TENNESSEE DEPARTMENT OF

ENVIRONMENT AND CONSERVATION

DOE OVERSIGHT DIVISION

ENVIRONMENTAL MONITORING REPORT

JANUARY THROUGH DECEMBER 2000

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TABLE OF CONTENTS

TABLE OF CONTENTS i

ACRONYMS ii

EXECUTIVE SUMMARY v

INTRODUCTION vii

SURFACE WATER MONITORING 1-1

AMBIENT SURFACE WATER MONITORING PROGRAM 1-1
SPECIAL PROJECT: SEDIMENT/SURFACE WATER SAMPLING INVESTIGATION OF HIGHWAY 58 BRIDGE CONSTRUCTION 1-8
AMBIENT SEDIMENT MONITORING PROGRAM 1-13
COLIFORM CONCENTRATION LEVELS ON EAST FORK POPLAR CREEK 1-23
TOXICITY BIOMONITORING OF DOE EFFLUENT DISCHARGES 1-39

DRINKING WATER 2-1

SANITARY INSPECTIONS AND CROSS CONNECTION CONTROL PLANS 2-1
OVERSIGHT OF DISTRIBUTION LINES 2-5
OVERSIGHT OF FREE RESIDUAL CHLORINE AND BACTERIOLOGICAL SAMPLING OF OAK RIDGE RESERVATION SANITARY WATER DISTRIBUTION SYSTEMS 2-11
REVIEW OF AREA WATER SYSTEMS 2-15
IMPLEMENTATION OF EPA'S ENVIRONMENTAL RADIATION AMBIENT MONITORING SYSTEMS (ERAMS) DRINKING WATER PROGRAM 2-19
SPECIAL PROJECTS 2-25

BIOLOGICAL/FISH AND WILDLIFE 3-1

BIOLOGICAL MONITORING PROGRAMS 3-1
RAPID BIOASSESSMENT PROTOCOL III SAMPLING ON STREAMS ON THE ORR 3-5
DIATOM COMMUNITY RESPONSES TO ENVIRONMENTAL IMPACTS: A WATER QUALITY ASSESSMENT 3-17
TWRA FISH TISSUE SAMPLING AND ADVISORIES 3-27
CANADA GEESE MONITORING 3-33
DETERMINATION OF SR-90 AND CS-137 PATHWAYS TO WHITE TAIL DEER ON THE ORR 3-35

GROUNDWATER MONITORING 4-1

OVERSIGHT AND SPLIT SAMPLING OF DOE AMBIENT SAMPLING AND ANALYSIS 4-1
GROUNDWATER BASIN DELINEATION REPORT 4-9
RESIDENTIAL WELL SAMPLING PROJECT PROGRAM REPORT 4-13
OAK RIDGE RESERVATION AND VICINITY SPRING AND SEEP MONITORING PROJECT REPORT 4-19
DETERMINATION OF LINER BREACHING BY GROUNDWATER IN Y-12 NON-OPERATIONAL SANITARY LANDFILL 2 4-31

AIR QUALITY MONITORING 5-1

HAZARDOUS AIR POLLUTANTS METALS MONITORING ON EAST TENNESSEE TECHNOLOGY PARK 5-1
ENVIRONMENTAL RADIATION AMBIENT MONITORING SYSTEMS (ERAMS) AIR PROGRAM 5-7
FUGITIVE RADIATION AIR EMISSIONS MONITORING 5-13
OAK RIDGE RESERVATION LOW VOLUME (PERIMETER) AMBIENT AIR MONITORING PROGRAM 5-17
HAZARDOUS AIR POLLUTANTS METALS MONITORING ON Y-12 AND ORNL (X-10) 5-23

RADIOLOGICAL MONITORING 6-1

AMBIENT GAMMA RADIATION MONITORING OF THE URANIUM HEXAFLUORIDE (UF6) CYLINDER YARDS AT THE ETTP 6-1
OAK RIDGE RESERVATION FACILITY SURVEY PROGRAM 6-11
REAL TIME AMBIENT GAMMA MONITORING OF THE OAK RIDGE RESERVATION 6-23
AMBIENT RADIATION MONITORING ON THE ORR USING ENVIRONMENTAL DOSIMETRY 6-29

LIST OF ACRONYMS AND COMMON ABREVIATIONS

ASER	Annual Site Environmental Report (written by DOE)
BCK	Bear Creek Kilometer (station location)
BFK	Bruch Fork Creek Kilometer (station location)
BJC	Bechtel Jacobs Company
BMAP	Biological Monitoring and Abatement Program
BNFL	British Nuclear Fuels Limited
BOD	Biological Oxygen Demand
BWXT	Y-12 Prime Contractor (current)
CAA	Clean Air Act
CAP	Citizens Advisory Panel (of LOC)
CCR	Consumer Confidence Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of Concern
COD	Chemical Oxygen Demand
CPM (cpm)	Counts per Minute
CRM	Clinch River Mile
CROET	Community Reuse Organization of East Tennessee
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility (at ORNL)
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOE-O	Department of Energy-Oversight Division (TDEC)
DWS	Division of Water Supply (TDEC)
E. coli	Escherichia coli
EAC	Environmental Assistance Center (TDEC)
ED1, ED2, ED3	Economic Development Parcel 1, Parcel 2, and Parcel 3
EFPC	East Fork Poplar Creek
EMC	Environmental Monitoring and Compliance (DOE-O Program)
EMWMF	Environmental Management Waste Management Facility
EPA	Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, Trichoptera (May flies, Stone flies, Caddis flies)
ERAMS	Environmental Radiation Ambient Monitoring System
ET&I	Equipment Test and Inspection
ETTP	East Tennessee Technology Park
FDA	U.S. Food and Drug Administration
g	Gram
GHK	Gum Hollow Branch Kilometer (station location)
GPS	Global Positioning System
GW	Ground Water
GWQC	Ground Water Quality Criteria
HAP	Hazardous Air Pollutant
HCK	Hinds Creek Kilometer (station location)
IBI	Index of Biotic Integrity
IC	In Compliance
“ISCO” Sampler	Automatic Water Sampler
IWQP	Integrated Water Quality Program

