

Reference 10 (Part 1 of 3) –  
WNYNSC Off-Site Radiation Investigation,  
Volume I- Summary Report (D&M, 1995)

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**New York State  
Energy Research and Development Authority**

**Western New York Nuclear Service Center  
Off-Site Radiation Investigation**

**Volume I: Summary Report**

**December 1, 1995**

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 **DAMES & MOORE**

**WESTERN NEW YORK NUCLEAR SERVICE CENTER  
OFF-SITE RADIATION INVESTIGATION**

**VOLUME I: SUMMARY REPORT**

**December 1, 1995**

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**Note:** The WNYNSC Off-Site Radiation Investigation discussed in this report is fully described in three separate volumes:

- Volume I: *Summary Report*, December 1995
- Volume II: *Technical Report*, December 1995
- Volume III: *Technical Data Annex*, December 1995

**WESTERN NEW YORK NUCLEAR SERVICE CENTER  
OFF-SITE RADIATION INVESTIGATION  
SUMMARY REPORT**

**OVERVIEW**

In November 1993, the New York State Energy Research and Development Authority (NYSERDA) contracted with Dames & Moore to perform radiological measurements in an area adjacent to the boundaries of the Western New York Nuclear Service Center (WNYNSC). The WNYNSC Off-Site Radiation Investigation was designed to confirm the radionuclide distribution reported by previous aerial and ground surveys, to define the location of elevated regions of radioactivity with better precision than the aerial surveys, and to estimate the radiation dose to residents associated with the radioactive materials and the radiation distribution observed.

The WNYNSC site is located approximately 50 kilometers (30 miles) south of Buffalo, New York. The WNYNSC occupies 1,354 hectares (3,340 acres) almost entirely within the town of Ashford in Cattaraugus County. Title to the WNYNSC is held by NYSERDA on behalf of the people of the state of New York. Facilities at the WNYNSC include a former commercial nuclear fuel reprocessing plant. The fuel reprocessing plant was operated by Nuclear Fuel Services, Inc. (NFS) from 1966 to 1972. In 1968, NFS reported an airborne release that exceeded the release rate authorized under its operating license. During the release, the winds carried the material to the west and northwest, some of it reaching areas outside the WNYNSC boundary (NFS, 1968).

Aerial surveys performed in the vicinity of the WNYNSC in subsequent years (EG&G, 1981 and EG&G, 1991) have demonstrated:

- The total gamma radiation exposure rates in off-site areas around the WNYNSC were not elevated in any distinctive pattern and were comparable to natural background in other parts of Western New York.
- Measurements focused on only Cs-137 gamma radiation indicated an area of elevated radiation levels running approximately 4 km northwest from the NFS process building main stack, as shown on Figure S1. The Cs-137 gamma radiation exposure rates in this "Cesium Prong" were only slightly above the ambient levels observed at other locations around the site boundary. The presence of Cs-137 was observed by using instruments set to detect the gamma radiation energy of only this radionuclide.
- The Cs-137 gamma radiation from man-made origins was detectable, but the radiation exposure levels measured are less than the fluctuation in natural background radiation in the Western New York area.

The objective in conducting the current evaluation of radioactive material distribution in off-site properties was to obtain better data for use in the joint environmental impact statement underway for completion of the West Valley Demonstration Project (WVDP) and closure of existing facilities at the WNYNSC. The data will also be useful to determine what, if any, measures might be necessary to limit individual exposure to that radioactivity.

#### **RADIOLOGICAL CHARACTERIZATION ON A COARSE GRID**

During the period November 1993 - January 1994, Dames & Moore performed measurements of gamma radiation and sampled the surface and near surface soils at 44 locations in the 1,000-acre area between the western boundary of the WNYNSC and Cattaraugus Creek, as shown on Figure S2. The survey confirmed the location of the

elevated areas of Cs-137 shown on aerial survey reports and identified a smaller area of approximately 46.5 acres near the WNYNSC boundary for more extensive evaluation.

### RADIOLOGICAL CHARACTERIZATION ON A FINE GRID

A Fine Grid Investigation (FGI) was defined to evaluate the magnitude, deposition patterns, and extent of radioactive material in the study area in greater detail. Field survey efforts were focused on the area of elevated Cs-137 radioactivity deposit identified in the coarse grid survey.

