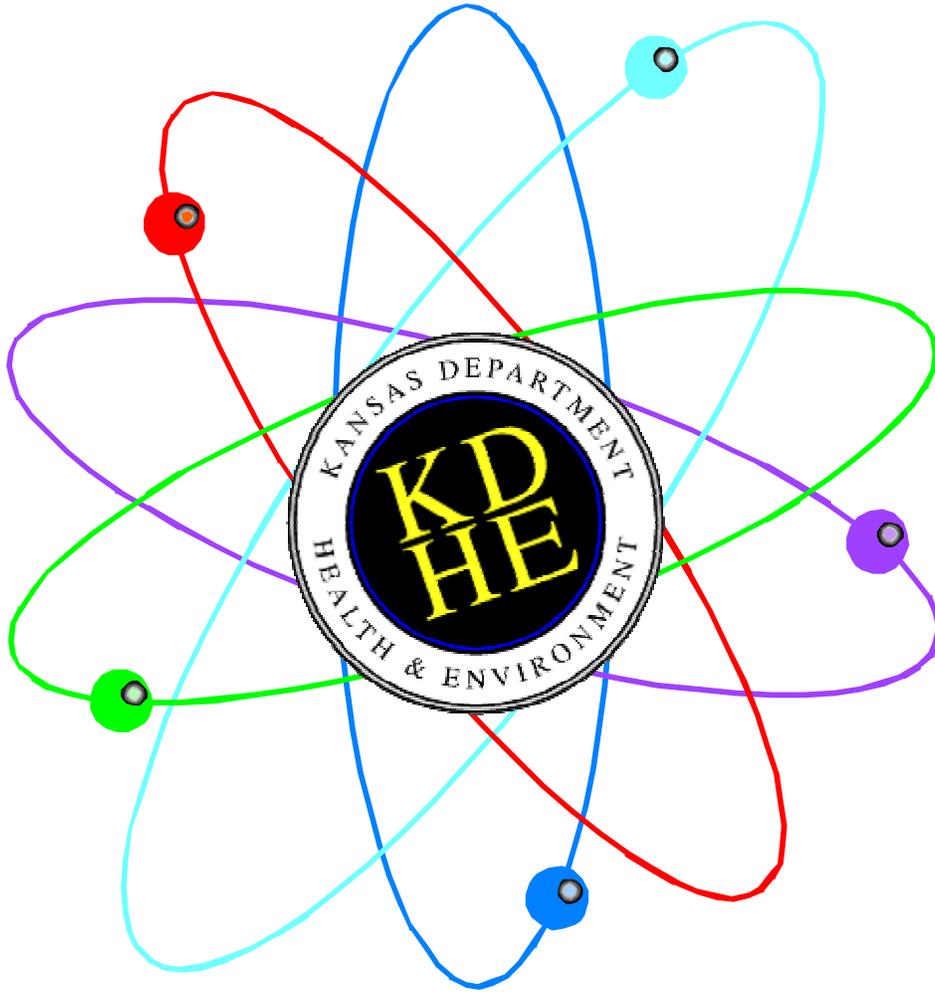


**Kansas Department of Health and Environment**  
Report of Radiological Environmental Monitoring of the Environs Surrounding  
**Wolf Creek Generating Station**



**July 2005-June 2006**  
**Division of Environment, Bureau of Air and Radiation**  
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## INTRODUCTION

Wolf Creek Generating Station (WCGS) is a pressurized water nuclear reactor capable of producing over 1,200 megawatts of electrical power. Located near Burlington Kansas, the plant is operated by Wolf Creek Nuclear Operating Corporation (WCNOC). The facility releases radioactive material to the environment in the form of liquid and gaseous effluents. This report details the results of surveillance of the environs surrounding WCGS conducted by the Kansas Department of Health and Environment (KDHE) from July 1, 2005 through June 30, 2006.

KDHE's Wolf Creek Environmental Radiation Surveillance (ERS) program began in 1979 in accordance with Kansas Administrative Regulation (K.A.R.) 28-19-81 with the initial selection of surface water sampling locations. The ERS program was ready for operational use in 1984, which allowed for one year of baseline data collection prior to the commercial operation of WCGS, which commenced in September 1985. The ERS program parallels (and partially overlaps) the WCNOC Radiological Environmental Monitoring Program (REMP).

The purpose of the ERS program is to detect, identify, and measure radioactive material released to the environment from the operation of WCGS. Data indicating the release of elevated levels of radioactive material will be used to determine the need for corrective and/or protective actions to protect the health and safety of the public.

The ERS program includes the following monitoring methods:

- Measurement of ambient external radiation levels using optically stimulated luminescence dosimetry
- Monitoring of radionuclides present in ambient air through weekly collection and laboratory analysis of continuous air samples
- Monitoring of radionuclides present in water, terrestrial vegetation, aquatic vegetation, fish, sediments, and soil through scheduled and random sample collection and laboratory analysis.

A tabular summary of the WCGS environmental radiation surveillance program conducted during SFY 2006 is presented as Table I.

## Program Description and Elements

State program samples were delivered to Kansas Health and Environment Laboratories (KHEL) Radiochemistry Laboratory at Forbes Field for analysis. State OSLDs were processed by Landauer, Inc. under contract.

Wolf Creek Environmental Management personnel collect samples for the WCNOG REMP. WCNOG has a contract with Environmental Inc., Midwest Laboratory, of Northbrook, IL for laboratory analysis of REMP samples. Enrico Fermi Unit 2 dosimetry department processes and evaluates WCNOG TLDs.

The ERS utilizes the WCNOG emergency planning sector logic for identification of the sample geographic sector relative to WCGS plant center. Sixteen 22.5-degree sectors are established and designated by letter. The first sector, sector A, is 11.25 degrees east west of true north to 11.25 degrees west of true north, i.e. from 348.75 degrees true to 11.25 degrees true. The remaining sectors continue in a clockwise direction, from B to R (the letters I and O are not used). The main thrust of the program is within the 10-mile emergency-planning zone (EPZ).

### Air

Air samples are collected weekly. Five air-sampling sites, three of which are collocated with WCNOG, have continuously operating low-volume air samplers contained in a fiberglass housing mounted on utility poles approximately one meter from the ground. Air samplers are located at Sharpe, KS (A-1), east of the Coffey County Lake dam (H-1), Burlington, KS (L-1), New Strawn, KS (P-1), and Harris, KS (D-1). The collocated sites include the highest calculated annual average ground level relative concentration (X/Q) area at Sharpe, the highest calculated annual average ground level relative deposition (D/Q) area at New Strawn, and a control location at Harris. An average flow rate of 30 liters per minute is used with 47 mm diameter glass fiber particulate filters and 5 percent triethylene diamine (TEDA) impregnated carbon cartridges for radioiodine activity (the major isotope of concern is  $^{131}\text{I}$ ). TEDA binds the iodine chemically and reduces losses from desorption.

Field assay of each particulate filter is performed at the time of collection. The particulate filter is counted using a thin window GM 'pancake' detector (Ludlum Model 22-40 or equivalent) and a count rate instrument. A sample net count rate of greater than two times the net count rate of the current control (Harris D-1) air sample indicates a potential anomaly and the filter is flagged for individual gamma isotopic analysis.

Gamma isotopic analysis is performed on two composite samples, one composed of the five particulate filters and the other of the five charcoal cartridges. Indication of  $^{131}\text{I}$  or any other fission or activation product requires gamma isotopic analysis of each individual particulate filter and associated charcoal cartridge.

## **Direct Radiation Monitoring**

Direct radiation monitoring is accomplished using Landauer Luxel OSLDs. OSLDs are read by Landauer. OSLD readings are corrected for transit and handling exposure.

Thirty-one locations around the WCGS are monitored by KDHE, including three control locations greater than ten miles from WCGS. Two OSLDs are used per site to generate an average quarterly reading. The dosimeters are contained in specially constructed holders suspended approximately one meter above the ground. Staff members exchange TLDs and OSLDs quarterly. KDHE has collocated OSLDs with WCNOG at twelve sites.

## **Surface water**

Surface water sampling is done by the collection of one-gallon grab samples at the indicated locations. A control sample is collected from John Redmond Reservoir. One sample is collected from the Coffey County Lake, monthly at the spillway. Samples are collected from the Neosho River near Leroy and the public fishing area on CCL, near the Makeup Discharge Structure (MUDS). A sample is also collected annually from the New Strawn City Lake.

A gamma isotopic and tritium ( $^3\text{H}$ ) analysis is done on each CCL water sample and  $^3\text{H}$  analysis is done quarterly on a composite sample from JRR. Samples are split with WCNOG.

## **Ground water**

Ground water is collected annually at wells in sectors B (control), L, and M. The control sample location is hydrologically up gradient from the facility and the other two are hydrologically down gradient. Samples are split with WCNOG. The ERS SFY 2006 Surveillance Plan was not updated to reflect this plan, and listed four sample locations.

Gross alpha, beta, tritium and gamma isotopic analysis are done on each sample.

## **Milk**

Milk samples were collected in Coffey County at two locations. Indicator samples were obtained from the Kobf Dairy near Westphalia, KS. Control samples were obtained from Linsey Dairy near Lebo, KS. Each milk sample is analyzed for low levels of radioiodine and other gamma emitting nuclides. Only five out of eight scheduled samples were obtained as the result of scheduling problems.

## **Sediment and soil**

Shoreline sediment, bottom sediment and soil samples were taken in the environment surrounding WCGS. Indicator sediment samples were collected in the Coffey County Lake discharge cove, public environmental education area, and public fishing area. Indicator samples were also collected on Wolf Creek below the Coffey County Lake dam. Control samples were obtained from

John Redmond Reservoir. The Coffey County Lake and John Redmond Reservoir samples are split with WCNOG.

Annual soil samples were collected close to Sharpe, east of WCGS at the Scott Valley Church (control), east of the Coffey County Lake dam, and at the Coffey County Lake public fishing and environmental education areas.

Soil samples collected from the Coffey County public use areas are split with WCNOG. Random soil samples were collected at 10 locations within the 50-mile IPZ, nine of which were within the 10 mile EPZ.

A gamma isotopic analysis is done on all sediment and soil samples collected.

### **Fish, game animals, and domestic meat**

Fish samples were collected from the Coffey County Lake and below John Redmond Reservoir on the Neosho River. Sample portions from fish collected in the Coffey County Lake and below John Redmond Reservoir on the Neosho River were split with WCNOG. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. Sixteen fish for a total of ten species were sampled.

Game animal sampling is usually limited to the collection of edible meat portions from road-killed deer. Sample portions of road-killed deer are usually collected as available by WCNOG and split with KDHE for laboratory analysis. No samples were available during SFY 2006.

A gamma isotopic analysis is done on all samples collected. Sample portions were edible. Tritium in tissue analysis (fat and water) is done on at least one species of fish from each location sampled.

### **Terrestrial and aquatic vegetation**

Terrestrial vegetation samples were taken at various locations around WCGS. This includes samples of crops grown throughout Coffey County, broad leaf vegetation taken from gardens near the WCGS boundary, pasturage near WCGS, and crops irrigated with water from the Neosho River. Pasturage samples were usually collected concurrently with soil samples. Samples collected on WCNOG property, garden vegetables collected from gardens near WCGS, and samples of crops irrigated with water from the Neosho River were split with WCNOG. A gamma isotopic analysis was done on each vegetation sample and edible portions of food products collected.

As available, semiannual aquatic vegetation (algae and/or rooted aquatics) samples are normally collected from the Coffey County Lake, Wolf Creek below the Coffey County Lake dam, and John Redmond Reservoir. The aquatic vegetation samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake samples are split with WCNOG. Gamma isotopic analysis is performed on all aquatic vegetation samples.

## **EQUIPMENT**

The following is a description of the equipment used by the KHEL Radiochemistry laboratory.

### **Multichannel gamma-spectrometer**

Gamma radiation is measured spectra determined with a Canberra Genie-2000 Multichannel Analyzer (MCA) system. Detectors available are three high purity germanium detectors (efficiencies – 20 % - 40%) and one germanium-lithium (GeLi) Detector (efficiency 20%).

### **Low background alpha/beta system**

Low background alpha/beta gas-flow internal proportional counters – one Tennelec LB5100, one Oxford Series 5XLB, one Tennelec LB4000 multi-detector and one Canberra 2201.

### **Internal proportional counter (IPC)**

Gross alpha and radium analyses are performed with windowless gas-flow internal proportional counters – four Protean MPC 2000 and two NMC PC5.

### **Liquid scintillation**

Analysis for tritium in water is performed using a one Wallac 1409 and one PE Tri-Carb 3100 TR.

### **Miscellaneous equipment**

The Radiochemistry Section has various devices used for special purposes. A Ludlum Model 2200 single channel analyzer is used with a radon flask scintillation counter for radon and radium analyses. Another Ludlum Model 2200 single channel analyzer is used with a halogen quenched GM pancake probe for routine monitoring of personnel and incoming samples.

## **QUALITY ASSURANCE**

The KDHE Radiation Laboratory has an established internal Quality Assurance program. Quality Control elements include routine calibrations and performance checks on counting equipment and participation in an environmental radioactivity laboratory intercomparison studies program (see Table 14.0). This program is currently accomplished with blind samples purchased from Environmental Resource Associates.

