YUCCA MOUNTAIN PROJECT

Studies

Yucca Mountain Biosphere Modeling

Presented to:
Nuclear Waste Technical Review Board

Presented by:
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CRWMS M&O Contractor

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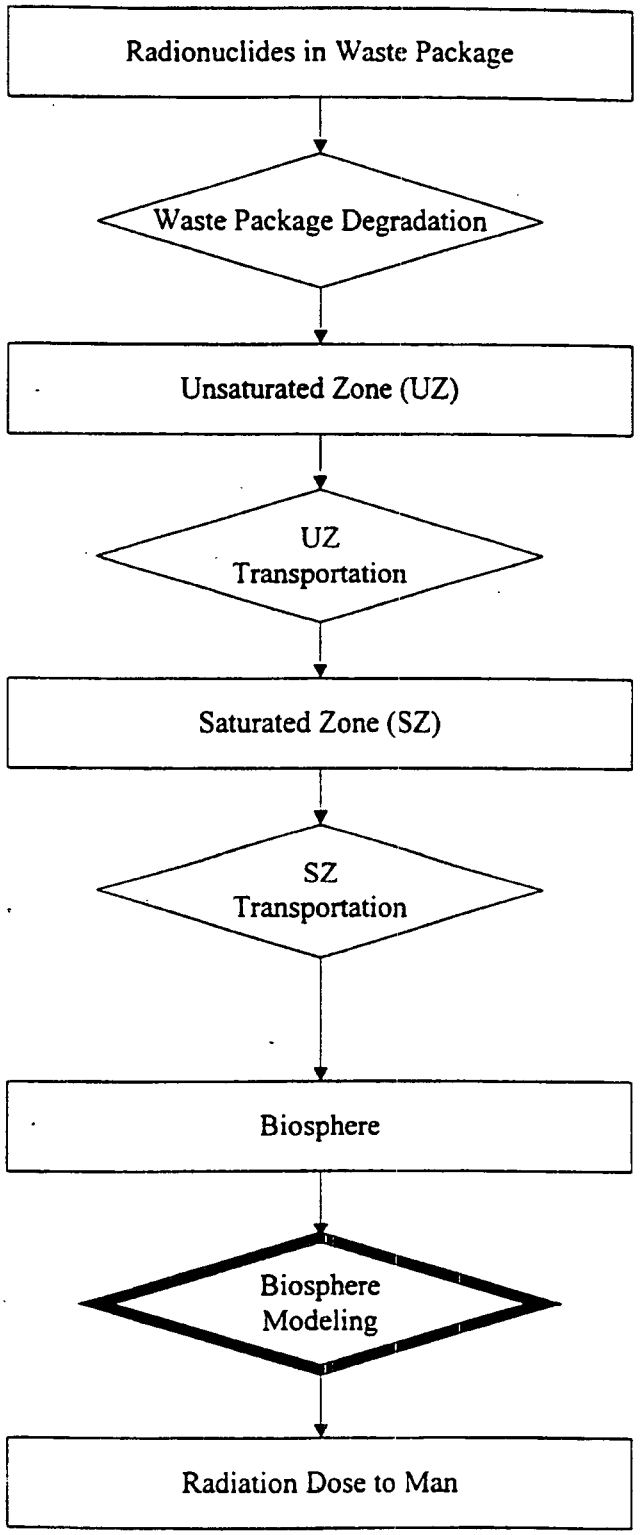
U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Biosphere Modeling in TSPA