The initial FGI study area consisted of approximately 46.5 acres. Of this total, 5.2 acres were classified as *disturbed* by human activity or use: 2.3 acres of active farmland with tilled fields; 0.8 acres around a residence area consisting of one house and two trailers/mobile homes; and three areas totaling 2.1 acres used for the storage of derelict vehicles and bulk items. The other 41.3 acres in the initial study area were classified as *undisturbed* by human use and consisted of native woodlands. A review of historical maps and aerial photographs indicates that these areas have been undisturbed since 1968.

The components of the survey included

- An evaluation of soil samples from grid blocks with a variety of terrain and ground cover to provide an indication of horizontal deposition and vertical penetration of the Cs-137, and to provide confidence on the magnitude of variability.
- A systematic measurement of Cs-137 gamma radiation at eight fixed points in 10 m x 10 m grids to provide a determination of soil activity averaged over the areas.

- A systematic measurement of total gamma radiation at eight fixed points in each 10 m x 10 m grid, to provide a determination of radiation dose rate averaged over the areas.
- A measurement of Cs-137 gamma radiation during a serpentine walkover of each 10 m x 10 m grid between the eight fixed points of the systematic measurements, provided 100% coverage of accessible areas to ensure that anomalous point sources of radioactive material concentration would not be overlooked.

During the period July 1994 - September 1995, Dames & Moore performed the FGI. The survey data set consists of over 35,000 instrument readings in three modes and analysis of over 200 soil samples. The surface area surveyed contained over 1500, 10 m x 10 m grids in the 46-acre focus area. Levels of Cs-137 concentration in the surface layer of soil based on the activity inferred from instrument readings averaged in each 10 m x 10 m grid are shown in Figure S3 and ranged from  $3.3 \pm 1.4$  pCi/g in disturbed areas to  $34.7 \pm 8.2$  pCi/g in the undisturbed woodlands.

Where the surface area had been disturbed by cultural impacts, radiation from the Cs-137 was only slightly distinguishable from ambient gamma radiation background. Within the undisturbed woodlands, this survey delineated an area with statistically elevated Cs-137, similar to the area identified in the aerial survey of 1984, as displayed in Figure S4.

Soil sampling at locations in the study area indicated that Cs-137 activity is associated with the organic humus layer on the ground surface. In the study region, this surface layer is approximately 2"-4" (5-10 cm) thick, lying on more impermeable clay below.

Soil radioactivity analysis indicated a variable local distribution of the observed activity; the Cs-137 concentration might vary by a factor of 2 to 3 within a meter or two horizontal displacement. This variation appeared to be due to local surface effects, (e.g.

driplines from trees and limited variations in thickness of the humus), rather than isolated particles of higher activity.

Walkover surface scans in the FGI identified 29 10m x 10m grids where the peak count rate observed in one quarter of the grid was considered anomalous, greater than three times the average count rate in that grid. Detailed surveys of these grids demonstrated that hot particles were not present.

The gamma radiation dose rate survey results indicated that there were localized regions in the study area in which the dose rate averaged over an area of 50m x 50m, was 1.2 to 1.5 microrem/hour greater than the ambient background of 3.7 microrem/hour. This level of external gamma radiation dose rate is within the variation of dose rate reported around the WNYNSC by previous aerial surveys (EG&G, 1991).

The local variations in soil radioactivity appeared within the broad gaussian pattern of deposition from an airborne plume; on a large scale, the Cs-137 concentration decreased with distance from the peak value along the central radial, and it decreased with distance away from the central radial of the deposit. Local terrain and surface characteristics had minor influence on the gaussian pattern. The contours of the Cs-137 soil concentration from this survey are compared to the contours of the previous aerial survey in Figure S4. The deposition area is consistently located by the two surveys, within the uncertainties associated with each of the surveys.

