Further analysis of the effect of Melton Hill Dam upon the river and upon operational radioactive discharges through White Oak Creek is needed.

5. Continue basic studies in biology and ecology and on the mechanisms of dispersion.

In conclusion, Parker was of the opinion that the steering committee should aim for completion of the study in about 2 years. He suggested that we should have a safety evaluation report a year from now; collect data regarding the effects of Melton Hill Dam as soon as feasible; and plan for another final report on safety evaluation thereafter.

The open meeting was concluded at 11:15 a.m.

RJM:jmd, 5/24/62

ATTENDANCE LIST
OPEN MEETING, CLINSH RIVER STUDY STEERING COMMITTEE
April 25 and 26, 1962

Name	Attended Session*		
	1	2	3
H. H. Abee (ORNL)	x	x	x
S. I. Auerbach (ORNL)	x	x	x
A. F. Becher (ORGDP)			x
W. G. Belter (AEC-Wash)	x	x	x
P. H. Carrigan (USGS)	x	x	x
C. M. Carter (ORNL)	x		
M. A. Churchill (TVA)	x	x	x
J. S. Cragwall (USGS)	x	x	x
C. M. Davidson (TVA)	x	x	x
J. W. Fields, Jr. (ORNL)	x		
Mary R. Ford (ORNL)			x
C. L. Fox (ORNL)	x		
B. J. Frederick (USGS)	x		
A. G. Friend (USPHS)	x	x	x
F. E. Gartrell (TVA)			x
Glenn Gentry (TGFC)		x	x
J. H. Gibson, Sr. (ORNL)	x		
S. Helf (U. S. Army)	x	x	x
R. L. Hervin (AEC-ORO)	x	x	x
S. Leary Jones (TDPH)	x	x	x
O. W. Kochtitzky (TVA)	x	x	x
W. T. Lammers (Davidson College, TVA)	x		
T. F. Lomenick (ORNL)	x		
W. H. Longaker (ORNL)	x		x
J. P. Monis (USGS)	x	x	
R. J. Morton (ORNL)	x	x	x
D. J. Nelson (ORNL)	x	x	x
F. L. Parker (ORNL)	x	x	x
R. J. Pickering (USGS)	x	x	
D. B. Porcella (USPHS)	x	x	x
R. M. Richardson (USGS)	x	x	x
Vincent Schultz (AEC-Wash)	x	x	x
C. S. Shoup (AEC-ORO)	x	x	x
E. G. Struxness (ORNL)	x	x	x
L. P. Wilkins (TGFC)		x	
E. J. Witkowski (ORNL)	x		

*Session 1, Wednesday a.m., April 25, 1962.
Session 2, Wednesday p.m., April 25, 1962.
Session 3, Thursday a.m., April 26, 1962.

Nelson

MINUTES
EXECUTIVE MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Health Physics Lecture Room (R-207), Building 4500
April 26, 1962

The executive session was convened by the chairman, E. G. Struxness, at 1 p.m. with the following members present: W. G. Belter, J. S. Cragwall, A. G. Friend, F. E. Gartrell, Glenn Gentry, S. Leary Jones, Vincent Schultz, and C. S. Shoup. Staff members present were: S. I. Auerbach, P. H. Carrigan, M. A. Churchill, R. L. Hervin, F. L. Parker, and R. J. Morton who served as secretary. Chairman E. G. Struxness presided throughout the session.

The chairman referred to his memorandum to steering committee members on April 18, 1962, requesting a vote to approve or disapprove a paper on "Proportional Sampling for Radionuclides in the River System Below Oak Ridge" by M. A. Churchill, scheduled for presentation at the Annual Meeting of the American Geophysical Union in Washington on April 27, followed by publication in the Proceedings. A motion by Jones, seconded by Shoup, to approve this paper for presentation and publication was passed unanimously.

The committee next considered a request from A. G. Friend for approval of a paper, entitled, "Studies on the Distribution of Radionuclides in the Clinch and Tennessee Rivers Below Oak Ridge," by A. G. Friend and D. B. Porcella, to be presented at the 1962 Nuclear Congress in New York on June 6, 1962. Copies of the paper had been distributed to committee members earlier. Before the committee took action on this request, there was general discussion of the basis on which the committee should act in approval of papers for presentation or for publication and the criteria involved in such approval.

Shoup suggested that for public relations reasons papers of this kind should point out definitely that the levels of radioactivity in the river are lower than the maximum permissible concentrations for water. Struxness and Belter spoke to this point, and it appeared to be the consensus of the group that if the data show that conditions in the river are safe the fact that the contamination is below acceptable limits should be pointed out in interpreting the analytical data. Someone mentioned that newspaper representatives, when present, would be especially interested in indications of hazards or adverse conditions and would make their own interpretations; but Belter replied that, in general, it is "better to beat them to the punch."

With regard to the basis for approval, Schultz said that he did not review Friend's paper for correctness of information and interpretation; he understood review and approval was only to be on guard against premature publication of data or inadequate credit to others who had helped in their collection. Chairman Struxness read from the minutes of the executive meeting, May 4, 1961, at which time a policy was formulated for handling reports, lectures, and talks. "It was agreed that any data supplied and used in the status reports is free to be published elsewhere after the report is issued. Until the time that this data is published, the data must be considered 'not for release.' 'Base data' or data on stream flow and stable chemistry are not to be covered under this rule unless the figures include some radiochemical analysis or other data of a nature that might cause 'a scare' or adverse press reaction. In the case of oral presentation, approval must be given by the chairman of the Clinch River Study Steering Committee." Struxness said he had interpreted this policy to mean that data obtained from the Clinch River Study

could be published if approved by a majority vote of the steering committee, and that oral presentation of such data could be approved by the chairman of the steering committee. Friend asked whether the author should ask for approval of his written paper or approval for use of the data. Schultz said he understood that the steering committee should not try to dictate how a paper is written. Gartrell thought that in its action in May 1961 the committee was concerned with the publication of premature conclusions which the committee might consider to be unsound.

There was detailed discussion by practically all members present. It appeared that one basic question is whether the committee should consider editorial form as a factor in approval. It seemed to be the consensus that the manner in which a paper is written is not the primary criterion, but Cragwall felt that the written paper must be examined if committee members are to be sure that there are not objections to the way in which statements are made. "We cannot pass on a paper, yes or no, without seeing the paper." Shoup thought there should be leeway for judgment; for example, approve a paper on the basis of a preliminary draft.

Gartrell thought that the steering committee actually acts to develop group judgment about a paper and to make a group recommendation in the face of which it is not believed that an author would go contrary to the expressed wishes of the committee. Schultz wanted the minutes to show that the steering committee cannot prevent an author from publishing. There seemed to be general agreement that there is no mandatory refusal to allow publication. It was agreed, without objection, that there is no effort by the committee to stifle papers to prevent either presentation or publication. Several examples were reviewed to illustrate the basis for approval and action by the committee.

Finally, the chairman summarized the policy on the blackboard as follows:

1. Presentation of a paper or talk containing data from the Clinch River Study, not previously published in a status report, must have the approval of the chairman of the steering committee before presentation.

2. Publication of a paper or report containing data from the Clinch River Study, not previously published in a status report, must be approved by a majority vote of the steering committee members prior to publication.

A motion by Gartrell, seconded by Shoup, that the proposed Nuclear Congress paper by Friend and Porcella be approved for presentation and publication was passed unanimously.

The chairman asked that the committee consider the problem of preparation of material for (progress) the status reports. There has been much difficulty and delay in adapting the reports presented to the steering committee at the open meetings so as to make them suitable for the next status report. The reports presented may be too voluminous, not logically organized in relation to other parts of the study, ambiguous or incomplete in descriptive statements, uncertain in their conclusions, and sometimes inconsistent or not fully justified in interpretations of the data presented. He asked for suggestions.

The editor of the status reports said that the contributing authors had been most cooperative in helping him to condense, edit, and reconcile the information contained in their progress reports to the steering committee. The main problem

is to obtain written sections and tables for each status report that are concise, clear, and technically correct in so many diverse fields. Schultz suggested that subeditors to assist with the various special fields might be helpful. Jones suggested that it might be necessary to write two versions of papers and reports presented to the steering committee - one discursive and the other condensed for publication. The chairman, E. G. Struxness, said he believed that it would be necessary for each investigator to prepare a carefully written summary especially for his section or sections in the status report even if this did entail the writing of two versions. Cragwall asked whether we have a satisfactory outline for status reports. Struxness and the editor of the report said that they believed the basic outline in the draft of status report No. 3 is adequate and sufficiently flexible to be generally satisfactory. In concluding this item the chairman said that he would encourage all investigators to prepare, especially for the status report, a concise finished draft, including their tables and figures of data.

The committee considered next the role and working procedures of the four subcommittees. There was lengthy discussion of this topic, including the responsibility and prerogatives of the steering committee. Friend said that the committee was too often a following rather than a steering committee, because it lacked current information about the program while the data were being studied and progress reports prepared by the various subcommittees. He suggested that the subcommittees' material should be consolidated into summaries and submitted to the steering committee for approval or disapproval. He said he realized that to accomplish this each subcommittee would have to work together for a considerable time, perhaps a week or more.

Schultz agreed about the need for such consolidated summaries, saying that individuals are left too much on their own responsibility to go in whatever direction they choose. He thought that more time was needed for each subcommittee to do its work. Belter spoke to this point and seemed to agree with others that the steering committee should have summaries of available information currently prepared by the various subcommittees. Cragwall commented on the time required to summarize current information, saying that each subcommittee should have someone to work up the data and help to summarize it in such a way that it would lead to the "top of the pyramid"; that is, to a final report. Shoup expressed his opinion that the Subcommittee on Safety Evaluation had done well in summarizing its position and stating its needs in the progress report presented and discussed during the open meeting this morning. Hervin commented and answered questions regarding the recommendations made in this progress report by the Subcommittee on Safety Evaluation. He said that, for this subcommittee at least, going through the available data is the time-consuming function. The subcommittee needs someone to work on this. After the information is assembled and summarized, the evaluation of safety conditions is essentially straightforward.

During discussion it was suggested that to the extent possible, staff members are needed by particular subcommittees to work practically full time until the available data have been pulled together. Cragwall mentioned particularly the Subcommittee on Sediment Sampling and Analysis as an example where extensive data require much study and analysis before they can be very meaningful to the steering committee. Regarding sediment sampling, Belter asked whether we are now at the point where one more series of cross-sectional sampling will suffice to complete the study. Carrigan replied that this is almost true, although there are some additional facets to be considered. Carrigan commented further that members of his subcommittee, as well as other subcommittees and staff workers, must depend on the

requests of the safety evaluation subcommittee to guide them in planning for additional work.

Chairman Struxness said that from the discussion and suggestions, he understood that the subcommittees should be directed to summarize available information as soon as feasible, and then help to bring it together with other summaries so as to give a clearer and more comprehensive picture of the over-all status of the study. Friend said that this was what he had in mind in opening the discussion. On the blackboard the chairman stated this conclusion as follows: "Direct subcommittee chairmen to assemble, condense, and evaluate all of the information obtained to date and to make recommendations on what further work is needed to 'wrap up' the Clinch River Study. Request that this assignment should be completed and reported to the steering committee within the next 2 months (by July 1, 1962)."

Chairman Struxness again raised the question (which he had mentioned earlier), whether F. L. Parker should have a broad assignment of responsibility to work with the subcommittees and the staff of the study so as to coordinate various phases of the work and guide the work program in order to achieve the essential objectives by the time the study is completed. He outlined four reasons why he thought such an assignment is needed and that Parker is the logical choice for this function. There was general discussion of this suggestion with consensus that it was advisable. A motion, made by Gartrell and seconded by Jones, that F. L. Parker be appointed "Study Coordinator" with the scope and nature of his responsibility to be defined for him by Chairman Struxness was passed unanimously.

Belter requested that the committee consider the possibility that participation in the study by the Public Health Service could be considerably increased. He said that the quarterly environmental survey program in this and two other areas had progressed to the point where he would propose that the PHS group concentrate their efforts entirely on the Clinch River Study. He suggested that this might be done by increasing the man power and facilities on aspects of the study that are already being investigated or by investigation of additional aspects. There was general agreement in the committee that if this could be worked out satisfactorily it would be advantageous. Struxness asked Friend how much man power was available in the PHS group. Friend said about fourteen people, total, but that exclusive of analytical workers there were six people (names listed on blackboard) who might assist in the field and sampling programs. These included one zoologist, two soil scientists, two technicians, and one engineer. The chairman asked the committee to consider what aspects of the program could profitably use one or more of these six people. Auerbach said that a large collection of fish has been planned for next summer, requiring six to eight people for about 10 days on the river. He said also that ORNL is not in position to do the analytical work, and that it has been proposed that ORNL and PHS should carry out this investigation jointly. Friend said he agreed, except that he would be reluctant to assign the two soil scientists to work on fish collection and analysis.

Struxness said that these comments suggested two areas of work where these men could be helpful: (1) mineral-sorption studies (under Tamura's supervision) to accelerate the work on river sediments and radionuclide retention, and (2) the fish collection and analysis project mentioned by Auerbach which could be carried out jointly by the Ecology Section and the PHS group and would assist in supplying data needed by the Subcommittee on Safety Evaluation. He asked whether there were other studies which might be considered. Auerbach said that another is water sampling, particularly on small streams, such as Bearden Creek. Data from such samples might

help to explain the high ruthenium activity upstream from the Laboratory. After further discussion, the committee agreed that it should be arranged for the PHS to increase its participation in the study. Primary consideration should be given to two areas of work; namely, (1) sediment studies and (2) fish collection and analysis.

Cragwall again raised a question as to the desirability of obtaining analyses of the treated as well as the raw water at the ORGDP water plant. It was also suggested that the sampling and analysis of small wells, located within the possible influence of the river, might be considered. There was considerable discussion of both possibilities. Also, there were distinct differences of opinion as to the value and probable success of carrying out such analytical studies within reasonable limits of time and expense. Churchill believed we should have evidence that there is a potential hazard in the raw water at the ORGDP water plant before a study of the plant efficiency and the levels of contamination in the treated water can be justified. Hervin argued that it does not matter that there is no hazard at present or possibly in the future. The Subcommittee on Safety Evaluation needs to have an estimate of the expected levels of radioactivity in the treated water actually used in order to evaluate the drinking water hazard from contaminants in Clinch River. Belter pointed out that a study of the removal of radionuclides by the ORGDP water plant is no simple collection of a few samples, but would require at least several months of rather intensive study. Gartrell, Jones, and Churchill were of the opinion that the data obtained, either from the ORGDP water plant study or from the sampling of small wells along the rivers, would not produce the kind of data that would be of value for the purposes of the Clinch River Study. They doubted whether the data could be interpreted in relation to conditions observed in the rivers. After further discussion, it was agreed that the sampling of small wells is not promising as a scientific investigation, but, in the absence of any data on radioactivity in such wells, a selective well-sampling program might be informative. The sampling of raw and treated water from the ORGDP water plant and studies of the kinds and levels of radioactivity in various parts of this plant were left for future consideration by the PHS, the staff of the study, and the steering committee when more definite ideas of the purpose of and the amount of work required for such an investigation are available.

The chairman referred to status report No. 3, of which a limited number of copies of a draft of the report are available, and requested that comments and suggested corrections or revisions should be submitted as soon as feasible. He requested that comments be submitted to R. J. Morton, who will complete the final revision. It is estimated that the report may be issued in about 2 months; that is, about July 1.

Future meetings of the steering committee were discussed. Friend invited the committee to hold its next regular meeting with the PHS in Cincinnati, Ohio. A motion by Gartrell, seconded by Cragwall, that the next regular meeting of the committee should be held in the fall in Cincinnati was passed unanimously. It was suggested that a letter of inquiry regarding convenient dates should be circulated to committee members, after which a definite date could be selected. ?

It was suggested that there may be need for a special called meeting of the steering committee about mid-summer to consider revision of work plans and summaries of information, which may be developed under the leadership of F. L. Parker, serving as program coordinator. Gartrell invited the committee to hold this summer

meeting with the TVA in Chattanooga, in the event such a meeting is held. Without objection, the committee thanked Friend and Gartrell for their invitations and agreed that the summer meeting, if held, would be in Chattanooga.

The meeting was adjourned at 4:15 p.m.

RJM:jmd, 5/24/62

GB#12

November 29, 1962

MEMORANDUM

To: Clinch River Study Steering Committee

From: E. G. Struxness

Subject: Minutes of Special Meeting, November 15, 1962

Meeting #5

Enclosed is your copy of minutes of the meeting of the Clinch River Study Steering Committee at Oak Ridge National Laboratory, November 15. If you have additions or corrections please advise me at your convenience.

Edw. G. Struxness

E. G. Struxness, Chairman
Clinch River Study Steering Committee

EGS:ms

Enclosure

MINUTES
SPECIAL MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
OAK RIDGE NATIONAL LABORATORY
Conference Room - Building 3504
November 15, 1962

A special meeting of the Steering Committee was called to order at 8:30 a.m. by the chairman. Present were: committee members, E. G. Struxness, chairman, W. G. Belter, J. S. Cragwall, O. W. Kochtitzky (representing F. E. Gartrell), and C. S. Shoup; staff and subcommittee representatives, S. I. Auerbach, P. H. Carrigan, K. E. Cowser, R. L. Hervin, R. J. Morton, and F. L. Parker; consultants (Health Physics Advisory Committee members), G. M. Fair and J. C. Frye; others, Harold Bernard (AEC-Washington), Emil T. Chanlett (University of North Carolina), Earnest F. Gloyna (University of Texas), and J. Wade Watkins (U. S. Bureau of Mines).

In opening remarks, Struxness referred to his letter of November 12, 1962 postponing the regular meeting of the Steering Committee in Cincinnati until February 1963. He said that the committee and staff could not be ready for a meeting in November as announced earlier because subcommittee reports and other necessary information were not available. Purposes of this meeting are to: (1) review circumstances which prevented readiness for a meeting in November; (2) obtain information as to what each subcommittee can do to be ready for the February meeting; and (3) urge the subcommittees and members of the staff to develop reports as completely as possible by the time of the meeting in February. He then called upon the chairmen or representatives of the four subcommittees.

Aquatic Biology. Auerbach said that the subcommittee report could not be ready in November because the program has been slowed up both in collection and analysis of fish. He recalled that the Steering Committee at its last meeting agreed that extensive data on radioactivity in fish were needed for use of the Subcommittee on Safety Evaluation. Accordingly, the aquatic biology studies have included an ambitious program to determine the concentrations of a wide spectrum of radionuclides in a representative number of each of several fish species. The aim is to collect and analyze 40 fish of each of the important species in pertinent locations, which is truly a major undertaking. Collections are complete for some species but incomplete for others, and analyses are in progress. Most of the data from these fish analyses should be in and tabulated by February.

Sediment Sampling and Analyses. Carrigan recalled delays earlier in the year in finding and testing suitable core samplers. This was accomplished, a core sampling system was adopted, a

contractor (Sprague and Henwood) was employed and did the sampling, and the collection of core samples has been completed. The aim of the subcommittee is to evaluate all data presently available (which is now essentially completed), and to determine the radioactivity in the sediment samples which have been collected. Struxness remarked that this group would be hard pressed to complete analytical work and the report by February. Carrigan said that detailed analyses of all the cores could not be entirely completed even by overtime work. There are about 600 ft of cores and analysis of 2 in. segments for radioactivity is desirable. The gamma-scanning instruments are just now installed and being readied for operation. Carrigan said that gross gamma scans can be done on all the cores in a month or so and suggested that on this basis certain cores should be selected for the detailed analyses. Auerbach asked whether strontium will be determined in Burros' laboratory and Carrigan said it will. Struxness asked whether the analytical work is being organized with February as the target date and Carrigan said that it is.

Water Sampling and Analyses. Cragwall was the only member of this subcommittee present. He said that the results of the analyses had not been received last week, mentioning that the U.S. Public Health Service Laboratory had to be moved and that the computer program had been delayed. Cragwall understood that the analytical data are expected by Churchill very soon. He expressed the opinion that if received soon the data can be evaluated and reported before the February meeting.

Struxness asked about the status of the water sampler installation at Melton Hill Dam. Shoup said the sampler is not yet installed and that funds have been a little slow in becoming available. It was understood that Shoup will follow through on this aspect. In discussion it was mentioned that the sampler project at Melton Hill was considered in a meeting several months ago. When the program is in operation the Subcommittee on Water Sampling and Analysis should have the results for its use. The continuing program is to be handled by the Applied Health Physics Section but the information obtained will be available for the Clinch River study. This will be similar to the water sampling program at White Oak Dam, where Applied Health Physics obtains the samples and the Clinch River study does the analyses. It is visualized that later the sampling station at Melton Hill Dam can take the place of the present station at the Oak Ridge water treatment plant. Struxness requested that Cragwall take back to Churchill for the subcommittee information regarding the status of the sampling program at Melton Hill Dam.

As to the status of the "cross check" analyses of water samples by ORNL and USPHS, the results from ORNL have been received but those from USPHS have not. Parker asked how many "cross check" samples are being analyzed. Carrigan said 5 or 6. It was agreed that this is not enough. Asked whether there will be additional samples, Carrigan said yes but the number is not known definitely.

Safety Evaluation. Parker commented that a meeting of the Subcommittee on Safety Evaluation has been called for November 20 but may be cancelled because much data are not yet available.* Cowser has been working as a staff member to assist this subcommittee and is preparing a report on his evaluation of available and prospective information. Cowser said that the preliminary report is well along and should be ready within about a week. If prospective data become available a final report should be ready to submit by the time of the Steering Committee meeting in February. Regarding the whole body counting of people at ORGDP, Parker reported 9 of the 10 examinations completed but the data not yet analyzed and interpreted.

For information of the Steering Committee, Kochtitzky reported that TVA is going ahead with dredging operations downstream from Melton Hill Dam and discussed some conditions. Two dikes to retain the soft sediments were completed this week. In the first week's sediments dredged, counts from the sediments were lower than background, measured November 13, 1962. Rain druing the previous weekend increased background about twofold. Next Monday, November 19, 1962, the new dipper dredge is to report for work. Shoup asked when dredging will interfere with the river study. Kochtitzky said it was planned that dredging (now in progress) would be completed by early summer, impoundment should start about May 1, and conditions for the study will be changed by these operations. Rock above White Wing Bridge will require blasting. Cragwall asked when a change in plans for the Clinch River study should be scheduled. Kochtitzky did not reply directly but said that one turbine should be operating in July and the second in December 1963.

Struxness, in summary, said it was clear that the committee and staff could not possibly have been ready for a meeting in November. Regarding the February meeting he urged that all subcommittee chairmen:

1. Come prepared to submit a final report on the initial phase of the study. The second phase will be after Melton Hill Dam is in operation. He requested that the report be made as complete as possible and also that it be prepared in a way that will make it easily adapted for inclusion in the status report.

2. Come prepared to tell the Steering Committee specifically what is planned to be done during F.Y. 64. Budget requests must be prepared immediately after the February meeting and must show how much money and manpower are proposed for particular purposes. Shoup emphasized the necessity for money and manpower estimates to be available next February.