## **Units**

The unit of radioactivity used is the picoCurie (pCi). One pCi is equal to 2.22 disintegrations per minute or 0.037 Becquerels (Bq). Radioactivity concentrations in liquids such as water and milk are expressed in picoCuries per liter (pCi/l), radioactivity concentrations in air are expressed in picoCuries per cubic meter (pCi/m<sup>3</sup>), and radioactivity in solids such as soil or vegetation is expressed in picoCuries per kilogram (pCi/kg). TLD exposure results are expressed as milliRoentgen (mR) per a 90-day quarter. One mR is equivalent to ten micro-Grays (10 µGy or 10<sup>-5</sup> Gy).

## Uncertainty statistics

Radioactive decay of unstable atomic nuclei is a random event. The greater the number of total counts obtained (a function of sample count time and sample volume/mass); the closer the measurements will be to the actual value. Due to the large number of samples analyzed and the limited resources available for counting individual samples, each sample is counted only once and for the minimum time necessary to reduce the statistical error to an acceptable level. Unless otherwise specified, results for all samples are reported at the 95 percent confidence level. Because systematic (non-random) uncertainties involved in sample collection and sample preparation are highly subjective and generally difficult or impossible to quantify with substantial accuracy, the KHEL Radiochemistry Laboratory reports only the uncertainty resulting from random processes (propagation of statistical counting error).

A “less than” value reported indicates that the radioactivity in the sample is below the lower limit of detection for the procedures, equipment, and counting time used. The KHEL Radiochemistry Laboratory method detection limits (MDLs) for various analyses are summarized in Table 15.0 of this report. MDLs will vary based on sample matrix, sample size, counting time, detector efficiencies, and type of measurement required. WCNOG’s lower limits of detection values are found in Table 16.0.

## RESULTS

Results are reported in the following data tables for the samples taken around WCGS during SFY 2006. Radionuclides detected in the environment surrounding WCGS during SFY 2006 include <sup>228</sup>Ac, <sup>7</sup>Be, <sup>60</sup>Co, <sup>137</sup>Cs, <sup>3</sup>H, <sup>40</sup>K, <sup>226</sup>Ra, <sup>125</sup>Sb and <sup>228</sup>Th. The isotopes <sup>228</sup>Ac, <sup>7</sup>Be, <sup>40</sup>K, <sup>226</sup>Ra, and <sup>228</sup>Th are naturally occurring radionuclides common in the environment. The isotopes <sup>137</sup>Cs and <sup>3</sup>H are fission products from WCGS nuclear reactor operation. The isotopes <sup>60</sup>Co and <sup>125</sup>Sb are activation products, also the result of WCGS nuclear reactor operation. A small background component of the <sup>3</sup>H (half-life = 12.3 y) and <sup>137</sup>Cs (half-life = 30.1 y) activity is attributable to previous nuclear weapons tests. Small amounts of <sup>3</sup>H are also produced naturally from cosmic ray interactions with water vapor in the upper atmosphere. Background levels of <sup>137</sup>Cs and <sup>3</sup>H are accounted for in control samples and in preoperational data. The fission and activation product activity levels found to date in the environment surrounding WCGS are not above expected regulated levels and are very small when compared with activity levels due to naturally occurring radionuclides.

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The most significant radionuclide present in surface water samples collected in the Coffey County Lake is tritium ( $^3\text{H}$ ), a beta emitter. The highest  $^3\text{H}$  concentration measured in the Coffey County Lake during SFY 2006 was 12,704 pCi/l in May 2006. This maximum Coffey County Lake  $^3\text{H}$  concentration is 64% of the National Primary Drinking Regulation maximum contaminant level (MCL) of 20,000 pCi/l. *The water from the Coffey County Lake is not used as a drinking water source.* The average CCL surface water  $^3\text{H}$  concentration for SFY 2006 was 10,700 pCi/l, or 54% of MCL. Coffey County Lake is not approved for any aquatic recreation other than fishing. All other non-CCL surface water and ground water samples collected in the environs of WCGS during SFY 2006 indicated no radionuclides present attributable to the operation of WCGS.

Aquatic vegetation samples are the best indicators for monitoring the seasonal fluctuations of fission and activation product levels in the Coffey County Lake. No aquatic vegetation sample showed any nuclides attributable to WCGS operation. Five trending samples and six random samples were analyzed.

Sediment samples have been excellent indicators for the long-term buildup of fission and activation product activity levels in the Coffey County Lake. The highest fission product activity in sediments during SFY 2006 was 196 pCi/kg-dry  $^{137}\text{Cs}$  found at the Coffey County Lake Discharge Cove (WCBS-AQ-1). Seven trending samples and 16 random samples were analyzed.

Airborne sample analysis indicated that no radionuclides attributable to the operation of WCGS were present above the lower limits of detection during SFY 2006.

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCGS during SFY 2006 indicated no radionuclides present attributable to the operation of WCGS.

Samples of six species of fish were taken from the Coffey County Lake during SFY 2006. Sample analysis of edible fish portions collected in the environs of WCGS during SFY 2006 indicated that no gamma emitters attributable to WCGS operation were present. The highest  $^3\text{H}$  concentration in tissue was 12,864 pCi/kg-wet found in a white bass sample taken at the CCL Discharge Cove. Using an ICRP 30 dose conversion factor for ingestion ( $h_{E,50}$ ) of  $6.40 \times 10^{-8}$  mrem per pCi  $^3\text{H}$  ingested, a standard man consuming 21 kg/y of fish containing 12,864 pCi/kg  $^3\text{H}$  would receive a committed effective dose equivalent of 0.017 mrem. The projected dose equivalent is far below the 100 mrem/y regulatory limit for a member of the public.

Data from direct radiation monitoring sites revealed no significant changes from preoperational data. The lowest direct radiation levels are found closest to the WCGS. The direct radiation levels on the Coffey County Lake baffle dikes at the 1,200 m exclusion area boundary are the lowest of any monitored site. The limestone used to construct the baffle dikes has a lower natural background radioactivity than the original soil present before the construction of the Coffey County Lake. This effect of construction on the terrestrial component of natural background radiation was noted on radiation surveys conducted around the WCGS site before bringing the initial fuel load on the site. The water from the Coffey County Lake also acts as an effective shield from terrestrial radiation that was present before Coffey County Lake filling.

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The ratio of KDHE results to WCNOG results ranged from 0.5 to 2. The KDHE Grand Average of all sites was 107.1 mR/yr. A summary of comparison data may be found in Table III. Data tables and maps are also attached.

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**Table 1.** ERS Program summary report for SFY 2006

Type of Sample	Number of Sampling Stations	Total Samples Collected
Air (particulate and iodine)	5	520
Direct Radiation	31	248
Surface Water	5	43
Ground Water	3	3
Sediments	4	7
Random Sediments	16	16
Milk	2	5
Aquatic Vegetation	5	5
Random Aquatic Vegetation	7	7
Fish	2	12
Game Animals/Domestic Meat	0	0
Soil	5	5
Random Soil	10	10
Terrestrial Vegetation	9	9
Random Terrestrial Vegetation	12	12
Total	116	908

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**Table II ERS Summary Statistics SFY 2006**

Description	Average	Standard deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR per 90 day quarter	26.8	2.1	0.19	19.8	32.1	124
Airborne particulate and radioiodine cartridge gamma isotopic analysis	Gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any air particulate filter or radioiodine cartridge evaluated.					
Surface water tritium ( <sup>3</sup> H), pCi/l						
John Redmond Reservoir, control (N-1/MUSH)	<350	--	--	<350	<350	12
Coffey County Lake (J1A/SP)	10699.8	1180.6	340.8	8921	12704	12
Coffey County Lake (MUDS)	9626.0	1734.51	500.7	5685	11676	9
Neosho River Near Leroy	<350	--	--	<350	<350	9
Ponds surrounding WCGS	<350	--	--	<350	<350	1
Ground water tritium ( <sup>3</sup> H), pCi/l (All Stations)	<350 (<158)	--	--	<350 (<173)	<350 (<145)	3
Water sample gamma isotopic analysis	Gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface water, drinking water, or ground water sample evaluated.					
Gamma isotopic analysis of soil, pasturage, garden vegetables, and grain.	Gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, milk, pasturage, garden vegetable and grain sample evaluated.					
Maximum activity attributable to Wolf Creek Generating Station operation, pCi/kg						
Coffey County Lake bottom sediment, dry	<sup>137</sup> Cs, 196.6 ± 13.7					
Coffey County Lake fish, wet	<sup>3</sup> H, 12864 ± 3600					

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**TABLE III. ERS program data comparison<sup>a</sup> summary statistics SFY 2006.**

Description	Average	Standard Deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR <sup>b</sup>	26.1 (23.0)	2.6 (6.3)	0.4 (0.9)	19.8 (12.1)	32.1 (35.0)	48
Airborne particulate filter and charcoal cartridge gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNOG (Environmental, Inc.) demonstrated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any particulate filter or charcoal cartridge evaluated.					
Surface water tritium ( <sup>3</sup> H), pCi/l						
CCL <sup>c</sup> spillway, J-1A (SP)	10699.8 (10378.2)	1180.6 (1545)	340.8 (466.0)	8921 (8624)	12704 (14119)	11
JRR <sup>d</sup> below dam (control), N-1 (MUSH)	<350	--	--	<350 (<184)	<350 (219)	11
Ground water <sup>3</sup> H, pCi/l	<350 (<158)	--	--	<350 (<173)	<350 (<145)	3
Surface and ground water gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNOG (Environmental, Inc.) indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface, ground, or drinking water sample evaluated.					
<b>Maximum activity by isotope attributable to WCGS operation, pCi/kg</b>						
Bottom sediment	Gamma emitter: <sup>137</sup> Cs, 196.6 ± 13.7 (234.4 ± 40.4)					
CCL fish	All results for fish indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present <i>above</i> the lower limits of detection. Beta emitter: <sup>3</sup> H, 12864 ± 3600 (7524 ± 226)					
Shoreline Sediment	All results for shoreline sediments indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present <i>above</i> the lower limits of detection at co-located sites.					
Soil, terrestrial vegetation	Gamma isotopic analysis by both KDHE and WCNOG (Environmental, Inc.) indicated that no comparable gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, shoreline sediments or terrestrial vegetation sample evaluated.					

<sup>a</sup> KDHE (WCNOG).

<sup>b</sup> mR per 90-day quarter.

<sup>c</sup> Coffey County Lake.

<sup>d</sup> John Redmond Reservoir.

<sup>e</sup> Average of MDA values.

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**Table IV** Data comparison summary by selected analysis SFY 2006

Analysis	Average Ratio of KDHE results to WCNOG results <sup>a</sup>	Comments
TLD Direct Radiation	1.13 N=48	12 collocated sites.
Surface Water <sup>3</sup> H	1.03 N=11	Coffey County lake spillway
Bottom sediment gamma isotopic	0.96 N=3	Comparison of <sup>137</sup> Cs results
Fish tritium ( <sup>3</sup> H) in tissue	0.84 N=8	WCNOG samples are analyzed for tritium content in the water of the tissue while KDHE analyzes for the tritium content in the fat and water of the tissue. Rejected results not compared.

<sup>a</sup> KDHE/WCNOG

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**TABLE 1.0** Weekly Air Particulate/Iodine Monitoring

Number of Samples	Average <sup>7</sup> Be Concentration	Average Iodine Concentration
52	0.11 ± 0.01	<0.03

Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58/60</sup>Co, <sup>59</sup>Fe, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134/137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141/144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>234/228</sup>Th, and <sup>239</sup>Np. **No radionuclides attributable to WCGS operation were detected.** See Map #1.0 for sample locations.

**TABLE 2.0** Wolf Creek quarterly **direct radiation** monitoring SFY 2006. Direct radiation monitoring results in mR. Exposures are normalized to a 90-day quarter. Results are expressed as the average of two OSLD readings per location. WCNOC sample location designations are denoted by parentheses. Sample locations are shown on Map #2.0.