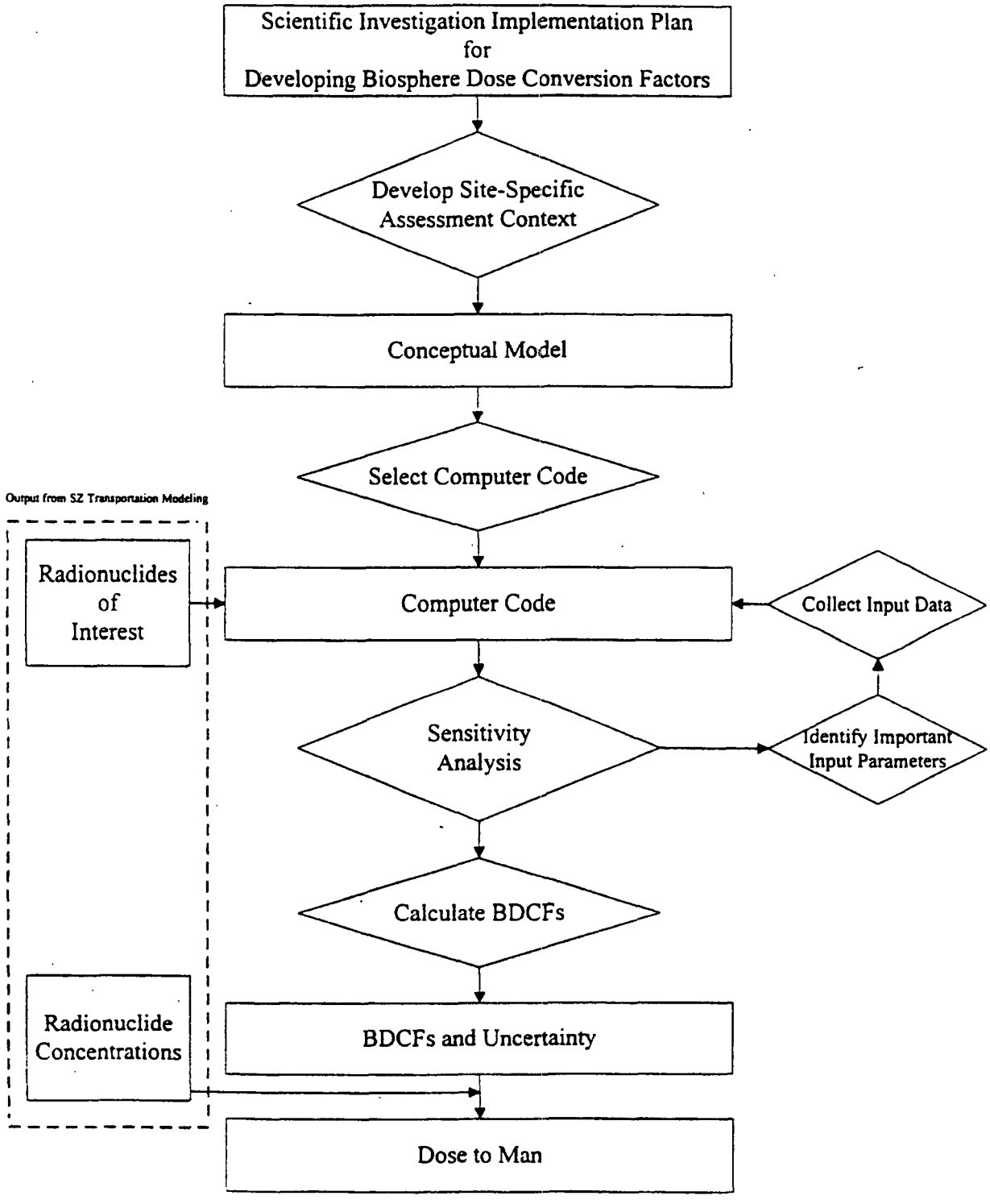
Biosphere Definition

- The region of the earth in which environmental pathways for the transfer of radionuclides to living organisms are located and by which radionuclides in air, ground water, and soil can reach humans to be inhaled, ingested, or absorbed through the skin. Humans can also be exposed to direct irradiation from radionuclides in the environment (National Research Council, 1995).

Biosphere Modeling Objectives

- Model radionuclide movement through the site-specific environmental pathways
- Calculate Biosphere Dose Conversion Factors (BDCFs) for each radionuclide expected to enter the biosphere
  - Factor is the resulting Total Effective Dose Equivalent (TEDE) from unit radionuclide concentration in ground water, i.e., mrem/year/picoCurie/liter
  - Factors are scenario specific
    - » Three receptors
      - Subsistence farmer, residential farmer, and average person in Amargosa Valley
    - » Three precipitation states
      - 1X, 2X, and 3X