LIST OF ACRONYMS AND COMMON ABREVIATIONS CONTINUED

K-####	Facility at K-25 (ETTP)
K-25	Oak Ridge Gaseous Diffusion Plant (now called ETTP)
KBL	Knoxville Branch Laboratory
KEAC	Knoxville Environmental Assistance Center
L	Liter
LC_{50}	Lethal Concentration at which 50 % of Test Organisms Die
LMES	Lockheed Martin Energy Systems (past DOE Contractor)
LOC	Local Oversight Committee
LWBR	Lower Watts Bar Reservoir
MARSSIM	Multi-agency Radiation Survey and Site Investigation Manual
MBK	Mill Branch Kilometer (station location)
MCL	Maximum Contaminant Level (for drinking water)
MDC	Minimum Detectable Concentration
MEK	Melton Branch Kilometer (station location)
µg	Microgram
mg	Milligram
MIK	Mitchell Branch Kilometer (station location)
ml	Milliliter
MMES	Martin Merietta Energy Systems (past DOE Contractor)
µmho	Micro mho (mho=1/ohm)
mR	Microroentgen
mrem	1/1000 of a rem – millirem
N, S, E, W	North, South, East, West
NAAQS	National Ambient Air Quality Standards
NAREL	National Air and Radiation Environmental Laboratory
NAT	No Acute Toxicity
NEPA	National Environmental Policy Act
NIC	Not In Compliance
NOAEC	No Observable Adverse Effect Concentration (to Tested Organisms)
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System
NRWTF	Non-Radiological Waste Treatment Facility (at ORNL)
OMI	Operations Management International (runs utilities at ETTP under CROET)
OREIS	Oak Ridge Environmental Information System **http://eimdb-web.bechteljacobs.org:8080/oreis/help/oreishome.html**
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Association
OSL	Optically Stimulated Luminescent (Dosimeter)
OU	Operable Unit
PACE	Paper, Allied-Industrial, Chemical, and Energy Workers Union
PAM	Perimeter Air Monitor
PCB	Polychlorinated Biphenol
pCi	$1x10^{-12}$ Curie (Picocurie)
PCM	Poplar Creek Mile (station location)
pH	Proportion of Hydrogen Ions (acid vs. base)
ppb	Parts per Billion

LIST OF ACRONYMS AND COMMON ABREVIATIONS CONTINUED

ppm	Parts per Million
ppt	Parts per Trillion
PRG	Preliminary Remediation Goals
QA	Quality Assurance
QC	Quality Control
R	Roentgen
RBP	Rapid Bioassessment Program
RCRA	Resource Conservation and Recovery Act
REM (rem)	Roentgen Equivalent Man (unit)
RER	Remediation Effectiveness Report
ROD	Record of Decision
SLF	Sanitary Landfill
SNS	Spallation Neutron Source
SOP	Standard Operating Procedure
SPOT	Sample Planning and Oversight Team (TDEC)
SS	Surface Spring
STP	Sewage Treatment Plant
SW	Surface Water
TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TIE	Toxicity Identification Evaluation
TLD	Thermoluminescent Dosimeter
TOA	Tennessee Oversight Agreement
TRE	Toxicity Reduction Evaluation
TRM	Tennessee River Mile
TRU	Transuranic
TSCA	Toxic Substance Control Act
TSCAI	Toxic Substance Control Act Incinerator
TSS	Total Suspended Solids
TTHM's	Total Trihalomethanes
TVA	Tennessee Valley Authority
TWQC	Tennessee Water Quality Criteria
TWRA	Tennessee Wildlife Resources Agency
U.S.	United States
UT-BATTELLE	University of Tennessee-Battelle (ORNL Prime Contractor)
VOC	Volatile Organic Compound
WCK	White Oak Creek Kilometer (station location)
WM	Waste Management
X-####	Facility at X-10 (ORNL)
X-10	Oak Ridge National Laboratory
Y-####	Facility at Y-12
Y-12	Y-12 Plant (Area Office)

EXECUTIVE SUMMARY

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division), is providing a report of its independent environmental monitoring for the calendar year 2000. The report is a series of individual reports completed by Division personnel. The reports are organized by general area of interest: Surface Water; Drinking Water; Biological/Fish and Wildlife; Groundwater; Air Quality and Radiation. An abstract section is provided in each report. All supporting information and data used in the completion of these reports are available for review in the Division's files.