In view of the problems in keeping the analytical work up to schedule in Cincinnati, Struxness asked whether the steering committee can do anything to help in alleviating the delays. Belter said the delays are serious and that the Laboratory might be able to help. It was agreed that Struxness and Parker should go to Cincinnati

*This subcommittee meeting was subsequently postponed until a later date.

to see and discuss the situation firsthand and prepare a letter telling the steering committee what was found and suggesting what can be done.

Belter recalled that at the last meeting of the committee it was agreed that the USPHS would assign two mineralogists to assist in the studies of bottom sediments. He asked how this additional manpower was being fitted into the Clinch River study. Carrigan said that their work was planned at ORNL. It did not seem feasible for them to work on the Clinch River cores so instead they have been doing special analytical studies in Cincinnati using sediment samples collected downstream from ORNL for this purpose. Belter said his question was concerned mainly with the progress of work being done during this fiscal year (FY-63). Carrigan said that the sediment sampling and analysis program should be up to the planned schedule by about December 31, 1962.

Regarding dates for the February meeting in Cincinnati, Struxness asked as to preference of dates. It was decided that the meeting will be held on Wednesday and Thursday, February 6 and 7, 1963.

The meeting was adjourned at 9:15 a.m.

(Minutes prepared by R. J. Morton, Secretary,
Clinch River Study Steering Committee).

RJM:ms 11/28/62

Don Nelson GB#12

with Fred's additions

from Meeting #6

PROGRESS REPORT NO. 2

SUBCOMMITTEE ON AQUATIC BIOLOGY

CLINCH RIVER STUDY

February 6, 1963

This document has been approved for release to the public by:

David R Hamrin 7/17/96
Technical Information Officer Date
ORNL Site

Membership

C. J. Chance	Tennessee Valley Authority
D. B. Porcella	United States Public Health Service
Price Wilkins	Tennessee Fish and Game Commission
S. I. Auerbach, Chairman	Oak Ridge National Laboratory

Purpose of Work

The objective of the Subcommittee on Aquatic Biology is to provide data on the quantities of radionuclides in the food chains links that lead directly to man (Minutes, Clinch River Study Steering Committee, April 26, 1962). Essentially then, this objective is concerned with fish since these are the primary food sources of man from the Clinch River. The responsibility of the Subcommittee on Aquatic Biology is to originate and develop this information and related data in a form which in turn can be utilized by the Subcommittee on Safety Evaluation in their continuing analysis of Clinch River conditions.

In order to achieve this objective the Subcommittee on Aquatic Biology decided to make a large collection of fish in the Clinch River during the spring and summer, 1962. In order to accomplish this objective, joint teams from ORNL and USPHS were organized and the major collection effort was made in the period May 16-May 24, 1962. The Subcommittee had set an objective of 40 individuals of at least 11 common species of food and game fish. Of this number, half were to be analyzed in the USPHS at Cincinnati and half at the ORNL analytical laboratories.

Fishing was limited to one portion of the Clinch River (CRM 19.1-CRM 4.5). Although a variety of collection devices, including gill nets, hoop nets, trammel nets, and an electric shocker were used, not all the species were taken in sufficient numbers to fulfill the initial goal. Therefore, fishing continued until the required number were obtained, or the goal was not attained as was the case with largemouth bass and sauger.

The status of this work is summarized in Table 1. A total of 390 fish have been caught and processed. Insofar as practical, these were divided between the two groups as shown. In the case of the large game fish, the bulk were taken by the USPHS in expectation that more would be forthcoming which would be handled by ORNL. As the table clearly indicates, radionuclide determinations are less than half completed. Almost complete Sr^{90} series are available for some of the bottom-feeding species. Due to computer difficulties, gamma emitters have not yet been obtained by the USPHS group. Injuries and other responsibilities have served to reduce the ORNL effort. In addition, accidents in processing occasionally resulted in the loss of a sample. In spite of these various handicaps, sufficient data has been gathered, we believe, for initial evaluation.

Sample Processing

After several meetings a uniform sample processing scheme was developed which was followed by both teams (Figure 1). The fish were processed in the field and laboratory to approximate, insofar as possible, normal human utilization. Thus, the exact processing depended upon the fish species and with game fish the size of the individual. All the fish were weighed, measured, scaled, and cleaned, including the head, in the field. The fish were divided into two groups. Group 1 included carp (*Cyprinus carpio*), carpsucker (*Carpiodes carpio*), smallmouth buffalo (*Ictiobus bubalus*), and golden redhorse (*Moxostoma erythrurum*). Group 2 included white bass (*Roccus chrysops*), white crappie (*Pomoxis annularis*), largemouth bass (*Micropterus salmoides*),

Table 1. Fish collected and analyses completed for hazard survey of Clinch River fish.

Species	No. Fish Collected and Agency Analyzing			Analyses Completed			
				USPHS		ORNL	
	USPHS	ORNL	Total	Sr^{90}	Gamma Scan	Sr^{90}	Gamma Scan
White Crappie	20	20	40	0	0	19	19
Bluegill	20	20	40	0	0	20	20
White Bass	20	20	40	0	0	18	18
Largemouth Bass	13	0	13	0	0	-	-
Sauger	13	4	17	0	0	-	-
Drum	20	20	40	0	0	20	20
Catfish	20	20 19	40	0	0	7	7
Carp	20	20	40	0	0	20	19
Smallmouth Buffalo	20	20	40	19	0	12	12
Carpsucker	20	20	40	20	0	19	17
Golden Redhorse	20	20	40	19	0	20	17

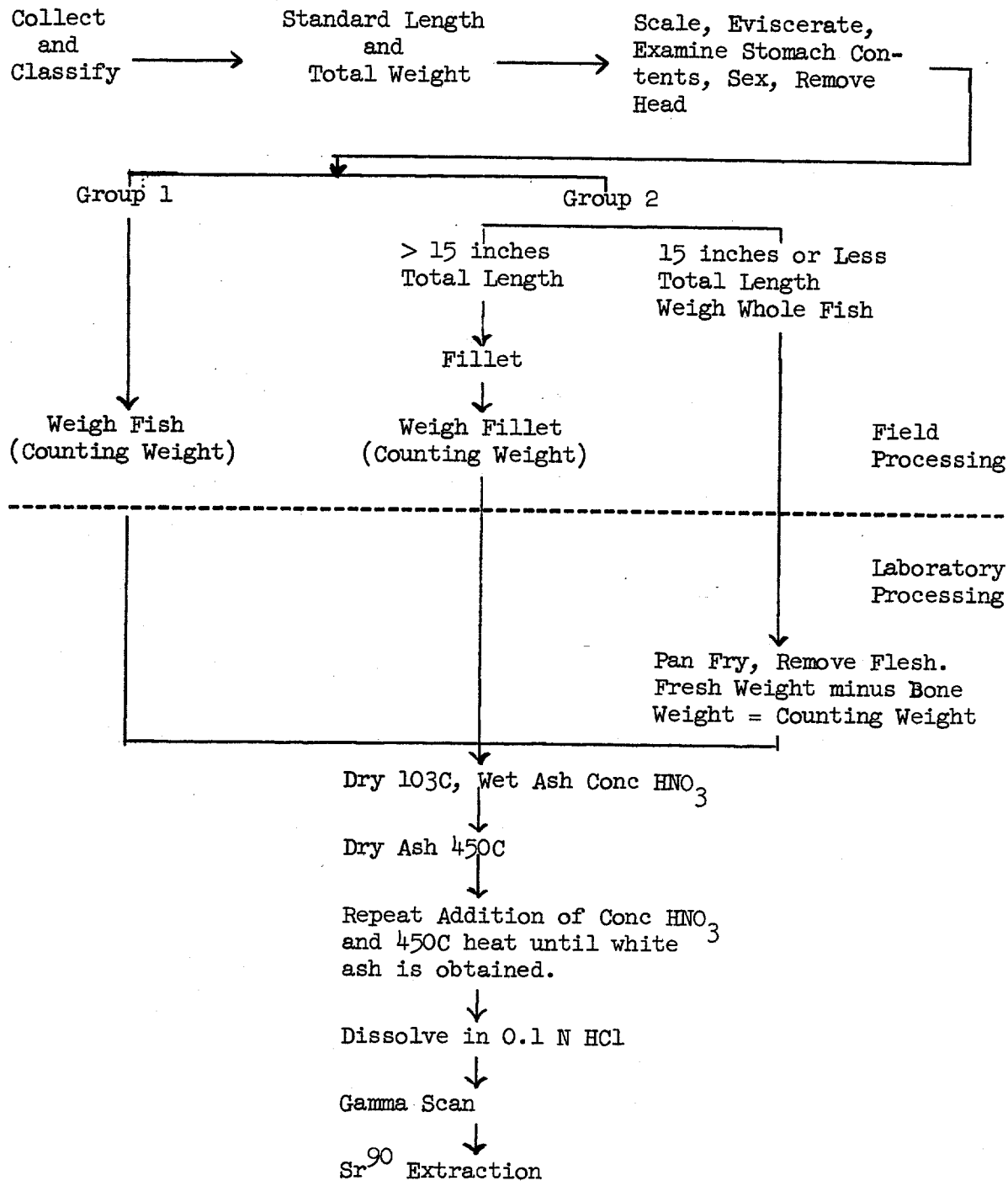


Figure 1. Flow Sheet for Preparation of Fish Samples for Radioanalysis.

bluegill (Lepomis macrochirus), sauger (Stizostedion cauadense), drum (Aplodinotus grunniens), and catfish (Ictalurus spp). The catfish were channel catfish (Ictalurus punctatus) with the exception of one flathead catfish (Pilodictis olivaris).

Fresh weights were taken in the field prior to freezing for subsequent laboratory processing. If fish in group 1 were greater than 15 inches total length, they were filleted and the fresh weight of the fillet was used as the sample weight. Group 1 fish 15 inches or less in length were pan fried, and the cooked flesh was removed for processing. The sample weight was the fresh weight minus the bone weight. Group 2 fish were processed in their entirety, including bones. The sample weight was the fresh weight of the fish.

The processing of the fillets and fried flesh of group 1 fish and the group 2 fish was the same except for minor modifications to cope with the volume of material. All samples were dried at 103 C, wet ashed with conc. HNO_3, and ashed at 450 C. The ash was further treated with conc. HNO_3 and heat until a white ash was obtained. The white ash was dissolved in 0.1 N HCL, with a final volume of 25 to 1000 ml, depending upon the size of the fish. Samples were scanned for gamma emitting isotopes and strontium was precipitated for Sr^{90} determinations.

Results

Results are listed by species in Tables 2-10. In the case of Sr^{90} the counting error is given. For both Sr^{90} and Cs^{137} the extent of variation within the sample series is indicated by the standard error of the mean. In computing averages for each series, all specimens analyzed were included even if the majority of specimens were negative for a particular radionuclide.

Tables 7-10 contain the Sr^{90} determinations made by the USPHS team. For convenience, these have been listed opposite the ORNL values. These are not, however, from the same fish but represent different individuals. The Sr^{90} data for the bottom feeders are

Table 2. White Crappie--analyzed at ORNL (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{95}
	(a)	(b)	(b)	(b)	(b)	(b)
	324 ± 68	13,514				
	18 ± 36					
	68 ± 342					
	32 ± 27	315	504			
	18 ± 40	419				
	54 ± 32	252	1,126			
	171 ± 86	721				
	77 ± 63	1,126				
	0 ± 32	1,306				
	72 ± 72	495				
	41 ± 27	676				
	428 ± 54					
	441 ± 63	901				
	77 ± 41					
	122 ± 68	1,982				
	541 ± 72	901				
	27 ± 45					
	9 ± 50					
	9 ± 32	946				
Average	133.105	1,239.68	85.79			
Standard Error(c)	38.67	693.35				
Range	0-541	0-13,514	0-1,126			

(a) ± 90% confidence limits of count rate.

(b) If blank, none detected.

(c) Standard error of the mean.

(d) NA (not analyzed).

(e) Tr (trace).

Table 3. Bluegill--analyzed at ORNL (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}
	(a)	(b)	(b)	(b)	(b)	(b)
	41 ± 54					
	66 ± 54					
	77 ± 77	1,216				
	68 ± 68	1,847				
	41 ± 72	428				4,279
	77 ± 126					
	59 ± 95					
	63 ± 81	1,171				
	45 ± 45					
	22 ± 41					
	68 ± 32		2,072			
	0 ± 54	279	1,667			
	45 ± 54	901				
	36 ± 45	1,847	1,396			
	86 ± 59					
	41 ± 68	676				
	18 ± 41					
	86 ± 86		2,117			
	122 ± 63	495				
	104 ± 104	1,036				
Average	58.25	494.8	362.6			213.95
Standard Error(c)	6.63	145.33				
Range	0-122	0-1847	0-2117			0-4279

Note: See footnotes on Table 2.

Table 4. White Bass--analyzed at ORNL (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}
	(a)	(b)	(b)	(b)	(b)	(b)
	41 ± 23					
	5 ± 14	270				
	23 ± 9	266	Tr(e)			
	41 ± 14	248	149			
	59 ± 18	667				
	23 ± 9	617				
	18 ± 9	977				
	32 ± 18	1,734				
	36 ± 18					
	9 ± 9	324				
	9,153 ±122	2,761				
	135 ± 18	392				
	27 ± 14	518				
	14 ± 9	1,532				
	14 ± 9	324				
	27 ± 14	640				
	32 ± 14	671				
	27 ± 9	369	392			
Average	539.777	683.888	30.05			
Standard Error(c)	506.704	163.41				
Range	5-9153	0-2761	0-392			

Note: See footnotes on Table 2.

Table 5. Drum--analyzed at ORNL (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{96}-Nb^{95}	Co^{60}	Zn^{65}
	(a)	(b)	(b)	(b)	(b)	(b)
	153 ± 90					
	18 ± 23	2,302				
	59 ± 41					
	0 ± 45	806				
	68 ± 54	761				
	18 ± 32	554		946		
	54 ± 9					
	27 ± 58					
	90 ± 27					
	76 ± 45	531				
	18 ± 13	139				
	315 ± 315	482				
	81 ± 81					
	0 ± 63	482				
	31 ± 22					
	27 ± 27					
	18 ± 67					
	45 ± 63					
	202 ± 54					
	72 ± 49	581				
Average	68.6	331.9		47.30		
Standard Error(c)	17.15	122.8				
Range	0-315	0-2302		0-946		

Note: See footnotes on Table 2.

Table 6. Catfish--analyzed at ORNL (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}
	(a)	(b)	(b)	(b)	(b)	(b)
	90 ± 135	Tr(e)				
	180 ± 135					
	90 ± 45	369	359			
	90 ± 135	Tr				
	90 ± 180					
	0 ± 90	Tr				
	90 ± 45					
Average	90.00	52.71	51.29			
Standard Error(c)	19.64					
Range	0-180	0-369	0-359			

Note: See footnotes on Table 2.

Table 7. Carp--analyzed at ORNL and Sr^{90} analysis by USPHS (μμc/kg fresh weight)

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}	USPHS Sr^{90}
	(a)		(b)	(b)	(b)	(b)	
	8,198 ± 270	532					745
	3,065 ± 180	486					3,312
	676 ± 135	694		Tr(e)			1,740
	2,072 ± 180	725					1,647
	6,667 ± 225	441	667				2,360
	2,252 ± 180	450	450				1,200
	1,126 ± 135	135		Tr			5,295
	8,378 ± 495	320					5,467
	4,279 ± 315	1,248					1,210
	6,306 ± 405	959					7,435
	1,847 ± 225	527					530
	5,135 ± 360	874	Tr		54		2,031
	47,207 ± 765	2,297	1,640		81		970
	1,532 ± 225	477	320				1,747
	53,378 ± 766	1,036	1,054		207		4,009
	5,180 ± 360	779					217
	11,036 ± 270	248					1,997
	811 ± 90	523	Tr		59		963
	1,532 ± 225	NA(d)	NA	NA	NA	NA	111
	135 ± 45	158		99			580
Average	7,943.65	679.42	217.421	5.21	21.105		2178.30
Standard Error(c)	3,317.73	112.60					400.766
Range	135-53,378	135-2297	0-1640	0-99	0-207		111-7435

Note: See footnotes on Table 2.

Table 8. Smallmouth Buffalo--analyzed at ORNL and Sr^{90} analyses by USPHS

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}	USPHS Sr^{90}
	(a)	(b)	(b)	(b)	(b)	(b)	
	135 ± 90						1,196
	1,396 ± 90	162					800
	856 ± 405	1,297					547
	631 ± 90	302					181
	405 ± 90	428	185				2,474
	811 ± 90	1,446					1,550
	405 ± 90	122					640
	1,036 ± 135	1,874					365
	1,036 ± 180	1,086					1,200
	405 ± 135	1,041					510
	1,126 ± 135	545	338				2,800
	405 ± 90	351					163
							890
							343
							1,050
							1,290
							660
							290
							270
Average	720.58	756.73	43.58				906.263
Standard Error(c)	109.93	177.75					168.401
Range	135-1396	0-1874	0-338				163-2800

Note: See footnotes on Table 2.

Table 9. Carpsucker--analyzed at ORNL and Sr^{90} analyses by USPHS

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}	USPHS Sr^{90}
	(a)		(b)	(b)	(b)	(b)	
	315 ± 90	851					3,327
	180 ± 45	351					1,638
	541 ± 45	802					450
	495 ± 45	NA(d)					550
	766 ± 90	NA					760
	1,441 ± 90	1,189		59			1,220
	901 ± 90	505					419
	1,216 ± 90	694					993
	676 ± 90	554					65
	495 ± 90	491	Tr(e)				266
	776 ± 90	1,036					1,391
	315 ±1878	~~590~~					2,150
	946 ± 90	1,086					3,523
	315 ±1756	~~239~~					210
	1,666 ± 90	1,414					300
	1,396 ± 90	1,428					450
	~~1,729 ±1874~~	~~239~~					1,705
	315 ± 45	784					863
	586 ± 45	545					343
							936
Average	792.63	752.82		3.47			1,077.95
Standard Error(c)	111.139	90.33					167.576
Range	315-1729	239-1428		0-59			65-3523

Note: See footnotes on Table 2.

Table 10. Golden Redhorse--analyzed at ORNL and Sr^{90} analyses by USPHS

	Sr^{90}	Cs^{137}	Ru^{106}	Zr^{95}-Nb^{95}	Co^{60}	Zn^{65}	USPHS Sr^{90}
	(a)		(b)	(b)	(b)	(b)	
	2,117 ± 180	1,486					140
	2,838 ± 270	2,162					736
	1,667 ± 270	716					800
	1,486 ± 225	707					1,468
	495 ± 360	369					1,719
	2,477 ± 135	581					780
	1,171 ± 135	302					607
	676 ± 90	180					1,650
	1,216 ± 135	1,059					620
	676 ± 180	419					3,320
	1,396 ± 180	NA(d)	NA	NA	NA	NA	230
	586 ± 180	NA	NA	NA	NA	NA	1,035
	1,081 ± 225	860					1,470
	946 ± 180	NA	NA	NA	NA	NA	1,210
	1,532 ± 225	315					220
	1,261 ± 90	387					760
	45 ± 531	~~1,441~~					3,290
	1,171 ± 90	707					1,830
	8,333 ± 360	297					835
	59 ± 495	~~1,662~~					
Average	1546.45	802.94					1,195.789
Standard Error(c)	392.79	138.85					205.866
Range	45-8333	180-2162					140-3,320

Note: See footnotes on Table 2.

summarized in Table 11. A striking difference in carp values exists between the two sets of determinations. The ORNL values are almost 4 times greater than the USPHS ones. At present we have no explanation for this difference. We are currently exchanging a number of processed samples to determine if this difference is related to a difference in radiochemical separation or to a possible difference in flesh processing between the two laboratories.

The major factor governing the method used in processing a fish species was the way the species is normally prepared for human consumption. On this basis, the flesh and bones of the bottom feeders were ground together. This method of preparation accounts for the significantly higher Sr^{90} burdens in these species. Because of these burdens the Subcommittee attempted to develop further information on the total quantities harvested from Watts Bar Reservoir, the proportion of total East Tennessee catch, represented by Watts Bar fish, and the proportional amounts shipped to various market centers. These data are summarized in Tables 12 and 13. Of particular interest was the fact that all the carp are marketed within the state of Tennessee--in the cities of Nashville and Memphis, where we suspect, they are primarily sold to the Negro population.

The data on game fish are meagre in comparison. In Table 14 we have summarized the data received on the number of 1960-1961 resident and non-resident licenses sold in the counties indicated. Not indicated are data from Anderson, Meigs, Knox, and Hamilton counties, all of which contribute to the fishing pressure on Watts Bar. Nor do we have data on county resident (non-license) fishing pressure. Certainly the resident figures shown can be increased by at least a factor of two--perhaps more, to reflect the true fishing pressure. For example, the State Fish and Game Commission conducted a partial creek census on Watts Bar Reservoir from March 1 through May 15, 1961. During this period they issued cards to 1213 fishing parties which represented approximately 2,444 fishermen. This figure was for only a part of the year. Of these individuals, 3.85% were non-residents

Table 11. Summary of Sr^{90} analyses of carp, smallmouth buffalo, carpsucker, and golden redhorse by ORNL and USPHS (μμc/kg fresh weight)

	ORNL	USPHS	Average All Fish
Carp			
Mean	7943.6	2178	5060.9
S.E.	3317.7	440.7	1715.1
Range	135-53,378	111-7435	111-53378
Smallmouth Buffalo			
Mean	720.6	906.3	834.4
S.E.	109.9	168.4	111.4
Range	135-1396	163-2800	135-2800
Carpsucker			
Mean	792.6	1078	938.9
S.E.	111.1	167.6	125.4
Range	315-1729	65-3523	65-3523
Golden Redhorse			
Mean	1546.4	1195.8	1375.6
S.E.	392.8	205.9	233
Range	45-8333	140-3320	45-8333

Table 12. Commercial fish harvest from Watts Bar Reservoir and the total harvest from East Tennessee

	Carpsucker	Carp	Smallmouth Buffalo
Watts Bar Reservoir	15,608 lbs	23,667 lbs	161,304 lbs
East Tennessee	61,676	135,016	327,302
Fish Dilution Factor*	3.95	5.70	2.03

$$* \text{ Fish dilution factor} = \frac{\text{Lbs of East Tennessee Fish}}{\text{Lbs Watts Bar Fish}}$$

Since there is no commercial fishery on the Clinch River, an average water dilution factor of 5.6 may be applied to the Watts Bar fish in addition to the fish dilution factor.

Fish and Water Dilution Factor	22.12	31.92	11.37

Table 13. Distribution of commercial fish from East Tennessee to consumer markets.*

Species	Consumer Markets	Percentage
Smallmouth Buffalo	Chicago, Illinois	40
	Louisville, Kentucky	30
	Memphis, Tennessee	30
Carp	Nashville, Tennessee	50
	Memphis, Tennessee	50
Carpsucker	Chicago, Illinois	10
	Nashville, Tennessee	45
	Memphis, Tennessee	45

* Estimates from Mr. Harold LaTendresse of Johnny's Fish Company, Knoxville, Tennessee.