## **DOSE ASSESSMENT**

The dose assessment for the WNYNSC Off-Site Radiation Investigation was performed to determine a potential radiation dose to an individual in the FGI study area due to the concentration of radioactive Cs-137 in the soil. The dose assessment process uses the 95% confidence level of the average activity in the soil (inferred from instrument readings of gamma radiation at the ground surface), along with conservative assumptions

on individual exposure and land uses, to develop an estimate of the potential dose to an individual through the computer modeling code, RESRAD (DOE, 1993). The RESRAD code is an analytical tool for modeling environmental transport of residual radioactivity in the soil. The code is recognized and used in analysis and comparative studies by both the NRC and the EPA. Additionally, the code enables the calculation of potential doses to individuals when appropriate exposure parameters are provided.

Plausible scenarios of current and future land use were identified, using actual land use data and standard scenarios described by the NRC and the EPA. The four land use scenarios that were evaluated included:

- (1) **Realistic current Use - Standard Scenario: *Resident-Farmer* Scenario.** The site is used for residential and subsistence farming. Exposure pathways include external radiation, inhalation and ingestion of radioactive material.
- (2) **Realistic Current Use - Modified Scenario: *Hunter-Camper*.** The use of the undisturbed woodlands is for recreation purposes, primarily hunting in season, and the cutting and collection of firewood. This use of the land will be evaluated using the outside direct exposure pathway, to obtain the dose for each 100 hours spent in the woods.
- (3) **Conservative Current Use - Modified Scenario: *Resident -Homeworker*.** One property in the FGI area included one permanent residence and two occupied house trailers. In addition to undisturbed woods, there were several acres of land cleared and used for the storage of derelict vehicles. The owner/resident operates a home auto mechanic shop on the site in the permanent building with residence quarters over the repair shop. This use of the land will be evaluated using the *resident-farmer* standard scenario, to account for extra time on site, since the occupational location is on the site just as in the *resident-farmer* scenario.

- (4) **Conservative Future Use - Modified Scenario: *Residence-Trailer*.** A plausible future use of the woodlands is that a residence could be built in an undisturbed area, leaving some of the radioactivity among the undisturbed trees in the vicinity of the yard. The residential use least disruptive to the surface deposit of Cs-137 would involve a trailer home rather than a conventional fixed structure. In this case, the trailer home is placed on 0.6 acres (50 m x 50 m) of cleared and leveled land, but the resident can spend some time outdoors in the undisturbed woods where the radioactivity remains on the surface. For this future use scenario, the observed characteristics of disturbed locations in the Off-site area were used to conservatively apply realistic site preparation activities to the thin layer of surface contamination.

Values of the critical scenario parameters and corresponding doses are summarized in Table S-1. Upper bound doses, calculated with the RESRAD environmental transport and dosimetry computer code, indicated that:

- In current land uses, potential annual doses for the maximally exposed individual are below 5 mrem in the current year.
- In future land uses, the most conservative scenario assumption (i.e., the scenario in which a residence house trailer is located in the highest 0.6 acre area of the contamination contours) results in a projected annual dose to the maximally exposed individual below 8 mrem in the current year.

Due to the radioactive decay of Cs-137 with a half-life of 30.2 years, annual doses in subsequent years will naturally decrease by 2.2 percent each year.

Table S1

Table S1a Summary of Parameters Used in Scenario Modeling

Parameter	Resident-Farmer <sup>1</sup>	Hunter-Camper <sup>2</sup>	Resident-Homeworker <sup>3</sup>	Residence-Trailer <sup>4</sup>
Cs-137 soil layer thickness (m)	0.3	0.075	0.15	0.3
Cs-137 Activity (pCi/g)	1.0	21	3	1.8
Transmission to Indoors <sup>5</sup>	67%	-	10%	80%
Time Indoors	55%	0%	55%	55%
Time Outdoors	21%	1.14% <sup>6</sup>	21%	21% <sup>8</sup>
Diet from on site				
Vegetables, fruit, grain	50%	0%	0%	0%
Milk	100%	0%	0%	0%
Meat and Aquatic foods	50%	0%	0%	0%
Drinking Water	100%	0%	100%	100%
Groundwater fraction	100%	0%	100%	100%

Table S1b Summary of Doses by Pathway for Reference Exposure Scenarios

Doses by Pathway (mrem per year)	Resident-Farmer <sup>1</sup>	Hunter-Camper <sup>2</sup>	Resident-Homeworker <sup>3</sup>	Residence-Trailer <sup>4</sup>
Ground Direct Inside	1.87	-	1.0	3.9
Ground Direct Outside	1.06	0.73	3.8	4.1 <sup>9</sup>
Inhalation	0	0	0	0
Plant foods	0.06	-	-	-
Meat Foods	0.07	-	-	-
Milk from site	0.04	-	-	-
Drinking Water	0	-	0	0
Soil Ingestion	0	0	0	0
Total Dose in First Year	3.10	0.73 <sup>7</sup>	4.8	8.0