Location	QTR 1	QTR 2	QTR 3	QTR 4
1. A-1 (1), North of WCGS	24.9	32.1	28.3	27.2
2. A-2, Sharpe	29.4	28.6	28.8	27.2
3. A-3, Forward Staging Area	29.4	24.1	24.8	23.2
4. B-1, East Sharpe	28.4	30.6	27.3	27.7
<b>5. B-2, Waverly Control</b>	28.9	27.6	28.3	25.7
6. C-1, near residence	26.4	30.6	27.3	27.7
7. D-1 (9), near residence	26.4	28.1	25.3	24.2
8. E-1, near residence	29.4	27.1	28.3	27.2
9. F-1, near residence	26.4	28.6	28.8	27.7
10. G-1 (14), WCNOC gate	28.4	28.6	27.3	29.2
11. H-0 (42), CCL baffle dike A	24.9	22.1	20.3	24.2
12. H-1, east of CCL dam	24.4	29.6	28.8	25.7
<b>13. H-2, LeRoy control</b>	27.4	29.6	27.8	26.2
14. J-1, near residence	26.4	28.1	25.3	25.7
15. K-1 (29), near residence	24.4	24.6	24.3	22.2
16. L-1 (27), near residence	27.9	25.6	28.3	27.7
17. L-2, Burlington	26.4	28.1	27.3	25.7
18. L-3, Coffey County Shop	24.9	27.6	26.3	24.2
19. M-1 (26), near residence	24.9	24.6	25.3	24.7
20. N-1, near pasture	27.9	27.6	29.3	28.2
21. P-0 (43), CCL baffle dike B	25.9	20.6	19.8	21.7
22. P-1, New Strawn	28.4	27.1	27.8	26.7
<b>23. P-2, Hartford Control</b>	24.9	26.6	26.3	24.7
24. P-3, CCL entrance	27.4	28.6	27.8	26.7
25. P-4 (46), CCL near MUDS	28.4	28.1	27.3	25.2
26. P-5, JRR public use area	26.9	26.6	25.8	24.7
27. Q-1, near residence	26.9	27.1	24.3	25.7
28. R-0 (41), Stringtown cemetery	27.4	29.6	29.8	28.7
29. R-1 (37), near residence	26.4	28.6	25.8	28.2
30. R-2 (44), CCL EEA	25.9	28.1	25.8	27.2
31. R-3, near Coffey County Airport	26.9	28.1	27.8	28.2

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**TABLE 2.1** Wolf Creek collocated quarterly **direct radiation** monitoring SFY 2006. Direct radiation monitoring results in mR. WCNOC results are expressed as normalized 90-day quarter average  $\pm$  two standard deviations of two dosimeters at each location (two TLD chips per badge are used for data evaluation). KDHE results are expressed as a normalized 90-day quarter average of two OSLDs at each location.

Location KDHE (WCNOC)	KDHE Monitoring period	KDHE	WCNOC
1. A-1 (1)	08-Jul-05-7-Oct-05	24.9	35.0 $\pm$ 3.7
	07-Oct-05-11-Jan-06	32.1	28.6 $\pm$ 1.9
	11-Jan-06-7-Apr-06	28.3	16.4 $\pm$ 0.9
	7-Apr-06-11-Jul-06	27.2	21.3 $\pm$ 1.1
2. D-1 (9)	08-Jul-05-7-Oct-05	26.4	31.9 $\pm$ 4.1
	07-Oct-05-11-Jan-06	28.1	24.5 $\pm$ 1.2
	11-Jan-06-7-Apr-06	25.3	13.9 $\pm$ 0.7
	7-Apr-06-11-Jul-06	24.2	19.4 $\pm$ 2.8
3. G-1 (14)	08-Jul-05-7-Oct-05	28.4	34.1 $\pm$ 3.6
	07-Oct-05-11-Jan-06	28.6	28.4 $\pm$ 2.6
	11-Jan-06-7-Apr-06	27.3	16.7 $\pm$ 1.1
	7-Apr-06-11-Jul-06	29.2	21.4 $\pm$ 1.7
4. H-0 (42)	08-Jul-05-7-Oct-05	24.9	20.1 $\pm$ 0.8
	07-Oct-05-11-Jan-06	22.1	28.4 $\pm$ 2.6
	11-Jan-06-7-Apr-06	20.3	16.7 $\pm$ 1.1
	7-Apr-06-11-Jul-06	24.2	21.4 $\pm$ 1.7
5. K-1 (29)	08-Jul-05-7-Oct-05	24.4	28.8 $\pm$ 1.4
	07-Oct-05-11-Jan-06	24.6	22.8 $\pm$ 1.4
	11-Jan-06-7-Apr-06	24.3	13.1 $\pm$ 0.9
	7-Apr-06-11-Jul-06	22.2	18.0 $\pm$ 1.5
6. L-1 (27)	08-Jul-05-7-Oct-05	27.9	32.5 $\pm$ 1.2
	07-Oct-05-11-Jan-06	25.6	27.0 $\pm$ 1.7
	11-Jan-06-7-Apr-06	28.3	17.9 $\pm$ 3.6
	7-Apr-06-11-Jul-06	27.7	20.4 $\pm$ 0.3
7. M-1 (26)	08-Jul-05-7-Oct-05	24.9	30.0 $\pm$ 1.0
	07-Oct-05-11-Jan-06	24.6	25.4 $\pm$ 0.9
	11-Jan-06-7-Apr-06	25.3	16.0 $\pm$ 3.2
	7-Apr-06-11-Jul-06	24.7	19.5 $\pm$ 1
8. P-0 (43)	08-Jul-05-7-Oct-05	25.9	24.9 $\pm$ 1.5
	07-Oct-05-11-Jan-06	20.6	19.5 $\pm$ 0.7
	11-Jan-06-7-Apr-06	19.8	12.1 $\pm$ 3.5
	7-Apr-06-11-Jul-06	21.7	14.9 $\pm$ 0.9
9. P-4 (46)	08-Jul-05-7-Oct-05	28.4	31.4 $\pm$ 1.4
	07-Oct-05-11-Jan-06	28.1	26.1 $\pm$ 1.1
	11-Jan-06-7-Apr-06	27.3	15.5 $\pm$ 0.2
	7-Apr-06-11-Jul-06	25.2	19.7 $\pm$ 1.4
10. R-0 (41)	08-Jul-05-7-Oct-05	27.4	33.2 $\pm$ 2.3
	07-Oct-05-11-Jan-06	29.6	27.4 $\pm$ 1.2
	11-Jan-06-7-Apr-06	29.8	16.7 $\pm$ 0.9
	7-Apr-06-11-Jul-06	28.7	21.6 $\pm$ 2
11. R-1 (37)	08-Jul-05-7-Oct-05	26.4	30.7 $\pm$ 3.3
	07-Oct-05-11-Jan-06	28.6	27.0 $\pm$ 3.6
	11-Jan-06-7-Apr-06	25.8	15.8 $\pm$ 1.4
	7-Apr-06-11-Jul-06	28.2	20.7 $\pm$ 2.8
12. R-2 (44)	08-Jul-05-7-Oct-05	25.9	32.4 $\pm$ 2.1
	07-Oct-05-11-Jan-06	28.1	26.2 $\pm$ 1.8
	11-Jan-06-7-Apr-06	25.8	16.4 $\pm$ 1.8
	7-Apr-06-11-Jul-06	27.2	20.6 $\pm$ 1.6

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**TABLE 3.0** Wolf Creek monthly duplicate samples for waterborne radionuclides in **surface water** SFY 2006. Gamma isotopic analyses by both KDHE and WCNOC of surface water samples indicated that no gamma emitters attributable to WCGS operation were present above the lower limits of detection. Sample results in pCi/l tritium (<sup>3</sup>H).

Date	J-1A (Spillway)		N-1 (JRR/MUSH) Control		P-1 MUDS	H-1 Neosho R.	
	KDHE	WCNOC	KDHE	WCNOC			
7/8/2005	12140 ± 300	14119 ± 336	<350	<164	9/30/2005	10642 ± 412	<350
8/11/2005	11521 ± 418	11819 ± 314	<350	<173	10/25/2005	10125 ± 401	<350
9/9/2005	10553 ± 414	10793 ± 298	<350	<169	11/30/2005	9063 ± 390	<350
10/20/2005	10520 ± 414	10939 ± 302	<350	219 ± 95	12/23/2005	5685 ± 333	<350
11/17/2005	10176 ± 420	9533 ± 276	<350	<163	1/31/2006	8878 ± 389	<350
12/15/2005	10243 ± 433	9882 ± 285	<350	<184	2/16/2006	9523 ± 351	<350
1/12/2006	8921 ± 387	8949 ± 267	<350	<145	3/30/2006	9990 ± 409	<350
2/9/2005	9204 ± 383	8624 ± 258	<350	<153	4/3/2006	11052 ± 374	<350
3/16/2006	9518 ± 404	9770 ± 283	<350	<155	5/30/2006	11676 ± 314	<350
4/13/2006	11216 ± 301	9455 ± 276	<350	<158			
5/11/2006	12704 ± 288	Not Received	<350	<176			
6/8/2006	11682 ± 308	10207 ± 276	<350	<186			

**TABLE 4.0** Wolf Creek annual samples for deposition of airborne radionuclides on **surface water (PONDS)** SFY 2006. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. See Map #1.0 for sample locations. WCNOC sample location designations are denoted by parenthesis. *No radionuclides attributable to WCNOC operations were found above method detection limits.*

Location	Date	Tritium ( <sup>3</sup> H)
P-1, New Strawn City Lake	3/30/2006	<350

**TABLE 5.0** Wolf Creek Annual samples for waterborne radionuclides in **ground water** SFY 2006. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. WCNOC sample location designations are denoted by parenthesis. *No radionuclides attributable to WCNOC operations were found above method detection limits.* See Map #1.0 for sample locations.

Date	L-1 (L49)	N-1 (C-10)	B-1 (B-12)
	KDHE (WCNOC)	KDHE (WCNOC)	KDHE (WCNOC)
	TRITIUM ( <sup>3</sup> H)		
8/11/05	<350 (<173)	<350 (<145)	<350 (<157)
	ALPHA + BETA		
8/11/05	<5	<5	<5

<sup>a</sup> WCNOC results for tritium only.

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**TABLE 6.0** ERS annual samples for airborne radionuclide deposition on **soil** SFY 2006. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. The presence of <sup>137</sup>Cs is not attributable to Wolf Creek operation unless accompanied by other reactor nuclides. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The symbol \* indicates naturally occurring radionuclides. See Map #1.0 for sample location. WCNOC sample location designations are denoted by parenthesis. **No radionuclides attributable to WCNOC operations were observed above method detection limits.**

Isotope	A-1 Sector A Sharpe KDHE 4/18/06 0.5m <sup>2</sup>	E-1 Scott Valley Church (Control) 6/21/06 0.5m <sup>2</sup>	H-1 East of CCL Dam Near HCA H-1 10/18/05 0.5m <sup>2</sup>
<sup>228</sup> Ac*	<28	1408.5 ± 34.2	956.4 ± 23.7
<sup>137</sup> Cs	<35	546.8 ± 27.8	276.3 ± 14.9
<sup>40</sup> K*	<33	13856.2 ± 866.4	11123.9 ± 541.4
	P-1 (MUDS) 6/26/06 KDHE (WCNOC)	R-1 EEA 5/26/06 KDHE	
<sup>228</sup> Ac*	1001.5 ± 23.9 (N/A)	1111.6 ± 25 (N/A)	
<sup>137</sup> Cs	69.4 ± 6.0 (<46.3)	25.2 ± 4.2 (<21.8)	
<sup>40</sup> K*	10721.8 ± 524.9 (10501.0 ± 939.8)	12370.6 ± 595.4 (13180.0 ± 690)	

**TABLE 6.1** ERS random samples for airborne radionuclide deposition in **soil** SFY 2006. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>40</sup>K activity. *No isotopes attributable to WCNOC operations were found above method detection limits.* See Map #7.0 for locations.

Location	Date	<sup>137</sup> Cs	Isotope <sup>40</sup> K
WCRS-1-F-109-8.6	1/4 mi. N of 10th & Wayside	8/23/2005	<8.0 4700 ± 261.5
WCRS-1-G-138-3.4	12th and Reaper Rd.	9/26/2005	189.3 ± 11.1 13242.4 ± 629.1
WCRS-1-L-215-5.8	10th and Lynx Lane	10/5/2005	10.8 ± 3.4 8558.8 ± 425.9
WCRS-1-A-364-7.7	22nd and Oxen Rd.	10/13/2005	41.5 ± 5.2 13002.8 ± 624.7
WCRS-1-A-008-10.4	25th between Planter Rd. and Quail Rd.	1/5/2006	102.7 ± 8.2 11925.4 ± 769.5
WCRS-1-C-45-8.0	20th and Underwood Rd.	3/1/2006	195.2 ± 10.2 10742.1 ± 523.8
WCRS-1-N-268-8.7	14th Lane and Garner Rd	3/7/2006	276.6 ± 13.9 12679.6 ± 614.9
WCRS-1-P-295-5.9	17th and Juneberry Rd.	4/4/2006	<8.0 14473.6 ± 684.8
WCRS-1-J-182-6.9	Planter between 8th and 9th	5/9/2006	77.6 ± 2.8 15513.6 ± 358.8
WCRS-1-C-51-2.3	1/4 mi. S of 14th on Shetland	6/13/2006	61 ± 5.6 8819.5 ± 437.6

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**TABLE 7.0** Wolf Creek ingestion pathway samples for radionuclide bioaccumulation in **milk** (from airborne radionuclide deposition on pasturage with subsequent ingestion by milk producing cattle) SFY 2006. Sample is collected at Lebo, R-1 (Linsey Dairy). Lebo is a control location. Sample results in pCi/L. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. See Map #1.0 for sample location. *No isotopes attributable to WCNOC operations were found above method detection limits.*

Date	<sup>40</sup> K Natural	Date	<sup>40</sup> K Natural
Lebo, R-1		Sunrise Dairy, D-1	
8/30/2005	<88	3/30/2006	<88
10/5/2005	<88	6/25/06	<88
4/26/2006	<88		

**TABLE 8.0** ERS annual samples for waterborne radioisotope concentration in **bottom sediments** SFY 2006, results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \* indicates naturally occurring radioisotopes. See Map #1.0 for sample location. WCNOC sample location designations are denoted by parentheses.