Table 14. Resident and Non-resident Fishing Licences for 1961-62

Type Licence	Roane County	Rhea County
Resident hunting and fishing	7,613	3,068
Non-resident fishing	187	185
Non-resident 3-day trip	1,853	1,963
Non-resident 10-day trip	622	1,142

Table 15. Distance traveled by fishermen fishing in Watts Bar Reservoir and the Clinch River. Distances (air line miles) were determined from fish tag return data.

Species Caught	Miles 0-50	51-100	101-150	151-200	201-250	Total
White Bass	81	43	3	3	1	131
White Crappie	20	0	2	0	0	22
Channel Catfish	12	0	0	0	0	12
Sauger	7	0	0	0	0	7
Smallmouth Buffao	5	0	0	0	0	5
Carpsucker	3	0	1	0	0	4
Carp	3	0	0	0	0	3
Blue Catfish	2	0	0	0	0	2
Skipjack	2	0	0	0	0	2
Walleye	1	0	0	0	0	1
Spotted Bass	1	0	0	0	0	1
Drum	1	0	0	0	0	1
Golden Redhorse	1	0	0	0	0	1
Bluegill	1	0	0	0	0	1
	140	43	6	3	1	193
Per cent of total returns	72.5	22.3	3.1	1.6	0.5	100

of Tennessee. During the vacation months of June, July, and August, this proportion would be greater. Using the data derived from our fish tagging studies performed last year, we attempted to determine the area of maximum consumption of Clinch River fish--either caught in the Clinch River or in Watts Bar Reservoir. These data are summarized in Table 15. Of the fish tagged, the greatest percentage (72.5) were utilized within 50 miles of the site of capture.

As additional analyses are completed on this series, they will be made available immediately to the Subcommittee on Safety Evaluation through the Chairman of the Clinch River Committee. Likewise, any additional data on population fishing pressure which can be obtained also will be transmitted. In supplying these data the Subcommittee believes it has discharged its initial assigned responsibility.

Respectfully submitted,

SUBCOMMITTEE ON AQUATIC BIOLOGY

S. I. Auerbach, Chairman

Nelson

PROGRESS REPORT NO. 1

SUBCOMMITTEE ON AQUATIC BIOLOGY

CLINCH RIVER STUDY

April 26, 1962

Membership

C. J. Chance	(Tennessee Valley Authority)
D. B. Porcella	(United States Public Health Service)
Price Wilkins	(Tennessee Fish and Game Commission)
S. I. Auerbach, Chairman	(Oak Ridge National Laboratory)

Purpose of Work

The objective of the biological phase of the Clinch River Survey is (a) to develop information on the extent to which radioactive contamination of the river biota may be an immediate and/or long term hazard to human populations, (b) to develop data which will provide a basis for estimating the capacity of the river for continuous input of radioactive wastes, and (c) evaluate the possible long term effect of ionizing radiation on the biotic communities in this environment.

The objectives, areas of investigation, and the specific studies underway by the several agencies concerned with the biological phases of the Clinch River Program are listed in detail in the Scope and Outline of Work of the Subcommittee on Aquatic Biology, which is being submitted to the Clinch River Program Steering Committee on April 26, 1962.

In future reports, organization of submitted material will attempt to adhere to the outline of work as finally approved by the Steering Committee. Much of the material to be included in the reports of this committee will be data for the use of the Subcommittee on Safety Evaluation. Syntheses and interpretation of results will be included when available, although such reports primarily will be prepared for publication in the open literature. Upon occasion special reports of member agencies, which are relevant to the Clinch River Study will also be included.

1.0 Studies on the kinds, quantity, movement, and turnover of biomass in the Clinch River (Biological Relationships).

1.1 Flora and fauna of the river community.

First Report--Melton Hill Preimpoundment Studies
C. J. Chance
Fish and Wildlife Branch
Tennessee Valley Authority

Investigation of fishery and other ecological conditions in the Clinch River area to be impounded by Melton Hill Dam was

initiated in 1960. Purposes of this project are to determine (1) the existing composition and abundance of river fishes for possible management recommendations prior to and immediately following impoundment, (2) the present quality and value of fishing and associated recreation for comparison with future lake values, (3) the seasonal movements of various fishes such as sauger and white bass as well as rough fishes, from Watts Bar Lake below up into the Melton Hill area, and (4) the quality of the water for possible extended trout habitat downstream from Norris tailwater. Furthermore, preliminary data will be collected for use in connection with the effects of the future Bull Run Steam Plant to be erected within the Melton Hill Reservoir project area.

Melton Hill Dam site is located 23 miles above the mouth of the Clinch River, near the head of Watts Bar Reservoir. At maximum pool level of 795 feet M.S.L., it will back water up 44 miles with the head of the reservoir 8 miles above Clinton, about 1/2 mile above Highway 61 Bridge. There will be one lock 75 x 400 feet and a 9-foot navigation channel extending uptstream to the Eagle Bend area above Clinton. Inflow will be regulated almost completely by Norris Dam, 57 miles upstream. At maximum pool, there will be 140 miles of shoreline and surface area of 5,720 acres. The dam is scheduled for completion in the spring of 1963. Construction of the two-unit steam plant to be located near Edgemoor Bridge, about Mile 48, is scheduled to be initiated in 1965.

To date, information on fisheries has been obtained from two rotenone samples in the main river as well as a few in tributary pools, and seasonal gill- and hoop-net collections at regular established stations. With normal operation of Norris Dam, river flows are too high for satisfactory use of nets. Therefore, netting operations are largely limited to occasional periods when discharge below Norris is cut off for several days. Following is a summary of fishery data collected in the Melton Hill area during this first year 1960-61:

Rotenone--In connection with a study of water quality and fishery conditions for trout in the Norris tailwater, a half-mile pool below Highway 61 Bridge was rotenoned July 24, 1960, and again on November 2, 1960. In July, 292 fish with a total weight of 130 pounds were collected. Only 6 game fish were taken--4 smallmouth bass and 2 rock bass. No trout were collected with rotenone but fishermen had caught a few at this point, 13 miles below Norris Dam. Miscellaneous minnows, darters, and other forage fishes were very abundant as were rough fishes. Gizzard shad, drum, black, and golden redhorses accounted for over 75% of the total sample weight. Water temperature was about 65°F. In November, the water temperature dropped to 55°F. just prior to the sample and few fish were collected. However, four trout

were collected, whereas none were taken here in the midsummer sample. Normally this section of the river in summer is below the best trout habitat, but as the discharge water becomes warmer in the fall, trout move downstream to deeper, cooler pools. This area, at the upper end of the planned Melton Hill pool, may contain suitable trout waters after impoundment, even though rough fish will probably also be very abundant. Fall rotenone sampling of tributary pools was generally unsuccessful because of cold water and abnormally high flows. Rotenone in warmer periods, creosol, and electric-shocking apparatus will be used more extensively in future tributary sampling.

Gill and Hoop Nets--Three areas with good car and boat access were located as suitable permanent netting stations in September 1960 as follows: below Old Edgemoor Bridge, Mile 47-48; AEC Reactor Station, Mile 33-34; and above the dam site, Mile 23-24. In the initial net samples at these stations in November 1960, a variety of nets were used, but in later collections the number and type of net including 1- to 2-1/2-inch mesh gill nets and 2-inch hoop nets was standardized for comparative purposes. Although access is poor, a fourth netting station below Highway 61 Bridge at the head of the reservoir area was established for the second sample. A summary of the netting results by station and season is shown in the accompanying table (Table 1).

Rough fishes have dominated the net catches at all stations, which is not considered unusual, since the present river habitat is more favorable to rough species, and no concentration points, such as dams, are available for game fishes. Of the grand total of nearly 1,000 fish weighing over 1,400 pounds netted to date, only 5% of the number and 2.5% of the weight were game fish. Game species found in the future reservoir area include sauger, white bass, white crappie, spotted bass, bluegill, rock bass, warmouth, and rainbow trout. The collection of 6 specimens of adult trout at the uppermost netting station in June 1961 further indicates that this section will contain suitable trout habitat in some seasons after impoundment.

Twenty-one species of rough fish have been netted in the preimpoundment collections including 2 species of gar, 4 shad (gizzard, threadfin, mooneye, river herring), 2 carpsuckers, 2 buffaloes, 5 redhorses, 3 other suckers (white, blue, and hogsucker), carp, drum, and channel catfish. At least 12 of these species have some commercial value, and it can be expected that Melton Hill Reservoir will support a sizeable commercial fishery. Furthermore, there are numerous flat areas and cleared fields within the reservoir area that will permit use of previously untried commercial gear such as trawls and haul seines. The rough fish composition of the net catches to date has been dominated by gizzard shad; mooneye; redhorses, particularly shorthead and silver; longnose gar; and river carpsucker.

Table 1

Summary of net collection data from four stations in the Melton Hill Reservoir area of the Clinch River, 1960-61. Number of net days in ()

Date	Game Fish		Rough Fish		Total fish per net day		
	No.	Wt. (lbs.)	No.	Wt. (lbs.)		No.	Wt. (lbs.)
ABOVE MELTON HILL DAM SITE, Miles 23-24							
Nov. 14-15, 1960	2	1.3	272	283.4	(7)	39.2	40.7
Feb. 9-10, 1961	1	1.2	6	4.9	(8)	0.9	0.8
June 22-23, 1961	4	2.5	120	202.0	(8)	15.5	25.3
Total	7	5.0	398	490.3	(23)	17.6	21.5
AEC REACTOR SITE, Miles 33-34							
Nov. 9-11, 1960	5	5.9	81	136.9	(14)	6.2	10.2
Feb. 9-10, 1961	1	1.6	13	21.0	(8)	1.7	2.6
June 22-23, 1961	1	1.4	47	83.0	(8)	6.0	10.6
Total	7	8.9	141	240.9	(30)	4.9	8.3
EDGEMOOR BRIDGE, Miles 47-48							
Nov. 7-9, 1960	4	6.0	174	264.6	(12)	14.8	22.5
Jan. 6-7, 1961	2	2.6	68	108.4	(7)	10.0	15.9
June 22-23, 1961	6	2.7	46	88.9	(8)	6.5	11.5
Total	12	11.3	288	461.9	(27)	11.1	20.5
BELOW HIGHWAY 61 BRIDGE, Mile 66							
Feb. 10-11, 1961	1	0.5	7	3.8	(5)	1.6	0.9
June 22-23, 1961	23	11.1	114	173.9	(8)	17.1	23.1
Total	24	11.6	121	177.7	(13)	11.3	14.6
Grand Total	50	36.8	948	1,370.8	(93)	10.7	15.1

On a comparable net-day basis, the lowest station, just above the dam, has produced the best results in both number and weight of fish caught. This area contains the deepest channel water and in most seasons is within the backwater of Watts Bar Reservoir below. The poorest catches have consistently been at the next station upstream near the AEC Reactor site. The third station upstream below the Edgemoor Bridge was the second best area for netting results. It is near this station that the future Bull Run Steam Plant will be located. The very low catches at three of the stations in February resulted from very high flows from swollen streams below Norris Dam, together with large amounts of floating algae and debris and near-freezing temperatures (38°) during the sample period. The Edgemoor station had been sampled a month earlier under normal river conditions and water temperatures of 50°. The total effort of 93 net sets at all stations yielded an average catch of 10.7 fish weighing 15.1 pounds per net.

Considerable seasonal movement of various species from Watts Bar Reservoir may be expected after impoundment. Of the game fishes, sauger, white bass, and crappie will move into the area below the dam and through the locks. Various suckers and other rough species will migrate to the headwaters in spring. In the samples to date, mooneye, blue sucker, and silver redhorse were much more abundant in the fall than the winter and spring collections, whereas largest numbers of river carpsuckers and buffalo were taken in spring. With water temperature ranging from 64° near the dam to 70° in the headwaters in the early June sample, river redhorse, river carpsucker, and drum had still not spawned, although females were quite ripe.

1.5 Human use of aquatic natural resources.

1.5.2 Determination of the harvest by commercial fishermen.

Submitted by C. J. Chance, Tennessee Valley Authority

Estimates of commerical fish harvested from Watts Bar Reservoir during the 4 year period 1958-1961 are summarized in Table 2. Of the categories listed, quillback, buffalo, and carp are shipped to northern market centers (New York, Chicago, and St Louis) where they are used strictly for human consumption. Paddle fish and cat fish are sold locally within the state of Tennessee for human food also.

2.0 Determination of radionuclide content in Clinch River biomass as related to location, position in the ecological food chain, season, and use as human food (Radionuclide Accumulation).

Table 2

COMMERCIAL FISH HARVEST - WATTS BAR RESERVOIR - 1958-61

Year	Species by weight									Total weight	Wholesale value
	Paddlefish	Catfish	Drum	Quillback	Buffalo	Carp	Sturgeon	Gar	Turtles		
1958	12,175	54,333	3,935	8,240	15,687	8,058	-	-	-	102,430	$20,931.18
1959	27,450	83,065	5,995	53,990	54,035	20,595	15	-	-	245,145	39,771.70
1960	25,430	66,080	5,460	30,660	63,705	22,170	-	-	-	213,505	33,971.10
1961	38,910	50,367	1,476	17,068	59,328	13,149	-	-	232	180,530	24,900.31

These data provide some idea of the magnitude of the current commercial fishery business on Watts Bar Reservoir. In so far as we know, these fish are used only for human food.

Inasmuch as a reduction in the abundance of such species is considered a sound practice in modern fish management, we anticipate that the harvest of these fish will be promoted, encouraged, and increased.

CJChance 3-14-62

2.3 Radionuclide content of principal fish species.

Expected body burden, q, of Sr^{90} resulting from the continuous consumption of food and game species of fish caught in the Clinch River.

Submitted by D. J. Nelson, Oak Ridge National Laboratory.

In a previous report (Status Report No. 1, Clinch River Study) a preliminary hazard evaluation of the Sr-90 in fish was prepared using analyses of fish flesh submitted by the Public Health Service and reported in their quarterly survey. The present report is also based on analyses of fish collected during Man and September 1960 by the U. S. Public Health Service and analyzed at the U.S. PHS Laboratory in Cincinnati. These analyses were submitted at the November 1961 meeting of the Clinch River Steering Committee by the U.S. PHS.

The Sr-90 content of 19 individual fish representing 6 species caught in May 1960 was:

Species	Location of Catch Clinch River Mile	Sr-90 μμc/kg wet wt.
Carpsucker	19.6	50
"	"	1600
"	"	175
"	"	120
Redhorse	"	24
Buffalo	"	160
Redhorse	14.6	5
"	"	40
Carpsucker	"	75
"	"	120
"	"	190
"	"	55
Channel catfish	"	60
"	"	65
Carp	4.5	5
"	"	90
Carpsucker	"	35
"	"	35
Flathead catfish	"	28
	Average Concentration	154 μμc/kg

The following assumptions and criteria were used to evaluate the expected human body burden:

1. One-half pound of fish is eaten each week (32.4 g/day).

2. Data pertaining to Sr-90 are from Report of Committee II ICRP, 1958 Revision.

a. Bone is the critical organ.

b. The effective half-life of Sr-90 in bone is 6.4×10^3 days.

c. 0.09 of the ingested Sr-90 is deposited in bone.

d. Sr-90 reaches 86% of its equilibrium value in humans in 50 years.

3. The equilibrium value calculation is based on the exponential model for critical organs other than the GI tract.

$$qf_2 = P\,(1-e^{-\lambda t})/\lambda$$

P is the rate of ingestion of Sr-90 in μc/day.
For long period of time $(1-e^{-\lambda t})$ becomes one.
λ is the effective decay constant 0.693/T.

$$\text{Therefore, } qf_2 = \frac{32.4 \times 0.154 \times 10^{-6} \times 0.09}{0.693/6.4 \times 10^3}$$

$$= \frac{0.449 \times 10^{-6}}{0.108 \times 10^{-3}}$$

$$= 4.16 \times 10^{-3}$$

The 50-year burden is 86% of this or 3.58×10^{-3} μc Sr-90. The maximum permissible body burden in bone for occupational exposure is 2 μc and for the population at large 1/30 of this or 6.67×10^{-2} μc. Thus, a member of the population at large eating these Clinch River fish in the manner stated would accumulate 5.37% of his maximum permissible body burden.

The Sr-90 content of 14 fish representing 8 species caught in September 1960 was:

Species	Location of Catch Clinch River Mile	Sr-90 μμc/kg wet wt.
Carpsucker	19.6	120
"	"	3160
"	"	1190
Quillback	"	840
Carpsucker (river)	14.6	80
"	"	640
"	"	470
Carp	"	6700
Redhorse	4.5	1800
"	"	1700
"	"	1000
Channel catfish	14.6	800
Smallmouth bass	4.5	850
Bullhead	4.5	490
	Average Concentration	1417 μμc/kg

The body burden expected from the continuous consumption calculated as before is:

$$qf_2 = \frac{32.4 \times 1.417 \times 10^{-6} \times 0.09}{0.693/6.4 \times 10^3}$$

$$= \frac{4.13 \times 10^{-6}}{0.108 \times 10^{-3}}$$

$$= 38.2 \times 10^{-3}$$

The expected 50-year burden is 32.9×10^{-3} μc.

This burden is 49% of the permissible body burden for an individual in the population at large.

Greater concentrations of Sr-90 were expected in fish caught in the summer than in the winter. The analyses listed here tend to support this expectation. However, the range of Sr-90 contents of fish from both sampling periods should be noted. There is a range over 2 to 3 orders of magnitude. In the May 1960 sample the inclusion of 1 carpsucker from CRM 19.6 effectively doubled the average Sr-90 concentration for the entire collection. Additional fish were obtained from CRM 79.8 in May 1960 (Norris Dam is located at CRM 80.0) and included in the tabular data by the U.S. PHS. Two carp (composited sample) and 3 channel catfish (composited sample) contained 37 to 215 μμc Sr-90/kg, respectively. These Sr-90 concentrations are within the range of Sr-90 concentrations of fish from the Clinch River downstream from White Oak Creek.

Because of the variability of the data and because of the apparent migration of contaminated fish, it should be emphasized that these small samples are not adequate for a definitive evaluation of the hazard status of Clinch River fish. Therefore, if sufficient funds are available for radiochemical analyses, a sample of about 200 fish from the Clinch River will be collected and analyzed for radionuclides released by the laboratory. The data obtained from this sample should give a statistically reliable estimate of radionuclide concentrations in Clinch River fish. Fish movement studies and laboratory studies of the biological half-lives of elements which are fission products will enable us to determine the potential hazard associated with fish migrations into and out of the contaminated portion of the Clinch River.

3.0 Investigation of the rates of uptake and turnover of radionuclides by fish and other biota in relation to chemical and other environmental factors (Chemical Relationships).

3.1 Chemical (stable) analyses of organisms.

Strontium in clams.
Submitted by D. J. Nelson, Oak Ridge National Laboratory

Previous studies showed that fresh-water clams are sensitive indicators of the behavior of Sr-90 in the Clinch-Tennessee River system. Clams act as integrating samplers of Sr-90 in the environment. Since their shells are deposited in annual layers, it may be possible to determine the history of Sr-90 releases to an environment from analyses of the individual layers. In the previous study, analyses of whole shells suggested Sr was not distributed homogeneously throughout the shell and that the Sr content increased with age. Therefore, four Elliptio crassidens shells were sectioned and the shell deposited in each year of growth was analyzed. The results suggested that Sr deposition in clam shells was directly proportional to growth rate and inversely proportional to the surface-volume ratio. However, it was apparent that inherent differences related to the shell structure of different clam species were possibly a factor affecting the Sr concentration in clam shells.

Knowledge of the distribution of Sr in present-day clam shells and in clam shells from prehistoric deposits may be used in interpreting the Sr cycle in the environment as well as for determining the behavior of Sr-90. Consequently, the shells of 6 additional species were sectioned, annual shell deposits were separated and analyzed for Sr.

The shells of the clams studied, when viewed in cross-section, consist of 3 distinct layers. The external prismatic layer is relatively thin and contributes little to the total shell. The remaining two layers, both nacreous, comprise the bulk of the shell and the relative contribution which each makes to the total shell differs with the species. The medially located peripheral nacreous layers consist of imbricate lamellae deposited by the peripheral edge of the mantle. The inner laminar nacre is composed of lamellae deposited within the area bounded by the pallial line. When a clam grows, the shell increases in length by the addition of peripheral layers and increases in thickness by the addition of laminar layers.

The previously reported analyses of E. crassidens shells showed that there was more Sr in the laminar nacre than in the peripheral nacre. Also, the Sr content of the peripheral nacre was relatively constant with age while Sr increased with age in the laminar layers. In the 6 additional species analyzed the results agree with previous findings in that there is a higher Sr content in laminar layers than peripheral layers. With the exception of both E. dilatatus and 1 of the Lasmigona complanata shells analyzed, the

Sr concentration in the laminar nacre increased with age. Thus, it appears that growth rate and surface-volume ratio are the 2 major factors explaining Sr deposition in $CaCO_3$ clam shells. The reasons for the exceptions are not known.

The shell fractions were analyzed with a modification of a spectrograph which is capable of obtaining quantitative determinations of Ba, Na, Mg, and Mn along with Sr. It is apparent that Na is relatively constant throughout the shell but Ba and Mn appear to have a distributional pattern similar to that of Sr. The distribution of these elements in the clam shells will be tested with a statistical correlation analysis.

Notes for tables on clam shell analyses:

1. Pr, prismatic layer.
2. P, peripheral nacre.
3. L, laminar nacre.
4. All values in μg/g shell ash weight.
5. Numbers in heading refer year class of layer in shell.

Sr in white crappie flesh and bone
Submitted by D. J. Nelson, Oak Ridge National Laboratory

When the distribution of Sr between fish and water is known, it should be possible to predict the levels of Sr-90 to be found in fish living in water receiving a constant release of Sr-90. Therefore, the relationship

$$\frac{\text{Sr in fish tissue}}{\text{Sr in water}} = \frac{\text{Sr-90 in fish tissue}}{\text{Sr-90 in water}} \quad \text{or,}$$

$$\text{Sr-90 in fish tissue} = \frac{\text{Sr in fish tissue} \times \text{Sr-90 in water}}{\text{Sr in water}}$$

may be used to calculate the expected burden for a constant release of Sr-90. The flesh and bone of white crappies are being analyzed for Sr in order to make these predictions.

The concentrations of Sr in flesh of 9 white crappies are: 6.6, 10.3, 8.6, 9.6, 5.4, 4.6, 6.8, 6.4, and 6.5 (average 6.6) all times 10^{-8} g Sr/g flesh, wet weight. Sr concentrations in Clinch River water average 5.9×10^{-8} g Sr/g water (Status Report No. 2, Clinch River Study). For convenience the MPC of Sr-90 in water, occupational exposure, of 1×10^{-12} curies/cc may be used to estimate the expected body burden in fish. The body burden calculated on this basis is 1.12×10^{-12} curies Sr-90/g flesh (1120 μμc/kg). When the Sr-90 determinations are completed on these fish, the actual body burden may be expressed as a fraction of that expected at MPCw.