Notes: "-" the pathway is not part of the scenario

"0" calculated dose  $\leq$  0.01 mrem/yr

1 US NRC standard evaluation scenario

2 Realistic scenario, current and future use of undisturbed woods

3 Conservative scenario, current use

4 Conservative scenario, future use

5 Shielding of inhabitants by building

6 1.14% of year = 100 hours

7 Total Dose for each 100 hours spent in the undisturbed woods

8 Time outdoors apportioned to 17% in cleared land and 4% in undisturbed woods

9 Sum of 1.5 mrem while in cleared land and 2.6 mrem while in undisturbed woods

## CONCLUSION

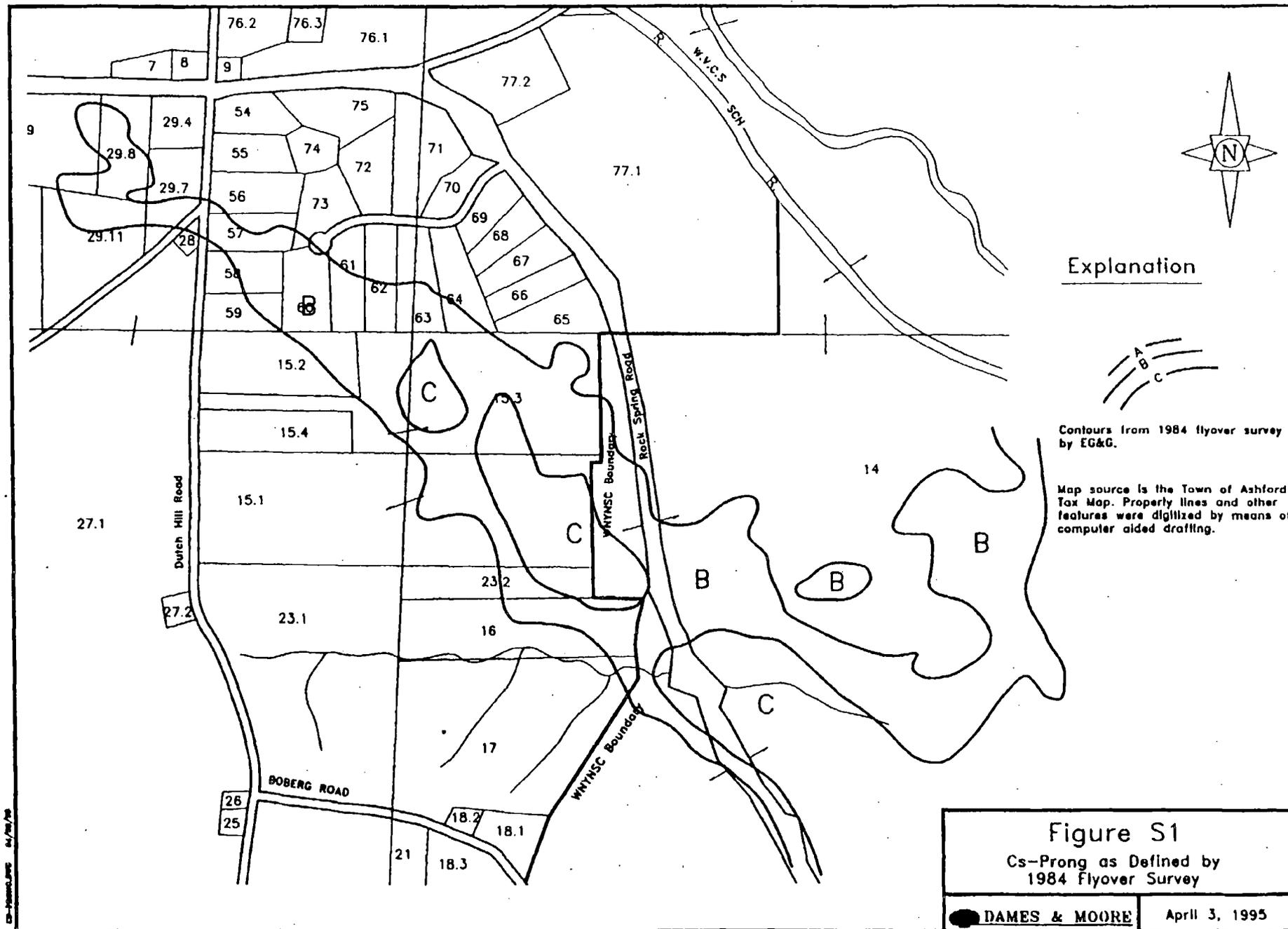
The WNYNSC Off-Site Radiation Investigation was performed in phases of field sampling, measurement and analysis. The observations and survey results discussed in this summary indicate that the area of deposited Cs-137 was adequately bounded and quantified by the survey procedures used. The instrument measurements provided a valid representation of the surface deposition that made more extensive sampling and laboratory analysis unnecessary. Eight readings in each 10m x 10m grid provided an indication of the average and 95th percentile Cs-137 activity to meet the characterization and interpretation requirements identified in the NRC manual NUREG-5849 (NRC, 1992).