Isotope	WCBS-AQ-1 (DC)	WCBS-AN-1 (JRR)
	CCL discharge cove 10/27/05	John Redmond Reservoir <b>Control</b> 11/11/05
	KDHE (WCNOC)	KDHE (WCNOC)
<sup>228</sup> Ac*	1442.3 ± 37.3(not reported)	1365.6 ± 24.7 (not reported)
<sup>137</sup> Cs	196.6 ± 13.7 (234.4 ± 40.4)	123.8 ± 7.4 (127.6 ± 49.2)
<sup>40</sup> K*	14433.6 ± 709.3 (14377.0 ± 1012.0)	17318.9 ± 834.3 (16987.0 ± 1103.0)
	WCBS-AR-1	
	EEA 5/26/06 KDHE (WCNOC)	
<sup>228</sup> Ac*	1163.8 ± 12.4 (not reported)	
<sup>137</sup> Cs	123.6 ± 3.8 (96.9 ± 33.6)	
<sup>40</sup> K*	12798.1 ± 300.0(12874.0 ± 715.7)	

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**TABLE 8.1** Wolf Creek random samples for waterborne radioisotope concentration in **bottom sediments** SFY 2006. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>60</sup>Co activity. See Map #3.0 for locations.

Location	Date	Isotope		
		<sup>137</sup> Cs	<sup>60</sup> Co	
WCRBS-1-N-278-1.6	Coffey County Lake	9/19/2005	41.0 ± 4.9	<11.0
WCRBS-2-N-260-1.7	Coffey County Lake	9/19/2005	180.0 ± 10.6	23.0 ± 3.4
WCRBS-3-M-242-1.7	Coffey County Lake	9/19/2005	34.0 ± 4.5	<11.0
WCRBS-5-L-236-1.7	Coffey County Lake	9/19/2005	20.0 ± 3.6	<11.0
WCRBS-7-L-220-1.8	Coffey County Lake	9/19/2005	9.0 ± 3.5	<11.0
WCRBS-4-P-284-2.8	Coffey County Lake	6/6/2006	11.0 ± 3.5	<11.0
WCRBS-3-Q-323-1.5	Coffey County Lake	6/6/2006	25.9 ± 3.3	<11.0
WCRBS-2-H-152-3.0	Coffey County Lake	6/6/2006	31.0 ± 3.5	<11.0
WCRBS-1-H-150-3.0	Coffey County Lake	6/6/2006	37.0 ± 6.6	<11.0

**TABLE 9.0** Wolf Creek annual samples for waterborne radioisotope concentration in **shoreline sediment** SFY 2006. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \* indicates naturally occurring radioisotopes. See Map #1.0 for sample location. WCNOG sample location designations are denoted by parentheses.

Isotope	N-1 (JRR) John Redmond Reservoir (Control) 11/11/05 KDHE (WCNOG)	J-1 Wolf Creek 8/30/05 KDHE	P-1 (MUDS) CCL Public Access Fishing Area 6-26-06 KDHE (WCNOG)
	<sup>137</sup> Cs	41.5 ± 5.7 (56.7 ± 30.6)	29 ± 4.2
<sup>60</sup> Co	<11 (<32.2)	<11	<11 (<39.3)
<sup>40</sup> K*	8312.5 ± 559.3 (8643.4 ± 756.6)	9595 ± 471	11566.7 ± 271.6 (8695.1 ± 816.0)
Isotope	Q-1 (DC) CCL Discharge Cove 10/27/05 KDHE (WCNOG)		
	<sup>137</sup> Cs	22 ± 5.2 (<36.4)	
<sup>60</sup> Co	<11 (<30.0)		
<sup>40</sup> K*	12993.4 ± 644.3 (10382.0 ± 876.6)		

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**TABLE 9.1** Wolf Creek random samples for waterborne radioisotope concentration in **shoreline sediments** SFY 2006. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>60</sup>Co activity. Strontium analysis is performed on selected samples. See Map #3.0 for locations.

Location	Date	<sup>137</sup> Cs	Isotope	<sup>60</sup> Co
WCRSS-1-A-349-0.9	Coffey County Lake	10/18/2005	13.1 ± 3.6	<11
WCRSS-1-L-220-4.2	Neosho R Burlington	3/1/2006	<11	<11
WCRSS-1-H-160-11.0	Neosho R South of Leroy	3/7/2006	<14	<11
WCRSS-1-L-230-3.3	Neosho R North of Burlington	4/4/2006	<14	<11
WCRSS-1-H-155-2.9	Coffey County Lake	4/18/2006	<14	<11
WCRSS-1-M-241-3.0	Neosho River	6/21/2006	<11	<14

**TABLE 10.0** Wolf Creek fish ingestion pathway duplicate samples for waterborne radioisotope bioaccumulation in **fish** SFY 2006. Sample results in pCi/kg-wet. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. A Tritium (<sup>3</sup>H) in tissue analysis is done on all edible fish portions collected. <sup>3</sup>H is a beta emitter. See Map #1.0 for sample locations. WCNOG sample location designations are denoted by parentheses. Two samples were rejected due to analyzed tritium levels which exceeded the tritium level of Coffey County Lake.

Location	Date	Description	<sup>3</sup> H KDHE (WCNOG)
Q-1 (DC) CCL Discharge Cove	10/11/05	Channel Catfish Common Carp Walleye White Bass	3189 ± 2784 (6741 ± 199) 5968 ± 3091 (6542 ± 212) 3340 ± 2771 (7254 ± 226) 12864 ± 3600 (7090 ± 214)
N-1 (JRR) John Redmond Reservoir Below dam on Neosho River	11/18/05	Channel Catfish Carp	1928 ± 3033 (<150) 1606 ± 1929 (<142)
<b>Control</b>	5/19/06	White Crappie Common Carp	<1200 ± (<106) <1200 ± (<101)
Q-1 (DC) CCL Discharge Cove	5/25/06	Smallmouth Bass Common Carp Smallmouth Buffalo Channel Catfish	7818 ± 3356 (7175 ± 209) 6460 ± 3150 (6389 ± 197) 6429 ± 3014 (6273 ± 188) 7277 ± 2959 (6534 ± 197)

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**TABLE 11.0** Wolf Creek samples for waterborne radioisotope bioaccumulation in **aquatic vegetation** SFY 2006. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. See Map #1.0 for sample location.

Location	Type	Date	Isotope		
			<sup>7</sup> Be	<sup>40</sup> K	
WCAV-N-1	JRR Below the Dam	Algae	4/18/06	<360 ± 7696	40253 ± 7696
WCAV-J-1	Wolf Creek 11 <sup>th</sup> St. Bridge	Arrowhead	8/30/05	1525.3 ± 320.5	31469 ± 2501.3
WCAL-P-1	MUDS	Pondweed	6/26/06	949 ± 115 (224.8 ± 120.8)	6897 ± 516 (1717.1 ± 244.3)
WCAV-Q-1	Coffey County Lake Discharge Cove	Cattails	6/13/06	<360	31982 ± 10638
WCAV R-1	EEA	Pondweed	5/26/06	8124 ± 644 (653.6 ± 70.5)	16194 ± 1412 (1622.3 ± 113.8)

**TABLE 11.1** Wolf Creek random samples for waterborne radioisotope bioaccumulation in **aquatic vegetation** SFY 2006. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. See Map #8.0 for sample location.

Location	Date	Description	Isotope	
			<sup>7</sup> Be	<sup>40</sup> K
US75 near 8th Rd	7/6/2005	Bullrush	Not Detected	39356 ± 2561
9th & Trefoil	7/6/2005	Spikerush	Not Detected	74640 ± 6368
19th & Iris	7/6/2005	American Lotus	629 ± 215.8	13721 ± 2020
CCL N 17th Rd bridge	8/16/2005	Pondweed Arrowhead	560 ± 126.3	11815 ± 790.5
CCL West End	9/19/2005	Pondweed Naiad	2021 ± 320.7	17341 ± 4152.1
CCL West End	9/19/2005	Pondweed Naiad	1601 ± 301	17869 ± 1560
CCL West End	9/19/2005	Pondweed	966 ± 185	8501 ± 956

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**TABLE 12.0** Wolf Creek trending samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2006. Includes ingestion pathway sampling of garden vegetables and sampling for waterborne radionuclide bioaccumulation in irrigated crops. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operation were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. See Map #1.0 for sample location. WCNOC sample location designations are denoted by parentheses.

Location	Date	Description	Isotope	
			<sup>7</sup> Be natural KDHE (WCNOC)	<sup>40</sup> K natural KDHE (WCNOC)
WCFV-J-1 (NR-D2) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/5/05	Soybeans	<360 (<150.1)	11564.9 ± 994.9 (15396.0 ± 725.7)
WCFV-J-2 (NR-D1) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/05/05	Corn	<360 (<139.7)	2450 ± 368.0 (3963.8 ± 563.7)
WCFV-J-3 (NR-D2) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/5/05	Corn	<360 (<129.2)	2641.9 ± 373.8 (3128.0 ± 367.9)
K-1 (NR-U1)	9/29/05	Non-irrigated Corn	<360 (<93.1)	1775.2 ± 131.1 (2308.8 ± 382.9)
E-1 Scott Valley Church <b>Control</b>	7/27/05	Compass Plant	1065.2 ± 152.2	14987.2 ± 987.1
A-1 Sector A, Sharpe/Pasture near Sharpe	7/15/05	Blackberries	529 ± 204.1	8543 ± 2536.9
H-1 East of CCL dam, near WCA H-1	7/15/05	Pasturage	7232.6 ± 551.6	1775.2 ± 131.1
P-1 (MUDS) CCL public access area, north side of parking lot, 10 m from shore	6/26/06	Pasturage	3132.0 ± 378 (1064.9 ± 216.9)	22917.0 ± 3512 (6269.3 ± 522.2)
R-1 (EEA) CCL environmental education area	5/26/06	Tallgrass	1605.0 ± 256 (357.1 ± 202.5)	24733 ± 555 (7484.2 ± 638.2)

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**TABLE 12.1** ERS random samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2006. Includes ingestion pathway sampling of garden vegetables. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. *No isotopes attributable to WCNOG operation were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{51}\text{Cr}$ ,  $^{54}\text{Mn}$ ,  $^{58}\text{Co}$ ,  $^{59}\text{Fe}$ ,  $^{60}\text{Co}$ ,  $^{65}\text{Zn}$ ,  $^{67}\text{Ga}$ ,  $^{95}\text{Nb}$ ,  $^{95}\text{Zr}$ ,  $^{99}\text{Mo}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{103}\text{Ru}$ ,  $^{106}\text{Ru}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{111}\text{In}$ ,  $^{123}\text{I}$ ,  $^{125}\text{Sb}$ ,  $^{131}\text{I}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{140}\text{Ba}$ ,  $^{140}\text{La}$ ,  $^{141}\text{Ce}$ ,  $^{144}\text{Ce}$ ,  $^{169}\text{Yb}$ ,  $^{226}\text{Ra}$ ,  $^{228}\text{Ac}$ ,  $^{228}\text{Th}$ ,  $^{234}\text{Th}$ , and  $^{239}\text{Np}$ . The isotopes  $^{89}\text{Sr}$  and  $^{90}\text{Sr}$  are beta emitters. Strontium analysis is done on selected samples. See Map #6.0 for sample location. WCNOG sample location designations are denoted by parentheses.