	1	2	3	4	5	6	7	8	9	10	11
Sr											
Pr	185	190	175	170-190	205	195-185	205-225	170	175	195-210	190-210
P	180	180	170	180	190	175	175	170	180	190	200-205
L	175	185	190-200	205-215	215	215-235	215-220	210	200-235	220-235	270-265
Ba											
Pr	30	10	9	9	15	20- 25	210	25	9	10- 10	30- 40
P	10	7	7	9	10	20	65	9	10	10	20- 25
L	10	7	8- 8	9- 10	15	30- 30	65-100	15	10- 10	10- 10	25- 35
Na											
Pr	1250	1250	1450	1200-950	1400	1350-910	1150-970	1350	1300	1350-1000	1200-950
P	1200	1250	1550	1300	1250	1500	1450	1300	1350	1400	1300-850
L	1300	1050	1150-850	1400-850	1250	1400-1000	1350-950	1250	1150-1000	1250-800	1150-850
Mg											
Pr	200	50	40	50- 55	45	40- 50	50- 55	60	90	100-105	110-125
P				35	45		45	55	70	70	55- 70
L			35	30	30	40		30	35- 45	35- 40	35- 40
Mn											
Pr	710	765	745	1900	900	1450	1750	1050	1000	1450	1900
P	650	225	540	500	275	485	550	360	600	795	1725
L	700	950	1900	1400	1100	1700	1850	1150	1500	1450	2000

Lasmigona complanata 470

	1	2	3	4	5	6	7	8
Sr								
Pr	275	350- 335	225- 235	205- 195	195	205- 205		
P	175	325- 320	175	155	165	170	180	200- 225
L		305- 320	250	205- 215	240- 250			
Ba								
Pr	45	34- 35	35- 40	12- 9	11	20- 17		
P	15	55- 55	10	9	11	10	20	20- 25
L		27- 48	70	12- 11	18- 18			
Na								
Pr	1200	1150- 925	1250-1000	1050-1050	1200	1050- 950		
P	1150	1150-1150	1500	1150	1350	1400	1150	1050-1050
L		1300-1000	1500	1250-1050	1150- 900			
Mg								
Pr	65	50- 45	40- 35	35- 40	50	50- 80		
P								
L								
Mn								
Pr	900	2800	1400	1600	1150	2200		
P	200	350- 400	250	220	300	400	1050	1500
L		2100	1150	1450	1750			

Anodonta corpulenta 635

	1	2	3	4	5	6	7	8	9-10
Sr									
Pr	165	155	150	145	145	180	145-140		
P		125	145	150	~ 120	120	150	115	120
L	135	145	155	165	170	170	220	140	185
Ba									
Pr	65	80	30	40	50	45	50- 75		
P		40	40	65	60	40	50	45	45
L	50	60	45	80	75	60	70	65	80
Na									
Pr	1050	990	950	1000	1000	1150	1130-1000		
P		960	900	960	840	880	940	1000	850
L	1000	950	910	1100	1150	1100	1250	1050	1100
Mg									
Pr	50	65		50		55	80- 85		
P									
L	~ 80	65	50	60	55	50	60	60	75
Mn									
Pr	590	800	1300	1800	1700	2000	3300		
P		250	480	570	590	470	780	810	760
L	340	560	760	1000	1000	770	1300	1050	1400

Anodonta corpulenta 630

	1	2	3	4	5	6	7	8
Sr								
P	165	160	140	145	145	230	155	200
L	235	225	230	270		470	340	
Ba								
P	50	35	50	50	45	45	40	50
L	20	70	65	95		120	125	
Na								
P	980	1050	1000	1100	900	1150	1100	1050
L	1150	1200	1100	1050		1000	1100	
Mg								
P	55	~ 45		~ 40			~ 60	
L		65	60	60		50	55	
Mn								
P	520	180	180	260	320	420	410	710
L	760	920	970	1650		2000	2500	

	Elliptio dilatatus 526				Elliptio dilatatus 620			
	1	2	3	Prism	1	2	3	Prism
Sr				160				170
P	230-225	200	170		240-240	210-205	205	
L	310-290	270	220		350-340	290-285	225	
Ba				55				65
P	130	105	45		130	110	50	
L	225	85	75		240	205	60	
Na				730				930
P	870-860	920	770		840-990	910-740	870	
L	690-740	810	900		980-740	1000-750	950	
Mg				65				70
P	50- 60	50	40		50- 50	45- 45	45	
L	35- 40	45	35		45- 40	40- 40	40	
Mn				590				580
P	1150-990	1300	450		690-720	700-710	690	
L	1050-900	1450	580		640-660	780-910	990	

Plagiola lineolata 321A

	1	2	3	4	5	6	7	8	9	10-11
Sr										
Pr	220	225	205	180		155	220	160	165	160
P	200	200	180	175	200	210	220	200	205	220
L	200	210	205	220	235	260	275	250	275	270
Ba										
Pr	45	40	45	55		50	60	45	45	45
P	25	30	25	35	55	55	55	50	40	60
L	25	30	40	45	65	70	90	65	80	75
Na										
Pr	1200	1300	1450	1150		1000	1150	1050	1150	1150
P	1000	990	1050	1050	960	1150	1100	1000	1100	1150
L	1000	1100	1000	970	960	890	1000	920	1050	950
Mg										
Pr	35	50	50	70			50	55	40	40
P										
L	120									35
Mn										
Pr	190	140	180	220		150	250	210	220	250
P				150	270	230	260	330	290	430
L	160	130	190	240	330	290	310	390	360	440

Actinonaias carinata gibba 626

	2	3	4	5	6	7	8	9-15	16-29	Prism
Sr										340
P	325	245	225	300	325	335	300	315	450	
L	380	385	315	450	500	520	470	500-470	620-580	
Ba										70
P	55	40	30	40	60	60	65	70	120	
L	70	70	55	80	100	110	105	155	215	
Na										950
P	1050	1000	1100	930	970	860	1050	950	1050	
L	980	980	950	880	900	960	750	900-920	800-810	
Mg										70
P	50					60	50	45	60	
L	55	55	45	45	70	55	75	80- 70	60- 55	
Mn										450
P	150	< 150	< 150	< 150	185	200	340	335	580	
L	350	420	300	530	625	770	920	1000-900	980-860	

Actinonaias carinata gibba 622

	2-3-4	5-6	7-8	9	10	11	12-13-14	15-16-17	Prism
Sr									320
P	360	380	315	310	340	290	330	310	
L	430	430	410	470	520	430	500	450	
Ba									80
P	65	50	60	65	80	70	85	100	
L	60	45	70	90	115	80	105	115	
Na									1000
P	950	1050	1050	920	1050	950	850	950	
L	960	880	1000	950	910	900	960	790	
Mg									55
P	35	30	30	30	40	35	40	40	
L	55	45	45	45	65	45	50	50	
Mn									550
P	220	180	220	300	400	400	540	590	
L	400	310	510	640	920	660	750	690	

Cyclonaias tuberculata 624

	3	4	5	6	7	8	9	10-12	13-17	Prism
Sr										160
P	200	220-210	180	175	180	185	155	160	170	
L	250	250-240	230	220	240	245	265	300	340	
Ba										25
P	45	75- 90	35	35	25	30	20	20	30	
L	45	100-110	30	50	35	50	50	60	90	
Na										870
P	940	920-950	960	940	990	1050	1050	1000	910	
L	970	980-840	990	870	880	930	910	880	820	
Mg										55
P	30	30							35	
L								35	40	
Mn										< 100
P	195	1250-1100	< 100	< 100	< 100	< 100	< 100	< 100	180	
L	325	1600-1400	185	130	140	140	175	250	330	

The Sr content and Sr-90 concentration in the same samples of white crappie bone have been determined (Table 12) and it is possible to compare the theoretical Sr-90 concentrations in bone with those values observed by analysis. The calculated or theoretical Sr-90 burden in fish bone was 3.85×10^{-9} curies Sr-90/g bone, dry weight based on the MPCw for occupational exposure. The average Sr-90 burden determined by analysis was 1.20×10^{-10} curies/g bone, dry weight which was 3.1% of the theoretical activity. Laboratory releases of Sr-90 vary from 10 to 30% of the MPC for water in the neighborhood of atomic installations which in turn are 10% of the occupational values. Therefore, these preliminary observations on bone are in good agreement with the expected bone concentrations.

The hazard to humans from the consumption of Clinch River fish may be estimated from the theoretical burden in fish. The human body burden of Sr-90 resulting from the consumption of white crappie was calculated on the following assumptions and criteria:

1. The Sr-90 concentration in fish flesh is 1.12×10^{-6} μc/g (based on the expected concentration in fish living in water which continuously receives releases of Sr-90 which are equal to the MPC occupational concentrations).

2. One-half pound of fish is eaten each week (32.4 g/day).

3. Data pertaining to Sr-90 are from the Report of Committee II ICRP, 1958 revision.

   a. Bone is the critical organ.

   b. The effective half-life of Sr-90 in bone is 6.4×10^3 days.

   c. 0.09 of the ingested Sr-90 is deposited in bone.

   d. Sr-90 reaches 86% of its equilibrium value in humans in 50 years.

   e. The maximum permissible body burden in bone for occupational exposure is 2 μc.

4. The equilibrium value calculation is based on the exponential model for critical organs other than the GI tract.

$$qf_2 = P\,(1-e^{-\lambda t})/\lambda$$

P is the rate of ingestion of Sr-90 in μc/day.
For long periods of time $1-e^{-\lambda t}$ becomes one.
λ is the effective decay constant 0.693/T, where T is the effective half-life of Sr-90 in bone.

Table 12. Sr and Sr-90 in White Crappie Bone

	Sr µg/g bone	Sr^{90} µµc/g bone
	217	36.7
	250	24.5
	218	10.0
	204	277.0
	189	12.6
	234	295.0
	251	3.0
	230	9.4
	244	297.0
	233	232.0
Average	227	120.0

Therefore, $qf_2 = \frac{32.4 \times 1.12 \times 10^{-6} \times 0.09}{0.693/6.4 \times 10^3}$

$$= \frac{3.26 \times 10^{-6}}{0.108 \times 10^{-3}}$$

$$= 3.02 \times 10^{-2}\ \mu c$$

The 50-year burden is 86% of this or 2.6×10^{-2} μc Sr-90 or 1.3% of the occupational burden. This would be 13% of the permissible burden for individuals living in the neighborhood of atomic installations. The permissible body burden for the population at large is 1/30 of that for occupational exposure or 6.67×10^{-2} μc. A member of the population at large eating white crappies in the manner stated would accumulate 39% of his maximum permissible body burden.

3.3 Uptake and elimination in radionuclides (biological half-lives) in fish and other aquatic organisms.

The biological half-life of Cs-134 in bluegills.
Submitted by D. J. Nelson, Oak Ridge National Laboratory.

The biological half-life of fission-product elements in fish is being determined since this parameter has a direct bearing on the dispersal of radionuclides by fish as they move from contaminated to uncontaminated areas of the river. The initial experiments are with bluegills (Lepomis macrochirus), a common panfish.

Fish are fed contaminated worms to build up a body burden of Cs-134. They are then placed in aquaria through which uncontaminated water circulates. These fish are counted periodically with gamma scintillation detection equipment and the decrease in radioactivity is a measure of the excretion of Cs from the tissues.

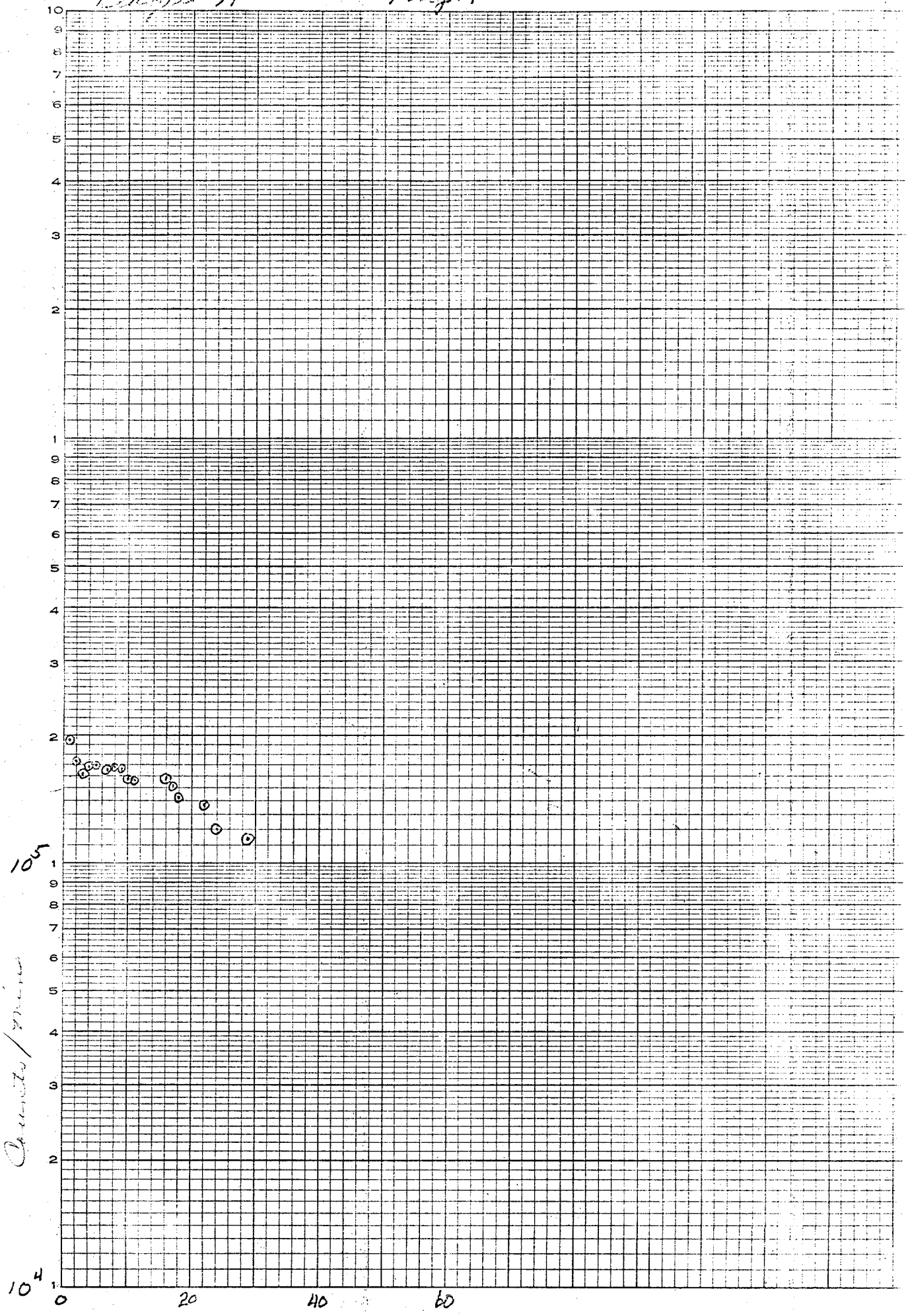
The experiments are still in progress but data from the first 3 fish (Figs. 1, 2, and 3) suggest a biological half-life of about 40 days for Cs-134. Bluegill "A" was accidentally killed. The fish was dissected and the individual body components were counted (Table 13). Cs-134 concentrations were highest in the soft tissues such as ovary, digestive tract, and skin and lowest in hard tissues (bone, scales, fins). Additional fish will be studied to determine whether the distribution of Cs-134 is similar in individual tissues.

Respectfully submitted,

SUBCOMMITTEE ON AQUATIC BIOLOGY

S. I. Auerbach, Chairman

Sheet A Fig. 1



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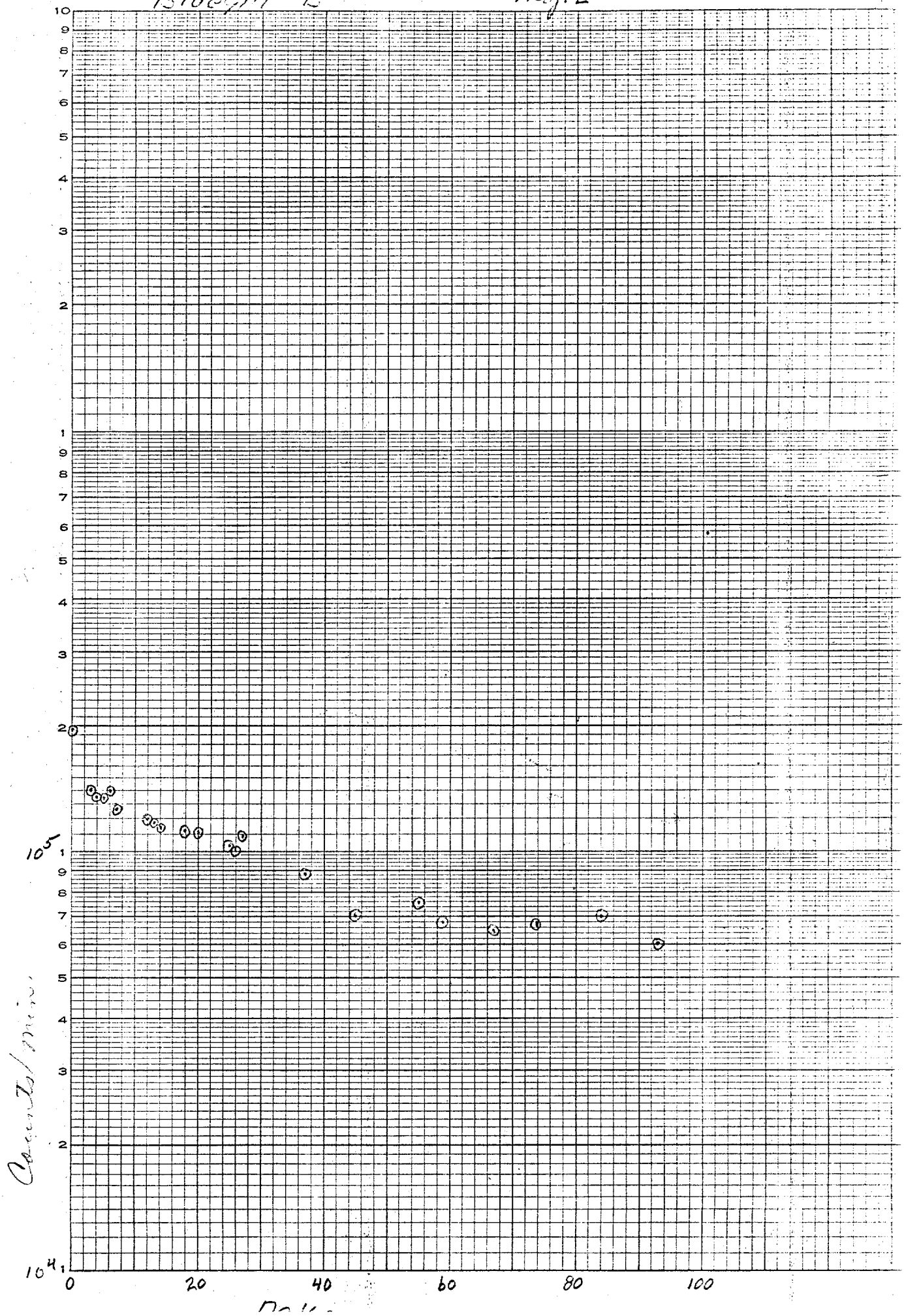
Bluegill B Fig. 2



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Bluejill "C" wt. 50.1 g Fig. 3

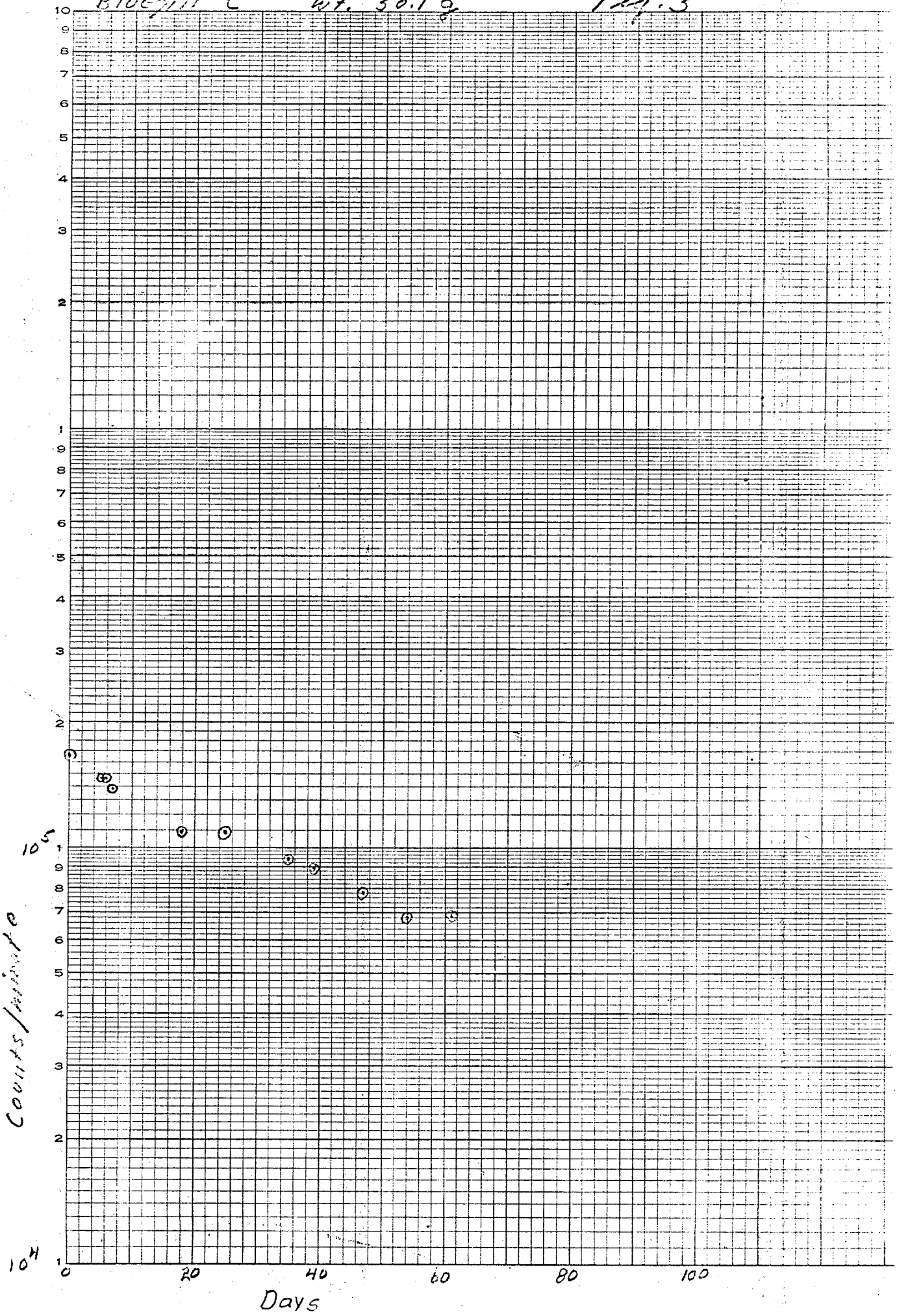

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Table 13. The Distribution of Cs-134 in Bluegill Tissues.

