1229

D STA...

ATOMIC ... GY CO...MISSION

WASH... ON, D.C.

717288

MAR 29 1971

ENV.

BEST COPY AVAILABLE

Alvin M. Weinberg, Director
Ridge National Laboratory
Office Box X
Ridge, Tennessee 37830

Dear Dr. Weinberg:

Your letter to Mr. Hollingsworth forwarding the "Proposal to Develop a Study Plan to Investigate the Potential Radiological Impact of an Expanding Nuclear Power Industry on the Tennessee Valley Region" has been referred to the Division of Reactor Development and Technology (RDT). As indicated in your letter, regional studies rather than ad hoc plant-by-plant studies of the radiological impact of the expanding nuclear power industry are required. Such a study was initiated by the Atomic Energy Commission in January 1970. This effort, known as the "Year 2000 Study," involves primarily the development of computer model and data to estimate the potential dose and dose commitments to individuals and population groups based on release rates nuclear power reactors, and nuclear fuel reprocessing plants expected to be located in the United States by the Year 2000. This study is being conducted by the Hanford Engineering Development Laboratory (HEDL).

Upper Mississippi River Basin has been selected as the location to ... the model development and pilot study for the Year 2000 Study. ... is planned to encompass the contiguous United States, the model ... be provided with sufficient generality to readily accommodate other areas of the country. All the major components of the model have been developed with the ability to handle all anticipated radionuclides, pathways, and waste treatment systems of interest. It is expected that the full model will be operational shortly. The next phase of the study will involve examining the importance of the variables and radioisotopes considered in the model by determining their sensitivity to the results.

would like to examine the possibility of supporting the proposed study on the basis of including it as part of the Year 2000 Study. This would take advantage of techniques and procedures established for Year 2000 Study and help ensure compatibility and proper interfacing with the other geographical segments of the Year 2000 Study. A decided benefit would be the application of much of the modeling in the Year

REPOSITORY Oak Ridge Operations Records Holding area
COLLECTION Documents 1944-94
BOX No. A-49-6 1 of 4 75-44 Bldg. 2714-H
04-60-40-01
FOLDER Environmental Program

1115957

MAR 9 1971

2000 Study on the transport and fate of critical radionuclides in regional, atmospheric, terrestial and aquatic systems of the Tennessee Valley Authority system. Further, the sensitivity studies and calculations being made for the Upper Mississippi River Basin study could very well assist in circumventing the development and inclusion of information in the TVA regional study that may have a negligible effect on the results.

Enclosed is an outline of the Year 2000 Study for your information. Other reports on the study will be forwarded to ORNL as they become available.

We appreciate receiving your proposal and as you have noted, TVA's and ATDL-NOAA participation could provide many advantages. Mr. M. J. Whitman of my staff, will contact Mr. J. L. Liverman, as you suggest, to arrange discussions among ORNL, TVA, ATDL-NOAA, HEDL and RDT on considerations involved in integrating the proposed study with the Year 2000 Study.

Sincerely,

Milton Shaw, Director
Division of Reactor Development
and Technology

Enclosure:
Outline of the Year 2000 Study

cc: D. F. Cope, RDT Sr. Site Rep., ORNL
S. R. Sapirie, Manager, OR

1115958

YEAR 2000 STUDY OUTLINE

Model will be applied initially to Upper Mississippi River Basin as a Reference Problem.

A. Calculations will determine exposure of people to radiation within the boundaries of the area defined. Figure 1 indicates the major parts of the model and their interfaces.

B. Calculations will include all potential radioactivity from power plants and fuel reprocessing plants in area plus effects of effluents from Lake Michigan and air transport from a 200 mile envelope on the periphery of the area. Figure 2 indicates the boundaries of the study area.

C. Number and size of nuclear power plants and reprocessing plants in basin will be projected to the year 2000.

   1. Projection based on: power demand, likely mix of fossil and and nuclear using a computer model of U. S. electric power economy developed at PNL. Figure 3 outlines the procedures for establishing the source information and Figure 4 is a preliminary source map for 1990.

   2. Location of plant sites will be Federal Power Commission regional power forecasts.

D. Release characteristics to air and water will be analyzed to identify critical radionuclides and relative quantities involved.

1115959

1. HEW studies of releases from Dresden and Yankee and predictions from SARs will be the primary sources of information on projecting relative amounts of radionuclides in effluent releases. Quantity released will be an input variable for Headquarters' use in applying the model. The model will be tested using arbitrary "unit releases."

2. Nuclides selected for study are those which:

   a. May be generated in significant amounts in power reactors.

   b. Have sufficiently long half-lives that they will endure through the process leading to their release and subsequent transport from a plant site to the point of intake.

   c. Are likely to result in an important fraction of the total population exposure in the area of study.

   Figures 5, 6, and 7 indicate those radionuclides being considered in the study.

E. Properties of plant gas and liquid waste treatment systems will be a separate input to the model.

   Individual components of the waste treatment system, e.g., the number and types of filters, scrubber systems, evaporators, dissolver off-gas systems and retention tanks and basins, on the radionuclide source will be variable.

1115960

F. Air Transport Model

Figure 8 indicates input and output of model

1. A square array of fifty mile internal nodes has been set up within the air envelope to describe the air and ground concentrations in the region.