Surface Water

In an effort to assess the environmental impact and quality of rivers, streams, lakes and impoundments around the ORR, surface water samples for physical and chemical parameters were collected at 22 locations and compared against the Tennessee Water Quality Criteria (TWQC) standards. Analytical parameters included inorganic metals, organic extractables, pesticides and PCBs. Two samples collected at the McCoy Branch site, located downstream from the Filled Coal Ash Pond, showed 12.0 ug/L of arsenic in the June 2000 sample and 11.0 ug/L in the October 2000 sample. These levels exceed the TWQC standard for arsenic of 1.4 ug/L for recreational use. These levels are below the 50 ug/L level for drinking water use. This site will continue to be monitored to determine if the levels of arsenic change.

Sediment sampling for mercury will be expanded in 2001 to include two sites at Clinch River miles 4.0 and 0.0, because the mercury samples taken below the confluence of Poplar Creek (river mile 12.0) increased in concentration. The concentrations remained below the DOE's Primary Remediation Goals (PRGs) for recreational uses. No promulgated standard for mercury in sediments exists.

Drinking Water

Sampling and monitoring activities of the public water systems on the ORR revealed no health related violations in the year 2000. A health related violation means that either the amount of contaminants found in a system's drinking water exceeded the maximum contaminant level safety standard or that the water was not properly treated. Monitoring points included local streams, the Clinch River, and area water treatment plants. Contaminants measured included turbidity, total coliform, gross alpha, beryllium, cyanide, thallium, lead and total trihalomethanes.

Biological, Fish and Wildlife

Overall, the sample results of DOE effluents for the year 2000 improved over the 1999 sample results. However, the effluent sample from Y-12 outfall 201 failed to meet the permit requirement for the Fat-head minnow (*Pimephhales promelas)* in terms of "No Observable Adverse Effect Concentration" (NOAEC).

Diatom and benthic macroinvertebrate samples were collected from twelve study sites located on five streams: East Fork Poplar Creek, Bear Creek, White Oak Creek, Melton Branch, and Mitchell Branch. Results indicate that these locations continue to be impacted by past and current DOE activities when compared to reference sites on or near the ORR. Suppressed species richness values at stream sites closer to DOE discharges reflect the impact to diatom communities. Increasing diatom species richness with distance downstream suggests a correlation with the decrease in metal concentration within East Fork Poplar creek.

Based on elevated levels of contaminants such as PCB and mercury, advisories were posted regarding the hazards of fish consumption for the Melton Hill and Watts Bar Reservoirs, and bodily water contact for East Fork Poplar Creek.

Seventy-eight of the one hundred and forty-one captured Canadian geese at the Tennessee Technological Park, the vicinity of ponds located near the 1500 area of the Oak Ridge National Laboratory (ORNL), near the swan pond at ORNL and the park located at Melton Hill Dam, were analyzed for radioactive contamination and showed no elevated levels of gamma counts.

The white-tail deer on the ORR are shown to have elevated levels of radionuclides. Cesium137 and strontium90 were the most prevalent radionuclide contaminants due to the deer breaching contaminated areas. In this regard, the present institutional controls must be strengthened to function as a deterrent to deer incursions into radiological areas. Even more preferable, the problem radiological areas should be identified and cleaned up.

Groundwater

The activities at the DOE sites continue to impact ORR springs with hazardous constituents such as technetium-99, strontium-90, arsenic, cadmium, selenium, thallium, chloromethane, trichloroethene, and 1,1,2,2, tetrachloroethane. However, the general groundwater qualities of the eleven residential wells sampled for volatile organic compounds, nutrients, radiochemistry, inorganic chemistry, and selected metals did not exceed the established regulatory maximum contaminant levels.

Air Quality

Data currently available indicate that DOE operations have an insignificant impact to local air quality on the ORR. The program may be modified to better evaluate combined impacts in a wider ORR and its environs.

Radiation

Some locations on the ORR that are potentially accessible to the public have doses in excess of the State/DOE primary dose limits for members of the public. Maintenance of DOE boundaries and fences is very essential and important to prevent public exposure. This especially is important at East Tennessee Technology Park (ETTP) where the public has closer access.

Conclusion

The 2000 monitoring results continue to indicate a positive shift on the overall improvement of the environment. Likewise, to maintain this positive outlook and to assure an acceptable healthier environment at present and in the future for the ORR, it is incumbent on DOE to remain committed to the efforts on obtaining and providing adequate funding for environmental remediation activities, waste management and disposal issues and effective institutional controls.

INTRODUCTION

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division), in accordance with the Tennessee Oversight Agreement Attachment A.7.2.2, is providing an annual environmental monitoring report of the results of its monitoring and analysis activities during the calendar year of 2000, for public distribution. The Division was established in 1991, to administer the Tennessee Oversight Agreement and the CERCLA required Federal Facility Agreement. These agreements are designed to assure the citizens of Tennessee that their health, safety, and environment are being protected through existing programs and substantial new commitments by the Department of Energy (DOE).

The Division's monitoring efforts planned for 2000 are described in its 2000 Environmental Monitoring Plan as submitted to the DOE Oak Ridge Operations in January 2000. All of the environmental monitoring projects planned for 2000 were attempted by the Division. In addition, three ground water dye trace studies were completed in 1999 and are included in this report.