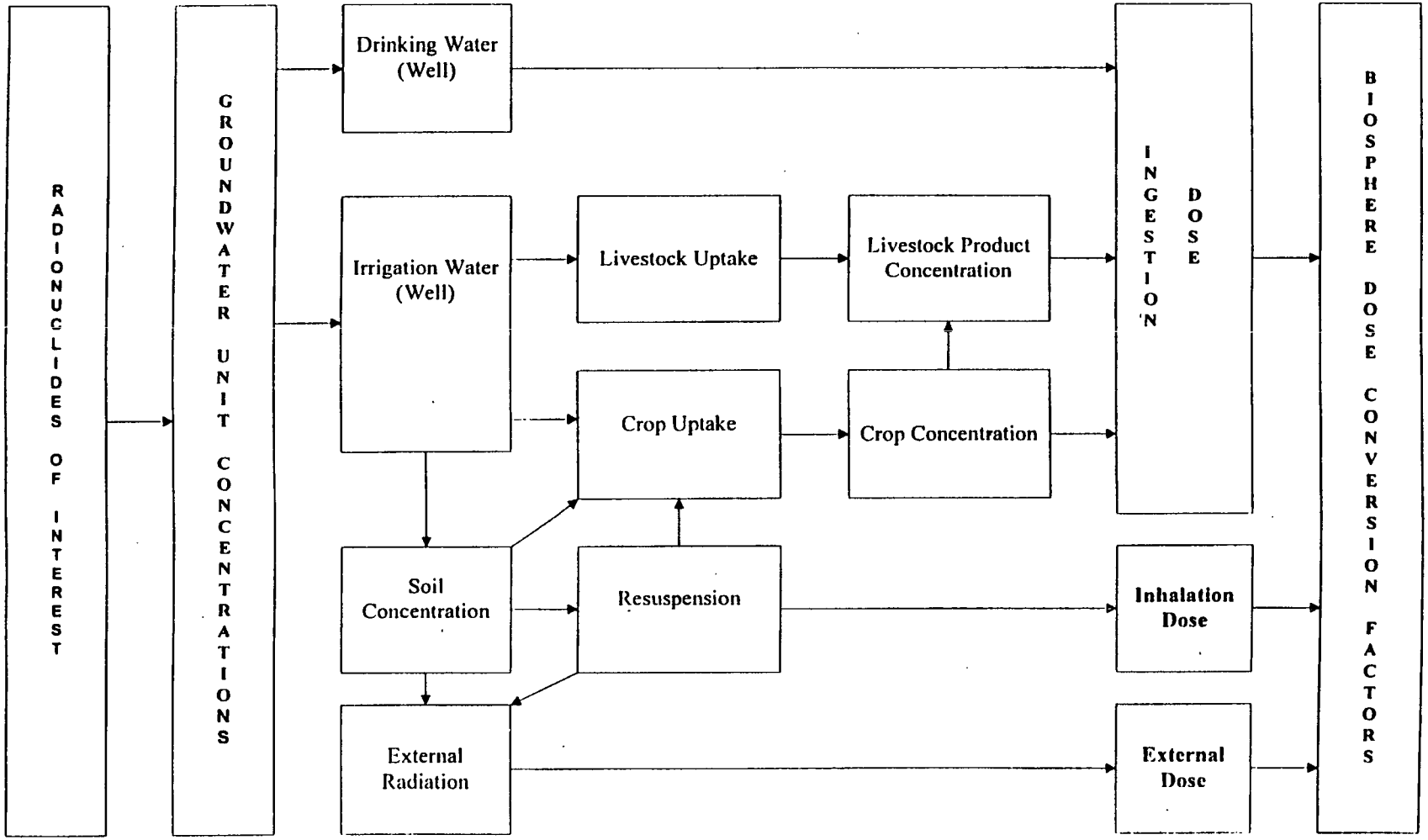
Biosphere Modeling



Development of Site-Specific Assessment Context and Conceptual Model

- Identify relevant site-specific features, events, and processes to be considered
  - environmental compartments
  - transport mechanisms
- Establish conceptual model

Human Exposure Pathways for a Groundwater Release Scenario



Evaluation and Selection of Computer Code

- Selection Criteria
  - existing, off-the-shelf
  - used in regulatory environment
  - capable of handling multiple scenarios
- Codes Evaluated
  - GENII-S, MEPAS, RESRAD, CAP88 PC, AIRDOS EPA, and RASCAL
- Code Selected: GENII-S

Data Collection and Sensitivity Analyses

- Use generic input data to perform sensitivity analyses
- Identify sensitive parameters and pathways
- Collect data with focus on sensitive parameters
- Repeat sensitivity analyses using collected data to confirm preliminary findings
- Finalize input parameters

Site-Specific Data for Yucca Mountain

- Far field water monitoring
- Biotransport mechanisms and processes
- Soil types and characteristics
- Consumption of locally produced food

Characteristics of the Biosphere Food Consumption Survey

- A full-scale sample survey that was approved by OMB (#1910-1400) April 31st and subsequently conducted using CATI system at UNLV.

