Section I

Dawson Forest Wildlife Management Area (2000-2002)

(Formerly the Georgia Nuclear Aircraft Laboratory – GNAL)

Figure I-1: Monitoring for Gamma Radiation Outside of the Hot Cell Building at DFWMA

Dawson Forest Wildlife Management Area (DFWMA) is a 10,000-acre tract of land located in Dawson County, approximately 5 miles southwest of Dawsonville, Georgia. It is the decommissioned site of the former Georgia Nuclear Aircraft Laboratory (GNAL), which was operated by Lockheed Aircraft Corporation, under contract for the U.S. Air Force, until it was decommissioned around the end of 1971. Facilities containing radioactive materials at GNAL included a test reactor, hot cell building (**Figure I-1**), seepage basins, and cooling-off area (for temporary outdoor storage of "hot" items after irradiation at the reactor site). The land, which is now owned by the City of Atlanta as a possible future airport site, is currently managed by the Georgia Forestry Commission for the purpose of forestry management and by the Georgia Department of Natural Resources for the purpose of game management.

Ga-DNR first initiated environmental monitoring of DFWMA shortly after their Environmental Radiation Program was formed at the end of 1977. At that time, a portion of the Site was found to contain residual activity of possible concern, including the cooling-off area, reactor area, and the inside of the hot cell building. These locations are detailed in the monitoring map (**Figure I-2)** on the next page. The cooling-off area and the hot cell building were subsequently fenced-in to prevent public access. Entrances to the hot cell building and to reactor-area structures were also sealed off to prevent intrusion, due to physical safety concerns and radiological concerns. Fences weren't deemed necessary at the reactor site, however, since the concentration of radioactive material, which was formed through reactor-generated neutron activation of soil, was lower and more diffuse, as compared to the hot spots found inside of the cooling-off area and inside of the hot cell building.

During the past 25 years, DNR has continued to monitor DFWMA, in order to insure that any residual radioactivity of possible concern remained confined within the fenced-in areas and sealed structures. Due to the relatively long-lived nature of residual radionuclides detected in some areas of DFWMA and due to physical safety concerns, radiological monitoring and the use of fences and barriers to restrict public access will likely continue until such time as there is a need to change the property's usage.