The report consists of a series of individual reports that involve independent environmental monitoring by the Division. The individual reports are organized by general areas of interest: Surface Water; Drinking Water; Biological/Fish and Wildlife; Groundwater; Air Quality; and Radiation. Abstract and conclusion sections are available in each report to provide a quick overview of the content and outcome of each monitoring effort. All supporting information and data used in the completion of these reports are available for review in the Division Program files. Overall, the report characterized and evaluate the chemical and radiological emissions in the air, water, and sediments both on and off the Oak Ridge Reservation.

The Division has considered the location, environmental setting, history, and on-going DOE operations in its environmental monitoring programs. The information gathered provides a better understanding of the fate and transport of contaminants released from the Oak Ridge Reservation into the environment. This understanding has lead to the development of an ambient monitoring system and increased the probability of detecting releases in the event that institutional controls on the Oak Ridge Reservation fail.

Currently, the Division's monitoring activities have not detected any imminent threats to public health or the environment outside of the Oak Ridge Reservation. However, unacceptable releases of contaminants from past DOE operational and disposal activities continue to pose risk to the environment and it is imperative to note that if current institutional controls fail or if the present contaminant source controls can no longer be maintained, the public would be at risk to environmental contamination.

Site Description

The DOE Oak Ridge Reservation (ORR), as shown in Figure 1, encompasses approximately 35,000 acres and three major operational DOE facilities: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Y-12 Plant (Y-12), and the East Tennessee Technology Park (ETTP, formerly the K-25 Gaseous Diffusion Plant). The initial objectives of the ORR operations were the production of plutonium and the enrichment of uranium for nuclear weapons components. In the 56 + years since the ORR was established, a variety of production and research activities have generated numerous radioactive, hazardous, and mixed wastes. These wastes, along with wastes from other locations, were disposed of on the ORR. Early waste disposal methods on the ORR were rudimentary compared to today's standards.

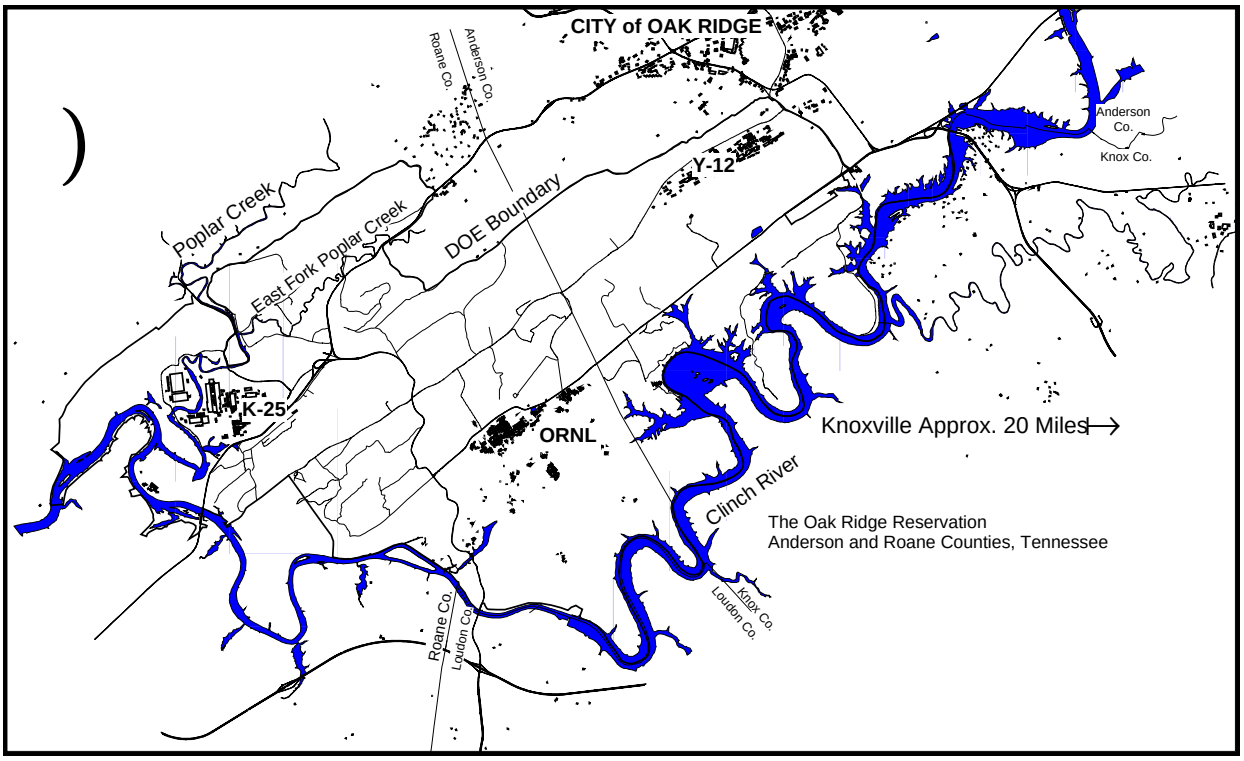

Figure 1: The Oak Ridge Reservation

The ORR is located within the corporate boundaries of the city of Oak Ridge, Tennessee, in the counties of Anderson and Roane. The Reservation is bounded on the north and east by residential areas of the city of Oak Ridge and on the south and west by the Clinch River. Counties adjacent to the Reservation include Knox, Loudon, and Morgan. Meigs and Rhea counties are immediately downstream on the Tennessee River from the ORR. The nearest cities are Oak Ridge, Oliver Springs, Kingston, Lenoir City, Harriman, Farragut, and Clinton. The nearest metropolitan area, Knoxville, lies approximately 20 miles to the east. Figure 2 depicts the general location of the Oak Ridge Reservation and nearby cities.