- A stratified random design insured an efficient sample, for which sample error was both measurable and minimal, given the resources available.

- Using information gained from pilot study, careful questionnaire design and interviewing procedures, thorough interviewer training, close supervision of interviewers, and CATI system, were used to minimize non-sampling error.

- 1,079 interviews completed in early June, with n = 195 in Amargosa Valley; n = 250 in Beatty; n = 65 in Indian Springs; and n = 569 in Pahrump.

- 21 Spanish language interviews completed.

- Special "Difficult To Interview" sample (n=33) collected to determine if "non-response bias" was present and if special adjustments would be needed.

Area Weighting Data

Sample and Total Household Frequency by Community 1997 Biosphere Survey

Community	Number of households surveyed n_h	Total number of households N_h	% of households surveyed
Amargosa Valley	195	452	43%
Beatty	250	751	33%
Indian Springs	65	529	12%
Pahrump	569	4,993	11%
Total	1,079	6,725	16%

* The sample is randomly drawn from households within each community.

Annual Adult Consumption Levels of Locally Produced Food and Tap Water Biosphere Study Area[1]

Variable (Food Type)	"Total Population" Level[2] Sample n	Mean	Standard Deviation	"Partial Subsistence" Level[3] Sample n	Mean	Standard Deviation	"Subsistence" Level[4] Sample n	Mean	Standard Deviation
LeafyVeg.	1035	4.39	10.30	468	9.70	13.47	7	63.55	22.46
RootVeg.	1022	2.13	5.83	342	6.37	8.57	17	28.86	12.57
Grains	1021	0.40	4.37	37	11.01	19.24	1	60.64	18.82*
Fruit	1037	4.47	11.54	441	10.54	15.41	9	59.32	30.81
Poultry	1026	0.45	2.27	94	4.88	6.33	14	15.74	8.94
Meat	1025	0.92	4.97	109	8.66	13.04	63	8.97	10.07
Fish	1041	0.04	0.50	36	1.05	2.33	1	7.50	---**
Eggs	1021	2.32	5.51	32	7.28	7.79	93	15.78	7.58
Milk	996	4.84	19.94	80	60.50	49.59	28	119.39	26.27
TapWater[5]	1068	646.16	475.02	896	769.70	402.15	(896)	(769.70)	(402.15)

see notes on next page

Notes for Consumption Table

1. The study area is comprised of the following areas: Amargosa Valley, Beatty, Indian Springs, and Pahrump. All food amounts shown are in kilograms. Water and milk consumption are shown in liters. The summary statistics reflect weighting (post-stratification) by gender and area population and are provided for the resident adult population (18 years and over).

2. The denominators of the means of the "total population" consumption levels (per resident adult) INCLUDE all who responded to the question of whether or not they consumed locally-produced-food of the type in question. This denominator is comprised of those who report that: (a) nothing they consume is locally-produced; and (b) that "all," "some," or "very little" of the food type in question they consumed is locally-produced. Only those who responded "don't know" or refused to answer are excluded. Thus, the conceptual denominator is constant across all food types (including tap water): It is the total resident adult population of the Study Area.

3. The denominators of the means of the "partial subsistence" consumption levels (per resident adult) EXCLUDE those who report that nothing they consume is locally-produced. Those who responded "don't know" or refused to answer are also excluded. This denominator includes only those that report "all," "most," "some," and "very little," of the food type in question (that they consumed) is locally-produced. Thus, the conceptual denominator varies across food type and is comprised only of those adult residents who report consuming locally-produced food of the type in question.