The dose assessment indicates that, under current and future land uses, conservative assumptions on personal exposure result in a projected annual dose to the maximally exposed individual below 8 mrem in the current year. The calculated upper bound doses are in the range of doses suggested by proposed federal decommissioning criteria (15 mrem per year) and state guidance (10 mrem per year) as discussed in Section 2 (EPA, 1994; NRC, 1994; NYSDEC, 1993). The doses are considerably below the 100 mrem per year dose limit recommended by the NCRP (NCRP, 1987a) and are only a small fraction of the average annual effective dose equivalent to a member of the U.S. population, 295 mrem per year (NCRP, 1987).

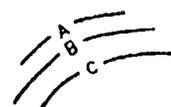
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- EG&G 1981 U.S. DOE Remote Sensing Laboratory, "A Comparison of Aerial Radiological Survey Results of the Nuclear Fuel Services (NFS) and Surrounding Area." Report EG&G # EP-F001. June 1981.
- EG&G 1991 U.S. DOE Remote Sensing Laboratory, "An Aerial Radiological Survey of the West Valley Demonstration Project and Surrounding Area." Report EGG-10617-1080, September 1991. [This 1991 report presents the results of the aerial survey conducted in Aug-Sep 1984].

- EPA 1994 U.S. Environmental Protection Agency, "Technical Summary Report Supporting the Development of Standards for the Cleanup of Radioactively Contaminated Sites (DRAFT)," Washington, DC, April 1994.
- NCRP 1987 National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States," NCRP Report No. 93, Washington, DC, 1987.
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- NRC 1992 U.S. Nuclear Regulatory Commission, "Manual for Conducting Radiological Surveys in Support of License Termination (DRAFT)," Report NUREG/CR-5849, 1992.
- NRC 1994 U.S. Nuclear Regulatory Commission, "Radiological Criteria for Decommissioning - Proposed Rule," Federal Register, August 22, 1994, Part III: pages 43200-43232.
- NYSDEC 1993 NYS Department of Environmental Conservation, "Technical Administrative Guidance Memorandum No 4003, Subject: Cleanup Guidelines for Soils contaminated with Radioactive Materials." September 14, 1993.