2. The basic equations to determine air concentrations have the same form as found in "Meteorology and Atomic Energy - 1968."

   a. The diffusion parameters will be taken directly from this document.

   b. Concentrations will be calculated as a function of distance from the reactor sites and at the centroids of populous regions.

   c. Radioactive decay and depletion by wet and dry deposition will be accounted for.

3. Climatological data will be obtained from weather stations within the study area and depletion estimates are based on the best information currently available.

   a. Climatological data available:

      i. Percent frequency of occurrence of wind direction by month.

      ii. Mean cloud cover by month.

      iii. Percent frequency of occurrence of precipitation by month and direction sector.

b. Direction readings from at least three weather stations are weighted inversely with distance to produce a wind vector at the reactor site. The associated frequencies of occurrence of this wind vector are then computed from the station data.

c. Cloud cover, wind speed, and day-night classification data are used to determine the Pasquill type of stability.

d. Wet and dry deposition by nuclide will be estimated by watershed and food production area.

G. Water Transport Model

Figure 9 shows the water transport of radionuclides

1. Ground water and run off transport

   a. Because of difficulties in obtaining good ground water transport data, it is assumed that no waste water is discharged to the ground or to consumable water intakes.

   b. Radionuclides reach the ground water via the surface water.

   c. Tritium and ruthenium are the only nuclides that reach ground water by wet and dry deposition from the atmosphere. Conservative assumptions in the handling of these nuclides (including no decay) will be used to present the worst case and to establish whether contributions from ground water are significant.

2. Surface Water Transport

   a. The techniques used in the COLHEAT computer code which was developed at PNL for the Hanford Reactors will be utilized as the basis for modeling surface water transport.

b. Mean monthly flows for the rivers in the basin will be based on U.S.G.S. measurements from 1951-1960.

c. Absorption and transport of the radionuclides by biota will not be considered. Consideration of biota primarily increases the travel time. Eliminating their effect results in a conservative answer and simplifies the calculations.

d. Adsorption and transport of radioactivity in sediment will be considered.

H. Food Production - Consumption Model

Figure 10 shows details of the food production-consumption model.

1. Food Production

a. Food production patterns in the basin will be obtained from government publications.

b. Transportation of food between surplus and deficit counties will be calculated using an existing PNL model.

c. Irrigated crops in the basin will consider the effect of radionuclides in the irrigation waters.

d. The commercial and sport fishing catch in the basin may be an important source of radioactivity for certain segments of the population as about 19 million pounds are caught annually in the basin.

2. Food Consumption

Dietary habits will be obtained from Public Health Surveys which are published periodically (once in several years) for each area. Figure 11 shows the dietary consumptions for the adult and small child in the Richland, Washington area.

I. Dose Calculations

1. Dose commitment

a. Dose commitment considered will be the 50 year accumulated dose due to intake during a period under consideration (normally one year).

b. Dose commitments will be calculated for the average and maximum standard adult living from 2001 to 2050.

c. Dose commitments will also be calculated for the maximum dose and average dose of a small child assuming growth to adulthood with changing dose factors for the residual internally deposited radionucldies.

d. Effects of long-term accumulated radioactivity in the environment will be considered.