Location	Date	Description	Isotope	
			$^7\text{Be}$	$^{40}\text{K}$
12th and Kafir	7/27/2005	Whole Corn	<360	8656.7 ± 1986
20th and Reaper	8/19/2005	Red Milo	<360	5151.1 ± 393.3
Planter between 10th and 11th Rd	8/16/2005	Brome Hay	566.7 ± 75.9	3788.2 ± 1055.1
0.5 mi S of Coffey County airport	8/23/2005	Chicory	2547.2 ± 323.5	20084.9 ± 1595.5
14th Rd 0.25 mi E of CCL	9/8/2005	Whole Milo	2164 ± 313.1	9546.8 ± 846.3
9th Rd. 0.25 mi. W of Shetland	9/8/2005	Soybeans	624.7 ± 150.8	21055.1 ± 4118.2
10th Rd. 0.25 Mi. W of Iris Rd.	9/8/2005	Pears	2407.1 ± 332	7035.6 ± 679.9
Near 18th and Underwood	9/9/2005	Corn	<360	2117.5 ± 128.5
Shetland Lane 0.25 mi S. of 14th	6/13/2006	Wheat	<360	4084 ± 1045
12th & Underwood	6/21/2006	Pasturage	1907 ± 183	18597 ± 1588
12th and Kafir	7/27/2005	Whole Corn	2856 ± 378	8656.7 ± 1986
20th and Reaper	8/19/2005	Red Milo	566.7 ± 75.9	5151.1 ± 393.3

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**Table 13.0** KDHE RADIOCHEMISTRY LABORATORY EPA INTERCOMPARISON STUDIES

Analysis	Date	Known Value ± Control Limit (pCi/l)	Expected Precision	KHEL Average Results ± Uncertainty
Gross Alpha	8-16-05	55.7 ± 24.1	13.9	51.7 ±2.2
	1-16-06	9.6 ± 8.7	5.0	10.1 ±0.6
	4-10-06	21.3 ± 9.2	5.3	22.5 ±1.50
Gross Beta	8-16-05	61.3 ± 11.5	17.3	56.6 ±1.8
	1-16-06	61.9 ± 17.3	10.0	59.5 ±2.2
	4-10-06	23.0 ± 8.7	5.3	23.9 ±1.2
Tritium	11-15-05	12,200±2,100	1,220	12,000 ±226
	1-16-06	16,700±2,900	1,670	28,800 ±445
<sup>89</sup> Sr	1-16-06	50.2±8.7	5.0	55.7 ±1.1
	4-10-06	32.4 ±8.7	5.0	33.2 ±3.8
<sup>90</sup> Sr	1-16-06	30.7 ±8.7	5.0	25.7 ±1.4
	4-10-06	9.0 ±8.7	5.0	8.7 ±0.45
<sup>60</sup> Co	8-16-05	13.5 ±8.7	5.0	13.4 ±0.2
	11-15-05	84.1 ±8.7	5.0	82.2 ±4.8
	1-16-06	95.3 ±8.7	5.0	96.0 ±2.9
<sup>134</sup> Cs	8-16-05	92.1 ±8.7	5.0	91.6 ±2.8
	11-15-05	33.9 ±8.7	5.0	36.8 ±0.8
	1-16-06	23.1±8.7	5.0	23.1 ±0.7
<sup>137</sup> Cs	8-16-05	72.7 ±8.7	5.0	68.5 ±1.6
	11-15-06	28.3 ±8.7	5.0	29.1 ±1.5
	1-16-06	111 ±10	5.0	104 ±1
<sup>133</sup> Ba	8-16-05	106 ±18	10.6	108 ±2.1
	11-15-05	31.2 ±8.7	5.0	31.5 ±1.1
	8-16-05	65.7 ±8.7	6.6	66.0 ±4.4
<sup>65</sup> Zn	11-15-05	105 ±18	10.5	108 ±3.6
	1-16-06	192 ±33	19.2	194 ±3.8
	8-16-05	25.8±5.2	3.0	26.0 ±1.0
<sup>131</sup> I	1-16-06	11.9 ± 3.5	3.0	11.5 ±0.1
	4-10-06	19.1 ±5.2	3.0	19.5 ±0.4

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**TABLE 14.0** KHEL Radiochemistry Laboratory method detection limits SFY 2006. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the Radiochemistry Laboratory. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

<b>GeLi [HPGe] detection system <sup>a</sup></b>						
Environmental Sampling						
	Water and Milk	Filter	Wipe	Soil and Sediment	Biota	Vegetation and food products
Minimum sample size Minimum Counting Time Method Detection Limit	2000 ml 8 hr. pCi/l	1500 m <sup>3</sup> 3 hr. pCi/m <sup>3</sup>	Total 3Hr. pCi/wipe	.45 kg 15 hr. pCi/kg-dry	0.3 kg 15 hr. pCi/kg-wet	1 kg 15 hr pCi/kg-dry
<sup>7</sup> Be	64 [22]	0.03 [0.02]	****	346 [186]	231 [144]	35 [19]
<sup>40</sup> K	88 [39]	0.03 [0.02]	****	828 [654]	459 [262]	152 [72]
<sup>51</sup> Cr	52 [32]	0.01 [0.009]	5 [3]	35 [22]	41 [32]	55 [46]
<sup>54</sup> Mn	4 [2]	0.004 [0.003]	1 [0.7]	44 [11]	30 [15]	72 [24]
<sup>58</sup> Co	4 [2]	0.008 [0.002]	2 [1]	45 [23]	37 [20]	92 [36]
<sup>59</sup> Fe	8 [3]	0.01 [0.01]	3 [2]	51 [16]	41 [15]	97 [52]
<sup>60</sup> Co	11 [7]	0.01 [0.0053]	2.5 [1.7]	56 [35]	43 [26]	79 [50]
<sup>65</sup> Zn	8 [4]	0.01 [0.007]	****	48 [30]	38 [22]	93 [63]
<sup>95</sup> Nb	7 [3]	0.009 [0.007]	2.5 [1.4]	68 [30]	44 [26]	9 [4]
<sup>95</sup> Zr	6 [3]	0.01 [0.002]	0.5 [0.3]	35 [27]	27 [19]	84 [54]
<sup>99</sup> Mo	5 [3]	0.002 [0.0014]	1 [0.6]	73 [43]	33 [21]	****
<sup>103</sup> Ru	10 [7]	0.004 [0.003]	****	29 [20]	29 [21]	69 [47]
<sup>106</sup> Ru	55 [43]	0.07 [0.05]	1.5 [1]	269 [192]	43 [29]	96 [65]
<sup>110m</sup> Ag	4 [3]	0.006 [0.0002]	****	47 [33]	47 [34]	86 [55]
<sup>125</sup> Sb	35 [12]	0.02 [0.01]	****	97 [44]	96 [51]	15 [6]
<sup>131</sup> I	5 [3] (1) <sup>d</sup>	0.00027 [0.00027] <sup>c</sup>	1.5 [1]	33 [20]	37 [23]	45 [13]
<sup>134</sup> Cs	5 [3]	0.007 [0.004]	1.4 [1]	44 [29]	37 [24]	57 [39]
<sup>137</sup> Cs	7 [4]	0.006 [0.004]	1 [0.3]	49 [29]	32 [21]	80 [56]
<sup>140</sup> Ba	10 [6]	0.004 [0.003]	****	26 [17]	24 [15]	60 [39]
<sup>140</sup> La	9 [5]	0.01 [0.02]	****	28 [9]	34 [21]	13 [6]
<sup>141</sup> Ce	8 [3]	0.002 [0.001]	****	46 [23]	22 [13]	6 [3]
<sup>144</sup> Ce	35 [14]	0.013 [0.0096]	****	216 [103]	110 [70]	28 [14]
<sup>226</sup> Ra	116 [69]	0.05 [0.03]	****	828 [654]	323 [195]	90 [51]
<sup>228</sup> Ac	30 [18] 15 h	0.0127 [0.0099]	****	68 [33]	146 [87]	27 [12]
<sup>228</sup> Th	387 [142]	0.09 [0.06]	****	859 [317]	944 [356]	454 [167]
<sup>234</sup> Th	618 [87] 15 h	0.159 [0.423]	****	1009 [378]	1300 [556]	570 [94]
<sup>235</sup> U	****	****	45 [30] 15 h	****	****	****
<sup>239</sup> Np	41 [33]	0.01 [0.009]	5 [3]	64 [44]	40 [30]	97 [71]

<sup>a</sup> GeLi = Germanium lithium; HPGe = High purity germanium.

<sup>b</sup> Two methods of analysis are done: **1)** 8 hour direct gamma isotopic analysis of a 2000 mRmilk or water sample that has a method detection limit (MDL) of 3 pCi/R and **2)** 3 hour gamma isotopic analysis of ion exchange resin after a 1500 mRmilk sample is filtered through an ion exchange column that has an MDL of 1 pCi/R

<sup>c</sup> The MDL for <sup>131</sup>I when analyzing a charcoal cartridge is 0.03 [0.02] pCi/m<sup>3</sup> based upon a 250 m<sup>3</sup> sample volume. If the sample volume is increased to 1500 m<sup>3</sup>, the MDL is 0.002 [0.001] pCi/m<sup>3</sup>.

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**Table 14.0 continued.** KHEL Radiochemistry Laboratory method detection limits SFY 2006. Method detection limits of present analytical methods for selected radionuclides monitored by the KHEL Radiochemistry Laboratory. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

Low Background Alpha and Beta Counting System					
	Water	Milk	Wipe Total	Soil and Sedimen 0.01kg	Vegetation and Food products 0.1 kg
Minimum Sample Size	1000 ml	1000 ml	200 min.	200 min.	200 min.
Minimum Counting Time	200 min.	200 min.	200 min.	200 min.	200 min.
Method Detection Limit	pCi/L	pCi/L	pCi/wipe	pCi/kg-dry	pCi/kg-dry
<sup>89</sup> Sr	1	2	3	200	500
<sup>90</sup> Sr	1	2	4	200	500
<sup>131</sup> I	1	****	****	****	****
<sup>228</sup> Ra	1.2	****	0.3	60	****
Gross Beta					
	Water	Filter	Wipe		
Minimum Sample Size	200 ml	250m <sup>3</sup>	Total		
Minimum Counting Time	200 min.	100 min.	100 min.		
Method Detection Limit	4 pCi/l	0.004 pCi/m <sup>3</sup>	2pCi/Wipe		
Gross Alpha					
	Water	Filter	Wipe	Soil and Sediment	
Minimum Sample Size	200 ml	250 m <sup>3</sup>	Total	0.001 kg	
Minimum Counting Time	200 min.	100 min.	100 min.	100 min.	
Method Detection Limit	1 pCi/l	0.0006 pCi/m	0.5 pi/Wipe	160 pCi/kg-dry	
Random Scintillation Counting System					
<sup>226</sup> Ra (radium) in water					
Minimum Sample Size	1000 ml				
Minimum Counting Time	200 min.				
Method Detection Limit	0.04 pCi/l				
Liquid Scintillation Counting System					
	Tritium ( <sup>3</sup> H)		<sup>222</sup> Rn (Radon)		
	In water	In Tissue	In Water		
Minimum Sample Size	10 ml	3 g	10 ml		
Minimum Counting Time	100 min.	120 min.	60 min.		
Method Detection Limit	350 pCi/l	1200 pCi/kg-wet	25 pCi/l		

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**Table 15.0** Lower limit of detection (LLD) values for selected radionuclides for Wolf Creek environmental sample analysis<sup>a</sup>.

Analysis	Water (pCi/l)	Airborne (pCi/m <sup>3</sup> )	Fish (pCi/kg-wet)	Milk (pCi/l)	Food Products <sup>b</sup> (pCi/kg-wet)	Sediment (pCi/kg-dry)	Aquatic Vegetation (pCi/kg-wet)
Gross Beta	4 (2)	0.01 (0.003)	*	*	*	*	*
<sup>3</sup> H	2000 <sup>c</sup> (1000)	*	(300)	*	*	*	*
<sup>54</sup> Mn	15	*	130	*	(40)	(30)	(40)
<sup>59</sup> Fe	30	*	260	*	*	*	*
<sup>58</sup> Co and <sup>60</sup> Co	15 (5)	*	130	*	(10)	(30)	(40)
<sup>65</sup> Zn	30	*	260	*	*	*	(10)
<sup>95</sup> Zr and <sup>95</sup> Nb	15	*	*	*	(10)	*	(40)
<sup>131</sup> I	1 <sup>d</sup> (0.5)	0.07 (0.007)	*	1 (0.3)	60	*	*
<sup>134</sup> Cs	15	0.05	130	15	60	150 (60)	(20)
<sup>137</sup> Cs	18	0.06	150	18	80 (10)	180 (60)	(10)
<sup>140</sup> Ba and <sup>140</sup> La	15	*	*	15	*	*	*
<sup>51</sup> Cr	*	*	*	*	*	*	(500)
<sup>125</sup> Sb	*	*	*	*	*	*	(50)
<sup>226</sup> Ra	*	*	*	*	(200)	(500)	(200)
<sup>228</sup> Th	*	*	*	*	(20)	(40)	(20)
<sup>7</sup> Be	*	(0.001)	*	*	(100)	(300)	(100)
<sup>40</sup> K	*	(0.002)	(500)	(100)	(500)	(500)	(500)

<sup>a</sup> This table is adapted from Table 5-3 of WCNO's Offsite Dose Calculation Manual (ODCM). Values in parenthesis reflect typical LLDs achievable by offsite laboratories. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported. The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with

$$LLD = 2.10x \left[ \frac{S_b}{E V Y \exp(-\lambda \Delta t)} \right]$$

95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal. For a particular measurement system, which may include radio-chemical separation.

Where LLD is the *a priori* lower limit of detection (picoCuries per Unit mass or Volume),  $S_b$  is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute), E is the counting efficiency (counts per disintegration), V is the sample size (units of mass or volume), 2.10 is a conversion factor with units picoCurie per disintegration per minute (4.66/2.22 dpm/pCi), Y is the fractional radiochemical yield (when applicable),  $\lambda$  is the radioactive decay constant for the particular radionuclide (s<sup>-1</sup>), and t is the elapsed time between sample collection (or end of the sample collection period), and time of counting (s).

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not used as an *a posteriori* (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described.

<sup>b</sup> Includes terrestrial vegetation.

<sup>c</sup> LLD for drinking water samples. If no drinking water pathway exists, a value of 3000 pCi/R may be used.

<sup>d</sup> LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

Note: If the above equation is used with an actual background count of a sample and a recently determined counting efficiency (using *a posteriori* values instead of assumed *a priori* values), the minimum detectable activity (MDA) may be calculated. Ideally, the MDA will be very close to the LLD. The LLD is a device to predict the detection capability of the counting system, while the MDA reflects the actual detection capability of a counting system. An MDA should be determined for each sample analyzed. The method detection limit (MDL) and MDA are equivalent.