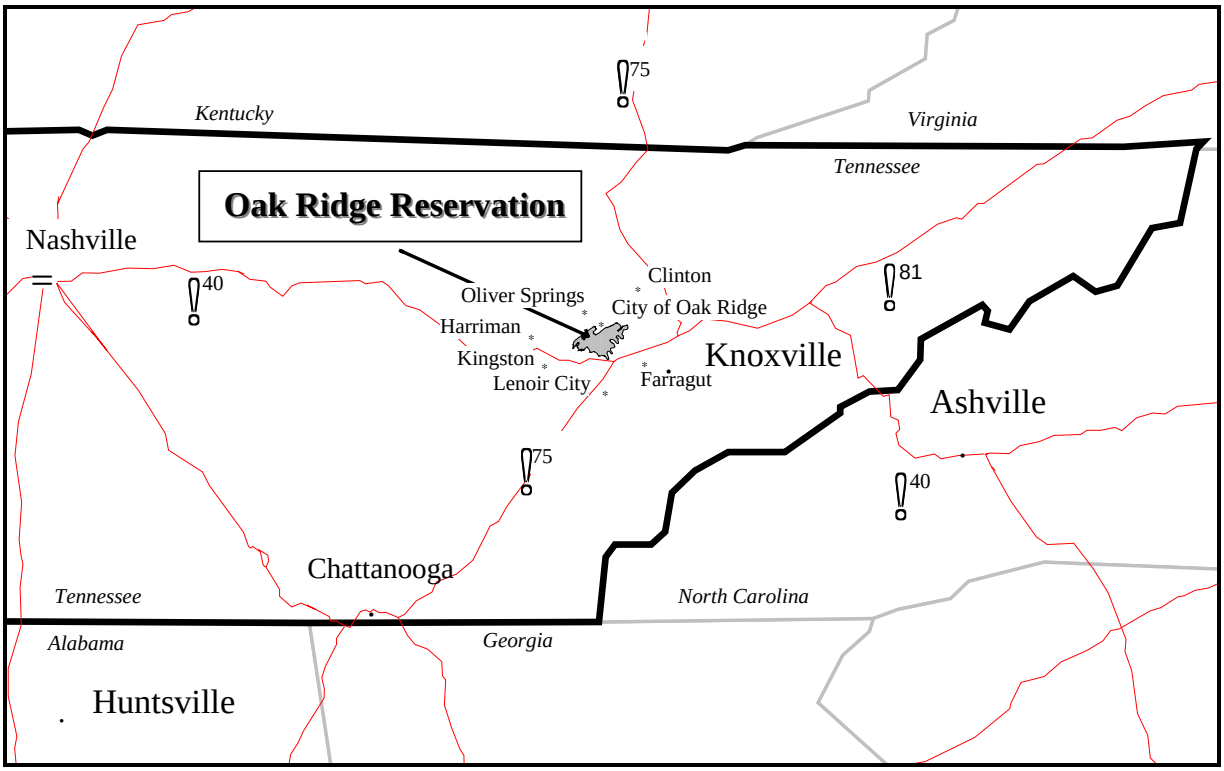

Figure 2: Location of the Oak Ridge Reservation

The ORR lies in the Valley and Ridge Physiographic Province of East Tennessee. The Valley and Ridge Province is a zone of complex geologic structures dominated by a series of thrust faults and characterized by a succession of elongated southwest-northeast trending valleys and ridges. In general, the ridges are underlain by sandstones, limestones, and/or dolomites that are relatively resistant to erosion. The valleys are underlain by weaker shales and more soluble carbonate rock units.

The hydrogeology of the ORR is very complex with a number of variables influencing the direction, quantity, and velocity of groundwater flow that may or may not be evident from surface topography. In many areas of the ORR, groundwater appears primarily to travel along short flow paths in the storm flow zone to nearby streams. In other areas, evidence indicates substantial groundwater flow and, thereby, contaminant transport may occur preferentially in fractures and solution cavities in the bedrock for relatively long distances.

As seen in Figure 3, streams on the ORR drain to the Clinch River. Melton Hill Dam impounded the Clinch River in 1963. Contaminants released on the Oak Ridge Reservation enter area streams (e.g., White Oak Creek, Bear Creek, East Fork Poplar Creek, and Poplar Creek) and are transported into the Clinch River and Watts Bar Reservoir on the Tennessee River.