Tissue	Cs-134 Activity Counts/Minute/g
Scales	19,571
Skin	100,172
Muscle	54,716
Liver and digestive tract	116,659
Ovary	164,546
Gills	89,984
Bone	229
Fins	18,883

GB#12

MINUTES
OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
December 4, 1963
East Auditorium - Building 4500 - Oak Ridge National Laboratory
Oak Ridge, Tennessee

Meeting #7 ?

The open meeting was called to order at 9:05 a.m. by F. L. Parker who presided throughout the morning and afternoon sessions. Progress reports of the four subcommittees and a summation of the information by F. L. Parker, study coordinator, were presented in accordance with an agenda outline distributed previously. Parker noted that the agenda had been changed since the memorandum of October 21, 1963 from E. G. Struxness. Professor H. A. Thomas, Jr. of the Harvard Water Resources Group was unable to attend this meeting and, therefore, progress reports and discussion were continued into the afternoon session. Thomas sent several copies of his report "Operations Research in Liquid Radioactive Waste Disposal" for use of the individual members of the Steering Committee.

Parker announced that the four subcommittees were expected to meet the latter part of this afternoon and if necessary early tomorrow morning, December 5. The subcommittee chairmen were urged to outline recommendations in definite form for the executive meeting of the Steering Committee tomorrow at 9:30 a.m.

Those present at the morning session registered their attendance as shown on the attached attendance list.

The agenda for presentation and discussion of progress reports was arranged according to the work assignments of the four subcommittees as outlined below.

A. Water Sampling and Analysis

M. A. Churchill, subcommittee chairman, introduced these reports and commented on the effects of Melton Hill Dam when it goes into operation about December 1964.

"Dye Tracer Studies--Summer 1963," B. J. Frederick (USGS), F. L. Parker, and P. H. Carrigan, Jr. (USGS).

A multilithed report including figures was distributed as a basis for the discussion. Color pictures of the diffusion of the dye in Clinch River were shown by means of slides. In response to a question Frederick said that the diffusion coefficient was uncertain because the data available were insufficient to define the constant

factors. He recommended that the water sampling network be reactivated for a brief period and that correlative data that are needed should be obtained.

"Status of Analyses of Water Data," R. W. Andrew (USPHS). No written report was distributed. Andrew explained the nature of the errors which had delayed final checking and release of water analysis data from the USPHS computer program. He said that the error has been corrected for the present data and that the analyses are being recomputed. He noted that the data on concentrations of Sr^{90} are not involved since this is determined by radiochemical analysis. The earliest estimate of the time of completion of the retabulation of data is during January 1964 after which a new Progress Report No. 3 of the Subcommittee on Water Sampling and Analysis will have to be prepared. don't use data in No. 3

"Stable Chemical Composition of the Clinch and Tennessee Rivers," R. J. Pickering (USGS).

Copies of a written report were distributed and the presentation was based on this report.

Recess for a coffee break was taken at 10:10 a.m. and the session was reconvened at 10:30 a.m.

B. Bottom Sediment Sampling and Analysis

This group of reports was introduced by P. H. Carrigan, Jr. in the absence of R. M. Richardson (USGS), chairman of the Subcommittee on Sediment Sampling and Analysis. Carrigan reported progress in the preparation of the subcommittee report which was drafted several months ago and is now being revised and completed.

"Bottom Sediment Cores Collected During the Summer of 1962," R. J. Pickering (USGS).

A multilithed progress report on the study of bottom-sediment cores was distributed as a basis for this discussion. Pickering mentioned that this subject referred to a comprehensive study of Clinch River bottom sediments initiated by collection of more than 150 cores from the portion of the river below CRM 23.0 during June, July, and August 1962. The written report explained and discussed the work to date in processing and analysis of these cores.

"Behavior of Radionuclides Associated with Clinch River Sediments," W. P. Bonner and T. Tamura.

Copies of a written paper were distributed and its presentation was supplemented by slides.

"Relationships in the Longitudinal Distribution of Radionuclides in the Clinch and Tennessee Rivers," P. H. Carrigan, Jr. (USGS).

Copies of a written report were distributed as a basis for this presentation.

"Seasonal Changes in the Longitudinal Distribution of Radioactivity in Bottom Sediments of the Clinch River," P. H. Carrigan, Jr. (USGS).

Copies of a written report were distributed as the basis for this discussion. The report discussed particularly seasonal variations in radiation counts made by the Flounder instrument on bottom sediments in the Clinch River. This report considered the effects of thermal stratification in relation to the seasonal variations presented.

"Radiation Levels in Sloughs and Possible Extraneous Sources of Radiation," R. J. Pickering (USGS).

Copies of two multilithed reports were distributed as a basis for this discussion. The first presented the results of a "Survey of Bottom-Sediment Radioactivity in Clinch River Sloughs." This survey was made at the suggestion of the Subcommittee on Safety Evaluation. The second report presented data on "Extraneous Sources of Release of Radionuclides to Clinch River." The results of analyses of samples collected at various locations in the X-10 and Y-12 areas were presented. Also results from analyses of 10 water samples collected in and around the Oak Ridge Reservation and analyzed in the USGS tritium laboratory in Washington, D. C. indicated that tritium is present in the waste samples and in White Oak Lake water. The tritium samples included sources in the White Oak Creek basin, and at other locations to obtain background values from outside this basin.

"1963 Applied Health Physics Survey," H. H. Abee.

No written paper was distribued. Abee illustrated on the backboard and discussed a comparison of the values found in 1962 and in 1963 during the annual sediment survey in the Clinch and Tennessee Rivers.

"Clinch River Channel Improvements: A Study of Radiological Hazards," O. W. Kochtitzky and H. H. Abee.

Copies of a written report were distributed as a basis for this discussion which was presented by O. W. Kochtitzky (TVA). The photographs, which were not included in the multilithed paper, were shown as illustrations by projection during the presentation.

The session recessed for lunch at 12:15 p.m. Immediately after lunch a demonstration of the counting equipment for analysis of bottom sediments, located in Building 3504, was given for any people in the open sessions who were interested in seeing this equipment.

The meeting was reconvened at 1:45 p.m.

C. Aquatic Biology

Three reports under the auspices of the Subcommittee on Aquatic Biology were introduced by S. I. Auerbach, subcommittee chairman. Before introducing the first report Auerbach distributed and called attention to two items of investigations: (1) a questionaire distributed and filled out in 11 communities in an attempt to obtain data concerning habits of the population in eating fish; and (2) a comparison of analyses of fish samples made by the ORNL and by the USPHS in Cincinnati. It was noted that in general the results obtained by USPHS and by ORNL were similar and within the expected range of variation for such analyses.

"Use of Specific Activities in Predicting the Uptake of Sr^{90} by White Crappie (*Promoxis annularis*)," D. J. Nelson.

Copies of a written report were distributed as a basis for this discussion. The report was illustrated by slides of photographs and data.

"Movement of Smallmouth Buffalo (*Ictiobus bubalus*) in the Vicinity of White Oak Creek," D. J. Nelson.

Copies of a brief report which summarized the data obtained from this study of fish migration were distributed. The movement of the fish between noncontaminated and contaminated areas was determined by autoradiographic examination of fish scales.

Some advantages of this technique of determination were pointed out, particularly that the radioactive rings in fish scales provide a continuum of information which permits interpretation of the history of fish movement in the past.

D. Safety Evaluation

This subject was introduced with brief remarks by Dr. C. P. McCammon, subcommittee chairman.

"Status Report: Estimates of Radiation Exposure Doses to Man from Radionuclides Released to the Clinch River," K. E. Cowser.

The status report on the safety evaluation studies was not ready for distribution because some data had not been completed. Cowser reviewed the analyses of data that are being made and tabulated, especially the dose to man from eating various kinds of fish. Thus far, the safety evaluation studies have not produced any evidence that potential danger to people is being caused by radiation through the various channels of exposure being investigated.

Summation

A summation of the open session was given by F. L. Parker. He spoke particularly of: (1) adequacy of information obtained relative to Phase I of the study, i.e., before completion and operation of Melton Hill Dam; (2) the extent to which the five basic objectives of the study have been accomplished during Phase I; and (3) the need to plan now for final reports on Phase I and, also for work required to complete Phase II and to prepare reports on this final phase of the study. Parker said that the reports heard at this meeting should, for all practical purposes, be final reports on Phase I of the study.

In Summary:

1. The final report of the Subcommittee on Water Sampling and Analysis has not yet been completed. However, since the form of the data and the general nature of the results have been repeated several times, the subcommittee should be authorized to prepare a final written report to the steering committee and the editor should incorporate it in the final report on the study. The sampling program has been stopped for a year and futher water sampling is proposed only for a temporary period after Melton Hill Dam is operating. Unofficially it appears that the scheduled date for operation of Melton Hill has now been set back to December 1964. It is proposed to reactivate the sampling station for a three-month period representing both winter and summer conditions to test the validity of the conclusions drawn from tracer tests during the past summer and the coming winter.

2. There is still considerable work remaining to be done on the sediment cores taken in 1962. Parker believed, however, that for the purposes of the first phase of the study the data from the radionuclide inventory would be sufficient. Further information on the mechanisms involved in the accumulation and movement of bottom-sediment radioactivity would be of a great interest, but their study should be continued beyond the time of the present Clinch River Study project.

3. The Aquatic Biology and the Safety Evaluation Subcommittees must, of course, continue their work. Parker believed, however, that there is sufficient data already available concerning these aspects of the study to prepare a final report on Phase I.

With regard to the basic objectives, Parker said: "It is obvious that in the course of the first three years' study we have successfully completed the first and third objectives of the study; namely, (1) to determine the fate of radionuclides currently being discharged to the Clinch River; and (3) to evaluate the direct and indirect hazards of current disposal practices in the river." He urged the subcommittees and the steering committee to consider whether this is true and if so to decide on an appropriate method of publication of the results of the study to date, i.e., the end of Phase I.

The other three major objectives are currently under study, namely, (2) to determine and understand the mechanisms of dispersion of radionuclides released to the river; (4) to evaluate the over-all usefulness of this river for radioactive waste disposal purposes; and (5) to recommend long-term monitoring procedures. The usefulness of the river for waste disposal and long-term monitoring procedures can be fully evaluated only after Melton Hill Dam releases have provided us with some experience on the fate of radionuclides released to the river under these special conditions. Attempts to understand the mechanisms of dispersion of the radionuclides released will be continuing for a long time after the special river-study project has been completed, though the work already accomplished in this study has done much to advance such understanding.

In concluding his summary Parker emphasized again the importance of: (1) completion of subcommittee progress reports representing data and covering the remainder of Phase I of the study; (2) planning and preparation of an over-all final report on Phase I of the study; (3) subcommittee recommendations to the Steering Committee for work necessary to complete the second phase of this study; (4) special attention and discussion by the subcommittees on what is required in the Phase II studies in order to recommend long-term monitoring procedures and evaluate the future usefulness of the Clinch River for receiving radioactive wastes.

In concluding the session as presiding officer, Parker announced that the four subcommittees are to meet this afternoon and tomorrow morning (if necessary) and designated the respective meeting places.

The meeting was adjourned at 3:15 p.m.

Minutes prepared by Roy J. Morton, Secretary
Clinch River Study Steering Committee.

RJM:ms
December 26, 1963.

ATTENDANCE LIST
OPEN MEETING - CLINCH RIVER STUDY STEERING COMMITTEE
Oak Ridge National Laboratory, Oak Ridge, Tennessee
December 4, 1963

Name	Location	Agency
H. H. Abee	Oak Ridge, Tennessee	ORNL
R. W. Andrew	Cincinnati, Ohio	USPHS
S. I. Auerbach	Oak Ridge, Tennessee	ORNL
W. G. Belter	Washington, D. C.	AEC-Hq.
W. F. Buchhof	Atlanta, Georgia	USPHS
P. H. Carrigan, Jr.	Oak Ridge, Tennessee	USGS-ORNL
M. A. Churchill	Chattanooga, Tennessee	TVA
J. S. Cragwall, Jr.	Chattanooga, Tennessee	USGS
B. J. Frederick	Oak Ridge, Tennessee	USGS
Glenn Gentry	Nashville, Tennessee	State of Tenn.(TGFC)
R. L. Hervin	Oak Ridge, Tennessee	AEC-ORO
W. H. Jordan	Oak Ridge, Tennessee	ORNL
O. W. Kochtitzky	Chattanooga, Tennessee	TVA
J. A. Manning	Birmingham, Alabama	Jefferson Co. Health Dept.
W. H. Martin	Nashville, Tennessee	TDPH
C. P. McCammon	Nashville, Tennessee	TDPH
Erich L. Meyer	Washington, D. C.	USGS
J. P. Monis	Knoxville, Tennessee	USGS
R. J. Morton	Oak Ridge, Tennessee	AEC-ORNL
D. J. Nelson	Oak Ridge, Tennessee	ORNL
R. J. Pickering	Oak Ridge, Tennessee	USGS-ORNL
R. M. Richardson	Oak Ridge, Tennessee	USGS-ORNL
R. D. Shull	Washington, D. C.	AEC-Hq.
C. P. Straub	Cincinnati, Ohio	USPHS
E. G. Struxness	Oak Ridge, Tennessee	ORNL
T. Tamura	Oak Ridge, Tennessee	ORNL
W. T. Willis	Montgomery, Alabama	State Health Dept.

MINUTES
EXECUTIVE MEETING--CLINCH RIVER STUDY STEERING COMMITTEE
Building 2001, Oak Ridge National Laboratory
December 5, 1963

The executive session was convened by the chairman, E. G. Struxness at 9:45 a.m. with the following members present:

W. G. Belter, J. S. Cragwall, Glenn Gentry, C. S. Shoup, and C. P. Straub. Absent members were: F. E. Gartrell, S. Leary Jones, and Vincent Schultz. Subcommittee chairmen present: S. I. Auerbach, Aquatic Biology; P. H. Carrigan, Jr., Bottom Sediment Sampling and Analysis; M. A. Churchill, Water Sampling and Analysis; and C. P. McCammon, Safety Evaluation. Staff members present: F. L. Parker, Study Coordinator; R. L. Hervin and O. W. Kochtitzky, members of Subcommittee on Safety Evaluation; R. J. Morton, Secretary; and Roger D. Shull, Division of Reactor Development, U. S. Atomic Energy Commission, Washington. A visitor, Dr. Leonard Hannerz of the Swedish Water Protection Service, Stockholm, Sweden was introduced by S. I. Auerbach.

Chairman Struxness welcomed C. P. Straub as a new member of the Steering Committee representing the U.S. Public Health Service succeeding A. G. Friend. The chairman also announced that at this meeting two alternates would serve for absent members, namely, O. W. Kochtitzky for F. E. Gartrell, and C. P. McCammon for S. Leary Jones.

As the main order of business for this session the chairman called for presentation and discussion of reports by subcommittees of the Steering Committee.

Water Sampling and Analysis.-- M. A. Churchill, chairman.

Churchill reported that this subcommittee held meetings yesterday afternoon and this morning to formulate recommendations and plans for the next progress report. Revision of the data on analyses of water samples is now in progress at the Public Health Service Research Center in Cincinnati. When the revised data are available the subcommittee can see more clearly what is needed to complete Phase I of the Study. Since the beginning of Phase II will be delayed, additional work in Phase I can be done next summer if necessary.

The recommendations of the subcommittee were summarized and discussed. Since it appears that the longer the period of complete shut-off of flow at Melton Hill Dam the greater will be the concentrations (and potential hazards) of radionuclides downstream, the subcommittee recommended that the TVA be asked to shut off flow at Melton Hill completely for as long as possible, say a full week or more. It

recommended that such a cutoff be arranged and the resulting conditions investigated, and that work on the water sampling program be extended to include this investigation next summer.

With regard to the future monitoring program, the subcommittee recommended that at least one continuous monitoring station downstream from White Oak Creek should be established and maintained. This would provide three monitoring stations to be operated routinely--at Melton Hill Dam, White Oak Dam, and downstream. Locations at CRM 14.5 (intake of ORGDP water supply) and Centers Ferry at CRM 4.5 have been considered for the downstream station. It is believed that the location at CRM 14.5 is preferable because the data would be equally informative and establishment and maintenance of a station at this location would be more convenient.

Struxness asked whether there is concern about conditions in the lower reaches of the Clinch River, for example, at the mouth of the Emory River where upflow in the Emory might cause contamination of the Harriman Water Supply. Churchill replied that, because of the reduction of concentrations in the river by dilution and the long time required for backflow up the Emory River to Harriman, no trouble from contamination of the Harriman water supply is anticipated.

Struxness asked how much the continuous monitoring station at CRM 14.5 will cost. Members of the staff had estimated the installation cost as not more than $5,000 and probably less.

The subcommittee believes that there will not be much change in the Tennessee River at Watts Bar Dam or below due to the operation of Melton Hill Dam, and that the effects below the mouth of Clinch River will not be sufficient to justify re-establishing the basic water sampling network as a part of Phase II of the study. Therefore, it was recommended that the basic water sampling program be omitted in plans for Phase II.

Belter asked when and in what form the water analysis data would become available from the Public Health Service. Churchill replied that the best estimate is that revision of the data can be completed by the end of January after which a month or more will be required for the subcommittee to prepare its progress report. He explained that, although the earlier portion of the data would not require revision, the progress report would start from the beginning of operation of the basic water sampling network, namely, November 1960. He said the subcommittee believed that this data would be sufficient on water contamination for Phase I of the Clinch River Study.

Struxness asked whether the complete cutoff of flow at Melton Hill Dam recommended by the subcommittee would take the place of a planned release with tracer studies to simulate future discharges at Melton Hill and to simulate winter conditions. Churchill replied that the two types of studies are not the same. He said that although the subcommittee was in favor of tracer studies to simulate winter conditions after Melton Hill Dam is in operation it did not make this as a definite recommendation. The subcommittee confined its recommendations to

practical objectives and felt that investigations of winter dispersion should be considered by the Steering Committee and authorized if thought to be justifiable and feasible.

Struxness asked whether the subcommittee had considered actual conditions (concentrations and duration of radioactive contamination, etc.) that may develop at ORGDP and Centers Ferry as a result of the operation of Melton Hill Dam. Churchill replied that this had been considered and was the justification of the plan for a continuous downstream monitoring station. The question was raised as to who should be responsible for operation of the downstream station. Struxness said that time would not permit discussion of details but requested that F. L. Parker and C. S. Shoup keep in touch with the development of this station and consider how funds and personnel for operation could best be provided.

Chairman Struxness invited comments on the report of the subcommittee particularly regarding the recommendations. Cragwall (who is a member of the subcommittee) believed that there is much merit in the proposal that Melton Hill dam be operated to simulate future releases under winter conditions for one week or more and that dispersion in the Clinch River under these conditions be studied. He said that the subcommittee as a whole is in favor of this further dispersion study although it did not submit a specific recommendation for it. Belter asked what practical value a simulation of the conditions of winter dispersion in the Clinch River would have since, presumably, concentrations would not be as great as during the summer. Cragwall replied that the value would be mainly as a research study. He emphasized that the "transfer" value of the data being obtained in this study is of practical significance and emphasized that we should obtain information that will be applicable elsewhere.

Chairman Struxness canvassed the opinion of the individual members of the Steering Committee and the alternate representatives regarding approval of tests in simulation of winter dispersion with approximately a week of further study of the effects from normal operation of Melton Hill Dam. The proposal that such a study be conducted was approved in individual comments and finally by unanimous consent (without objection). Belter asked whether this will complete the dispersion tests during this fiscal year. A staff member replied that it would except for the unfinished analyses that remain, and preparation of reports on the earlier dispersion studies.

Bottom Sediment Sampling and Analysis.-- R. M. Richardson, Chairman.

P. H. Carrigan presented this subcommittee report because Richardson was unable to be present.

The reports in prospect for Phase I as outlined by Carrigan will cover the following:

1. Determination of total radioactivity in the bottom sediments of Clinch River.

2. Gross gamma counting of cores collected in 1962 and determination of gamma spectra on selected cores.

3. Evaluation of data up to June 1962.

4. Additional data on sediment samples obtained during Phase I (including work on bottom sediments by the USPHS and the ORNL Applied Health Physics Section, and the desorption studies which were reported by T. Tamura yesterday.)

Struxness asked when these reports can be expected. Carrigan said next spring or summer. Belter asked whether the reports would be in a form suitable for a final report. Carrigan said that they would, adding that they should be in "short form" that is summarized for use by whoever is interested. Belter asked whether the analyses would include mineralogy to which Carrigan answered that they would not.

Struxness raised the question as to who should report work on stable chemicals in water samples analyzed at ORNL (Pickering) saying that the Ecology Section is very interested in these results. Churchill said that if the Steering Committee desires these data can be included in the water subcommittee's report. The stable chemical data should be gotten into the open literature and this is encouraged. It was agreed that Pickering should coordinate with the State Department of Public Health (Jones) regarding publication. Cragwall emphasized that publication of such data in the open literature is very important. He said that "side" investigations should be covered in progress reports and that once they are submitted for use by the Steering Committee the people who have done the work should be encouraged to prepare and offer papers for publication. He said he wanted this emphasis on publication to be represented in the minutes of the meeting.

Carrigan outlined studies proposed to be included in Phase II of the Clinch River Study as follows:

1. The TVA Hydraulic Data Branch will make sediment surveys in the Clinch River to represent the beginning of Phase II and repeat these surveys periodically.

2. Efforts will be made to identify trends in the movement of bottom sediments and for this type of study special techniques using different marker materials are being explored. One possibility is the use of a fluorescent calcite which might be deposited on the bottom and could be identified in sediment samples which would indicate movement of sediment. This part of the study is to be done by the USGS and ORNL. It is visualized that to some extent a similar though less intensive investigation may be made in Watts Bar Reservoir (but not in Chickamauga Reservoir). Struxness asked when such a study would be made and Carrigan said after Melton Hill Dam is in operation. Examples

of other possible techniques of study were discussed. Some members of the Steering Committee were concerned about the amount of time and manpower required, the cost of the sediment-movement study, and the time of completion since the study presumably could not start before December 1964. Carrigan replied that the material placed on the bottom could be observed for a year now and then would remain there for long-range use and observation later if needed. As to cost he said that the material is relatively inexpensive and the manpower and effort can be adjusted to whatever level is feasible.

3. Geochemical studies of bottom sediments to be continued by USGS, PHS, and ORNL, including radionuclides associated with organic materials.