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**KDHE Air Particulate Be-7 Activity**

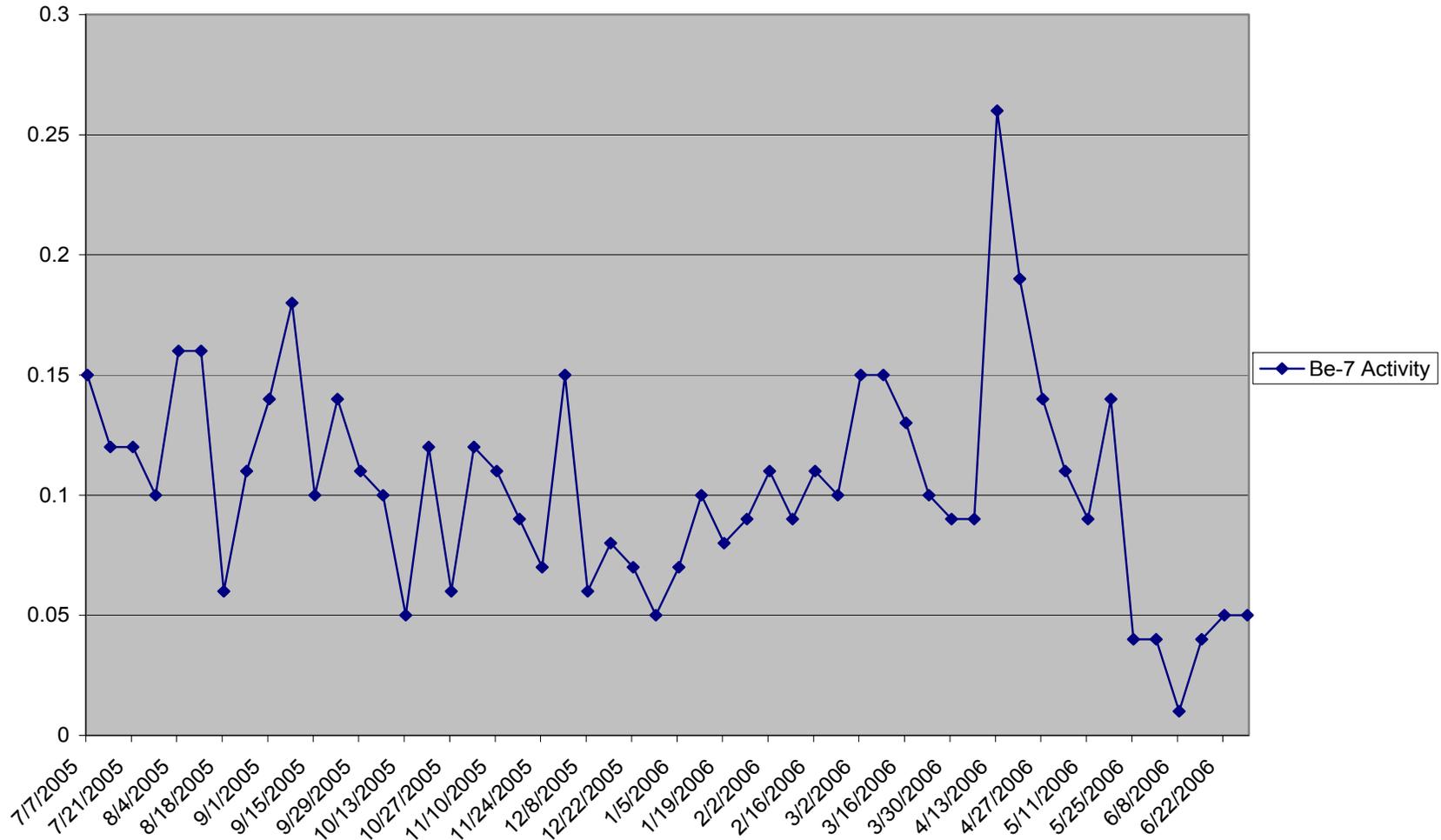


Chart 1.0 KDHE Air Particulate Be-7 Activity

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**KDHE Quarterly Direct Radiation by Sector**

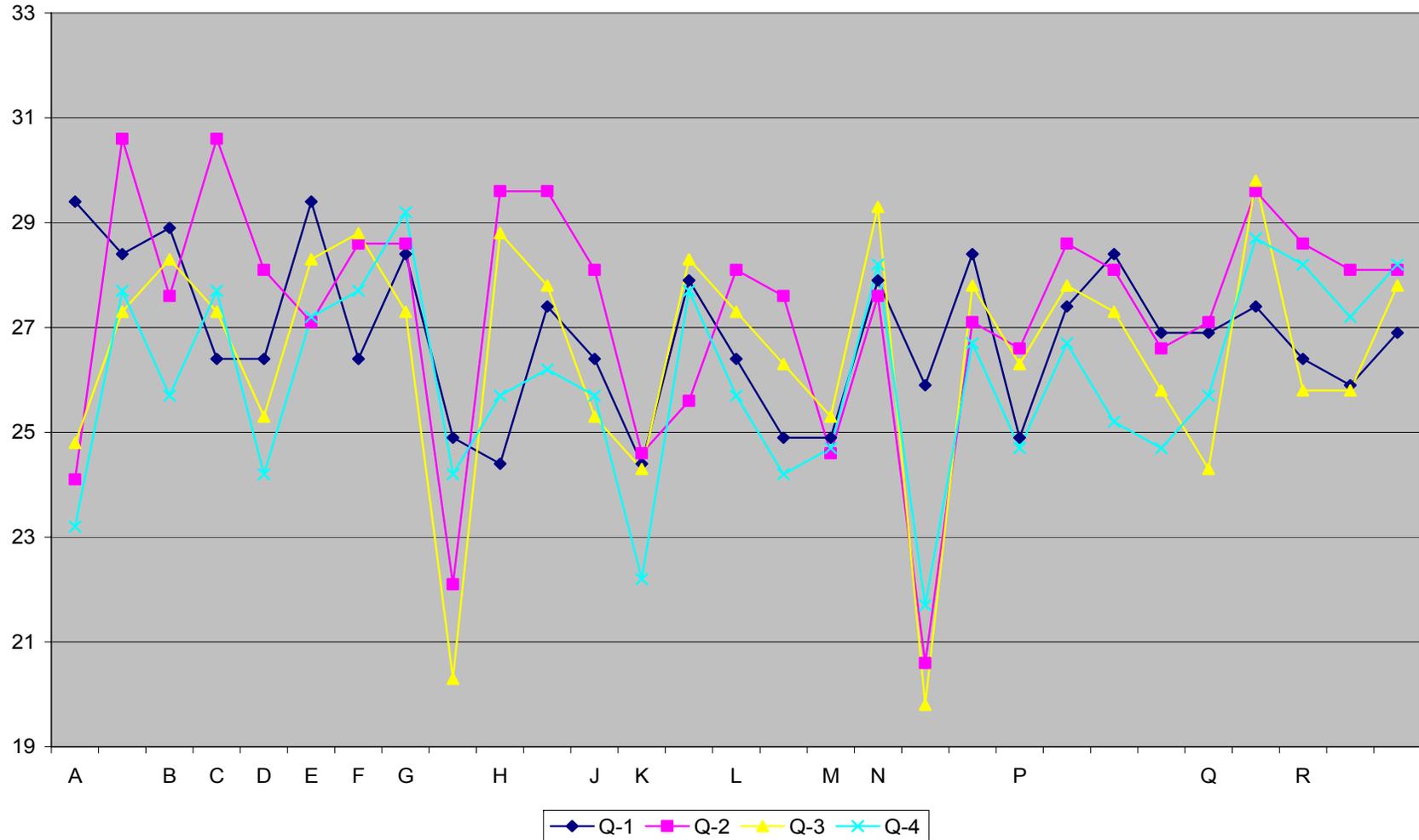


Chart 2.0 Quarterly Direct Radiation Results for all KDHE Direct Radiation Sites

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Quarterly Direct Radiation  
 Collocated Sites (by Sector)

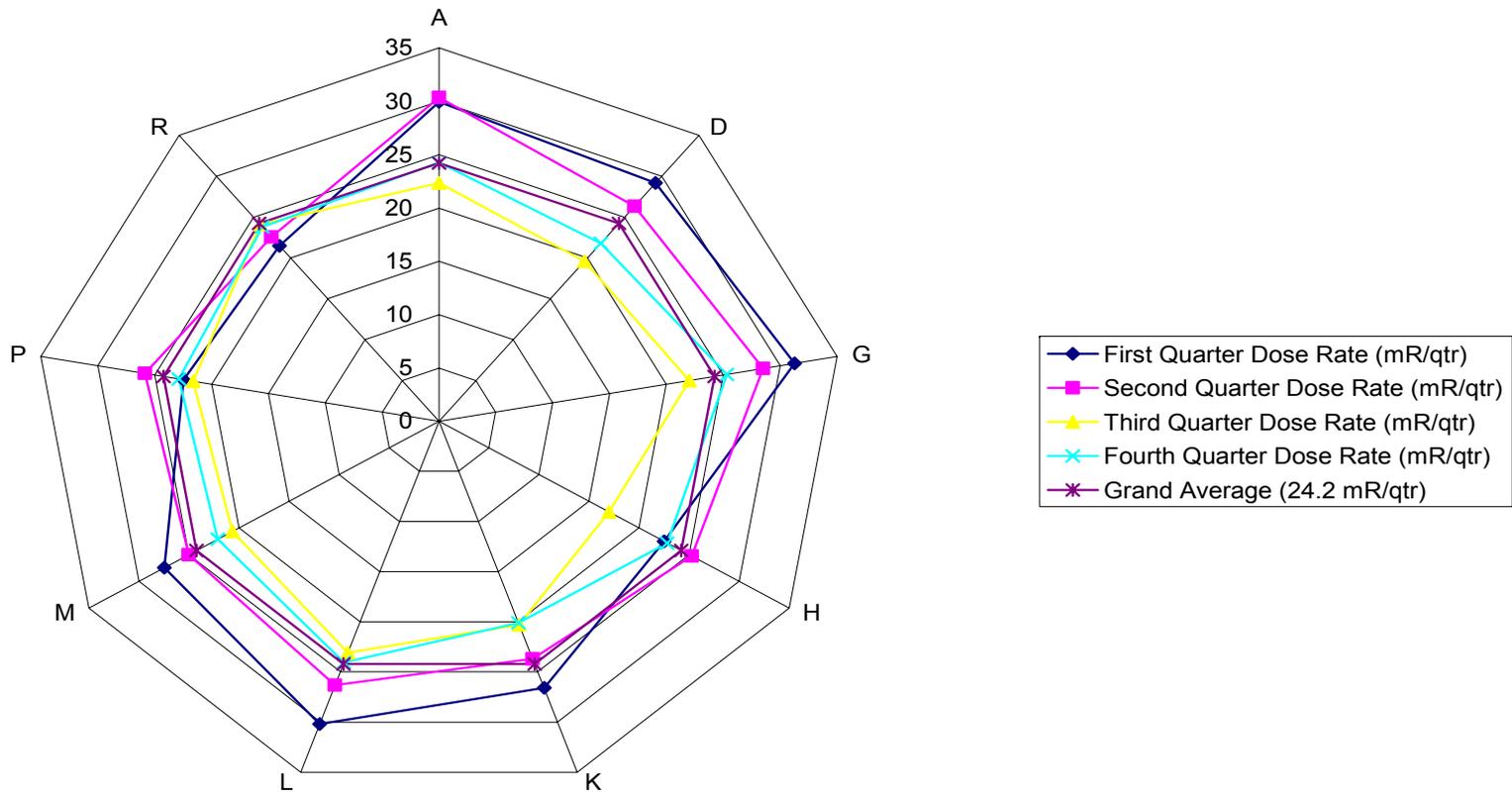


Chart 2.1 Quarterly Radiation Comparison for Collocated Sites

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**KDHE vs. WCNOC DIRECT RADIATION**  
Average By Sector