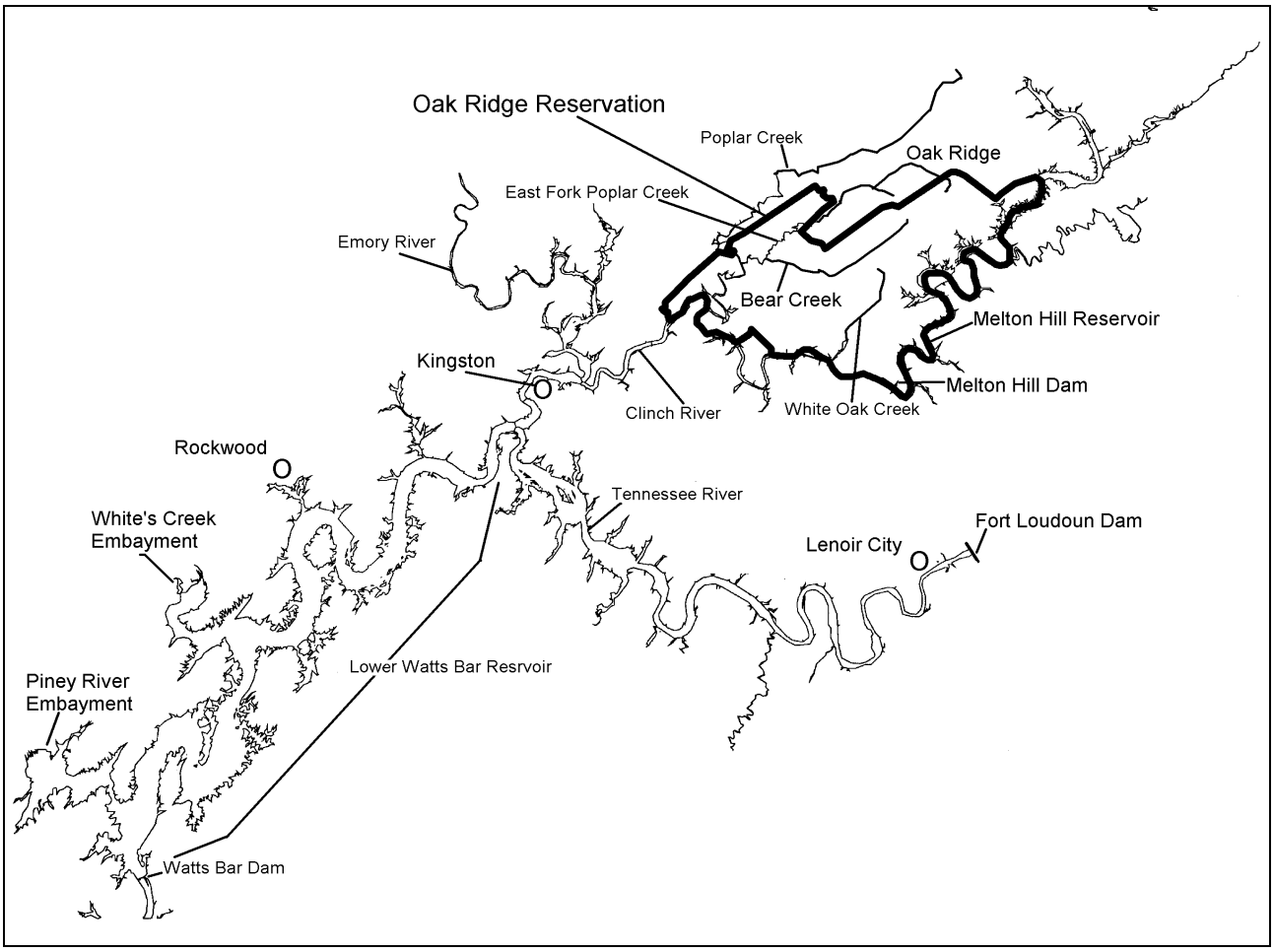

Figure 3: Watts Bar Reservoir

The climate of the region is moderately humid and the annual average precipitation is around 55 inches. Winds on the reservation are controlled, in large part, by the valley and ridge topography with prevailing winds moving up the valleys (northeasterly) during the daytime and down the valleys (southwesterly) at night.

SURFACE WATER MONITORING

Ambient Surface Water Monitoring Program

Principal Author: John Peryam

Abstract

Surface water analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducted sampling at 22 sites in 2000. The samples were analyzed for standard water quality parameters. Based on comparisons with the Tennessee Water Quality Criteria (TWQC) for recreation, only one site exceeded these criteria. The McCoy Branch site showed levels of arsenic (12.0 and 11.0 µg/l) on the 6/8/00 and 10/10/00 samplings, respectively, that were above the TWQC (1.4 µg/l). The elevated level is likely due to the presence of the Filled Coal Ash Pond located upstream of the sampling site. These levels are below the 50 ug/l and for drinking water use. The location will continue to be monitored to determine if the levels of arsenic change.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducts an ambient surface water sampling program that monitors 25 sites in Anderson and Roane Counties. Seven sites were originally chosen for the purpose of detecting any possible contamination from Department of Energy (DOE) sites via surface water, stormwater, or groundwater. Sites 1 and 2 were chosen as background data collection sites and are located above the Oak Ridge Reservation (ORR) before any impact by the three DOE sites. The original seven sampling sites on the Clinch River (sites 1 through 7) have been sampled quarterly under this program from 1993 to 1996. In 1997, fifteen sampling sites were added to the program. These newer sites are tributaries of the Clinch River located on the ORR. These sites are numbered 8 through 22 and listed in Table 1.1 and Figure 1.1. Three new sites were added in 1999. These three new sites are numbered 23 through 25; two of these are background streams (Clear Creek and White Creek) and the other unnamed stream is a tributary of the Clinch River that flows through Oak Ridge.