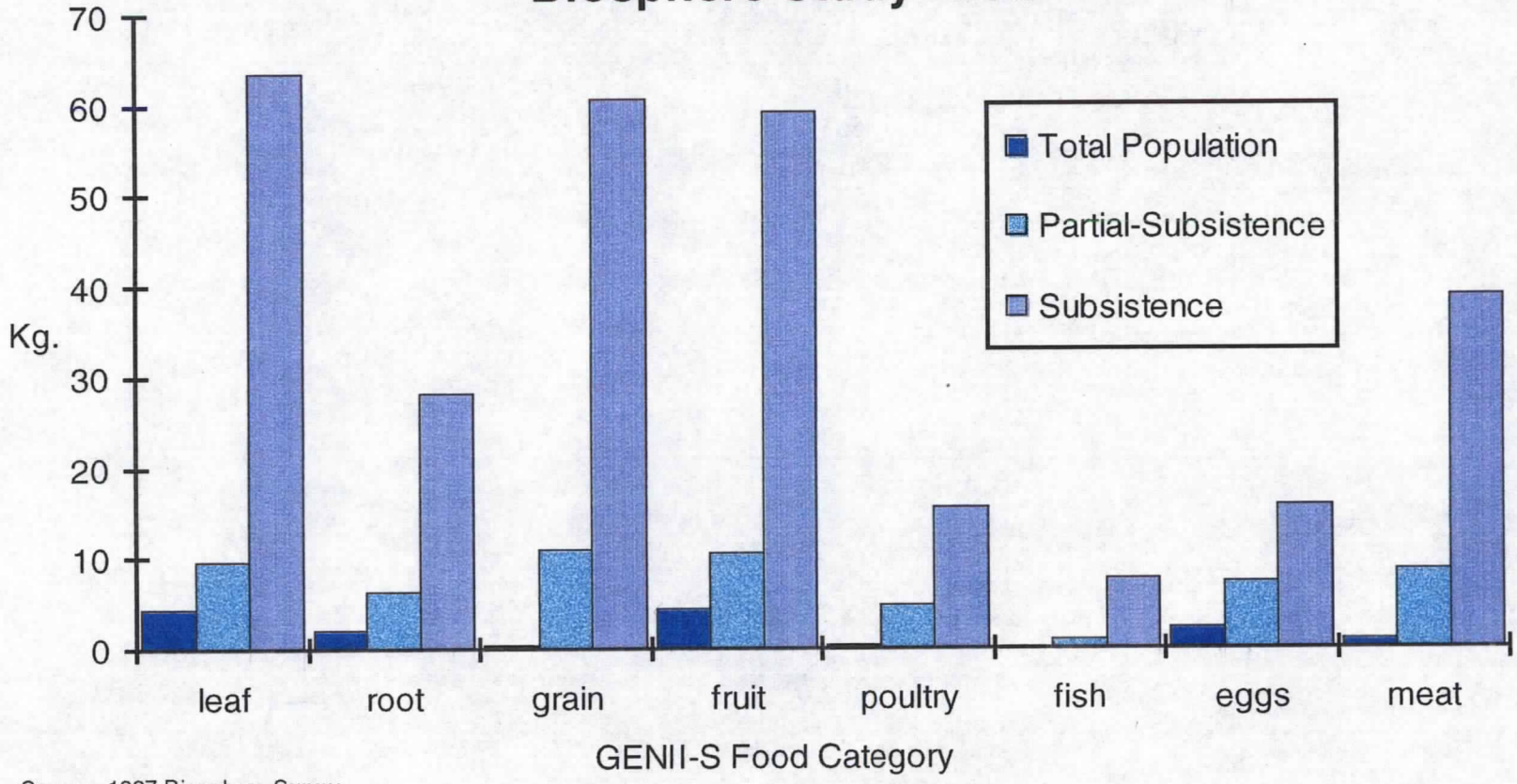
4. The denominators of the means of the "subsistence" consumption levels (per resident adult) EXCLUDE those who report that either: (a) nothing they consume is locally-produced; or (b) that only "most," "some," or "very little," of the food type in question (that they consumed) is locally-produced. Those who responded "don't know" or refused to answer are also excluded. Thus, the conceptual denominator varies across food type and is comprised only of those adult residents who report that **"all"** of the food type in question they consumed is locally-produced.

5. The denominator of the mean of the "total population" consumption level for tap water (per resident adult) INCLUDES those who responded as described in note 2 above. The denominator of the mean of the "partial subsistence" consumption level for tap water (per resident adult) EXCLUDES those reporting that they consume zero glasses of tap water per day. The water consumption question was asked in such a manner that precludes directly calculating a "subsistence" level. We assume that the "partial subsistence" mean approximates the subsistence mean.

* The standard deviation is calculated using weighted cases. There is actually more than one case but when summed the "weights" add up to approximately 1.00.