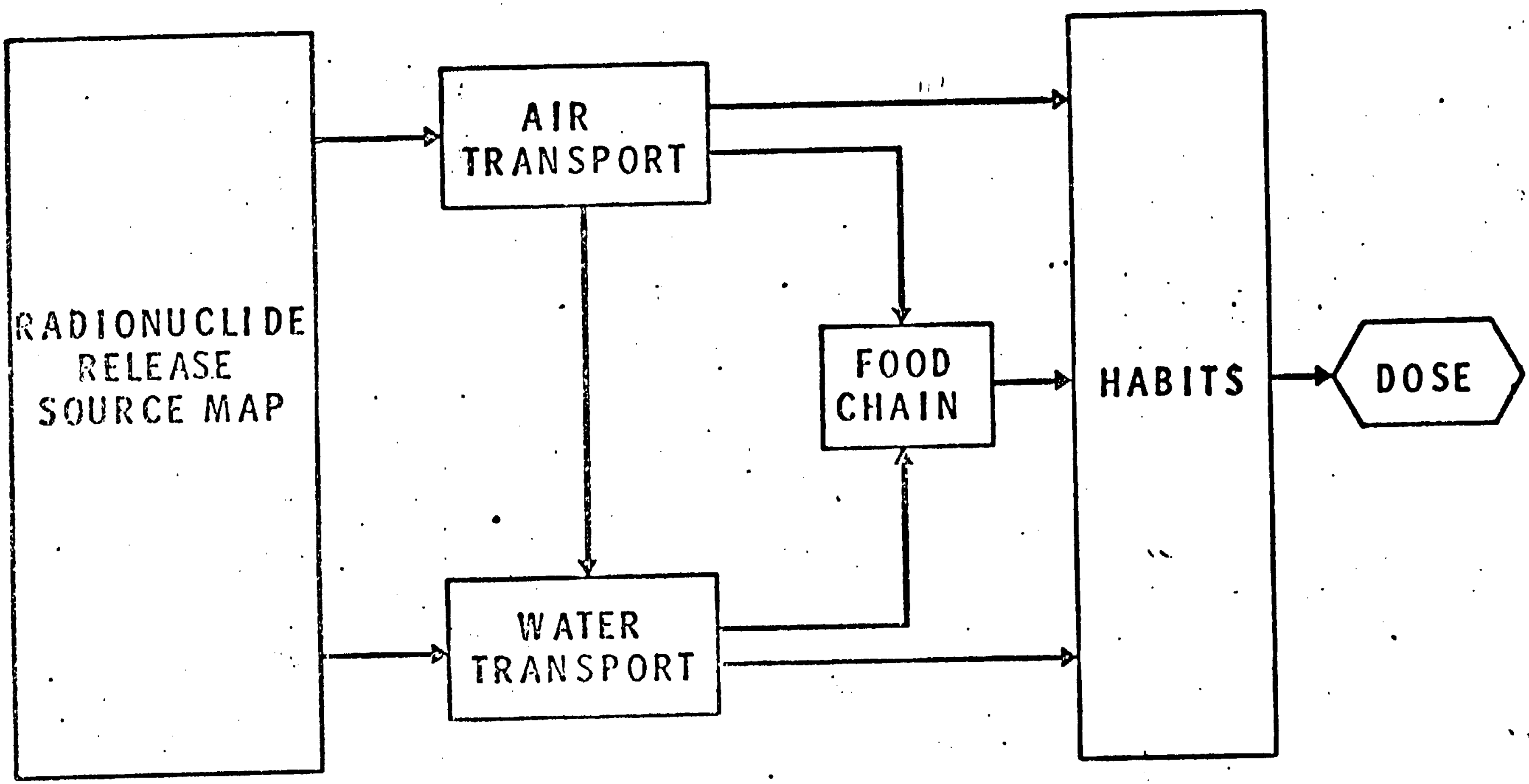
2. Integrated Man-rems

Radiation doses will be calculated at about 100 major population centers and several rural areas to permit summation of the products of dose times number of people receiving that dose.