Chemical contamination levels in streams may fluctuate greatly due to many factors, such as dilution, concentration, intermittent sources of contaminants, absorption, chemical interactions with geological substrates, etc. The Clinch River, being large and subject to dilution, is not expected to have high concentrations of pollutants in surface water grab samples. However, the sampling data do set up a baseline for comparison to previous sampling events. In the case of an unplanned release or an accident, the sampling data may help to reflect the amount and extent of pollution.

The sampling sites were sampled twice during 2000. Samples were analyzed for each of the parameters in Table 1.2. Surface water data was compared with Tennessee Water Quality Criteria (TWQC).

Table 1.1 Sample Locations

Site	Location	Clinch River Mile	Quarter(s) Sampled
1	Downstream of Norris Dam	78.7	2,4
2	Anderson County Water Treatment Plant	52.6	2,4
3	Melton Hill Park	35.5	2,4
4	Grubb Islands	17.9	2,4
5	Brashear Island	10.1	2,4
6	Bull Run Steam Plant	48.7	2,4
7	Water Treatment Plant	41.2	2,4
8	Scarboro Creek	41.2*	2,4
9	Kerr Hollow Branch	41.2*	2,4
10	McCoy Branch	37.5*	2,4
11	Western Branch	37.5*	2,4
12	East Fork of Walker Branch	33.2*	2,4
13	Bearden Creek	31.8*	2,4
14	Unnamed Stream	27.0*	None**
15	Unnamed Stream	26.6*	None**
16	Unnamed Stream	23.0*	2,4
17	Unnamed Stream	20.0*	2,4
18	Raccoon Creek	19.5*	2,4
19	Ish Creek	19.1*	2,4
20	Grassy Creek	14.55*	2,4
21	Unnamed Stream	14.55*	None**
22	Unnamed Stream	14.45*	2,4
23	Unnamed Stream	51.1*	2,4
24	White Creek	N.A.	2,4
25	Clear Creek	77*	2,4

*This figure is the approximate Clinch River Mile where the tributary meets the river.
**Stream was dry during one or more sampling trips.

Figure 1.1 Map of Sampling Sites (See Table 1.1)