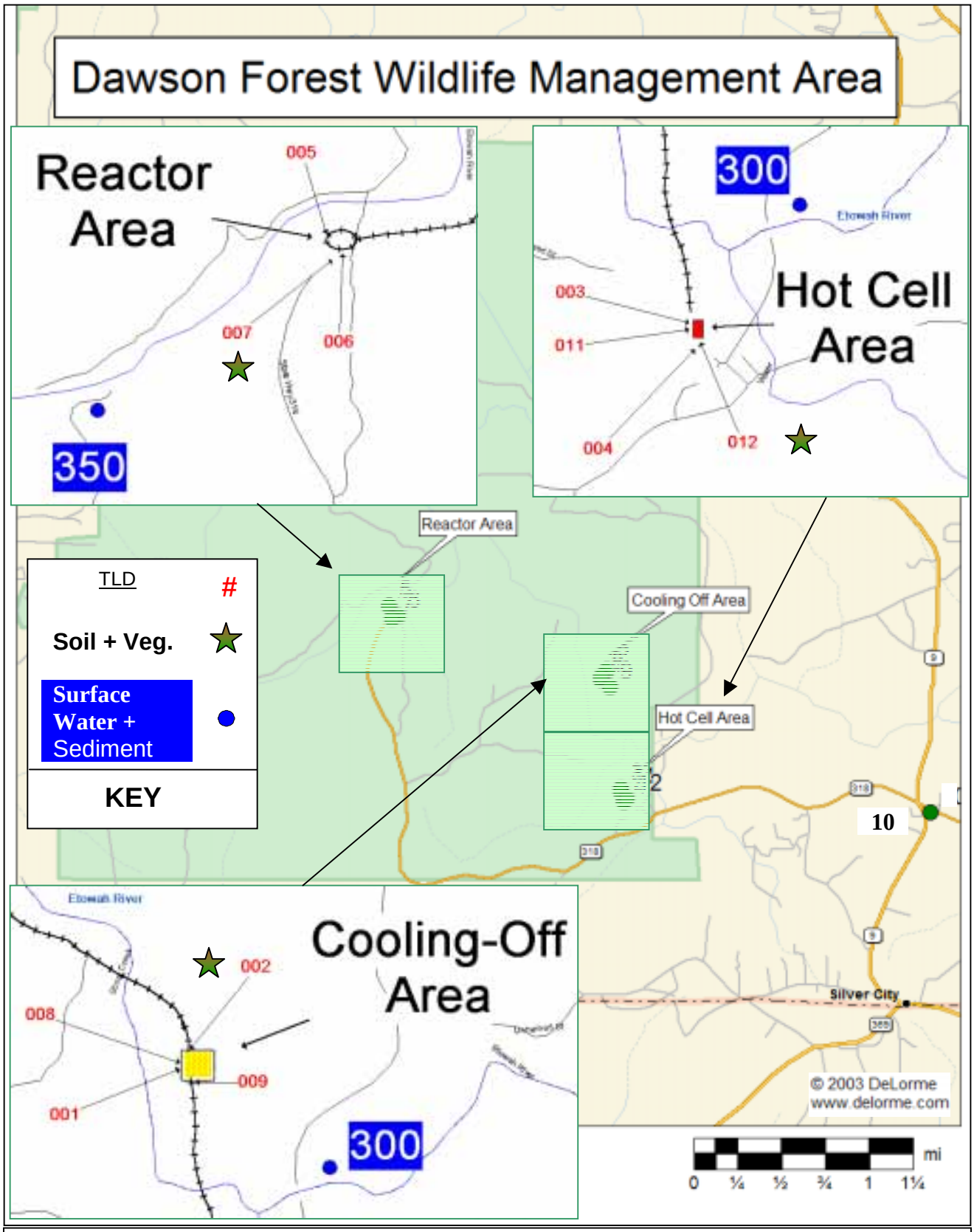

Figure I-2: Dawson Forest WMA (GNAL) Monitoring Locations (2000-2002)

External Radiation Dosimetry Measurements and Results

DNR has conducted quarterly or semi-annual direct (external) gamma radiation measurements in public-accessible locations at DFWMA since approximately 1979. A variety of instruments have been used for this task, including hand-held dose-rate monitors, a gamma spectrometer (**Figure I-1**), and TLDs (Thermo-Luminescent Dosimeters - **Figure I-3**). TLDs were the primary means used by DNR for continuous long-term dose monitoring. Gamma spectrometry was used primarily to determine the relative contribution of each radionuclide (including naturally occurring nuclides) to gamma doses. Hand-held instruments were used primarily to survey the perimeter to insure that hotspots remained confined.

Figure I-3: TLD Dosimeters Attached to Pole

Direct radiation dose rates, as recorded by the TLDs, have declined noticeably, during the past 25 years, in two areas (reactor area **Figure I-4** and cooling-off area **Figure I-5**). This is not surprising, given that the majority of man-made radioactivity at the start of DNR's monitoring was determined to be site-related Co-60, which has a half-life of approximately 5.3 years. Dose rates in the third area (Hot Cell Area **Figure I-6**) haven't changed noticeably, as the monitored area (outside of the hot cell building) doesn't appear to contain any detectable site-generated radionuclides. Doses at all TLD locations currently appear to be nearing background levels.