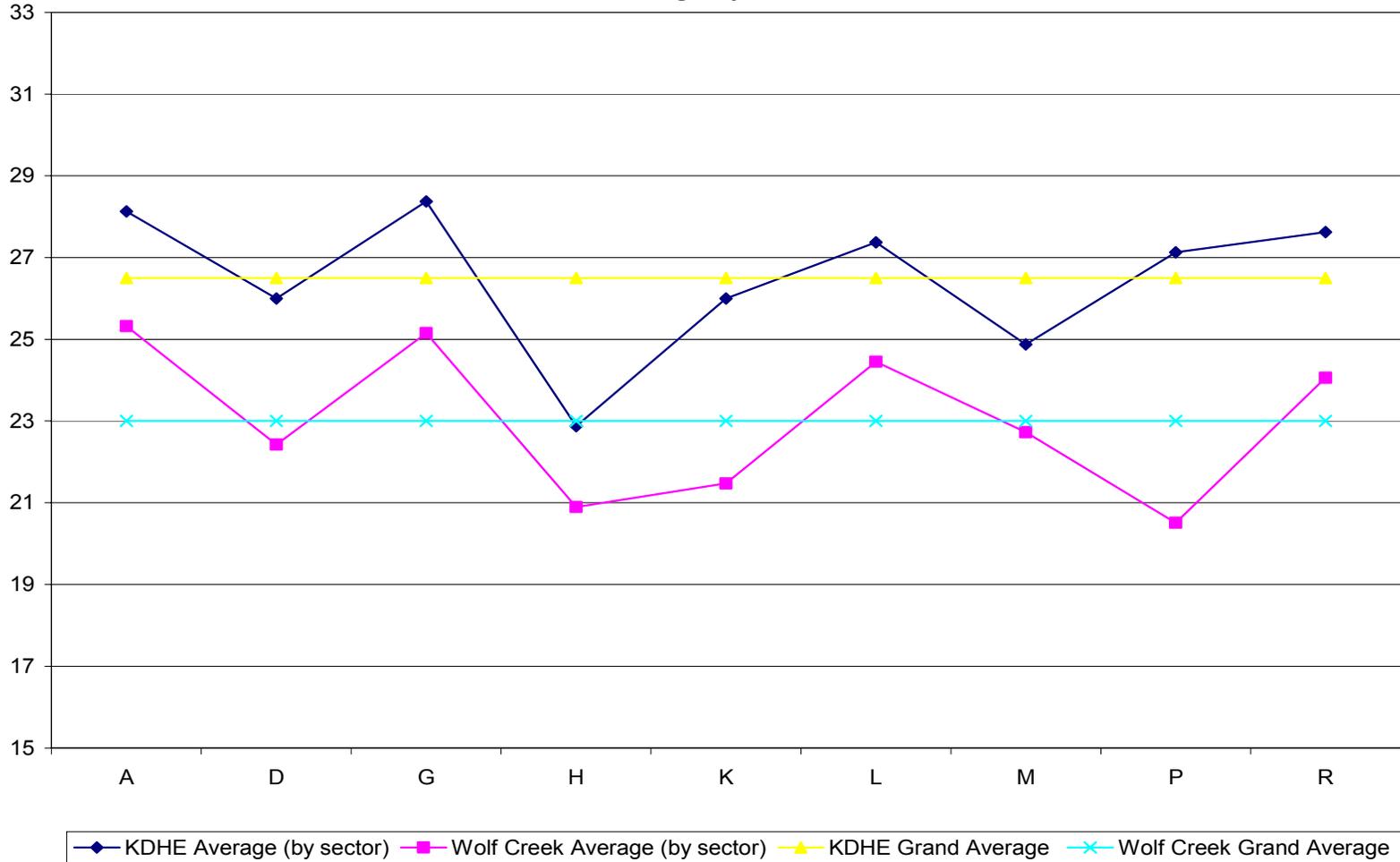


Chart 2.2 Comparison of WCNOC and KDHE Average Direct Radiation Readings

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Historical TLD Results

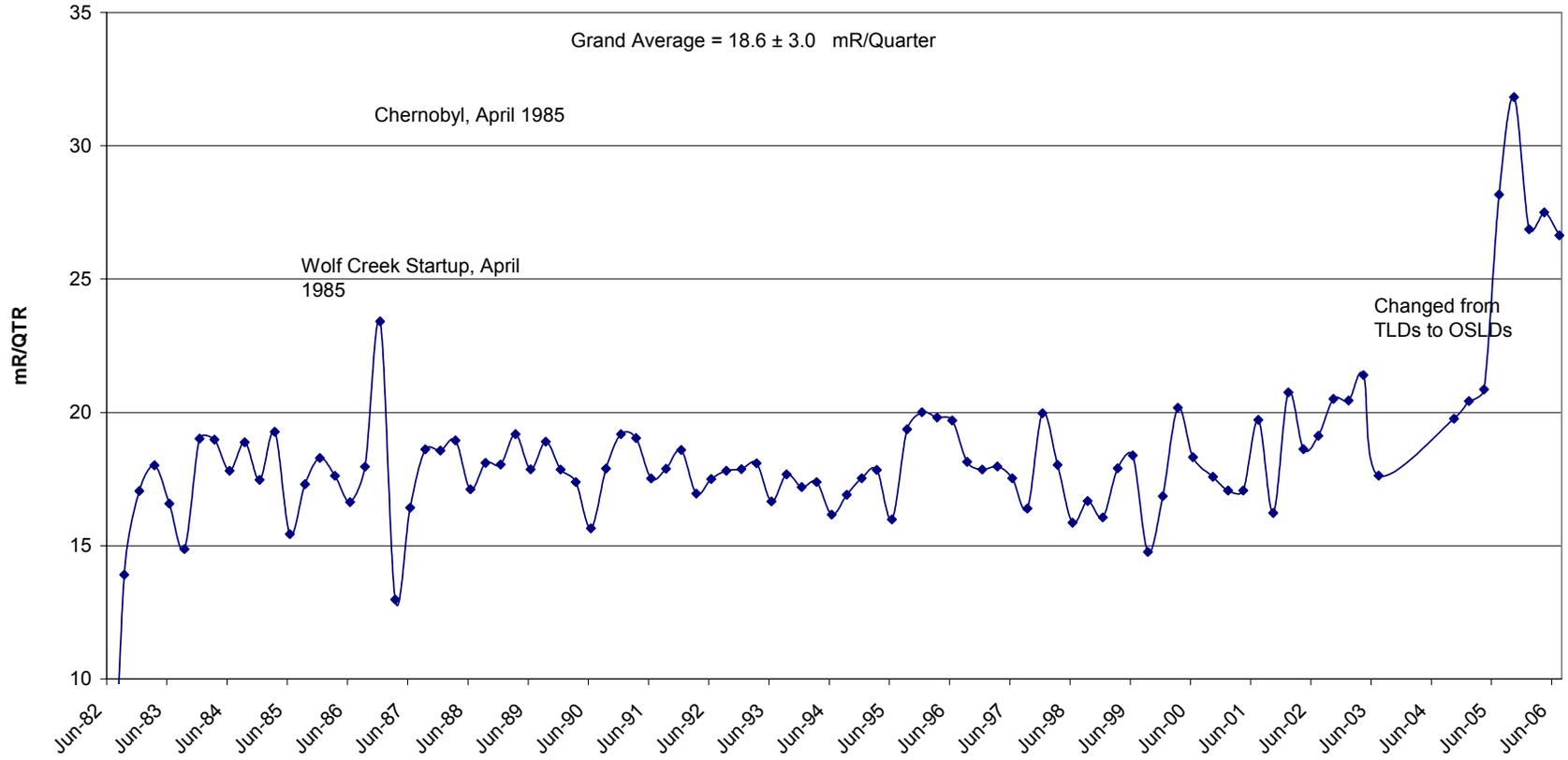


Chart 2.3 KDHE Historical Direct Radiation Monitoring (TLD) Results

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KDHE/Wolf Creek Surface Water

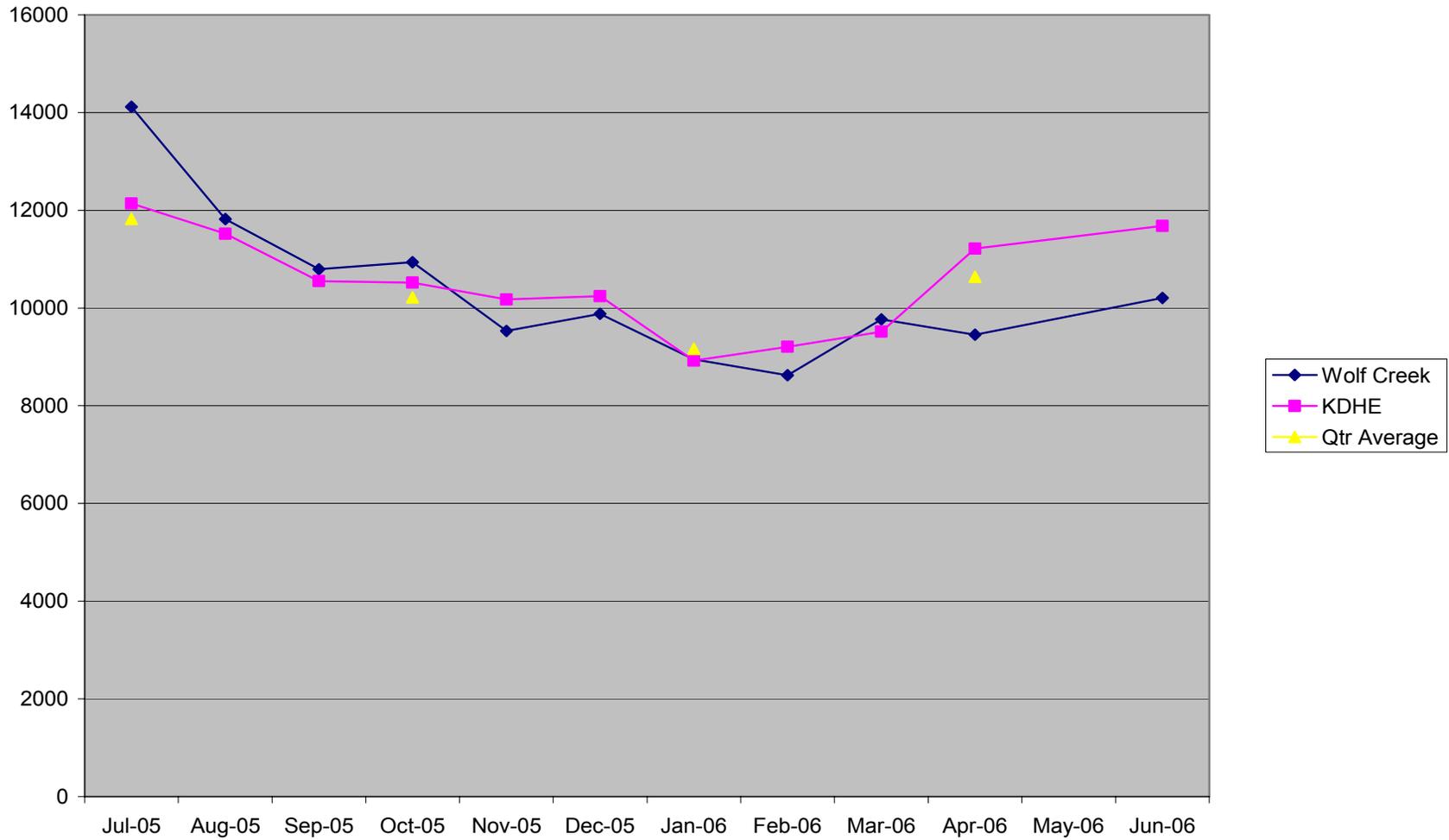


Chart 3.0 Comparison of Monthly Surface Water Tritium Results

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Historic Surface Water Tritium