1115964

FIGURE 1

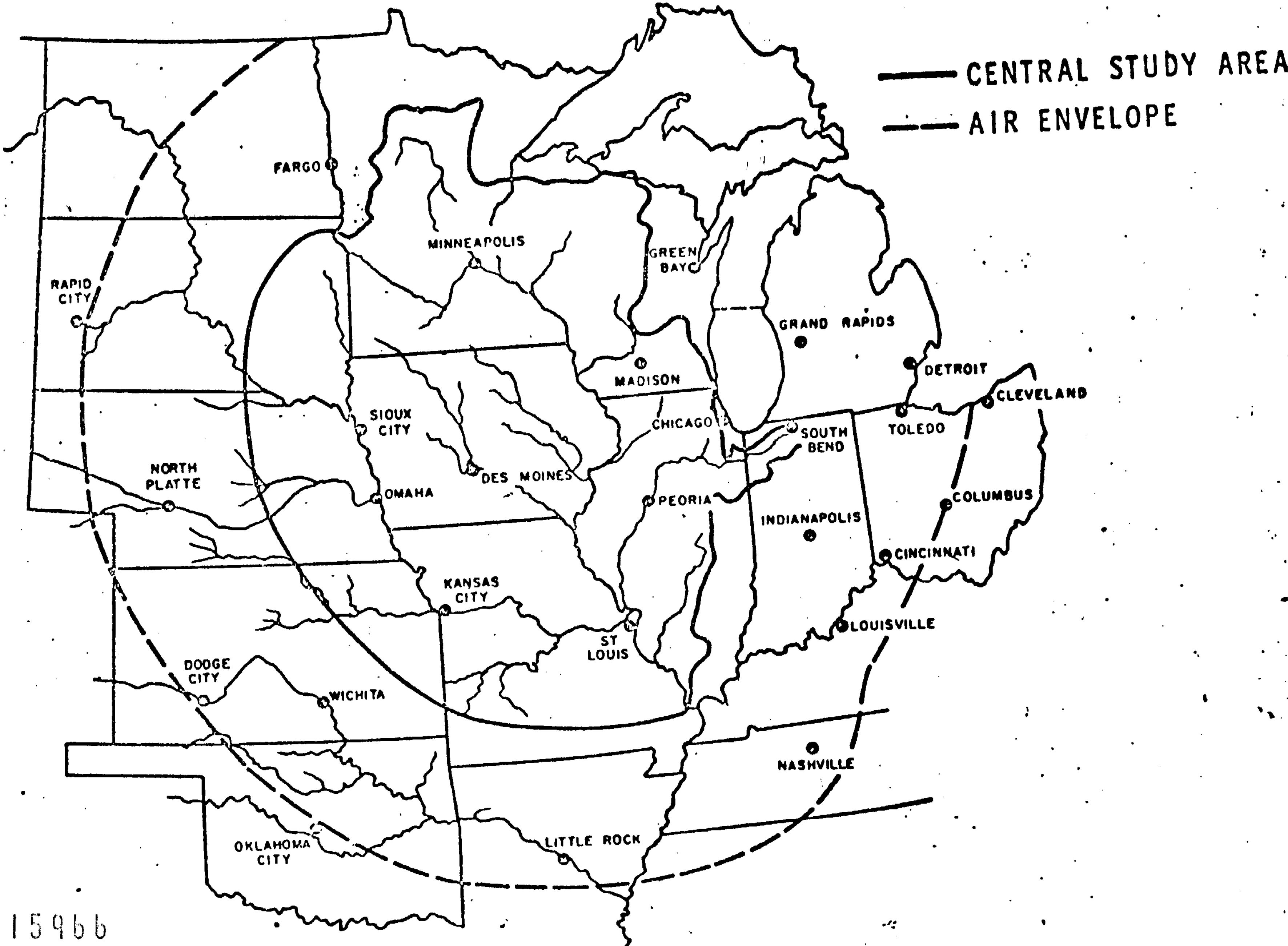
MODEL INTERFACES



1115965

FIGURE 2

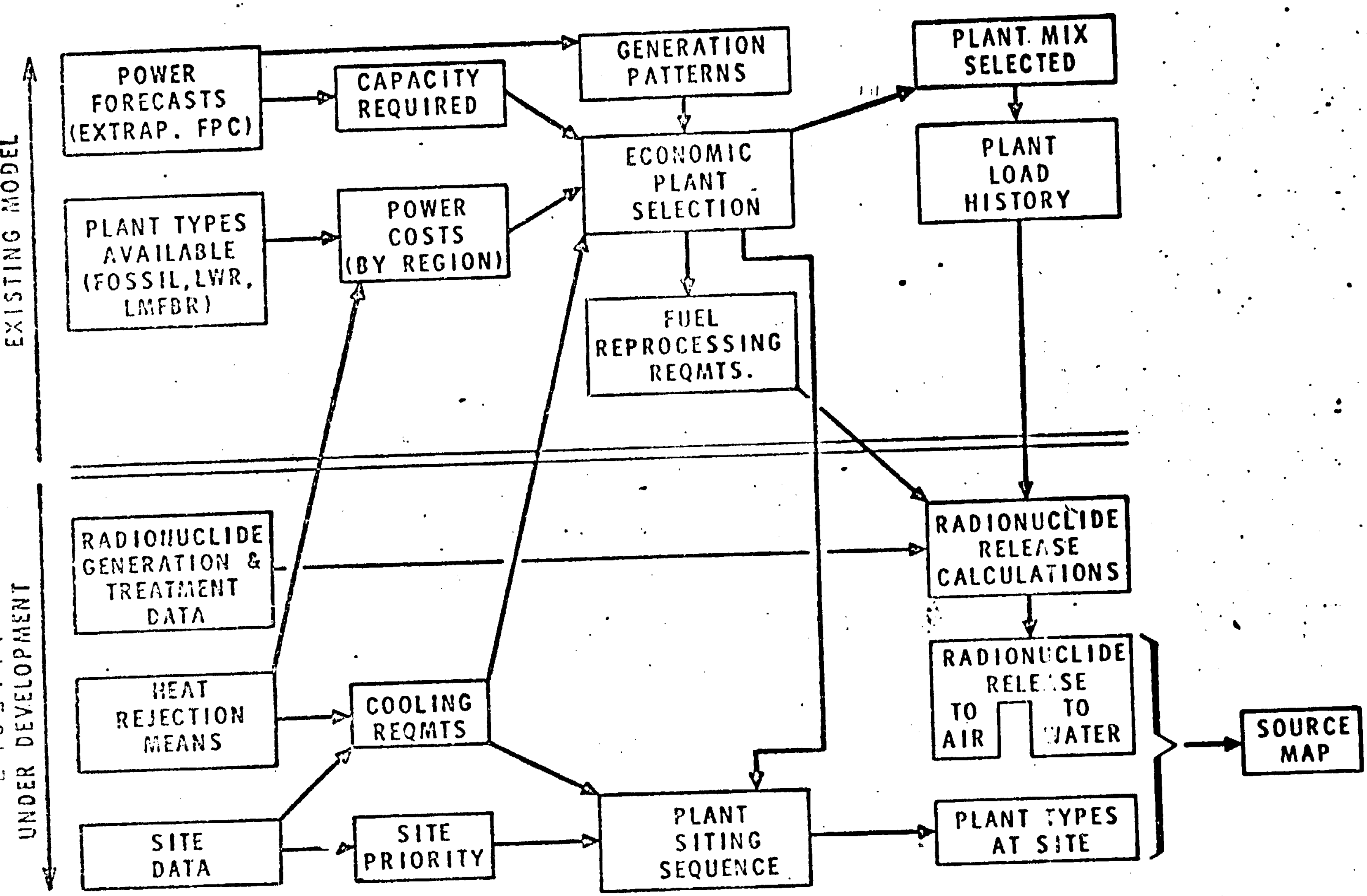
BOUNDARIES OF STUDY AREA



1115966

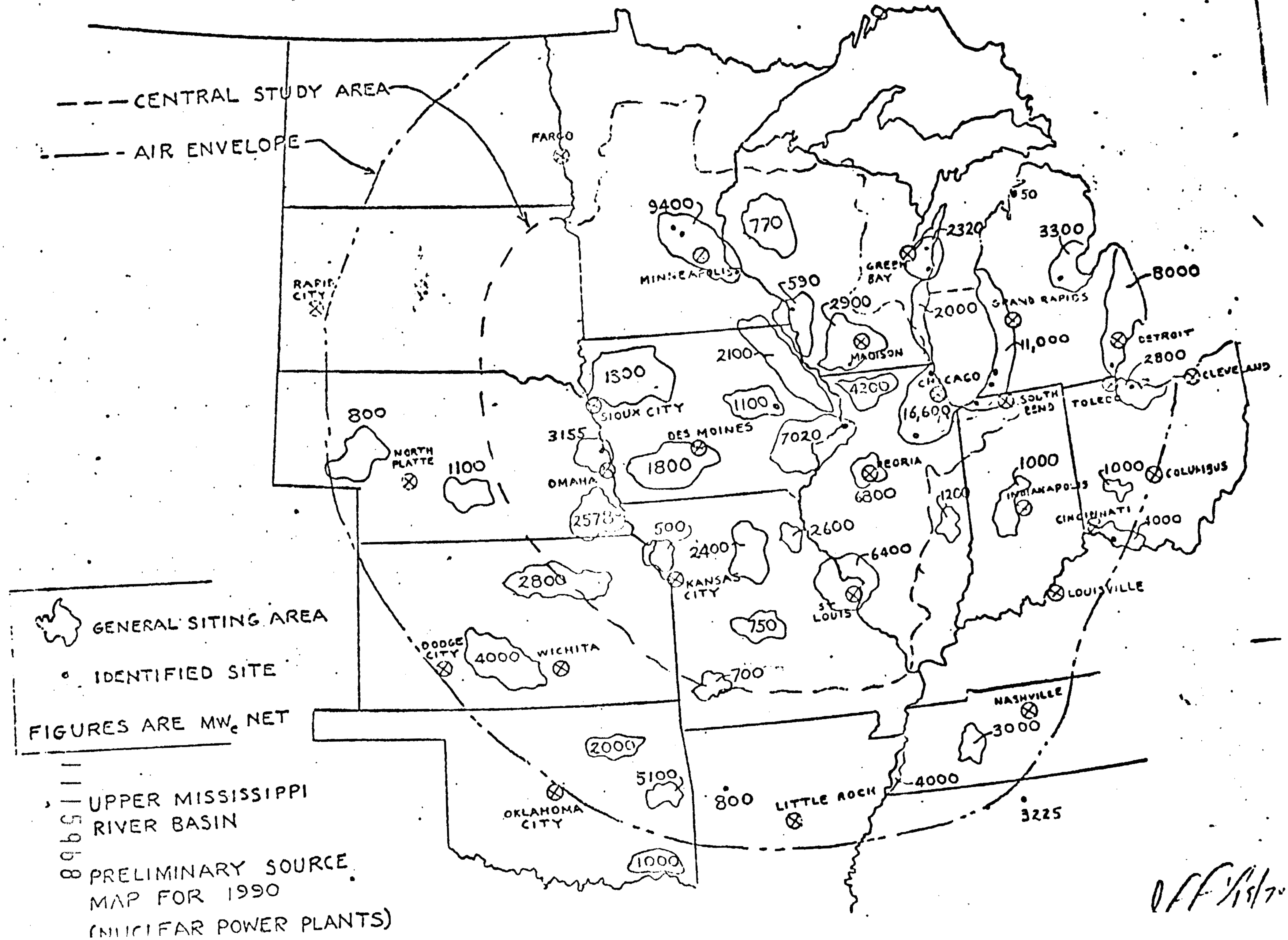
FIGURE 3

SOURCE MAP MODEL



1115967

FIGURE 4



5968 PRELIMINARY SOURCE MAP FOR 1990 (NUCLEAR POWER PLANTS)

FIGURE 5

RADIONUCLIDES CONSIDERED IN AIR RELEASE

NUCLIDE	HALF LIFE	RELEASE FROM LWR	RELEASE FROM LMFBR	RELEASE FROM REPROC	COMMENTS
^{3}H	12.26 YR	X	X	X	TERNARY FISSION PRODUCT; $^{10}B(n,2\alpha)$
^{39}Ar	270 YR	(X)	X		AIR ACTIVATION; LMFBR COVER GAS ACTIVATION
^{41}Ar	1.83 YR	(X)	X		AIR ACTIVATION; LMFBR COVER GAS ACTIVATION
^{85}Kr	10.76 YR	X	X	X	LONG HALF LIFE
^{103}Ru	40 DAY			X	VOLATILE OXIDE
^{106}Ru	1 YR			X	VOLATILE OXIDE
^{129}I	1.6×10^{7} YR	X	(X)	X	THYROID DOSE
^{131}I	8.05 DAY	X	(X)	X	THYROID DOSE
^{132}I	2.3 HR	X	(X)		THYROID DOSE
^{133}I	21 HR	X	(X)		THYROID DOSE
^{131}Xe	12 DAY	X	X	(?)	MAJOR AIR RELEASE CONSTITUENT
^{133}Xe	5.27 DAY	X	X		MAJOR AIR RELEASE CONSTITUENT