** Only one case was found for subsistence fish consumption.

Annual Per Adult Consumption of Locally Produced Food by GENII-S Food Group: Total Population, Partial Subsistence, and Subsistence Biosphere Study Area



Source: 1997 Biosphere Survey

BDCF and Uncertainty

- Calculate BDCFs for
  - 39 radionuclides (TSPA/95)
  - 3 receptor scenarios
  - 3 precipitation states
- Evaluate uncertainties
  - sources
  - range

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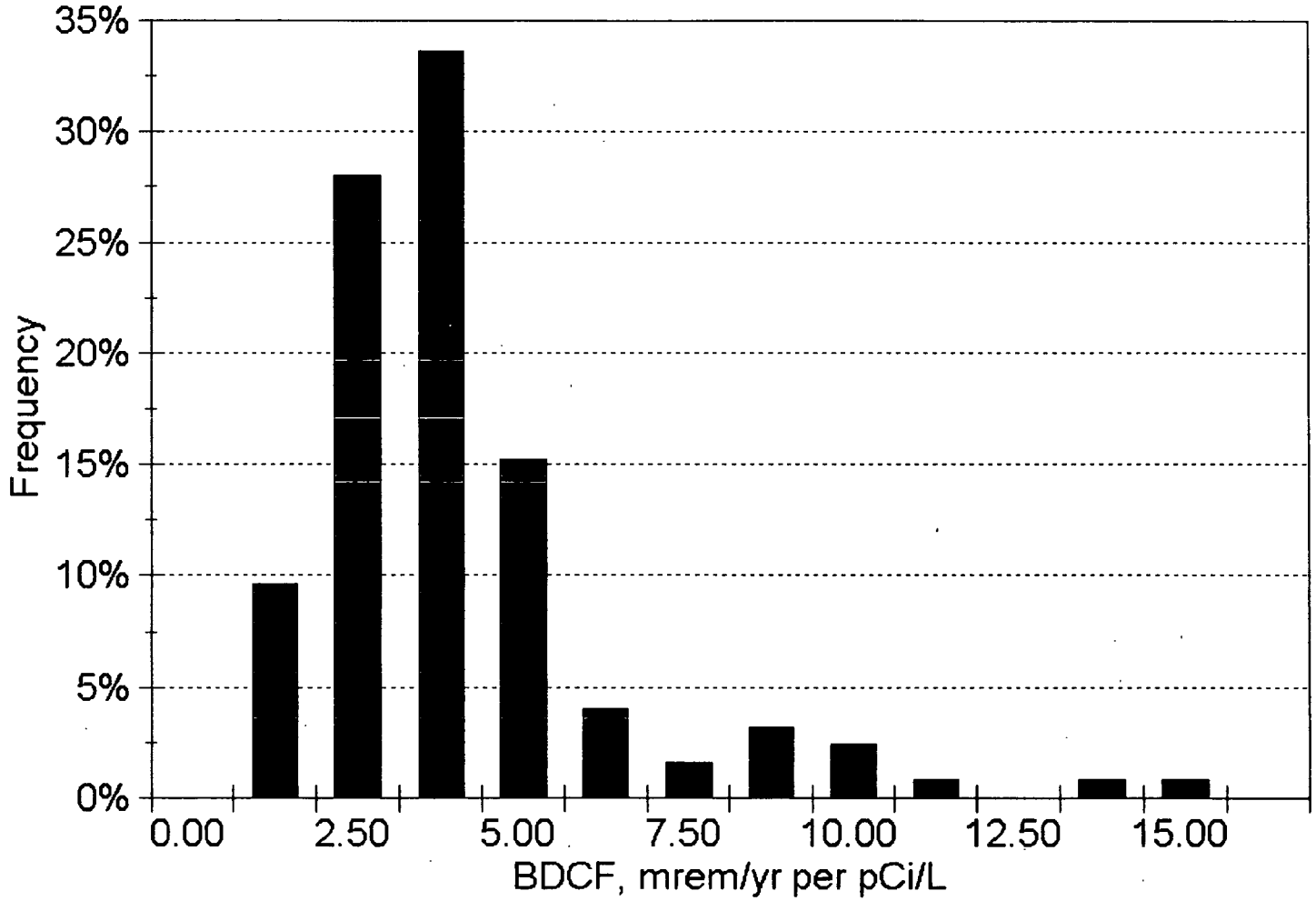
35%
30%
25%
20%
15%
10%
5%