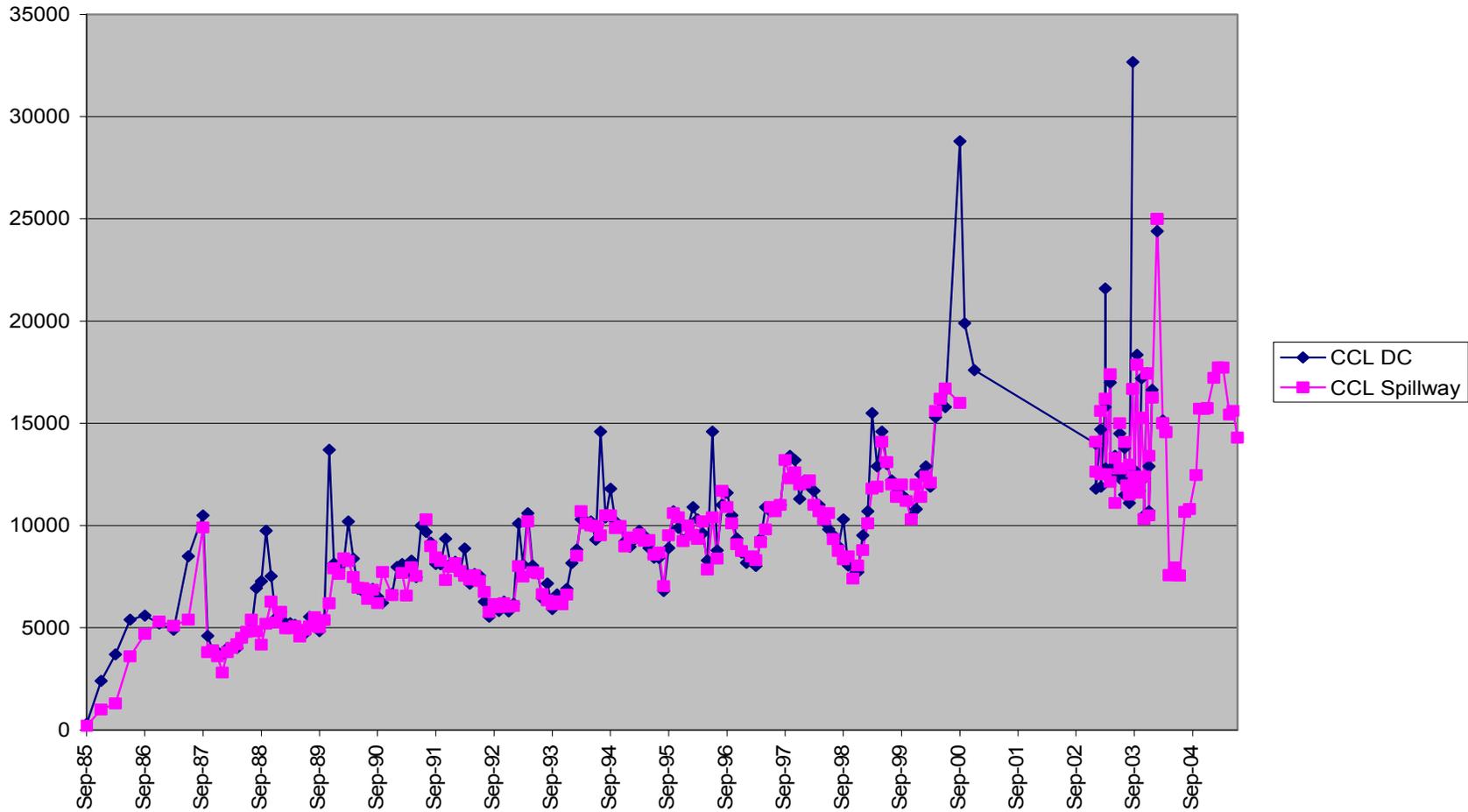


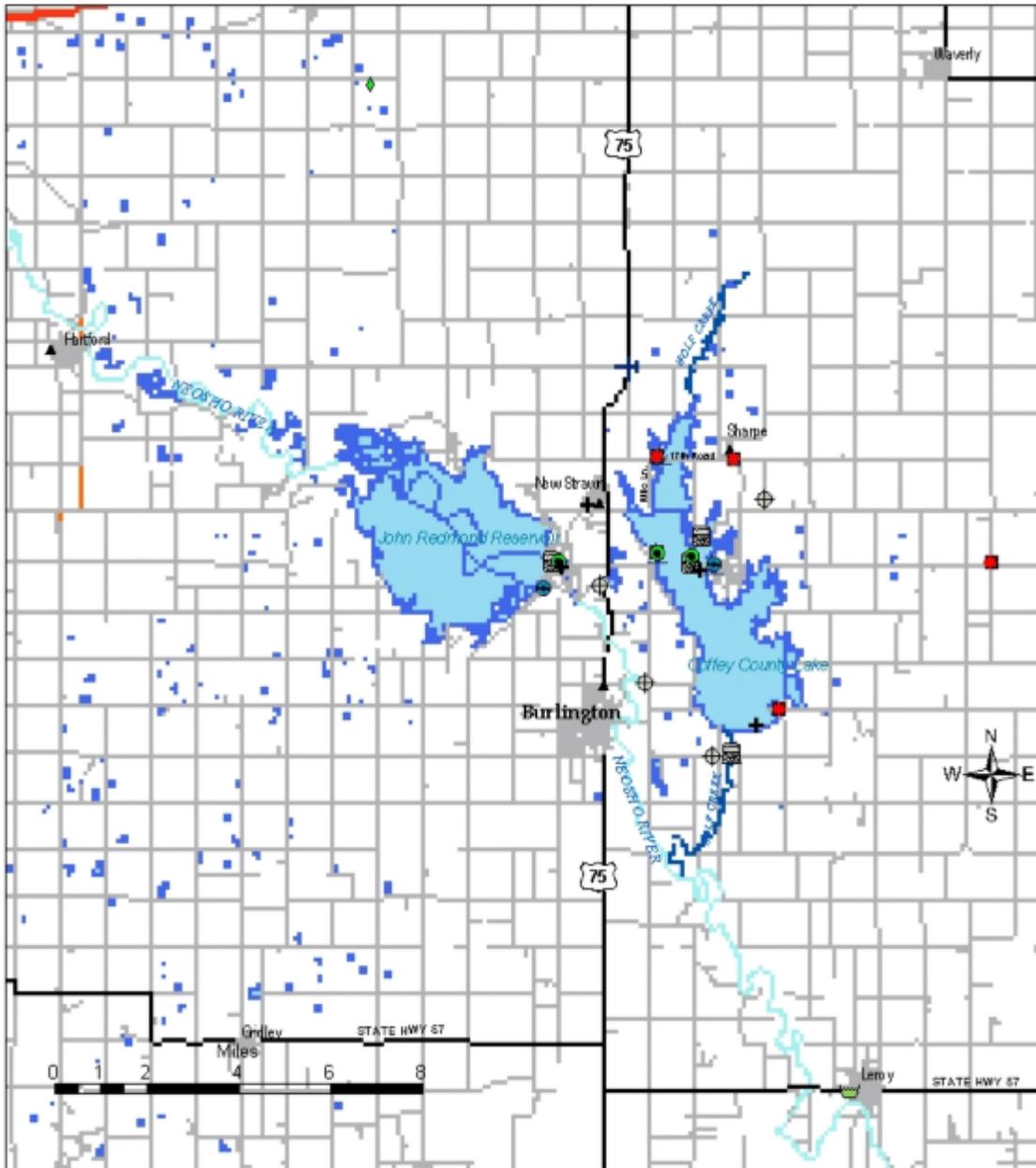
Chart 3.1 Historical KDHE Surface Water Tritium Results

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Maps

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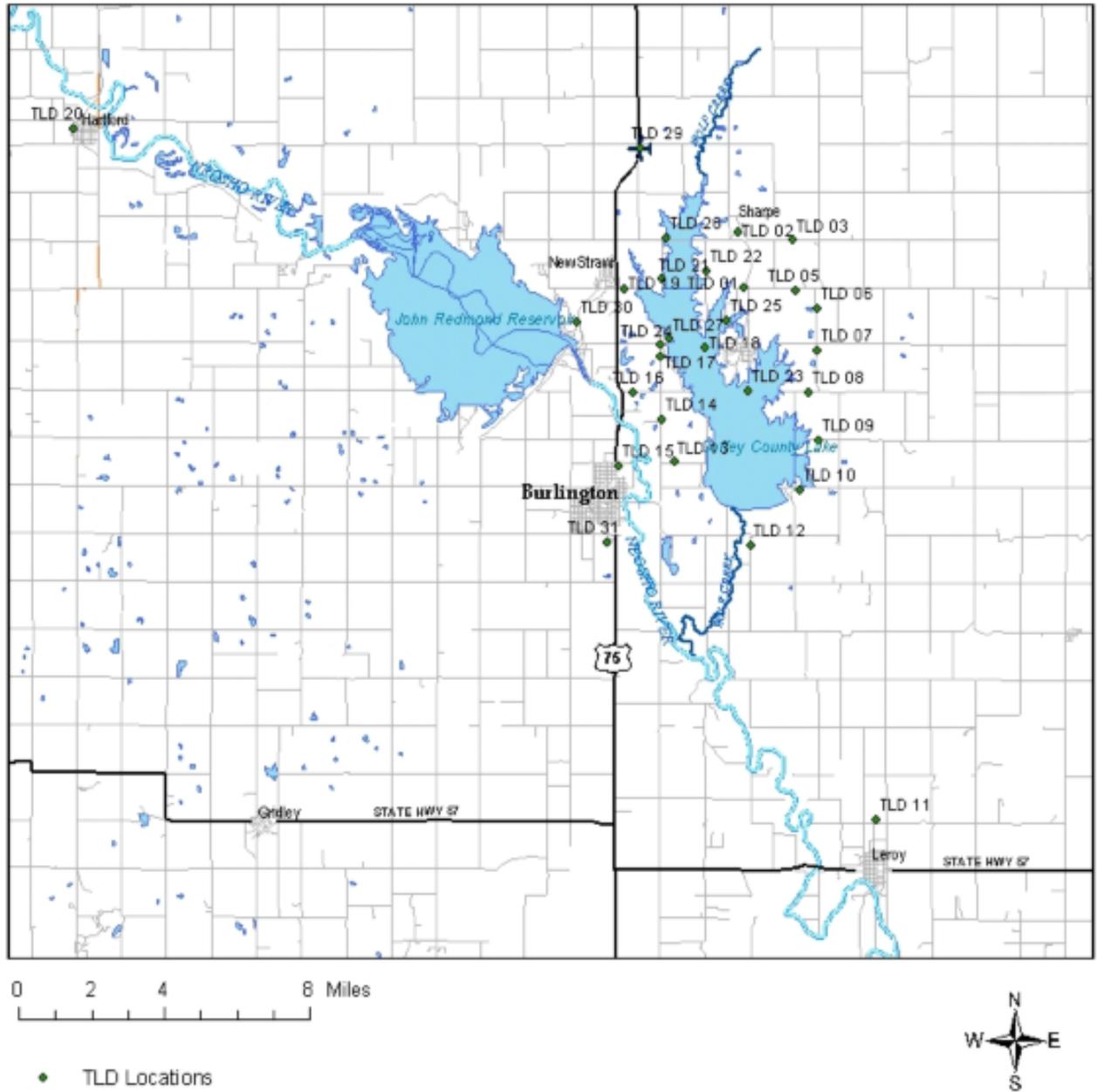


**Routine Sample Locations**

- |  |                    |  |                    |  |               |
|--|--------------------|--|--------------------|--|---------------|
|  | Aquatic Vegetation |  | Drinking Water     |  | Ground Water  |
|  | Air Monitor        |  | Fish               |  | Milk          |
|  | Bottom Sediment    |  | Vegetation         |  | Soil          |
|  |                    |  | Shoreline Sediment |  | Surface Water |

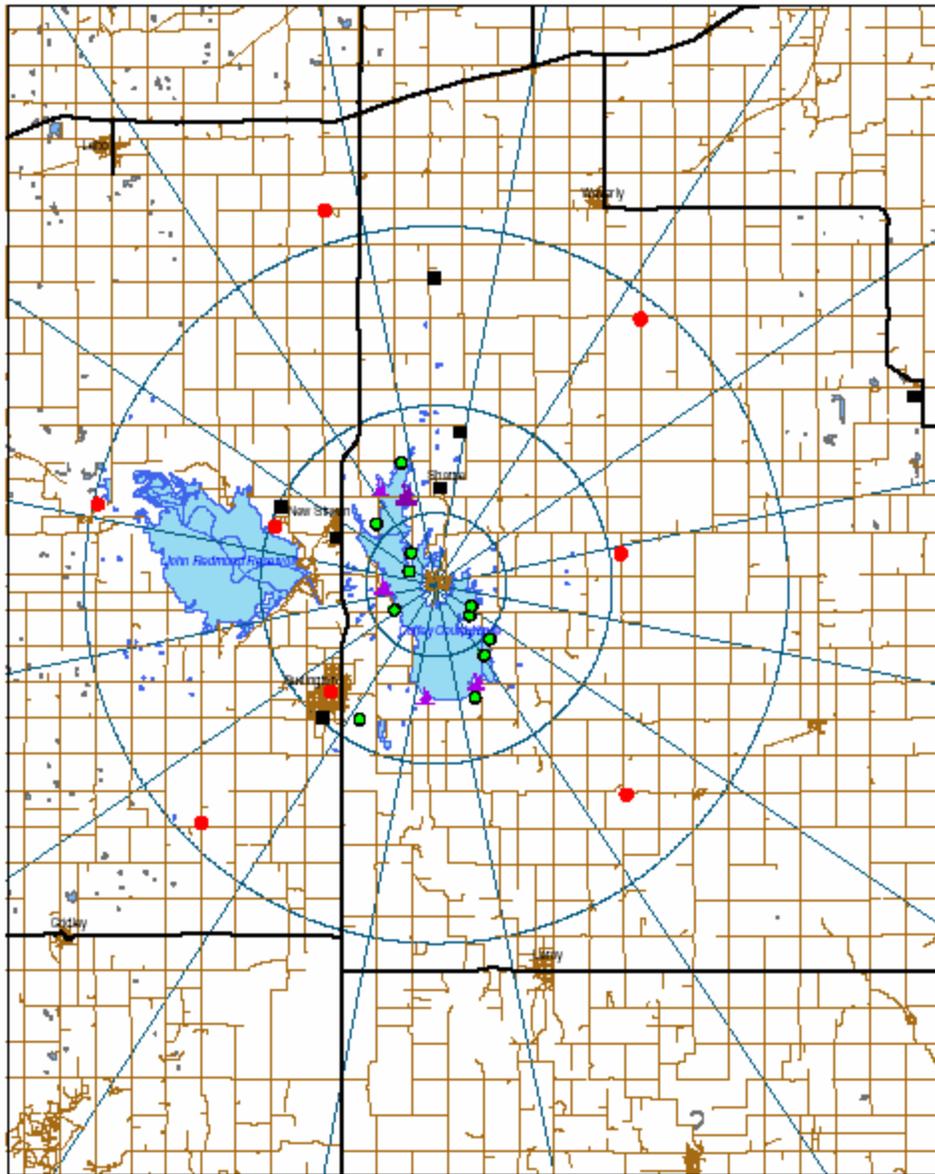
Map 1.0 Routine Sample Locations

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Map 2.0 KDHE OSLD (Shown as TLD) Locations

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**Random Sample Locations**



00.51 2 3 4 Miles

- Vegetation
- Soil
- Shoreline Sediment
- ▲ Aquatic Vegetation

Map 3.0 Random Sample Locations