1115969

FIGURE 6

RADIONUCLIDES CONSIDERED IN WATER RELEASE
I. ACTIVATION PRODUCTS

NUCLIDE	HALF LIFE	RELEASE FROM: LWR	RELEASE FROM: LMFBR	RELEASE FROM: REPROC	COMMENTS
^{22}Na	2.6 YR			(X)	LMFBR COOLANT ACTIVATION
^{24}Na	15 HR				
^{51}Cr	27.8 DAY	X			ACTIVATION OF STEEL ALLOYS
^{54}Mn	312 DAY	X			
^{55}Fe	2.4 YR	X	(?)		
^{59}Fe	45 DAY	X			
^{58}Co	71 DAY	X			
^{60}Co	5.24 YR	X			
^{65}Zn	243 DAY	X			ZINC ACTIVATION (BRASS, ETC)
^{95}Zr	65 DAY	X		X	CLAD ACTIVATION; ALSO F.P.
^{95}Nb	35 DAY	X		X	^{95}Zr DAUGHTER; ALSO F.P.

1115970

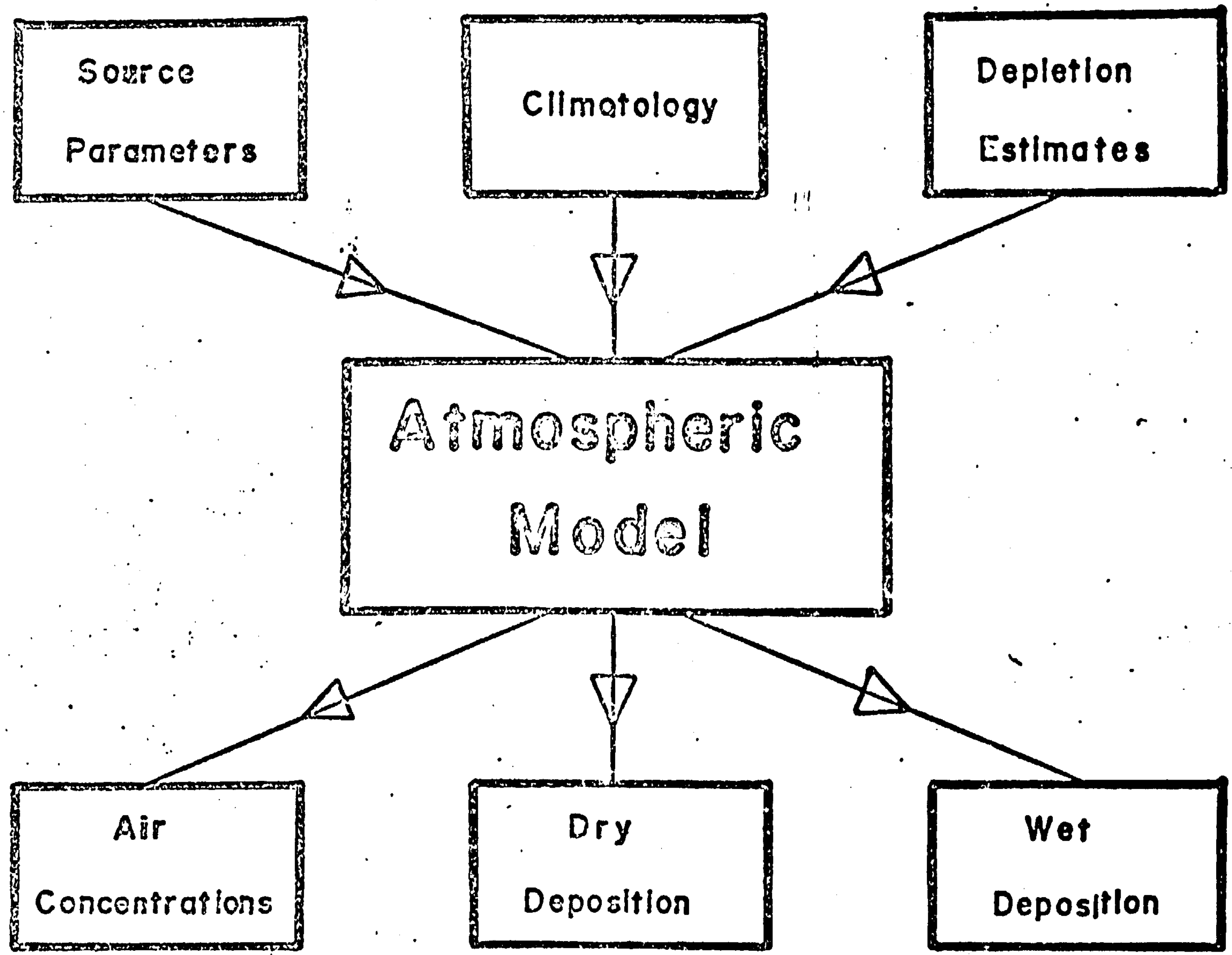
FIGURE 7

RADIONUCLIDES CONSIDERED IN WATER RELEASE
II. FISSION PRODUCTS

NUCLIDE	HALF LIFE	RELEASE FROM: LWR	LMFBR	REPROC	COMMENTS
^{3}H	12.26 YR	X	X	X	TERNARY FISSION PRODUCT; $^{10}B(n,2\alpha)$
^{89}Sr	50.6 DAY	X		X	BONE SEEKER
^{90}Sr	28.8 YR	X		X	BONE SEEKER; LONG HALF LIFE
^{90}Y	59 DAY	X		X	^{90}Sr DAUGHTER
^{103}Ru	40 DAY	X			GI TRACT, KIDNEY DOSE (^{103}Ru, ^{106}Ru)
^{106}Ru	1 YR	X		X	
^{132}Te	78 HR	X			PRECURSOR OF ^{132}I
^{129}I	$1.6x10^{7}$YR	X		X	THYROID DOSE (^{129}I, ^{131}I, ^{132}I, ^{133}I)
^{131}I	8.05 DAY	X	?	X	
^{132}I	2.3 HR	X			
^{133}I	21 HR	X			
^{134}Cs	2.1 YR	X		X	ACTIVATION OF F.P. ^{133}Cs
^{137}Cs	30 YR	X		X	BIOLOGICAL IMPORTANCE; LONG HALF LIFE
^{140}Ba	12.8 DAY	X		X	BONE SEEKER
^{140}La	40.2 HR	X		X	^{140}Ba DAUGHTER
^{141}Ce	32.5 DAY	X		X	GI TRACT DOSE
$^{144}Ce-Pr$	285 DAY	X		X	