**Explanation**

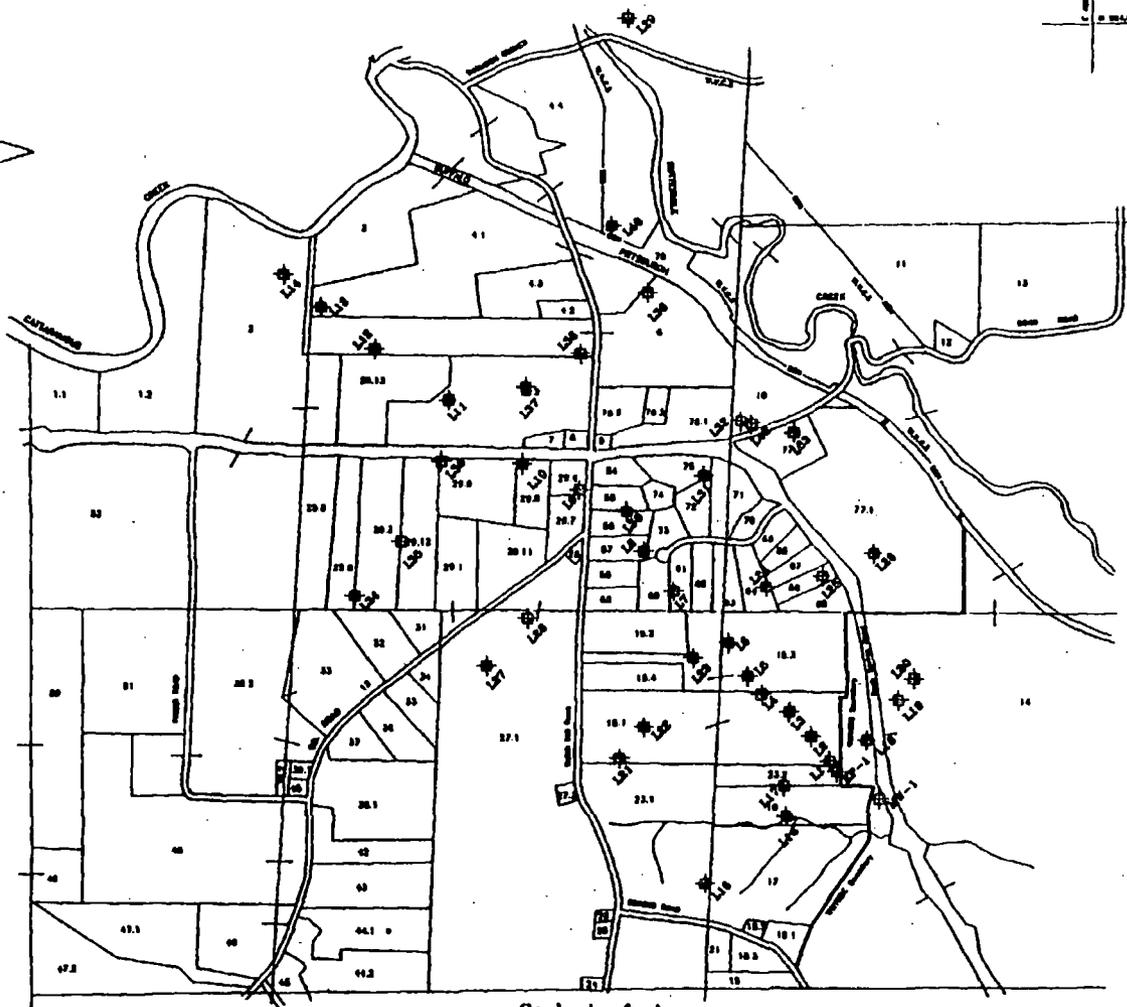
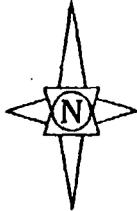


Contours from 1984 flyover survey by EG&G.

Map source is the Town of Ashford Tax Map. Property lines and other features were digitized by means of computer aided drafting.