Auerbach said that this fits with plans of the Ecology Section for organic-detritus studies. Struxness asked when these studies are to be made and Carrigan said near the end of fiscal year 1965. Belter said that he hoped some of this type of data will be obtained and included in reports on Phase I of the Clinch River Study.

4. Studies of radioactivity in suspended sediments to be done by Subcommittee on Water Sampling, Bottom Sediments Subcommitte, or jointly by both. This will involve separation and fractionation of the suspended matter, probably by the "Lammers" technique.

Asked by Belter whether this will be mainly Laboratory work, Carrigan said it would mainly, but with some field work. Struxness asked Churchill about the status of Lammers work on techniques for separation of the organic and mineral suspended matter in water. Churchill said that Lammers is going ahead, not rapidly but having worked along for three summers, in separating the material and studying which radionuclides are associated with particular fractions of the suspended matter. Some results have been obtained but are not ready to be reported yet. The main problem is accuracy of counting at such low levels. The TVA has approached the PHS for cooperation in regard to the counting. Chairman Struxness requested F. L. Parker to follow up on this problem and see whether Lammers' materials might be recounted at ORNL. Straub said that he would check regarding the PHS arrangements and inform Parker. Belter commented that this work should be reported if possible as part of Phase I of the Clinch River Study. He is especially interested in getting geochemical data in the Phase I report of the study. Auerbach and Shoup commented that some phases of Lammers' work are very long-range and will not be completed soon. For example, he is proceeding with more and more minute fractionation which can be carried as far as is desired or feasible.

5. Recommendations regarding bottom sediments in the monitoring program will be developed but this program should be considered more broadly to include the other phases -- water, biota, etc.

It was suggested that the chairmen of other subcommittees should meet with this subcommittee in formulating the recommendations concerning monitoring. Public relations as well as legal requirements should be considered. Belter said in summary that the recommendations regarding Objective No. 5 (long-range monitoring) should be "cooperative."

Chairman Struxness invited comments on the report by this subcommittee. Churchill said that he visualized Melton Hill Dam will hold back sediments while scour from high flows (16,000 to 22,000 cfs) will gradually move bottom sediments from Clinch River into Watts Bar Reservoir, that is, scouring will proceed without concurrent deposition. He suggested that the study of sediment movement should be extended down into Watts Bar Reservoir. Struxness asked how far downstream and Churchill said the sediments would move as far down as Watts Bar Dam. The main point is that at these high flows, and particularly with low water elevations in the Clinch River embayment, scouring will occur and there will be no deposition in the lower reaches of Clinch River. Belter asked how much of the geochemical work can be completed within the next three to four months. Carrigan said that for an answer it will be necessary to inquire of Pickering or of the USGS in Washington. Cragwall suggested that the answer to this question should be determined and that as much as possible of the geochemical data should be included in the report on Phase I.

In concluding the discussion on this report Chairman Struxness summarized the recommendations and noted that no objections have been raised. If further discussion is desired he requested that it be postponed until the afternoon session.

Aquatic Biology.-- S. I. Auerbach, Chairman.

Auerbach commented that the main function of this subcommittee is to furnish data for use by the Safety Evaluation Subcommittee. He said he would outline concisely the types of data to be obtained for Phase I and for Phase II of the Clinch River Study.

For Phase I the types of data to be obtained by the end of this fiscal year are:

1. Determinations of radionuclides in fish from sampling and analyses.

2. Information concerning the fish catch and consumption of fish from the TVA reservoirs, particularly downstream from Oak Ridge.

3. A large collection of rough fish and also data from the recomputation of a considerable backlog of earlier analyses.

4. Dilution factors in the Clinch and Tennessee Rivers, respectively.

Asked by Belter about data on radioactivity in clams, Auerbach and Straub said that the analyses are being made now.

Asked about the crappie report given yesterday, Auerbach said that this is in Phase I and will continue with an overlap into Phase II. There were questions and discussion concerning biological indicators of radioactivity in natural waters but Auerbach would not speculate as to which organism appears at this time to be most promising.

For Phase II of the study, the objectives and problems include:

1. Biological indicator, for example, the white crappie.

2. Some study of the effects of harvesting all species of fish including shad and processing for fish meal and cat food (for example, at a plant in Clinton, Tennessee).

3. Studies of conditions with respect to organic detritus. This involves counting of the material to determine the concentration of radionuclides and also information about the use of this material for food by organisms, that is, entry into the food chain.

4. Algae productivity in the river after the Bull Run Steam Plant is in operation.

Belter asked whether the Ecology group will obtain data regarding the quantities of radionuclides in the total biomass. Auerbach answered that he was not sure whether quantitative data can be obtained to confirm or deny estimates made by F. L. Parker. We probably can show positively that radioactivity in the biomass is less than in the sediments; and qualitatively can define the distribution of the major radionuclides in several species of organisms. Asked when the fish data will be available Auerbach said during this fiscal year.

Churchill commented that stratification affects the dilution factors and makes them indeterminate during certain periods. For example, in Watts Bar Reservoir Clinch River water is at the bottom; and the upper end of Melton Hill Reservoir will be stratified.

The meeting was recessed for lunch at 12:15 p.m. and reconvened at 1:15 p.m.

Safety Evaluation.-- C. P. McCammon, Chairman.

McCammon said that at meetings of this subcommittee held yesterday afternoon and this morning the question was raised whether there are some other radionuclides of significance from the safety viewpoint. Straub, a member of the subcommittee, commented on two possibilities: (1) short-lived isotopes that decay away in the samples before analysis; and (2) long-lived isotopes (for example tritium) which are not detected by the analytical methods used. It was agreed that the subcommittee should mention these possibilities to show it is aware of the problem; and also if it appears that there are no important hazards the subcommittee should say so.

There was discussion as to whether the Safety Evaluation Subcommittee should consider data on radionuclides upstream from White Oak Dam. Struxness said that he saw no objection to this. He added that he hopes the safety evaluation will be one part of the study that will be entirely acceptable. It should not be looked upon as an ORNL or an AEC evaluation.

It was suggested by the subcommittee that K. E. Cowser might check with the Operations Division and ORNL research groups to obtain data on radionuclide production. Perhaps after that some scouting analyses of White Oak Creek materials might be made in a search for the particular radionuclides that Cowser's inquiry might suggest.

The subcommittee considered the data on radiation levels in sloughs (presented by Pickering at the open meeting yesterday). There appeared to be no appreciable hazard from this source and no further study of sediments in sloughs were recommended.

Kochtitzky inquired as to what is considered the "neighborhood" in the definition of MPC's (for example, ICRP or NCRP definitions). Struxness suggested that any individual whose exposure can be proved to come from a controlled nuclear energy installation is within the "neighborhood" of the installation. There was general discussion but no instruction was given to the subcommittee. It was inferred that the subcommittee would have to make its own interpretation. Various other questions were raised and discussed but there was no definitive guidance from the Steering Committee for the Subcommittee on Safety Evaluation.

Cragwall asked when the safety report will be submitted. McCammon said that it will be two or three months after the data on water and fish analyses are available. Struxness said that this looks like about June, 1964.

Future Reports on the Clinch River Study

As a starting point for discussion of this item, Chairman Struxness called for distribution of "Proposed Plan and Outline for Status Report No. 5 on Clinch River Study," a statement prepared and submitted by R. J. Morton as secretary and editor for the Steering Committee. This statement, which was distributed and read by those present, was both a progress report and a suggested plan for future reports, including a general outline for Status Report No. 5. This plan assumed that Status Report 5 would not be issued until after the data on water analyses, bottom sediment analyses and fish analyses had become available in progress reports. It was suggested that following Status Report 5, which would be the final status report on Phase I, Report No. 6 should be a coordinated interpretation of the results of Phase I of the study and that Phase II should be covered by a final status report. The general outline for Status Report No. 5 was developed according to this concept. There was general discussion of all aspects of the problem of reporting on the remainder of the study.

Belter questioned whether Status Report No. 5 should wait for and include all the data that is forthcoming from work in Phase I. According to this plan Status Report No. 5 would be the final report presenting the detailed data from Phase I. He believed that this would make Status Report No. 5 too voluminous and also cause undue delay in its completion.

Struxness spoke to the question of the type of final reports that should be prepared to conclude the study. He proposed that there should be two final reports: (1) a detailed comprehensive report on the Clinch River Study, and (2) a summary report. As an example he exhibited such a final report and summary by the National Academy of Sciences-National Research Council on a study of "Renewable Resources". He argued that the final report on the study should be distinctive, of the highest possible quality, prepared with different covers than the previous reports, and not designated as ORNL, USGS or PHS Reports. The reports would be issued under the auspices of the Steering Committee, and Struxness said he visualized that we would distribute not 1000 copies but 7,000 to 10,000 copies. Kochtitzky asked how the distribution list would be compiled and commented that the number of copies to be distributed depends on the nature of the distribution list.

In general there appeared to be agreement that the final report should be in two parts: (1) a detailed comprehensive report; and (2) a summary report. Various possibilities for the preparation and printing of these reports were discussed. For preparation it was considered whether a consultant contract with a professional technical writer might be arranged for the writing and editing of both reports. Another possibility would be to get such a consultant to prepare only the summary report. For the printing, the possibilities mentioned were to have the work done by the Government Printing Office, by the AEC Division of Technical Information Extension, or by a private contract. Cragwall asked whether color illustrations would be used, commenting that if this were the case the Government Printing Office might be at a disadvantage. The relative advantages of having a professional writer from the outside as against preparation of the report by the technical staff of the study were discussed. It seemed to be the consensus that although an outside professional writer might prepare the final report in better literary style there would be much difficulty in orienting him in the technical phases of the study and the details of the findings. It was recognized that, to assure accurate presentation of the results and proper emphasis on the conclusions, the writer would have to be informed about this study even though he were familiar generally with the problems and techniques of such river investigations.

Chairman Struxness urged that the Steering Committee try to decide on an approach and general plan for handling the reports leading up to completion of the study. Belter proposed that the committee decide now regarding further status reports on Phase I and the final detailed comprehensive report. He suggested that the comprehensive final report be prepared by the present editor and

secretary with the usual assistance from the technical staff of the study. He visualized that the final decision on the preparation of the summary report (which would be based on the detailed comprehensive report) could be deferred until later.

Regarding Status Report No. 5, Belter believed that it should be prepared on the basis of information presented at the Cincinnati meeting in February 1963 and at the present meeting, leaving in abeyance the matter of how the progress reports on water analysis, sediment analysis, and fish analysis should be released when their preparation has been completed. Suggestions were made that they might be issued later as separate parts of Status Report 5, as separate appendices of this report, or as a composite supplement in one volume.

Cragwall made a specific proposal in the form of a motion that:

1. The editor, R. J. Morton, prepare Status Report No. 5 incorporating in it all the information made available to him through today and have a draft of the report completed by about April 1964.

2. The editor then proceed with the preparation of the comprehensive final report on Phase I of the study calling upon the members of the study staff for assistance as necessary.

3. That the subcommittees on Water Analysis, Bottom Sediment Analysis, Aquatic Biology, and Safety Evaluation should proceed to complete their progress reports to the end of Phase I; and that these reports should then be issued either as "separates" or as a one-volume supplement to Status Report No. 5. The motion was passed by a vote of the Steering Committee.

In further discussion of future reports, it was suggested that the Steering Committee give thought to the form and preparation of the summary report. A decision regarding the status report on Phase II was deferred until later. Shoup agreed to obtain information when needed about printing of the final reports by the AEC Division of Technical Information Extension.

There being no further business the meeting was adjourned at 3:30 p.m.

Minutes prepared by Roy J. Morton, Secretary, Clinch River Study Steering Committee.

RJM:ms
December 26, 1963

GB#12

OAK RIDGE NATIONAL LABORATORY

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NUCLEAR DIVISION

POST OFFICE BOX X

OAK RIDGE, TENNESSEE 37831

February 24, 1964

MEMORANDUM

To: Clinch River Study Steering Committee and Distribution (Attendance List Attached).

Meeting #8 ?

Subject: Minutes of Special Meeting of the Steering Committee at Oak Ridge National Laboratory, January 30, 1964, (Open Session).

Enclosed is a copy of the minutes of the Open Meeting of the Steering Committee at ORNL, January 30, 1964. Please review these minutes as soon as convenient and send me any corrections and suggestions for revision.

Thank you.

Sincerely,

Ed

E. G. Struxness, Chairman
Clinch River Study Steering Committee

EGS:ms

Enclosure

MINUTES
OPEN MEETING--CLINCH RIVER STUDY STEERING COMMITTEE

Conference Room, Building 2001
Oak Ridge National Laboratory
Oak Ridge, Tennessee
January 30, 1964

The open meeting was convened at 9:15 a.m. by F. L. Parker who presided until arrival of Chairman E. G. Struxness with Professor Harold A. Thomas, Jr., of the Harvard Water Resources Group. The attendance was registered as shown on the attached list. Parker gave a brief explanatory discussion regarding the report "Operations Research in Liquid Radioactive Waste Disposal" which was to be discussed in more detail by Professor Thomas.

Chairman Struxness arrived with Prof. Thomas and presided during the remainder of the meeting. He said the purpose of the meeting was to consider the proposed method of systems analysis of disposal of waste in the Clinch River based upon data collected as part of the Clinch River Study. He introduced Prof. Thomas and invited him to give a discussion and answer questions regarding the proposed analysis of the Clinch River data.

In preliminary remarks Thomas said the Harvard group would not attempt to solve all the complex problems involved in the ORNL study of the Clinch and Tennessee Rivers by mathematical analysis. He emphasized that the computer is an important tool by which useful analyses can be made but only a tool for judicious use.

Thomas also said that he expects to report his results in conventional scientific language rather than in strictly mathematical symbols. He remarked that if one uses mathematics he has a duty to translate back into conventional scientific terms.

Regarding the adaptability of the systems analysis to the Clinch and Tennessee Rivers situation, Thomas said that he had been working on other river problems, e.g., on the Indus River in Pakistan and with the Corp of Engineers in the United States on the Delaware River, and found the analysis adaptable. He said he had not studied the Clinch River data thoroughly but was impressed with the good sense and industry with which the Steering Committee has approached the study and he felt confident that the data can be analyzed by this method.

Thomas said he would consider at this meeting how the analysis fits into the work of the Steering Committee, i.e., the role of the analysis, and what it can do to

help the study. He reviewed a letter which he wrote earlier to E. G. Struxness, and suggested that the Steering Committee consider other details of the proposal in its executive session.

Thomas distributed copies of a statement, "Preliminary Model: Fate of Radioactive Wastes in Streams," which he used on a basis for his discussion of the model and the proposed analysis. He said that the model would be reviewed at two levels: 1) general, and 2) mathematical. He suggested that the mathematical discussion should be with small groups who are particularly interested. He mentioned earlier discussions of the analysis of these problems and said that in his judgment the most significant items are:

1. Importance of the Hydraulic Radius
2. The degree of regulation or "Flashiness"
3. Consideration of the influence of various factors in the stream upon treatability of the wastes.
4. Pattern of streamflow in relation to the pattern of withdrawal of water and pollutants. We must consider variability, and coincidence of high and low flows with use (withdrawal).

Thomas then reviewed the statement on the preliminary model which had been distributed, covering in detail the outline points 1-9 on pages I to 3 (see attached copy of statement). He sketched a power wave on the blackboard and remarked that a precise solution is very difficult but the solution is relatively easy with a computer by simulation. He said that serial correlation is important and is emphasized because in general it has been neglected. He commented that this model is not a decision model. Also it looks like a single-purpose model but it can be changed in various ways,e.g., the use-point in Item 6 can be set at any number of locations. As another example, variation is possible in Item 8 of the outline, where the computer program can be set to replicate an n-year period N times, thereby compiling means and standard deviations for the entire period of Nn years.

Thomas called attention to the "Input Data for Run I" on page 4. Actual numbers in this example apply to Chattanooga. The decay constant, h = 0.0277 is for Sr^{90}. The model includes some real numbers and some assumed numbers and the Steering Committee should consider whether the assumptions are reasonable.

He also called attention to the table "Results, 20 Sets of 10-Year Runs. Data Set I, N = 20, n = 10." He explained that in effect the analysis covered data equivalent to 200 years of record. The computation required only 2 minutes of computer time.

The meeting had an intermission at 10:30 a.m. and reconvened at 10:50 a.m. Struxness announced a question and answer period and requested F. L. Parker to moderate this part of the meeting.

Cragwall raised three questions regarding the length of stream flow records necessary to obtain useful results and confidence levels, e.g., with 10 years of continuous record. There was considerable discussion but it was finally agreed that 10 years of records can be used fairly well in such an analysis. Regarding peak concentrations Parker said that an analysis to identify the time and concentration at use-points would be helpful, e.g., at ORGDP it might be possible to avoid taking water into the system from the river during the periods of peak concentrations.

Struxness suggested two analyses which he thought would be informative: (1) discharge from the waste water treatment plant at ORNL versus the ORGDP water plant intake for the water system, and (2) White Oak Dam discharges versus the Chattanooga water plant intake. Belter asked about the difference, if any, between discharges at White Oak Dam and at the mouth of White Oak Creek. Carrigan answered that the total discharge over a long time period is the same but that the concentrations will be much different, especially after Melton Hill Dam is in operation. Churchill was of the opinion that the data on pollutant flux (y_1) is not very extensive. There were differences of opinion and the adequacy of the y_1 records was discussed by Straub, Thomas, and others.

Parker mentioned a recent statement by Assistant Secretary Quigley of the U.S. Department of Health, Education, and Welfare that the assimilative capacity of a stream for radioactive wastes must not be used as a waste disposal facility. J. J. Davis said he understood that the objective is health and safety and that the vector of highest importance is on drinking water. Thomas disagreed, and this viewpoint was discussed generally by the group. Thomas thought that there could be objectives of higher importance than health and safety in particular instances.

Parker said that in Chapter 2 of the report "Operations Research in Liquid Radioactive Waste Disposal," which had been reviewed earlier, it was indicated that the type of research that would be most profitable could be identified. This would be of great value in the Clinch River Study. Thomas commented that some people think systems analyses are made to solve problems; actually they may be of greater value in identifying problems and in estimating how much effect particular factors would have on the final conclusions.

Struxness asked F. L. Parker to explain his analysis of the biomass and estimate of the total radioactivity in biomass of the river. This had been mentioned several times during the discussion. Parker explained that he had assumed that all the phosphorus in the river was used in the production of aquatic organisms and that the organisms were all contaminated. This analysis gives a maximum estimate.

Parker questioned the validity of the − 0.9 correlation between water flow and use of water shown on page 4 of the statement distributed earlier. Thomas said that this calculation considered only the actual drinking of water not the total use of water; and it is true that in periods of low flow people drink more water.

Olson asked whether the breadth of the computer program design is great enough. It was said earlier that 200 years of experience had been run in 2 minutes on the computer. He thought that with such a small computer-time requirement the program might be made more versatile. Thomas pointed out again that numerous variations can be made with the same program, e.g., the choices explained under outline Items 6 and 8, varying the location of the use-point, et cetera.

The cost of various constraints, e.g., a decrease in the permissible concentration of radioactivity in a stream, was discussed. It was understood that lower permissible limits cost more money and it was felt that in studies such as this we have an obligation to tell people how much the additional cost will be.

Struxness commented that these questions which had been discussed are important in relation to evaluation of usage of the river in waste disposal and recommendations regarding long-term monitoring, which are two of the objectives of the Clinch River.

The meeting was recessed at 12:00 Noon.

Minutes prepared by R. J. Morton, Secretary, Clinch River Study Steering Committee

RJM:ms
2/18/64

ATTENDANCE LIST

OPEN MEETING -- CLINCH RIVER STUDY STEERING COMMITTEE

Oak Ridge National Laboratory
Oak Ridge, Tennessee
January 30, 1964

Name	Location	Agency
S. I. Auerbach	Oak Ridge, Tennessee	ORNL
C. G. Bell	Oak Ridge, Tennessee	ORNL
Walter G. Belter	Washington, D. C.	AEC-Headquarters
Lewis Bledsoe, Jr.	Knoxville, Tennessee	U. of Tennessee
P. H. Carrigan, Jr.	Oak Ridge, Tennessee	USGS
M. A. Churchill	Chattanooga, Tennessee	TVA
K. E. Cowser	Oak Ridge, Tennessee	ORNL
J. S. Cragwall, Jr.	Chattanooga, Tennessee	USGS
J. J. Davis	Washington, D. C.	AEC-Headquarters
Bernard J. Frederick	Oak Ridge, Tennessee	USGS
Jack M. Garrison	Norris, Tennessee	TVA, Engr. Lab.
F. E. Gartrell	Chattanooga, Tennessee	TVA
Glenn Gentry	Donelson, Tennessee	Tenn. SGFC
R. L. Hervin	Oak Ridge, Tennessee	AEC-ORO
Donald G. Jacobs	Oak Ridge, Tennessee	ORNL
S. Leary Jones	Nashville, Tennessee	Tenn. SPCB
John P. Monis	Knoxville, Tennessee	USGS
Roy J. Morton	Oak Ridge, Tennessee	ORNL (AEC-ORO)
T. Murano	Oak Ridge, Tennessee	ORNL (A.F.C.Japan)
D. J. Nelson	Oak Ridge, Tennessee	ORNL
Jerry Olson	Oak Ridge, Tennessee	ORNL
Frank L. Parker	Oak Ridge, Tennessee	ORNL
B. C. Patten	Oak Ridge, Tennessee	ORNL
R. J. Pickering	Oak Ridge, Tennessee	USGS
J. T. Price	Norris, Tennessee	TVA, Engr. Lab.
R. M. Richardson	Oak Ridge, Tennessee	USGS
Vincent Schultz	Washington, D. C.	AEC-Headquarters
M. U. Shaikh	Oak Ridge, Tennessee	ORNL (P.A.E.C.)
C. S. Shoup	Oak Ridge, Tennessee	AEC-ORO
Conrad P. Straub	Cincinnati, Ohio	USPHS
E. G. Struxness	Oak Ridge, Tennessee	ORNL
Tsuneo Tamura	Oak Ridge, Tennessee	ORNL
V. R. R. Uppuluri	Oak Ridge, Tennessee	ORNL
George M. Van Dyne	Oak Ridge, Tennessee	ORNL
Gale Young	Oak Ridge, Tennessee	ORNL

Preliminary Model: Fate of Radioactive Wastes in Streams

1. Objective. To determine long-term averages and the range of fluctuation in concentration of radioactive pollutants at use-points such as water-supplies.

2. The model has one waste water outfall, two streams, a benthal deposit or biomass, and one use point. Any number of different types of radioactive (or non-radioactive) waste may be investigated in separate computer runs using the same long-term sequence of synthetic streamflow traces. Likewise the effect of radioactive pollutants on several types of water-use may be investigated. These include (i) water supply (municipal, industrial, agricultural); (ii) recreation; (iii) commercial fishing; and (iv) sporadic breeding of flying insects.

3. The inflows of water and pollutants (vectors x_1, x_2 and y_1) may be incorporated in the model with any set of cross-correlation coefficients and serial coefficients. (See Chapter 12 "Synthetic Streamflow Sequences," Design of Water Resource Systems", Maass et al, Harvard University Press 1962).