1115971

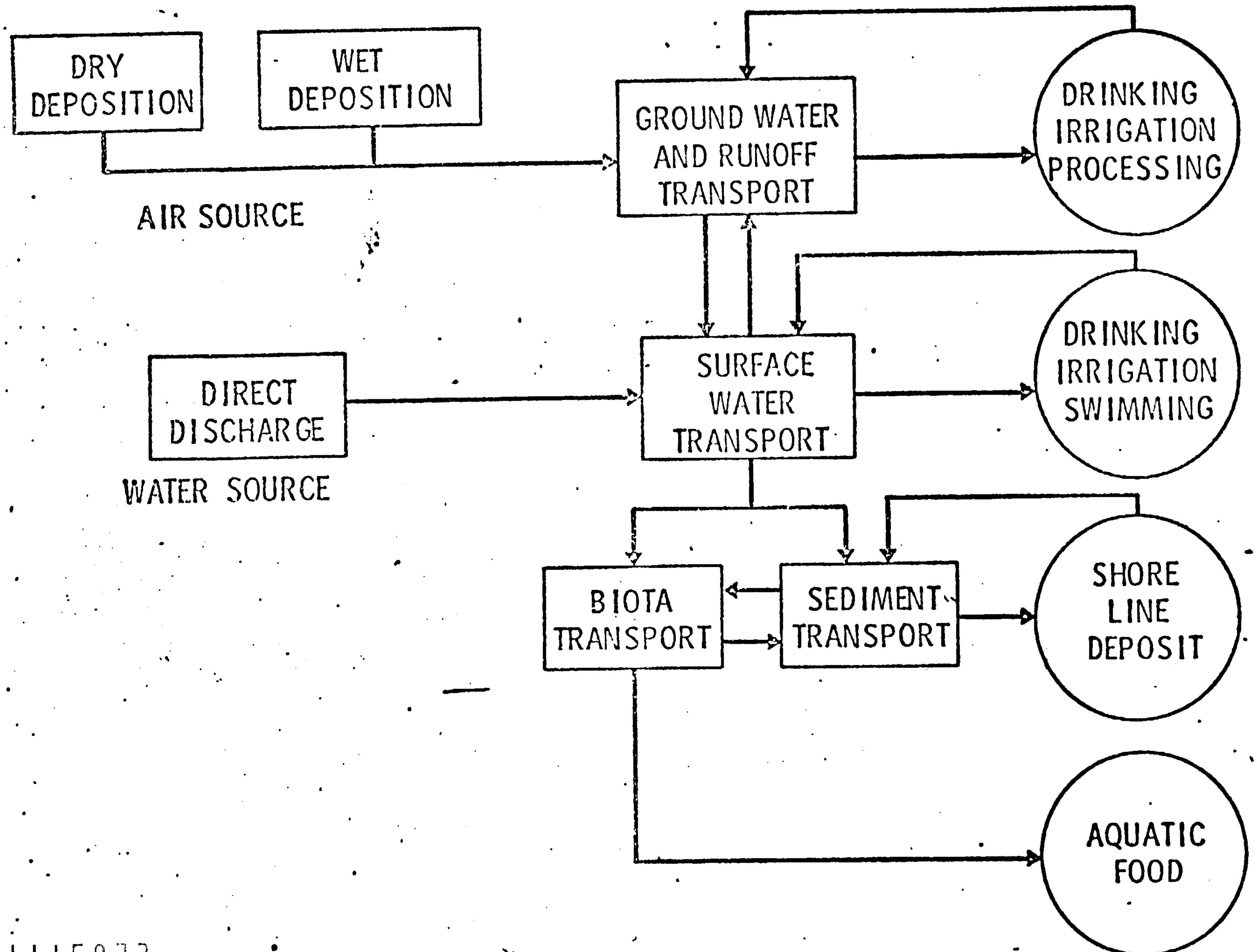
FIGURE 8



1115972

FIGURE 9

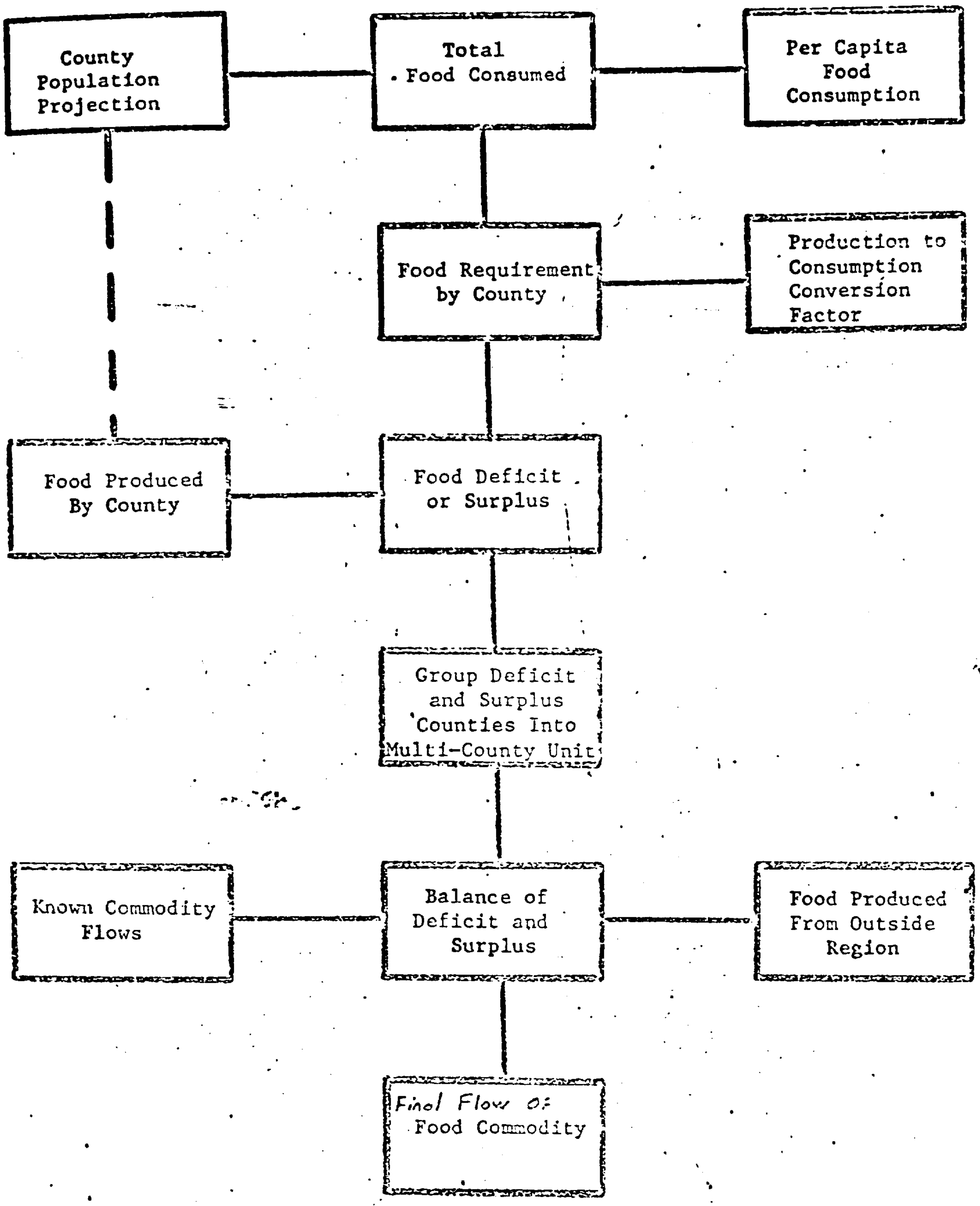
WATER TRANSPORT OF RADIONUCLIDES



1115973

FIGURE 10

FOOD PRODUCTION-CONSUMPTION MODEL



1115974

FIGURE 11

DIETARY ASSUMPTIONS FOR THE ADULT

FOODSTUFFS	MAXIMUM INDIVIDUAL	TYPICAL RICHLAND RESIDENT
DRINKING WATER	2.0 ℓ/DAY	1.2 ℓ/DAY
MILK	1.05 ℓ/DAY	0.85 ℓ/DAY
MEAT	227 g/DAY	227 g/DAY
FISH (SEAFOOD)	110 g/DAY	15 g/DAY
GREEN LEAFY VEGETABLES	200 g/DAY	100 g/DAY
OTHER VEG. AND FRUITS	1430 g/DAY	550 g/DAY

DIETARY ASSUMPTIONS FOR THE SMALL CHILD

FOODSTUFFS	MAXIMUM CHILD	TYPICAL RICHLAND CHILD
DRINKING WATER	0.8 ℓ/DAY	0.4 ℓ/DAY
MILK	1.0 ℓ/DAY	0.6 ℓ/DAY
FRESH LEAFY VEGETABLES	50 g/DAY	25 g/DAY

1115975