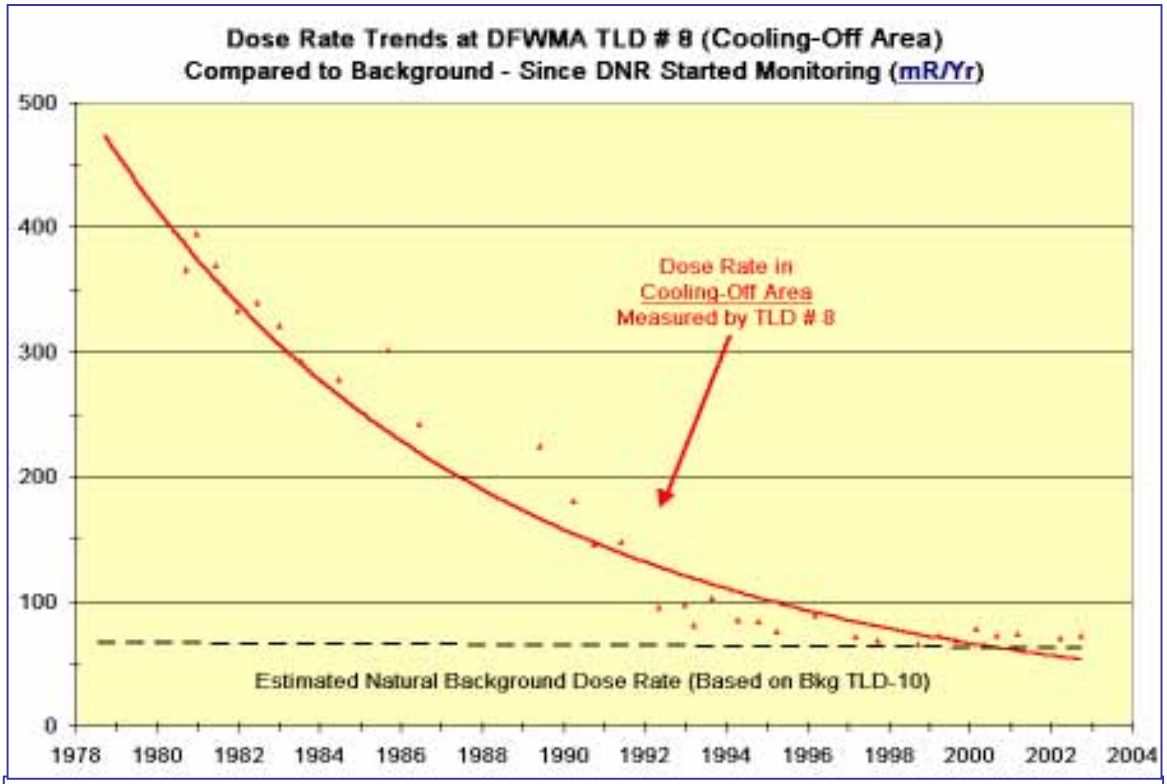

Figure I-4: Long-Term Gamma Dose-Rate Trend Comparison for Cooling-Off Area TLD # 8