4. Four functions relating the flux of pollutants to the streamflows are built into the model. They are constructed from field data on deposition, biological uptake, scour, leaching, and travel-time to the use-point. In the model each of the four functions has ten adjustable points (twenty input parameters) so that a high degree of flexibility is provided to fit a wide range of stream environments.

5. The model allows for hold-up and storage (benthal deposits and other biomass), nuclear decay, and treatment (or processing) of the pollutant flux removed.

6. The use-point may be set at different down-stream locations to investigate multiple stream-use situations.

7. In its present version the model is constructed for computer simulation of annual flows of water and annual fluxes of radioactive wastes. It may be constructed to simulate seasonal, monthly, weekly, daily and hourly time periods. The synthetic hydrology generator incorporates parameters from actual stream flow records from gaging stations.

8. The output of the program gives activity concentrations or fluxes at the use-point in terms of mean values for n-years. In addition, the standard deviation and extreme values (maximum and minimum concentrations) are given for the n-year period. The program also records the amount of radioactivity in storage in the stream-bed or biomass at the end of the period. Finally the computer program may be set to replicate an n-year period N times with new sequences of synthetic streamflows each representing an equally likely hydrological pattern for n future years. Over-all means and standard deviations are compiled for the entire period of Nn years.

9. The model represents the "technological function" for systems analysis of water quality management schemes. It is useful in making decisions relating to the design and operation of streamflow regulating works and water and waste-water treatment plants by virtue of the following features:

(i) Different waste-water treatment and decontamination processes can be incorporated in the vector y_1, which represents the pollutant output of the waste-treatment plant (different radio-isotopes with different flux-rates during different seasons of the year). In the present version of the model four adjustable parameters are incorporated in this input vector (mean annual flux, standard deviation of annual fluxes, and two correlation coefficients.)

(ii) The effect of existing or proposed river regulating works (e.g. hydropower dams) is built into the model by appropriate adjustments of the statistical parameters of the populations of x_1 and x_2.

(iii) The effect of new or existing river regulating works and waste-treatment processes on deposition, biological uptake, scour, leaching, and decay en route may be incorporated by proper adjustment of the parameters of functions I, II and III (and, if appropriate, function IV).

(iv) The effect of different types or modifications of water treatment (or other processing mechanism) ceteris paribus may be introduced by suitable adjustments of function IV.

10. List of symbols

x_1 = flow rate in stream 1; (cfs, or trillions of liters per year)

x_2 = flow rate in stream 2; (cfs, or trillions of liters per year)

x_3 = water supply rate; (cfs, or trillions of liters per year)

y_1 = pollutant flux introduced at waste outfall (load in waste treatment plant effluent); (curies per year or trillions of micro-micro curies per year)

y_2 = amount of activity transferred each year (or season) to biomass or benthal deposit

y_3 = amount of activity removed each year (or season) from biomass or benthal deposit.

Y = total amount of activity in storage; (curies)

y_4 = nuclear decay during time of travel to use-point

h = decay constant for radio-isotope ($0.693/t_{50}$)

x_3 = outflow of water at use-point

y_5 = flux of radioactivity to use-point before treatment

y_6 = activity flux removed in treatment or processing

y_7 = flux of activity to use-point after treatment or processing

y_7/x_3 = concentration of activity in water at use-point

Input Data for Run I

Variate	Mean	Standard Deviation	Cross-correlation with x_1
x_1	30.4 liters	4.95	1
x_2	0	0	0
x_3	0.0594	.0089	-0.9
y_1	10	6	0.25

All variates are assumed to be log-normal. Serial correlation for vector x_1, $\rho(\log x_i, \log x_{i+1}) = 0.353$

Decay constant, $h = 0.0277$

January 28, 1964

Results, 20 Sets of 10-year Runs. Data Set I

N = 20, n = 10

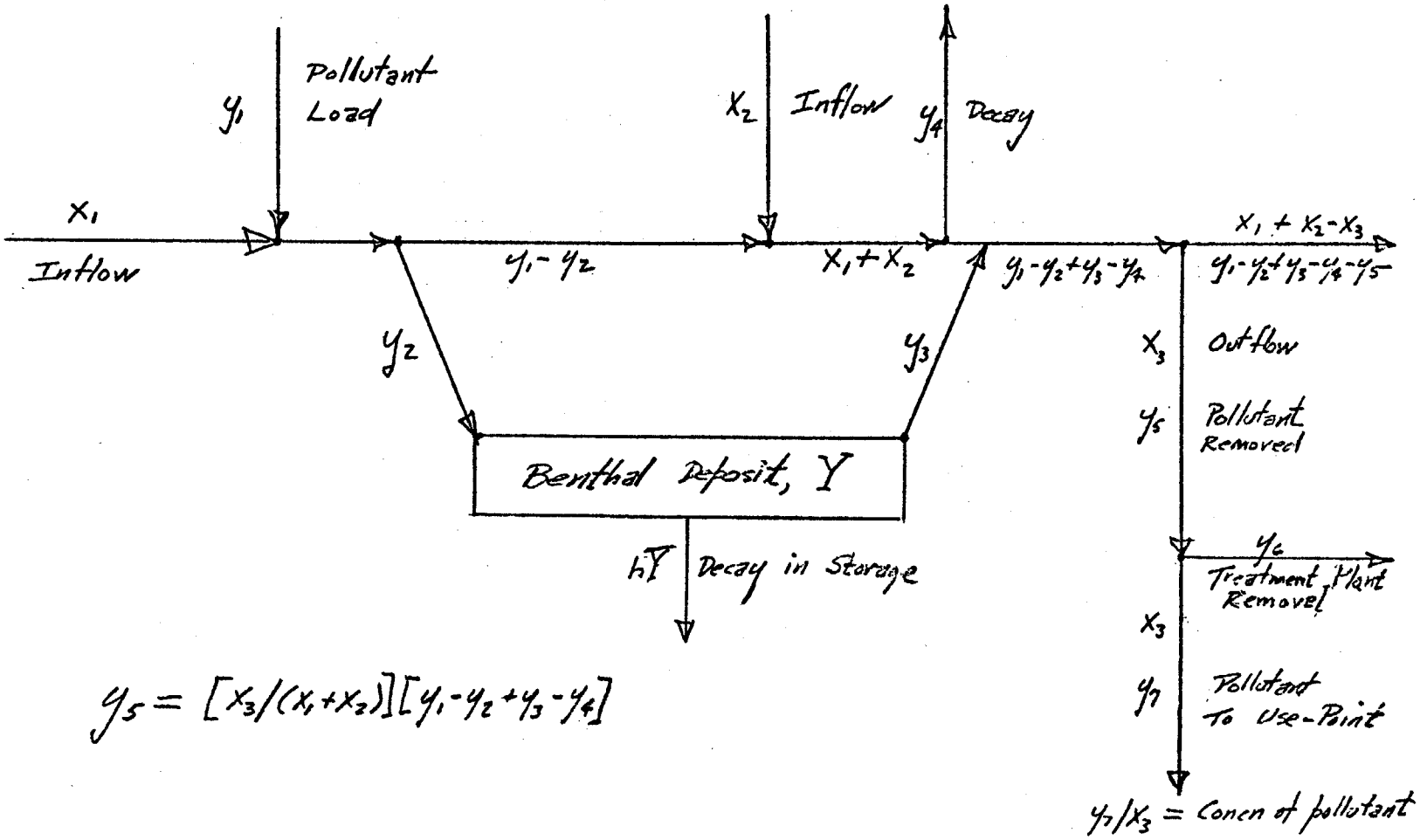
Run No.	Mean Conc'n μμc/ℓ	Standard Deviation μμc/ℓ	Max yr. in 10-yr. Period, μμc/ℓ	Min yr. in 10-yr Period, μμc/ℓ	Storage at end of Period, curies
1	0.25	0.08	.38	.12	.22
2	.19	.09	.36	.06	.76
3	.25	.12	.46	.11	4.36
4	.18	.08	.34	.09	.07
5	.20	.11	.40	.12	.26
6	.28	.19	.63	.08	.07
7	.18	.08	.35	.08	.00
8	.21	.09	.34	.10	1.00
9	.23	.11	.38	.09	.02
10	.25	.14	.53	.10	.00
11	.24	.10	.46	.09	.85
12	.21	.10	.40	.10	1.98
13	.21	.12	.53	.08	.81
14	.24	.14	.53	.08	4.46
15	.17	.05	.26	.10	.64
16	.21	.08	.38	.09	.40
17	.24	.14	.54	.08	.00
18	.17	.11	.47	.09	.20
19	.25	.13	.51	.07	1.01
20	.24	.13	.51	.10	1.27

Average .22 ± .03

VECTOR DIAGRAM: FLOW OF WATER AND POLLUTANT

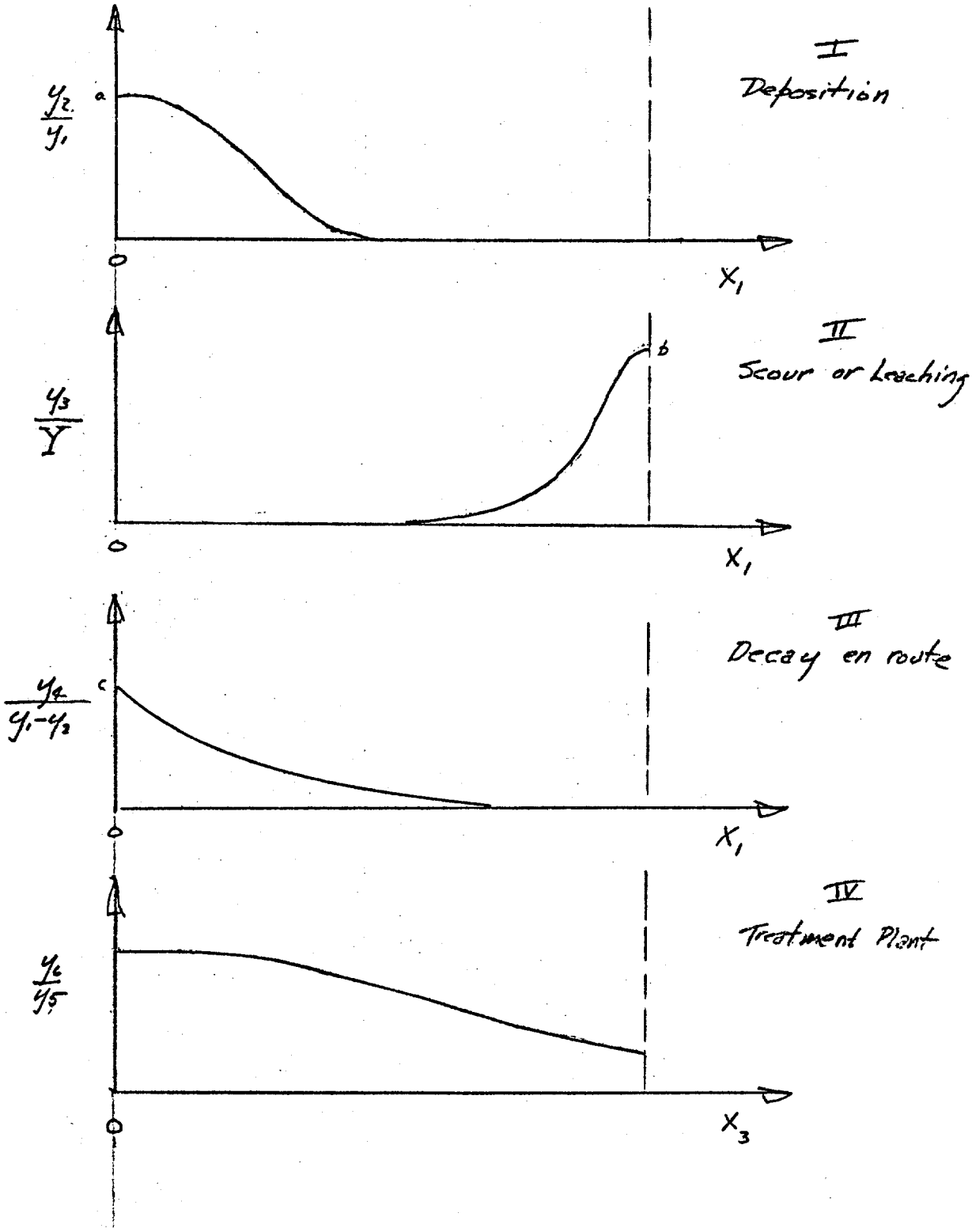
x_1, x_2, y_1 are exogenous stochastic variates

$$x_{i+1} - \mu_x = \rho (x_i - \mu_x) + \sqrt{1-\rho^2}\, \sigma_x t$$



$$y_5 = [x_3/(x_1+x_2)][y_1 - y_2 + y_3 - y_4]$$

Functions Interrelating Flows of Water and Pollutant



GB#12

MINUTES
EXECUTIVE MEETING--CLINCH RIVER STUDY STEERING COMMITTEE
Oak Ridge National Laboratory
December 16, 1964

Meeting #9 ?

The executive session was convened by Committee Chairman E. G. Struxness in the Central Auditorium, Building 4500, ORNL at 12:15 p.m. Members present were: E. G. Struxness, Chairman, J. S. Cragwall, Jr., F. E. Gartrell, Glenn Gentry, S. Leary Jones, R. W. Andrew as alternate for C. P. Straub, W. G. Belter, and C. S. Shoup. One committee member, J. J. Davis was absent. Also present were subcommittee chairmen, M. A. Churchill, R. M. Richardson, S. I. Auerbach, and C. P. McCammon; and from the study staff, P. H. Carrigan, Jr., K. E. Cowser, B. J. Frederick, R. L. Hervin, O. W. Kochtitzky, R. J. Morton, and F. L. Parker. Several others were present for a part or all of the executive meeting. Chairman Struxness had previously announced that those attending the open meeting would be wolcome at the executive session if they were interested in attending.

At the suggestion of C. P. Straub and WITHOUT OBJECTION the committee instructed the secretary to remove Straub's name as a member of the Subcommittee on Water Sampling and Analysis and substitute the name of R. W. Andrew who has functioned as a member since A. G. Friend resigned and has been responsible for much of the Public Health Service cooperation with this subcommittee.

By MOTION the Steering Committee approved the completion of Status Report No. 5 to include revisions suggested by reviewers, and the issuance and distribution of this report as revised.

Chairman Struxness recalled that the subcommittees and the staff of the study have been working on recommendations for long-term monitoring of which a draft had been submitted for consideration by the committee. He raised the question of what further revisions are necessary and what action the committee should take for disposition of the recommendations. There was considerable discussion. Struxness proposed that the recommendations be included in the final report on the study but acknowledged that this might cause a fairly long delay in making the recommendations available. Some opinions expressed were: Gartrell: the recommendations should be sent ahead of the report to the AEC; Schoen: directed to AEC-ORO, with which Shoup: agreed. Cragwall: the recommendations should be brought to the attention of the AEC officials and the ORNL people responsible for radiation safety as quickly as possible.

This document has been approved for release
to the public by:

David R Hamrin 7/17/96
Technical Information Officer Date
ORNL Site

On inquiry from Chairman Struxness and WITHOUT OBJECTION it was agreed that the recommendations should be sent to officials of AEC and ORNL; and some names suggested were J. A. Swartout, Nathan Woodruff, C. E. Larson, and A. M. Weinberg. It was agreed that copies should be sent to members of the Steering Committee and selected members of the study staff.

Belter raised the question whether there was agreement by the Steering Committee on the recommendations as stated. Also he thought that some terms, for example, "survey", should be defined or made more specific. He asked what the significance of the recommendations would be in terms of cost. Struxness reviewed the approximate costs that would be entailed and said that if the recommendations were observed scrupulously as stated the costs for personnel, analytical services, equipment, and other requirements might run from 50,000 to as much as 80,000 or 100,000 dollars per year. There was much discussion of the importance of the monitoring program. It appeared to be the consensus that, although expensive monitoring activities would be difficult to justify strictly on the basis of actual or anticipated radiation hazards, a continuing program of monitoring is necessary because of legal and public relations implications and because it may be impossible to obtain records of radionuclide discharges when needed if there has not been "bookkeeping" all along. Belter, asked to comment by Chairman Struxness, said that in his opinion the most important was a good record of what is discharged at White Oak Dam which if maintained reliably is indicative of various other conditions about which evidence might be needed. Gentry said, giving some examples, that indirect costs resulting from lack of data when needed can be considerable. It was generally agreed, however, that the statement of recommendations should be carefully studied and further revised before approval and distribution, and that in later action the Steering Committee should arrange for this.

There was considerable discussion of the necessity for monitoring of bottom sediments in the rivers downstream and how this should be accomplished. There was lack of agreement on several questions raised by the recommendations of monitoring of sediments. Some committee members thought that the monitoring of sediments could be discontinued. Jones said he did not agree. ORNL should maintain a minimum continuing record of data unless its officials are willing to accept the fact that some other agency might come in, collect samples, and do analyses. Jones gave examples from other locations to show how this might happen. It seemed to be the consensus that monitoring of bottom sediments should be of a lower order of priority in the continuing program that certain other monitoring activities, for example, measurements of discharges at White Oak Dam, and determination of radionuclide transport in waters downstream.

Before recessing for lunch Parker read for the information of the committee a statement regarding final reporting of the Clinch River Study which must be considered later in the executive session.

The committee recessed for lunch at 1:15 p.m. and reconvened at 2:15 p.m. in the Health Physics Lecture Room on the Second Floor of Building 4500 South.

Chairman Struxness recalled the earlier discussion of long-term monitoring. He now asked that the committee consider the recommendations and decide upon the action to be taken. There was discussion by a number of committee members and others present. McCammon thought that to make the recommendations for a monitoring program too weak would be a misinterpretation of the safety evaluation which showed very little potential hazard from present contamination of the river. Jones said that if there is a potential hazard then the Laboratory does need some bookkeeping to evaluate what is being done and trends that may develop. Parker said that Melton Hill Dam is designed for a maximum discharge up to 125,000 cfs. He commented that if this should occur the location and other conditions of sediments downstream would be radically changed. There was general discussion of various conditions that might develop. Belter felt that on the basis of the safety evaluation data the need for monitoring of sediments is minimal; and that the data do not provide technical justification for sediment monitoring. Churchill was asked whether TVA would continue to make sediment surveys to measure the depths of sediments at 5-year intervals and he said that this will be continued.

Parker suggested certain changes in the draft of recommendations. The committee VOTED to approve these changes and the recommendations as revised. It was commented however by several that further revision and editorial "polishing" were needed. Chairman Struxness proposed and WITHOUT OBJECTION was authorized to appoint a committee of four individuals to revise and edit the statement of long-term monitoring recommendations for the Clinch River and also to draft a letter of transmittal to recipients of the recommendations, both subject to review and approval by the Steering Committee. On this committee Struxness appointed: J. S. Cragwall, Jr., Chairman, F. E. Gartrell, S. Leary Jones, and F. L. Parker. Cragwall requested as chairman of this group that in order to expedite completion of the recommendation statement the other members should send to him within a week or less their versions of the recommendations. He would then collate the several drafts and recommend a statement for approval and transmittal by the Steering Committee.

The Steering Committee then took up the matter of final reports for completion of the Clinch River Study. Parker reviewed briefly his outline of proposals for final reporting, which included: (1) issuance of three supplements to Status Report No. 5; (2) Status Report No. 6 for release of material presented during the present meetings of the Steering Committee; (3) a popular summary report, which would be relatively short and issued in larger numbers than the other reports; and (4) a comprehensive technical report

which would serve as a final report on the research aspects of the study. These proposals were considered and action taken as summarized below.

1. Upon a motion by Gartrell the Steering Committee VOTED unanimously to authorize three Supplements to Status Report No. 5 to be issued separately with the same report number (ORNL-3721). These supplements will cover the progress reports by the Subcommittee on Water Sampling and Analysis, the Subcommittee on Bottom Sediment Sampling and Analysis, and the Subcommittee on Safety Evaluation.

2. Regarding Status Report No. 6 as the final report in this series of status reports, Cragwall recalled the action of the committee and read excerpts from the minutes of the meeting on December 5, 1963. Also he discussed the possibilities of publication of the final reports on this study. He said that the USGS has been approached as one agency that might undertake publication and that it was his impression that the USGS people were generally receptive to the idea.

It was understood, of course, that Status Report No. 6 would be in the ORNL format corresponding with previous status report. A motion was made by Jones and seconded that Status Report No. 6 should be issued to cover any material presented at this meeting that is not to be contained in the three supplements previously authorized and mentioned above. Approval of the motion was VOTED unanimously.

3. A motion by Jones was VOTED unanimously that a Popular Summary Report as previously described and discussed should be authorized and that plans and arrangements for its preparation, issue, and distribution should be made.

4. The committee next considered the preparation of a Comprehensive Technical Report as a final report on the Clinch River Study. Belter suggested that concurrent publication of this report should be arranged because three or four different groups are especially interested in it. Cragwall suggested that, although three or four distribution lists from various agencies might be used, the report should not be published in different issues but, for easier publication, should be reproduced in one format. It could have different or other appropriate covers and be distributed as desired by the several interested agencies. There was discussion of possible means of publication of this final report. A motion was VOTED unanimously that Chairman Struxness should appoint a Publications Committee for the comprehensive final report which should consider the possible forms and means of publication and make recommendations concerning this report to the Steering Committee. Chairman Struxness appointed on this committee: W. G. Belter, Chairman, Alfred Clebsch, R. J. Morton, C. S. Shoup, and C. P. Straub.

A motion was VOTED that the same publications committee should explore the form and means of publication and the distribution of the popular summary report and make recommendations to the Steering Committee about this report also.

It was suggested and accepted by the Steering Committee WITHOUT OBJECTION that eight individuals be designated as a group to begin work immediately on the comprehensive technical report, and as it was drafted to work also on the popular summary report. This was authorized and the following were named to constitute this group: E. G. Struxness, F. L. Parker, R. J. Morton, P. H. Carrigan, K. E. Cowser, M. A. Churchill, D. J. Nelson, and R. W. Andrew. From comments that were made it was understood that these individuals should be responsible and should be recognized for authorship of these reports, but the methods of allocating the work and recognizing authorship were not decided.

Belter suggested that May 1, 1965 be designated as a target date for completion of the draft of the several reports authorized above. There was no dissent and this recommendation was accepted by the Steering Committee. It was understood and comments were made that, to meet such a deadline, the work on report preparation must be given a high priority during the next several months.

As a minor item of business, Chairman Struxness informed the Committee that K. E. Cowser has been invited by the Health Physics Society to present a paper on the safety evaluation analysis, made as part of this study and based on the data collected by the Clinch River study group. He said that, acting as chairman, he would approve the presentation of this paper, and no dissent was voiced by the Steering Committee members.

With regard to future activities of the Steering Committee, Chairman Struxness said that there had been some thought that the study might be completed by the time of this meeting and the Steering Committee dissolved. The study has not reached the point where the Committee can be discontinued. The next meeting, if a meeting is found necessary, will be held on call by the chairman of the Steering Committee.