**Figure S1**  
 Cs-Prong as Defined by  
 1984 Flyover Survey  
**DAMES & MOORE** April 3, 1995

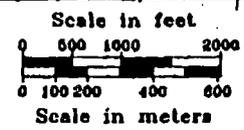
CS-PRONG LINE 04/28/95



Explanation

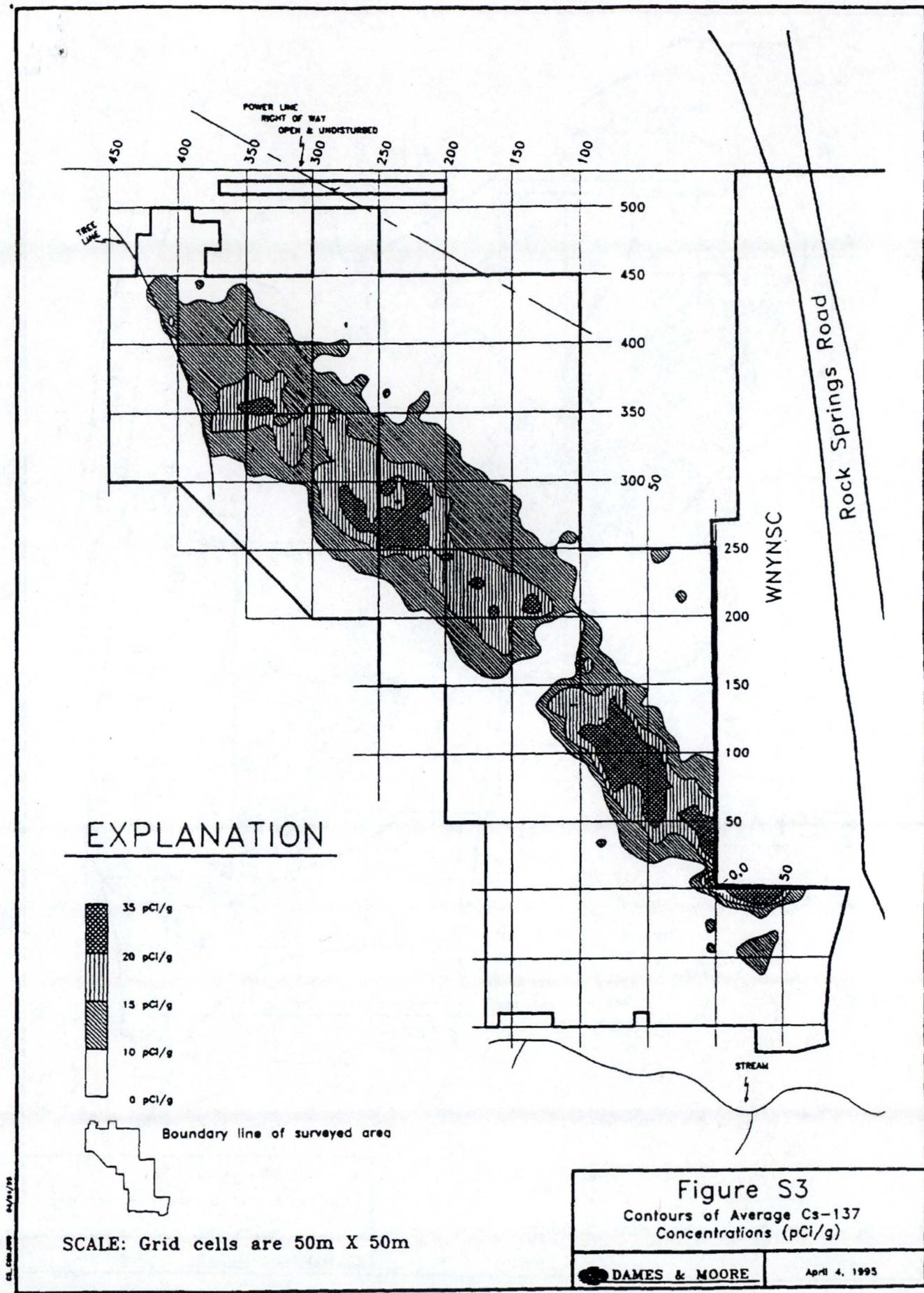
 Actual Sample Locations

Map source is the Town of Ashford Tax Map. Property lines and other features were digitized by means of computer aided drafting.

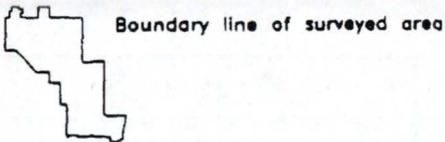
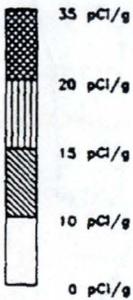