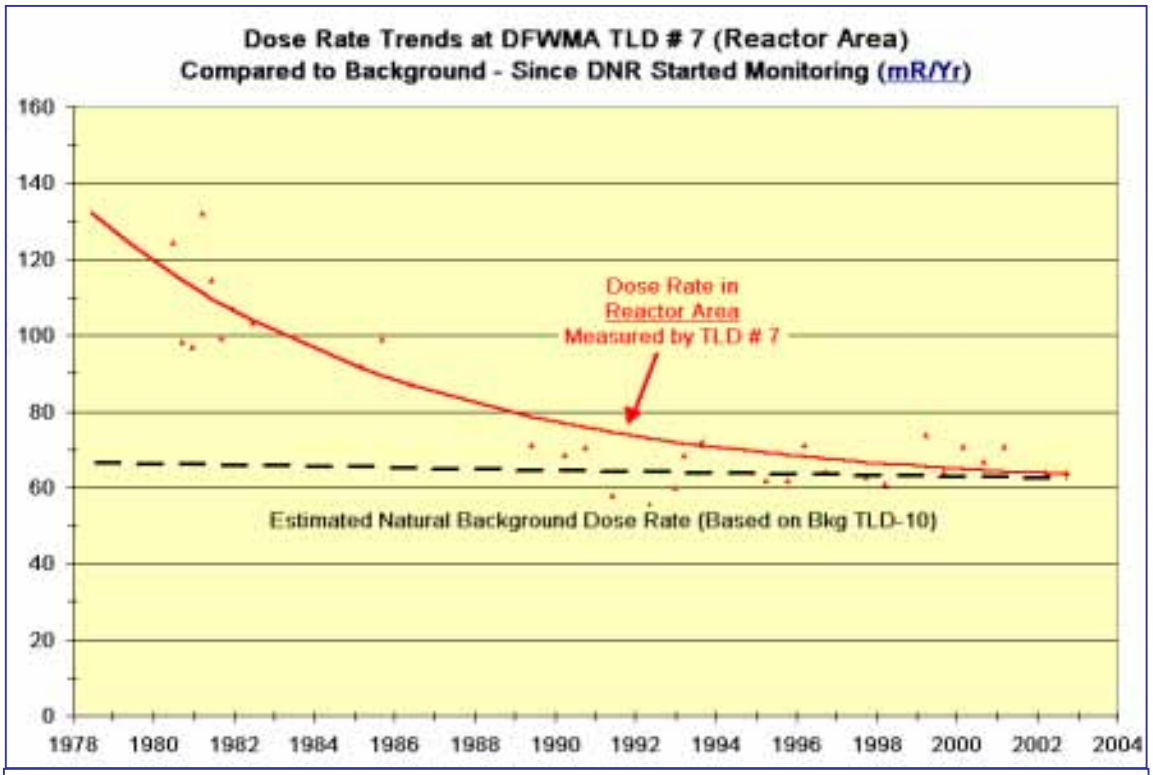

Figure I-5: Long-Term Gamma Dose-Rate Trend Comparison for Reactor Area TLD # 7

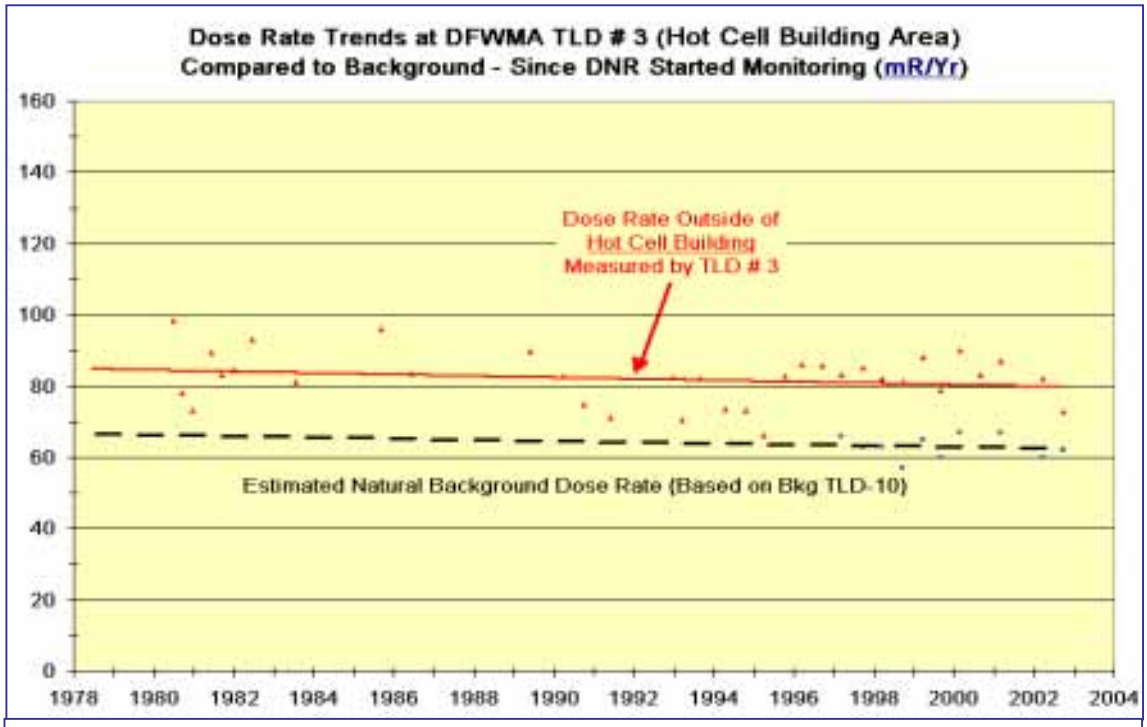

Figure I-6: Long-Term Gamma Dose-Rate Trend Comparison for Hot Cell Area TLD # 3

As illustrated in **Figure I-4**, radiation levels in the cooling-off area were initially higher than in any other area monitored by TLDs. This was the primary reason that the cooling-off area was fenced-in, to minimize any possible dose to the public. Elevated dose rates in this area were due entirely to Co-60 hot-spot activity, which was found to be present inside of the perimeter of this area. Hot-spot activity in this area is believed to be due to a tornado, which scattered a drum of waste materials over several acres of this area.

Initial dose rates in the reactor area, while also elevated, were significantly lower than in the cooling-off area, as illustrated in **Figure I-5**. Elevated gamma dose rates in this area were determined to be due primarily to two radionuclides: Co-60 and Eu-152. These radionuclides were produced primarily through direct, reactor-generated, neutron activation of soil, rocks, and reactor-building components (concrete and steel). Due to the neutron-activated nature of the activity in this area, radionuclide concentrations are more uniform and diffuse, than in the cooling-off area

As illustrated in **Figure I-6**, dose rates outside of the hot cell building haven't changed significantly (compared to background) over the past 25 years that DNR has monitored this area. Dose rates in this area, while higher than at the background location, are attributed almost entirely to naturally occurring radionuclides in the concrete hot cell structure, based on field gamma spectrometry and soil sample data.

During the current monitoring period (CY-2000-2002), TLD gamma dose rates were found to be within the expected range, based on previous results, and they are nearing background levels. However site-related man-made radioactivity still accounts for up to for 15% of the dose in some areas, as illustrated in **Figure I-7**. Given that TLDs are used only to monitor public-accessible areas, no conclusions could be drawn from the data regarding current doses and activity levels in restricted areas (inside of hot cell, inside of reactor structure, and inside of cooling-off area fence-line). Individual TLD dosimeter results are presented in **Table I-1** (next page).