0%
Frequency
0.00
2.50
5.00
7.50
10.00
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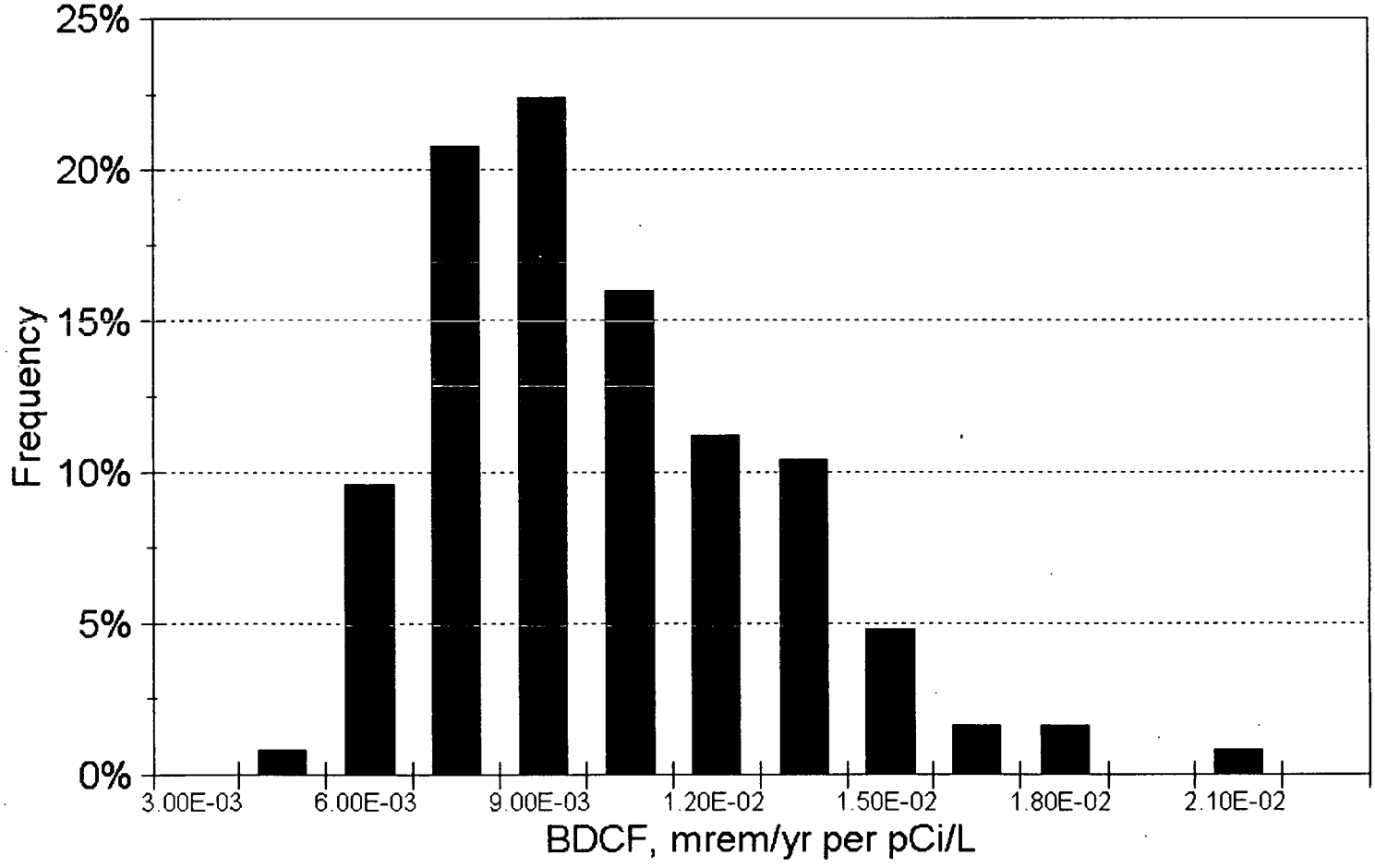
BDCF, mrem/yr per pCi/L

Preliminary Postclosure BDCF

Tc-99



Biosphere Modeling Status

- Completed development of SIIP, site-specific assessment context, and selection of model
- Conducted initial sensitivity analyses
- Completed initial data collection and evaluation
- Deliver preliminary BDCFs - November 1997
- Update data collection and refine evaluation
- Deliver final BDCFs for TSPA/VA - March 1998