**Figure S2**  
 Actual Sample Locations

01/15/95



**EXPLANATION**

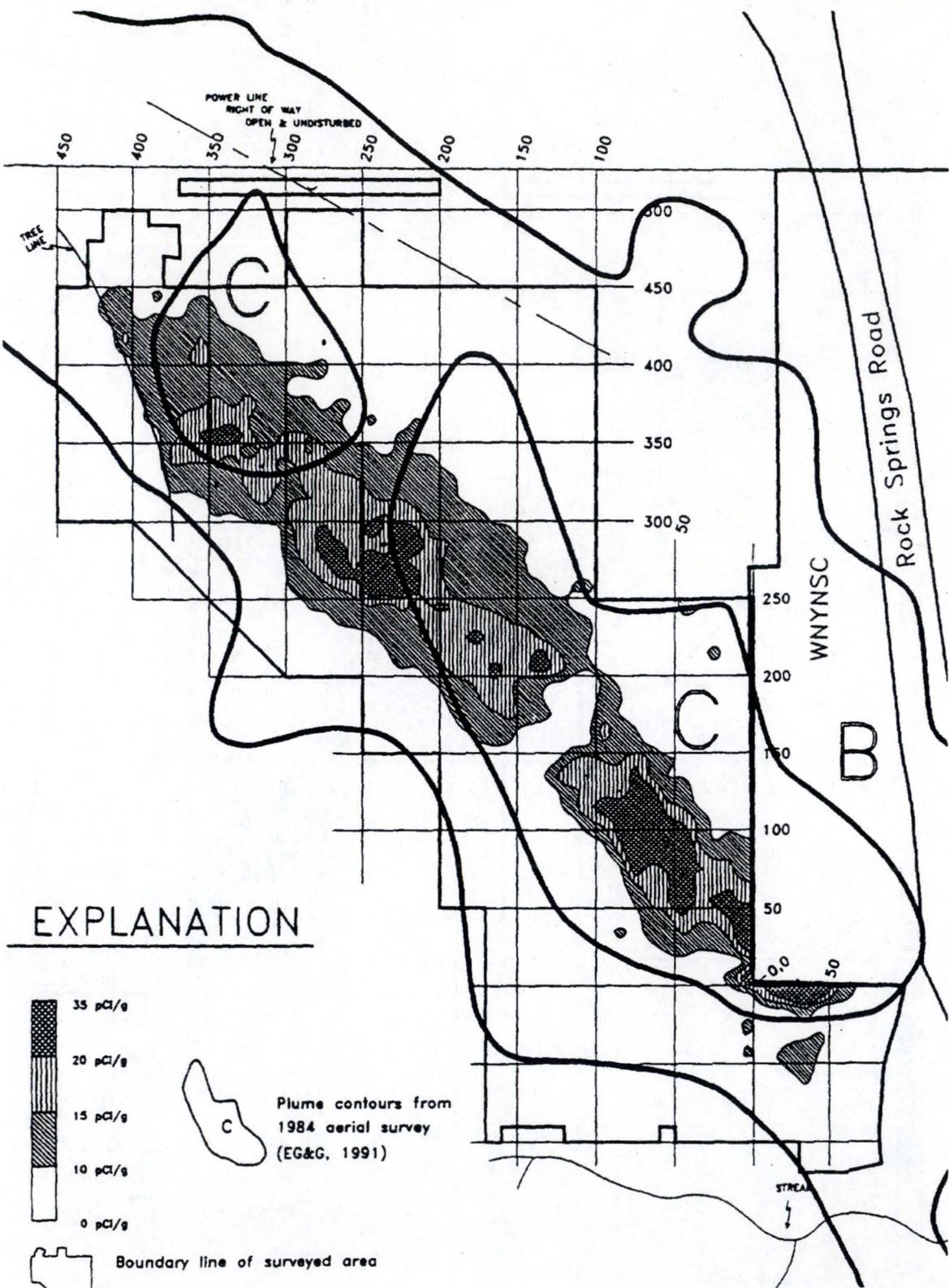


SCALE: Grid cells are 50m X 50m

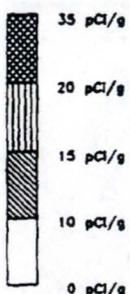
**Figure S3**  
 Contours of Average Cs-137  
 Concentrations (pCi/g)

**DAMES & MOORE**      April 4, 1995

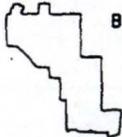
CS-137/95



**EXPLANATION**



Plume contours from 1984 aerial survey (EG&G, 1991)



Boundary line of surveyed area

SCALE: Grid cells are 50m X 50m

**Figure S4**  
Comparison of Ground Surveyed and Aerial Surveyed CS-137 Concentrations