The Subcommittee on Water Sampling and Analysis has suggested that the National Water Quality Network (of USPHS) should use a proportional composite sample from the ORGDP sampling station instead of grab samples which are ordinarily taken for analyses by the Network personnel. The subcommittee has been informed that Leo Weaver, who is in charge of the Water Quality Network sampling program, is agreeable to this suggestion. The Steering Committee AGREED that if and when the ORGDP sampling station is operational Chairman Struxness should write to Leo Weaver and arrange for his group to receive samples collected from the Clinch River at this station.

At the close of the session there was further discussion of preparation of the final reports. Belter said, as mentioned above, that he proposed May 1, 1965 as a target date for completion of drafts of these reports and asked for some discussion of timing. It was again emphasized that it is desirable to push for preparation of the reports as early as possible which will require a high priority for this effort. Parker suggested that there should be "rump" sessions of the six Oak Ridge members of the committee of eight appointed to prepare the reports, for discussion of various aspects of the reports and for planning their preparation. The Oak Ridge members could then transmit their recommendations to M. A. Churchill (Chattanooga), and R. W. Andrew (Cincinnati) for comments, further revision, and approval.

The meeting was adjourned at 4:00 p.m.

Minutes prepared by R. J. Morton, Secretary
Clinch River Study Steering Committee

RJM:ms

December 24, 1964.

MINUTES OPEN MEETING--CLINCH RIVER STUDY STEERING COMMITTEE
December 15-16, 1964
Central Auditorium and East Auditorium
Building 4500
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Tuesday, December 15, 1964

The open meeting was called to order at 9:15 a.m. by E. G. Struxness, Steering Committee Chairman. In introductory remarks Struxness made several announcements about arrangements for the open meeting and executive meeting during the next two days. He called attention to copies of reports being distributed and reminded that they were preliminary documents for use at these meetings and not to be quoted or used as references without permission of the Steering Committee. He introduced all members of the Steering Committee whether present or absent, giving their titles and agency connections and also the chairmen of the four Subcommittees, all of whom were present. Struxness also introduced and recognized visitors present from various agencies, including Harvard University, University of Texas, U. S. AEC (headquarters and operations offices), General Electric at Hanford, du Pont at Savannah River, USGS in Washington, USPHS in Cincinnati, TVA in Chattanooga and Oak Ridge, and Tennessee State agencies in Nashville.

Struxness listed the previous Status Reports, namely: No. 1, ORNL-3119 issued July 27, 1961; No. 2, ORNL-3202, March 30, 1962; No. 3, ORNL-3370, November 21, 1962; and No. 4, ORNL-3409, September 11, 1963. Status Report No. 5, ORNL-3721, has been drafted, circulated for review, and submitted to the Steering Committee for approval at its executive meeting December 16 (tomorrow). It was presumed that Status Report No. 6 is to be prepared from progress reports presented at this meeting.

Chairman Struxness requested that all persons attending the meeting record their attendance on the registration list (see attached). He requested F. L. Parker, Study Coordinator, to moderate the presentation of reports during the remainder of the open session. With some changes in the time of presentation shown on the agenda, reports and discussions were considered as summarized below.

A. Water Sampling and Analysis

1. Progress Report No. 4 (Final), Subcommittee on Water Sampling and Analysis, December 15-16, 1964.

The report was presented by M. A. Churchill, Subcommittee Chairman. He referred to various parts of the report, of which copies had been distributed, and showed slides of the results of the water sampling and analysis program beginning November 1960. Members of the Subcommittee were recognized, namely, R. W. Andrew, J. S. Cragwall and S. Leary Jones; and Wm. R. Nicholas of TVA, Chattanooga, Subcommittee Staff.

Churchill said that the data in this progress report supersedes the data presented earlier in Progress Reports Nos. 1, 2, and 3. He discussed briefly and explained the nature of errors in the previous data because of the imperfections in computer analysis procedures, the very low levels of activity dealt with, and other factors; and the methods used in correcting and adjusting the data as shown in the present report.

Churchill gave his opinions regarding several portions of the data as corrected and now presented. For example, he said that: (1) comparison of determinations of Strontium-90 by ORNL and PHS showed that the PHS results were higher than ORNL by only about 12% which is very good agreement for such low-level determinations; (2) discrepancies in values of cesium concentrations at Centers Ferry can be explained because of malfunction of the water sampler in the fall of 1961, but there is a possibility that unexplained cesium discharges between White Oak Creek and Centers Ferry caused or added to these discrepancies; (3) the mass diagram for ^{106}Ru showed amazingly good agreement, probably because the levels of ^{106}Ru being measured in the water were higher than for the other radionuclides; (4) based on studies by ORNL and USGS of changes that will be caused by operation of Melton Hill Dam, this subcommittee does not feel that reactivation of the water sampling program for future analyses is justified. It appears that the effects of operation of Melton Hill Dam will be essentially local.

Attention was called to the recommendations of the subcommittee on page 69 of the report. The first three are concerned with the water monitoring program which the subcommittee feels must be continued indefinitely at and below the Oak Ridge National Laboratory. The last three concern improvements that should be made in the type of studies reported here if such a study of the river is reinitiated in the future at and below Oak Ridge. They also should be helpful if similar studies are put into operation by others at some other location for similar purposes.

2. "Winter Power Release Diffusion Study," P. H. Carrigan, Jr.

A prepublication copy of a report "Power Release Diffusion Study - Early Spring 1964 " by P. H. Carrigan, Jr., B. J. Frederick, and F. L. Parker was distributed and used as a basis for Carrigan's discussion of this subject. This report is part of the material to be used in the preparation of Status Report No. 6.

After review of the results of 6-10 tracer tests and hydrologic analyses of dispersion in the Clinch River during the period 1952 to the present the authors stated that they did not consider it of paramount importance to conduct further tracer tests in the Clinch River. From the present series of tests of winter conditions conclusions were summarized. It was shown that, as previously believed, the minimum dilution factor at CRM 14.4 and CRM 5.5 is much less for winter power release patterns than is the minimum dilution factor for summer release patterns. The results of this test indicate that the time of arrival of the peak concentration of CRM 14.4 (intake of ORGDP water plant) can be reasonably predicted using analytical techniques developed for the Clinch River by the TVA in 1952. All in all, tracer tests made during the Clinch River Study indicated that the calculated predictions of conditions (time of flow and approximate concentrations of materials released at White Oak Creek) are sound and have not varied excessively from the values observed during the tests.

The discussion of diffusion studies by dye tracer tests was concluded by a series of color slides showing the spread of the red dye in the Clinch River during the 1963 (summer) dye tracer tests.

B. Aquatic Biology

1. Report of Subcommittee on Aquatic Biology, S. I. Auerbach, Chairman.

Auerbach reviewed and commented briefly on a report by this subcommittee, of which copies were distributed. In the report were three recommendations regarding sampling and analysis of game fish, commercial food fish, and nonedible rough fish used in making fish by-products. It recommended specifically that game fish and commercial food fish should be sampled annually at CRM 14.0, and that fish used in by-product production should be sampled as the need arises.

Also the subcommittee recommended that the Steering Committee consider how much of the assimilative capacity of a stream should be used for radioactive waste disposal.

In the discussion of possible sampling programs under 9 subheadings, the subcommittee expressed opinions regarding the relative importance of various materials. These may be summarized briefly as follow: The role of organic detritus in causing entry of radionuclides into the food chain is relatively important and is being studied; there is no advantage to continued sampling of clam shells; to be interpretable data collection regarding turnover of radionuclides in clam flesh should be limited to the Asiatic clam, a potential food species now living in the river; some studies of plankton may be useful where unusual conditions occur (as from operations of the Bull Run Steam Plant and Melton Hill Dam); other invertebrates are not of concern; birds and mammals living on the river are not considered to be of any concern; various organisms such as clams and aquatic diptera are not considered significant as vectors or

as reservoirs of radioactivity; the bottom feeding species of fish are important; of game fish white crappie are suggested for study because they are numerous and frequently caught; and studies of radiation effects on natural populations suggest that there are no permanent effects. The Subcommittee on Aquatic Biology does not consider it necessary to continue to sample game fish solely for hazard evaluation (very low concentrations), but believes that sampling of white crappie periodically is advisable from the viewpoint of public relations. Commercial species of food fish constitute a potential hazard and should be sampled annually; and small rough fish involved in the production of fish by-products, particularly gizzard shad, should be sampled as necessary.

The subcommittee had no recommendations regarding irrigation but recommended that it should be considered by the Subcommittee on Hazards Evaluation.

It was concluded that food chains to man appear to be a major mechanism by which radionuclides are dispersed from the aquatic environment.

2. "Fish Sampling and Analysis," D. J. Nelson.

No written report was distributed. Nelson reviewed the purpose and progress of the joint sampling program of ORNL and the USPHS in 1962 when game fish and rough fish were sampled. The fish samples were prepared for analysis using the usual method of preparation for eating. Rough fish were ground to include both flesh and bone together because, at least in some instances, it has been found that the eating of "fishburgers" is practiced. The latest information is that this practice is not common and does not occur downstream from ORNL, and therefore the higher values due to the inclusion of bones in the samples for analysis do not indicate potential exposures of concern to the subcommittee.

In his summary, Nelson said that because of studies on white crappie the Ecology workers can now predict radionuclide concentrations in game fish that may result from releases of ORNL wastes, most reliably for white crappie but with good assurance for other species. The data from the analyses of fish collected in 1962 and 1963 by ORNL and the USPHS have been turned over to the Subcommittee on Safety Evaluation.

C. Bottom Sediment Sampling and Analysis.

1. Progress Report of Subcommittee on Bottom Sediment Sampling and Analysis, R. M. Richardson, Chairman.

No written report from the subcommittee was distributed. The subcommittee later completed and submitted a summary statement "Recommendations on Monitoring of Radioactivity in Bottom Sediments of the Clinch and Tennessee

Rivers" for consideration at the executive meeting of the Steering Committee.

2. "Radiochemistry and Geochemistry of Clinch River Sediments," R. J. Pickering (USGS).

It was explained that this report and the next discussion by P. H. Carrigan, Jr. covered three reports concerned with studies of radioactivity in cores of bottom sediments collected in the Clinch River during the summer of 1962. To present the substance of his subject (above) Pickering submitted two written reports, namely, "Vertical Distribution of Gamma Activity in Clinch River Bottom Sediments; Results of Core Sampling and Analysis--Summer 1962" and "Physicochemical Characteristics of Clinch River Bottom Sediments and their Effect on the Radionuclide Content of the Sediment." Pickering presented an abridged summary of the two reports mentioned above both of which were quite voluminous in the data and discussion they contained. Regarding the physicochemical characteristics Pickering pointed out that the form of radionuclides in the bottom sediments is not known, particularly cobalt, strontium and ruthenium. Also there is need for more information on the effects of the organic fractions in the accumulation and retention of bottom-sediment radioactivity.

3. "Inventory of Radioactivity in Bottom Sediments of the Clinch River," P. H. Carrigan, Jr. (USGS).

This was not a full report on the inventory investigation but only a synopsis of the most important results and the general methods used in computing the inventory. The results of the inventory indicated that a total of 200.7 curies was the estimated radioactivity of bottom sediments between the mouth of White Oak Creek and the mouth of Clinch River, a distance of 21 miles; and that about 95% of the identified radionuclides were in the reach of the river downstream from CRM 15. In making the estimates a digital computer at ORNL was used with programs for the computations prepared by the author of the report.

The Steering Committee recessed for lunch at 12:15, and reassembled at 1:30 p.m. in the East Auditorium, ORNL. The afternoon session was moderated by F. L. Parker.

D. Special Report

1. "Systems Analyses Applied to River Systems," Myron B. Fiering.

The basis for this presentation was a written discussion on "Computer Simulation Models of River Systems" by M. B. Fiering of which copies were distributed in advance.

Fiering spoke first of simulation in general pointing out that the principal of simulation is very old and that some examples can be quite simple.

His presentation considered a more sophisticated and very complicated design involving economics, acceptable conditions, etc. Such analyses are made possible by the availability of large modern computers such as the IBM-7094 which was mentioned. In describing the design of a complex simulation model and program for analyzing a hydraulic system (or project) Fiering referred to particular parts of the written discussion outline upon which his presentation was based.

2. "Clinch River System Analyses," H. A. Thomas, Jr.

As a basis for further discussion of systems analyses Prof. Thomas distributed a written statement "A Model for Computer Simulation of the Fate of Radioactive Wastes in Streams." He commented that the first 10 pages of this discussion, which was distributed in advance, had been prepared by Dr. Fiering. The remainder of the statement was by Prof. Thomas and was used by him in continuing his presentation of this special report.

The open meeting of the Steering Committee was recessed (until 9 a.m. the following morning) at 3 p.m. In the same room (East Auditorium) there was presented an ORNL seminar on "System Analyses applied to Water Resources Problems with Reference to Pakistan and Egypt" by Professors H. A. Thomas,Jr. and M. B. Fiering of Harvard.

Wednesday, December 16, 1964

The open meeting of the Steering Committee was reconvened by Chairman Struxness at 9:10 a.m. December 16 in Central Auditorium, Building 4500, ORNL.

Struxness said that a brief period at the beginning of this session would be devoted to recognition of individuals who had participated actively and contributed to the Clinch River Study. He said he wished to recognize specifically the contributions to the study by F. L. Parker as Project Coordinator who initiated preparation for such a study in 1958-1959 and was the leader in obtaining information and formulating the basic plan for the study. Also Struxness mentioned the contributions of R. J. Morton as Secretary and Editor for the Steering Committee and the Clinch River Study.

The Chairman then distributed certificates of participation in the Clinch River Study, 1960-1964, which had been prepared for specific individuals who were recognized by the Steering Committee in this way. Parker commented that there should be much more adequate recognition for the contributions by E. G. Struxness as Chairman of the Steering Committee throughout the study. Parker then served as moderator for the remainder of the open meeting and called for a report by the Subcommittee on Safety Evaluation.

E. Safety Evaluation

1. Progress Report of Subcommittee on Safety Evaluation, introduced by C. P. McCammon, Chairman and presented by K. E. Cowser of the subcommittee staff.

McCammon said that the report was not in final form but that the basic calculations had been made and the safety evaluation could be prepared for release as a supplement to Status Report No. 5. At his request Cowser presented the report, entitled "Safety Analysis of Radionuclide Release to the Clinch River." He used slides to show the results of the safety evaluation and as a basis for discussion of the report. The preliminary draft of the report, including the tables of data and the figures, were available for reference, and there was general discussion of the method of evaluation and the conclusions of the subcommittee. Someone asked whether the estimate of potential exposure from drinking water taken from the Clinch and Tennessee Rivers considered water treatment. Cowser replied that treated water was not considered but that the worst assumption, namely, drinking of untreated water was made. Both Cowser and Straub stated that the controlling radionuclide exposure is that of ^{90}Sr and that the percentage of strontium removed from water by conventional water treatment processes is negligible.

The report of the safety evaluation and the discussion by Cowser covered potential exposures from drinking water, fish, immersion in water, contaminated sediments, radiation in water plants, and crop irrigation. It was found that at present there is no irrigation of crops using Clinch River water but, nevertheless, the calculations were made for information and for use if irrigation with Clinch River water should be done in the future.

In discussing conclusions and recommendations Cowser read from the preliminary draft of the report. It was apparent that on many of the pathways of exposure specific information was meager and that lacking adequate data the subcommittee had been very conservative in its conclusions and recommendations.

In discussing the report A. A. Schoen said that the Clinch River Study is exemplary, has produced the most results, and probably is the most sophisticated river study of this kind that has been made in the United States. There is much interest in the question of safety and he predicted that this report will be used in surprising ways by people who wish to emphasize particular points. There is danger that some of the quantitative data will be taken out of context and that unjustifiable conclusions will be drawn by people who are not familiar with the study and the inadequacies of specific data. Therefore he suggested that wherever possible the Subcommittee on Safety Evaluation should be realistic in estimating exposures and should describe conditions pertinent to the population at large rather than individual extreme examples. He urged that the Steering Committee should not make unrealistic assumptions, or fail to use the figures and data obtained from this study in working out examples of realistic exposure estimates.

Cowser requested Richard Foster to comment. Foster, of Hanford, said that the closer to the actual exposure the estimate can be made, the better; and this usually means estimating the body burden of radionuclides. At Hanford during the past two or three years whole body counting has been done of employees and of some people in surrounding areas who are exposed, for example, by drinking river water. He made the point that the data on concentrations in the river are better than is the information about usage of the water and its constituents by people. Commenting on the estimates concerning fish D. J. Nelson said that the best evidence is that very few people use fishburgers in which bone is ground together with flesh of fish resulting in a potentially higher radionuclide intake to those who eat the fish. Therefore in the tables of the evaluation report the "total" values are high estimates. He thought that the assumption of 37 lbs per year per person is a reasonable estimate of the amount of fish that may be eaten. This estimate was based on a survey of commercial fishermen in Alabama.

W. G. Belter emphasized that Schoen's suggestion to keep the estimates of exposure realistic is very important. Carrigan commented that realistic estimates based on quantitative data would require difficult and expensive epidemiological type studies. Schoen emphasized that the evaluation group is entitled to use its judgment as to what is most likely to occur and should feel free to give its estimates with comments or examples to clarify the more pessimistic assumptions. After further discussion the majority appeared to feel that this professional group must make it clear that its assumed exposures and estimated safety values are reasonable rather than extreme. If this is not done relatively uninformed people will make their own assumptions and resist efforts to maintain adequate safety standards. Cragwall felt that those engaged in the Clinch River Study should take the data we have and write the story for others to use, for example, newspaper reporters, instead of allowing them to assemble and interpret the figures themselves. He believed that such a statement should be in the safety evaluation report. Shoup agreed. He thought that there should be a release prepared for the public relations people to use and that this would further safeguard the proper use of the data.

As the final item of the open session F. L. Parker, Study Coordinator, presented his "Evaluation of the Clinch River Study and Recommendations for Long-Term Monitoring." In presenting a critique of the Clinch River Study Parker mentioned several basic needs for a study of this kind. An example is the necessity for definite goals which in this case were included in the plan of the study and have been very helpful in its guidance. An administrative setup that is flexible enough to include any investigational interest is very important.

Parker showed a slide of the organization of the Clinch River Study and the interrelationships of the several agencies which have joined and contributed in its conduct. He commended particularly the TVA and

Tennessee state agencies which have contributed greatly to the study without receiving special funds for this purpose. The bulk of the work program was carried out by people located at ORNL which was essential for efficiency in performance and coordination. He emphasized that the study was, in principle, a scientific investigation. The approach was to first obtain facts and then formulate interpretations.

He pointed out several weaknesses in the study which should be avoided in future investigations of this kind. Examples were failure to cross-check laboratory procedures and analytical results from the very beginning of the study, and too few conferences between the various agencies to be sure that all were following plans and procedures which had been agreed upon and understood by the various workers. He said we needed (and did not get) adequate temperature measurements upstream and downstream from the "duck under" points associated with stratification in the Clinch River. He thought that a strong point in the study was the water sampling program which was finally adjusted by the use of cumulative totals at successive downstream sampling points. Another was the successful adaptation of bottom sediment coring devices for Clinch River sediment sampling.

In closing his comments Parker said that one deficiency was lack of continuing constructive publicity regarding the study and too little publication of scientific papers and journal articles describing the study and giving some of the results. There were no published general articles, a minimum of news releases, and only a few talks and papers about the study during its progress.

Following his comments regarding evaluation of the study Parker led a discussion of long-term monitoring recommendations based on manuscripts which had been submitted by the subcommittees. The notes of this discussion and the manuscripts submitted were carried over into the executive session for consideration and action by the Steering Committee.

Chairman Struxness adjourned the open meeting at 12:10 p.m. and said that the executive session would convene immediately afterward. The Chairman thanked all who had come and participated in the open sessions yesterday and today.

Minutes prepared by Roy J. Morton, Secretary
Clinch River Study Steering Committee

RJM:ms

ATTENDANCE LIST - OPEN MEETING
Clinch River Study Steering Committee
Oak Ridge National Laboratory
December 15-16, 1964

Name	Location	Agency
R. W. Andrew	Cincinnati, Ohio	USPHS
S. I. Auerbach	Oak Ridge, Tennessee	ORNL
Walter G. Belter	Washington, D. C.	AEC-Hqrs.
H. Bernard	Washington, D. C.	AEC-Hqrs.
S. R. Bernard	Oak Ridge, Tennessee	ORNL
P. H. Carrigan, Jr.	Oak Ridge, Tennessee	USGS
M. A. Churchill	Chattanooga, Tennessee	TVA
Alfred Clebsch, Jr.	Washington, D. C.	USGS
W. D. Cottrell	Oak Ridge, Tennessee	ORNL
K. E. Cowser	Oak Ridge, Tennessee	ORNL
J. S. Cragwall, Jr.	Chattanooga, Tennessee	USGS
E. R. Eastwood	Oak Ridge, Tennessee	ORNL
M. B. Fiering	Cambridge, Massachusetts	Harvard U.
R. F. Foster	Richland, Washington	G. E.
B. J. Frederick	Knoxville, Tennessee	USGS
F. E. Gartrell	Chattanooga, Tennessee	TVA
Glenn Gentry	Nashville, Tennessee	TGFC
E. F. Gloyna	Austin, Texas	U. of Texas
R. L. Hervin	Oak Ridge, Tennessee	AEC-ORO
J. H. Horton	Aiken, South Carolina	Du Pont,SRP
S. Leary Jones	Nashville, Tennessee	Tenn.Stream Pol.Control Bd.

Name	Location	Agency
Wilbur O. Kochtitzky	Chattanooga, Tennessee	TVA
W. L. Marter	Aiken, South Carolina	Du Pont, SRP
Curtis P. McCammon	Nashville, Tennessee	TDPH
Roy J. Morton	Oak Ridge, Tennessee	AEC-ORO
D. J. Nelson	Oak Ridge, Tennessee	ORNL
Wm. R. Nicholas	Chattanooga, Tennessee	TVA
F. L. Parker	Oak Ridge, Tennessee	ORNL
R. J. Pickering	Oak Ridge, Tennessee	USGS
R. M. Richardson	Oak Ridge, Tennessee	USGS
A. S. Rogowski	Oak Ridge, Tennessee	ORNL
Arthur A. Schoen	Washington, D. C.	AEC-Hqrs.
C. S. Shoup	Oak Ridge, Tennessee	AEC-ORO
Roger Don Shull	Washington, D. C.	AEC-Hqrs.
W. S. Snyder	Oak Ridge, Tennessee	ORNL
Conrad P. Straub	Cincinnati, Ohio	USPHS
E. G. Struxness	Oak Ridge, Tennessee	ORNL
T. Tamura	Oak Ridge, Tennessee	ORNL
H. A. Thomas, Jr.	Cambridge, Massachusetts	Harvard U.
R. D. Wildman	Richland, Washington	AEC-HO