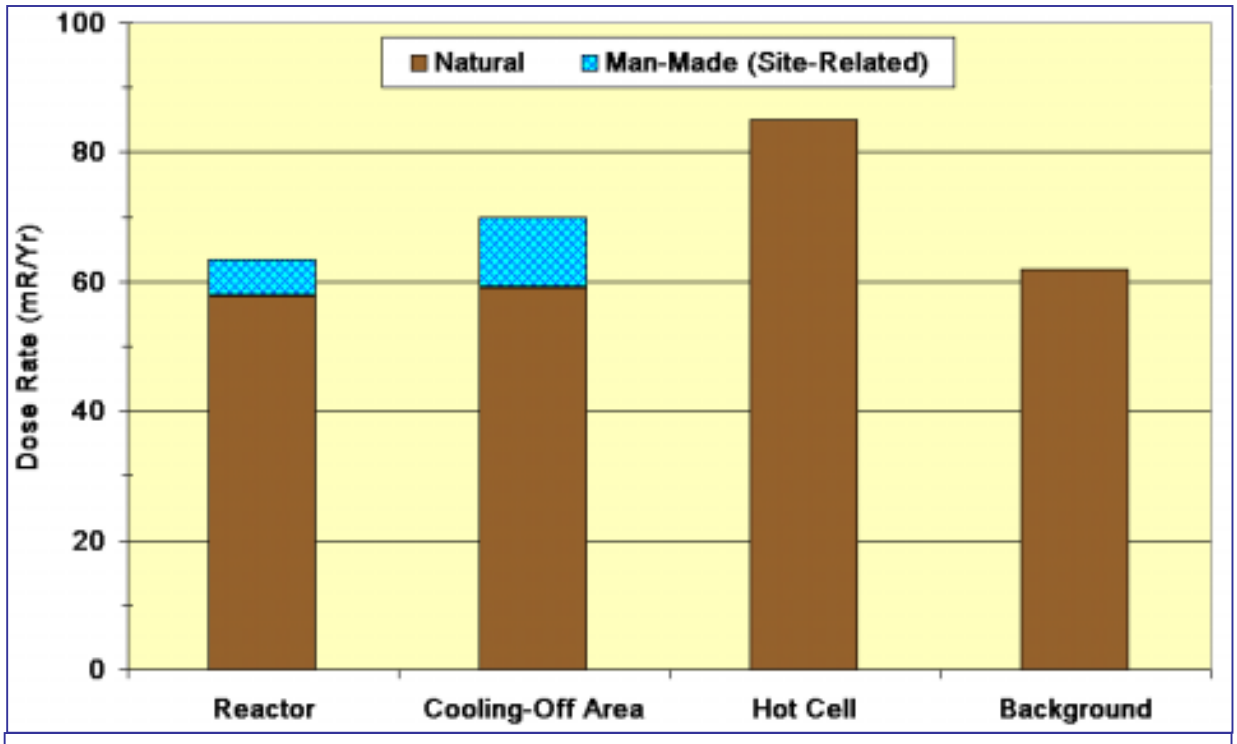

Figure I-7: Average Gamma (TLD) Dose Rate (mR/Yr) and Origin For DFWMA Areas during Current Period (CY 2000-2002)

Table I-1: TLD Dosimeter Direct Gamma Radiation Dose Rate Results (mR/year)

DFWMA Direct External Radiation (TLD) Dose-Rate Results - mRem/Yr (Including Natural and Man-Made)														
Sta	Type	Location	3/18/98	9/21/98	3/23/99	9/1/99	3/1/00	9/6/00	3/6/01	9/6/01	3/25/02	10/2/02	Mean	± 3-Std
1	Ind	NW - COA	80		84		78	72	77	72		74	77	4
2	Ind	N - COA	75	68		66				61		63	66	17
8	Ind	S - COA		66	73	69	78	73	74	75	71	73	72	11
9	Ind	SW - COA	65	61	68	62	70	71	69	67	65	65	66	10
Cooling-Off Area Average			73	65	75	66	75	72	73	69	68	68	70	11
3	Ind	N - Hot Cell	82	81	88	79	90	83	87	80	82	73	82	15
4	Ind	E - Hot Cell	81		89	75	87	77	84	80	80	75	81	15
11	Ind	Hot Cell Seep. Bas.	82		87	76	83	85	84	67	83	81	81	18
12	Ind	Hot Cell			93	81	92	88	91	67	86	76	84	27
Hot Cell Average			82	81	89	78	88	83	87	73	83	76	82	15
5	Ind	Reactor Shield Wall	64			57		63		70	66	66	64	13
6	Ind	E - Reactor	55	51	57	46	55	52		43			51	16
7	Ind	SE - Reactor	61		74	64	71	67	71	67	64	64	67	13
Reactor-Area Average			60	51	66	56	63	61	71	60	65	65	62	17
10	Bkg	Ga-9/Ga-318	63	57	65	60	67		67	55	60	62	62	13
117	St-Bkg	Ga-400 / Ga-120	53	59	65	57	66	64	65		61	60	61	13
118	St-Bkg	Ga-400 / Ga-20	73	69	76	71	80	70	78	55	72	72	72	20

Soil Sample (In-Lab) and Field Gamma Spectrometry Measurements

Soil samples were collected from several locations near designated TLD stations. These samples were analyzed for gamma-emitting radionuclides. Field (in-situ) gamma spectrometer measurements (reference **Figure I-1**) were also acquired from several locations where concrete structures were located, since portions of these structures couldn't be easily removed for in-lab analysis. As discussed in the direct radiation (TLD) section, above, Co-60 (up to **11x** Bkg) and Eu-152 (up to **26x** Bkg) were the only detected nuclides that were definitely attributed to site operations. Combined in-lab and in-situ testing results are presented in **Table I-2**.

Table I-2: Soil Sample Results (Including In-Lab and In-Situ Results) … pCi/Kg dry weight

DFWMA Soil and In-Situ Sample Results - pCi/Kg (dry)											
Sta	Samp	Collect	Agy	DW	Description	Co-60	Cs-137	Eu-152	K-40 (Nat)	Ra-226 (Nat)	Ra-228 (Nat)
2	385	03/23/1999	EPD	0.69	Cooling-Off Area Soil (Outside of Fence)	12	260	<20	17,000	700	1,200
2	393	03/01/2000	EPD	0.85	Cooling-Off Area Soil (Outside of Fence)	13	9	61	3,800	300	600
2	407	03/05/2001	EPD	0.72	Cooling-Off Area Soil (Outside of Fence)	<10	170	<30	17,000	1,100	1,900
2	413	03/25/2002	EPD	0.77	Cooling-Off Area Soil (Outside of Fence)	<10	38	<30	20,000	1,000	2,200
7	386	03/23/1999	EPD	0.86	Reactor-Area Soil	82	<10	380	2,100	200	100
7	394	03/01/2000	EPD	0.80	Reactor-Area Soil	<5	24	<10	18,000	900	1,900
7	408	03/05/2001	EPD	0.68	Reactor-Area Soil	110	140	520	8,700	600	900
7	414	03/25/2002	EPD	0.98	Reactor-Area Soil	94	180	270	7,800	500	800
7	in-situ	03/24/1999	EPD	--	Reactor Wall Area (Average concentration per surface)	12	100	1,230	33,000	3,300	4,000
7	in-situ	03/24/1999	EPD	--	East of Reactor … Soil Only	130	170	550	7,700	800	1,300
7	in-situ	03/24/1999	EPD	--	North-East of Reactor … Soil and Concrete Structure	105	460	470	18,000	2,200	2,400
7	in-situ	03/24/1999	EPD	--	Road near Reactor Wall	420	100	1,310	34,000	2,500	3,100
11	in-situ	03/24/1999	EPD	--	Hot Cell Area Near Fence	<60	170	<300	23,000	4,100	2,800

Notes: (1) No other gamma-emitting nuclides were detected.
(2) In-situ results assume a uniform distribution in soil to a depth of 12".

Vegetation Samples

Vegetation (grass) samples were collected semi-annually from two primary locations (Cooling-Off Area and Reactor Area). Vegetation samples are no longer routinely collected from the third area (outside of hot cell building), since no man-made activity (other than fall-out-related Cs-137) is detectable in this area. No man-made radionuclides were detected in any vegetation samples, as presented in **Table I-3**. Naturally occurring Be-7 (cosmic-origin) and K-40 (terrestrial-origin) were the primary nuclides detected.

Table I-3: Vegetation Sample Results (pCi/Kg Fresh Weight)

Sta	Sample #	Collect	Agy	DW	Cs-137	Be-7 (Nat)	K-40 (Nat)
			---- Cooling-Off Area ----				
2	389	09/01/1999	EPD	0.21	<13	1,200	4,200
2	395	03/01/2000	EPD	0.44	<22	7,800	7,800
2	399	09/06/2000	EPD	0.19	<12	900	5,000
2	405	03/05/2001	EPD	0.33	<26	1,100	4,600
2	409	09/05/2001	EPD	0.18	<13	1,100	3,100
2	415	03/25/2002	EPD	0.24	<19	4,000	7,600
2	421	09/30/2002	EPD	0.21	<17	2,500	6,100
			---- Reactor Area ----				
7	390	09/01/1999	EPD	0.17	<13	<100	5,800
7	396	03/01/2000	EPD	0.47	<14	6,600	6,600
7	400	09/06/2000	EPD	0.16	<13	400	4,700
7	406	03/05/2001	EPD	0.30	<12	800	2,900
7	410	09/05/2001	EPD	0.22	<11	1,100	3,500
7	416	03/25/2002	EPD	0.44	<22	4,300	7,400
7	422	09/30/2002	EPD	0.28	<14	1,700	4,200

Surface Water Samples

Surface (river) water samples, which were collected on the Etowah River upstream and downstream of the DFW (GNAL) Site, were tested for alpha, beta, H3, and gamma-emitting radionuclides. No man-made radionuclides were detected in any samples, as presented in **Table I-4**. Beta activity, which was just above the detection limit in some samples from both locations, is attributed primarily to naturally occurring radionuclides, including Pb-210 (long-lived radon-daughter product) and K-40, both of which are common in soil.

Table I-4: Dawson WMA Surface Water Sample Results (pCi/L)

Sta	Samp #	Collect	Agy	Alpha	Beta	Cs-137	H-3
---- Etowah River Upstream of DFW (Control)---							
300	391	09/01/1999	EPD	<2	<2	<5	<200
300	397	03/01/2000	EPD	<1	2	<5	<200
300	401	09/06/2000	EPD	<1	3	<5	<200
300	403	03/05/2001	EPD	<1	<2	<5	<200
300	411	09/05/2001	EPD	<1	<2	<5	<200
300	417	03/25/2002	EPD	<1	3	<5	<200
300	419	09/30/2002	EPD	<2	3	<5	<200
---- Etowah River Downstream of Reactor Area at DFW ----							
350	392	09/01/1999	EPD	<2	<2	<5	<200
350	398	03/01/2000	EPD	<2	2	<5	<200
350	402	09/06/2000	EPD	<1	<2	<5	<200
350	404	03/05/2001	EPD	<1	<2	<5	<200
350	412	09/05/2001	EPD	<1	2	<5	<200
350	418	03/25/2002	EPD	<2	<2	<5	<200
350	420	09/30/2002	EPD	<2	2	<5	<200

Note: No gamma emitting nuclides were detected.

D&D Analysis of Reactor-Area Soil Sample Data for Long-Term Dose Estimate

Long-term dose projections were made for a hypothetical, maximally exposed individual (MEI) who is assumed to continuously live, work, and farm on the decommissioned reactor site, using the D&D Dose Model, and using available sample analysis results for Co-60 and Eu-152. Doses due to these nuclides were projected to not exceed 4 mRem per year for all pathways combined, based on available survey and sample results. Since the reactor area contains sealed underground structures that haven't been surveyed by DNR, no allowance could be made for possible unknowns in these areas. Therefore, this dose estimate is only valid for current conditions, wherein the reactor-related underground structures remain sealed.

Direct (external) radiation accounted for the majority (≥95%) of this dose. Although current site-related (man-made) direct radiation doses may approach 10 mRem per year in some isolated spots, average dose rates that could be realistically received by the MEI would be less. **Figure I-8** provides a breakdown of the dose projections by year and by pathway (Direct, Inhalation, Food, Water, and Total). Based on the current conditions and usage of this area, the site-related portion of the dose in this area is projected to decline to less than 1 mRem/year by the year 2015.

Figure I-8: MEI Dose Projection for Reactor Area, Based on Current Usage