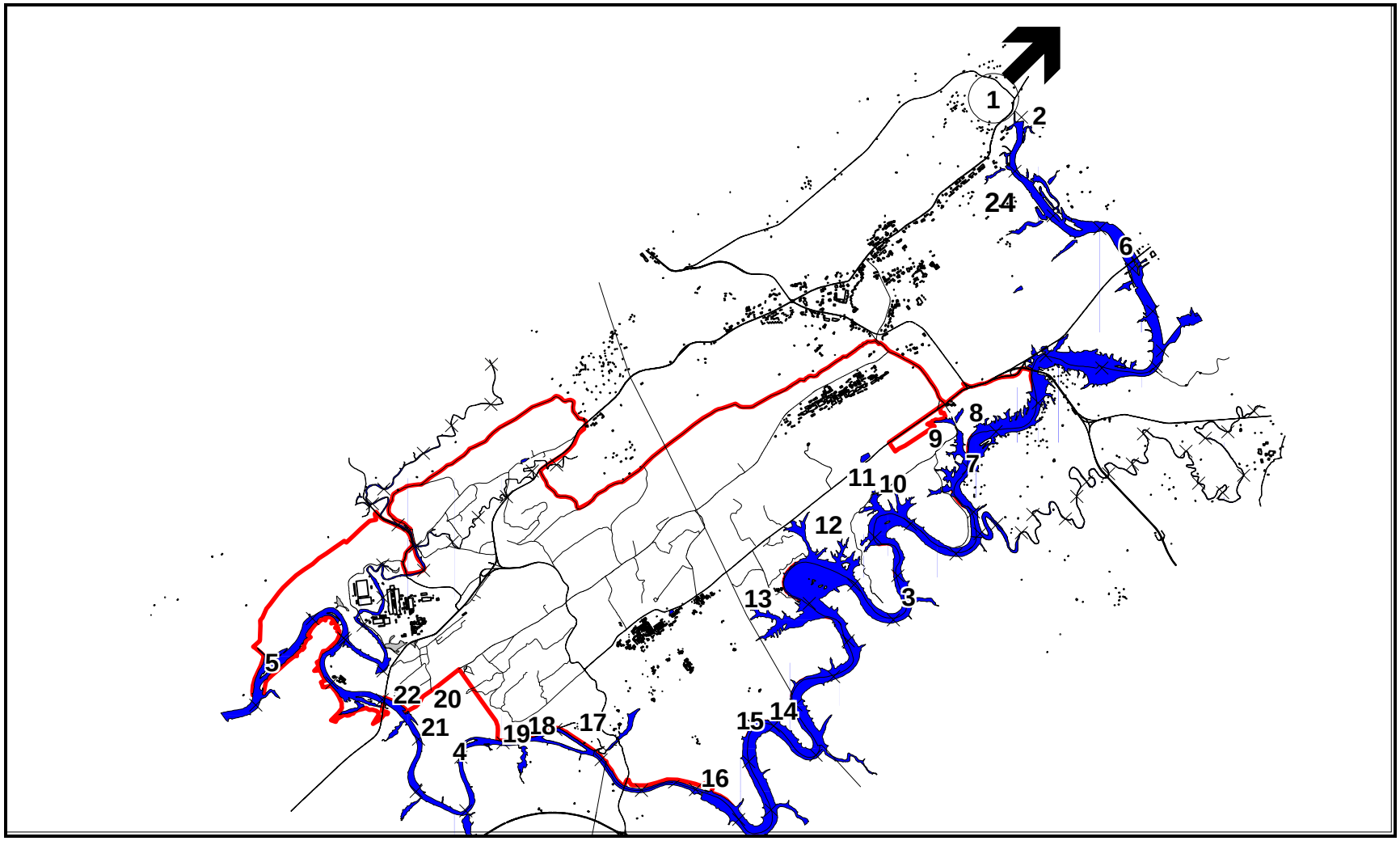

Table 1.2. Ambient Water Sampling Parameters

Parameter	Units	Tennessee Water Quality Criteria (TWQC)*
Conductivity	umho	
Dissolved Oxygen	mg/l	5.0 (f)
pH	Units	6.5-8.5 (f)
Temperature	degrees C	</= 30.5
E. Coli	cfu/100ml	1000
Enterococcus	cfu/100 ml	
Residue - dissolved	mg/l	500 (d)
Nitrogen, NO_3 & NO_2	mg/l	
Nitrogen, ammonia	mg/l	
Residue - suspended	mg/l	
Nitrogen, total kjeldahl	mg/l	
Phosphate, total	ug/l	
Hardness, total, as $CaCO_3$	mg/l	
Arsenic, As	ug/l	1.4 (r)
Cadmium, Cd	ug/l	3.9 (f)
Chromium, Cr	ug/l	16 (f)
Copper, Cu	ug/l	17.7 (f)
Iron, Fe	ug/l	
Lead, Pb	ug/l	5 (d)
Manganese, Mn	ug/l	
Mercury, Hg	ug/l	0.14 (r)
Zinc, Zn	ug/l	117 (f)

*Tennessee Water Quality Criteria: (d)-domestic water supply, (f)-fish & aquatic life, (r)-recreation.

Sampling Sites

Site 1 – Downstream of Norris Dam: Samples are taken from the Clinch River from the bank at the first recreation access point downstream of Norris Dam. The coordinates are approximately 36º 13' 11" N latitude and 84º 05' 20" W longitude. This site is upstream of possible DOE impacts and is a reference site in this respect. It may, however, show effects of agricultural, industrial and residential activities upstream.

Site 2 - Anderson County Water Treatment Plant: Samples are taken from the Clinch River from a boat in an area approximately 20 to 40 feet from the west bank of the river, just offshore from the water treatment plant. The coordinates are approximately 36º 03' 46" N latitude and 84º 11' 49" W longitude. This site is upstream of possible DOE impacts and is a reference site in this respect. It may, however, show effects of agricultural, industrial and residential activities upstream.

Site 3 - Melton Hill Park: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet from the west bank of the river approximately one half mile downstream of the Knoxville Utility Board's pumping station. The coordinates are approximately 35º 56' 39" N latitude and 84º 14' 21" W longitude.

Site 4 - Grubb Islands: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet from the west bank of the river approximately 100 to 200 feet downstream of the larger Grubb Island. The coordinates are approximately 35º 53' 52" N latitude and 84º 22' 24" W longitude.

Site 5 - Brashear Island: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet south of the last sandbar (going downstream) of the river approximately 400 to 500 feet upstream of Brashear Island. The coordinates are approximately 35º 55' 13" N latitude and 84º 26' 02" W longitude.

Site 6 - Bull Run Steam Plant: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet of the west bank of the river at a point near the upstream end of the skimmer wall. The coordinates are approximately 36º 01' 28" N latitude and 84º 10' 02" W longitude.

Site 7 - Water Treatment Plant: Samples are taken by the same methods as used at Site 2 in an area approximately one half mile downstream of the Water Treatment Plant Intake. The coordinates are approximately 35º 58' 30" N latitude and 84º 12' 30" W longitude.

Site 8 - Scarboro Creek: Samples are taken from the creek at a point near the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 59" N latitude and 84º 13' 00" W longitude.

Site 9 - Kerr Hollow Branch: Samples are taken from the creek at a point about 50 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 45" N latitude and 84º 13' 37" W longitude.

Site 10 - McCoy Branch: Samples are taken from the creek approximately 150-200 feet upstream of the confluence with Melton Hill Lake. The coordinates are approximately 35º 57' 57" N latitude and 84º 14' 54" W longitude.

Site 11 - Western Branch: Samples are taken from the creek at a point about 150 yards from the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 00" N latitude and 84º 15' 05" W longitude.

Site 12 - East Fork of Walker Branch: Samples are taken from the creek in a length of the stream about 150 feet in distance, beginning about 100 feet from the confluence with Melton Hill Lake. The exact location depends upon the water level of the Clinch River at the time of sampling. The gradient of the stream at this point is slight and sometimes the river backs up into the stream, therefore sampling must be done farther upstream to obtain a sample representative of the stream and not the river. The coordinates are approximately 35º 57' 22" N latitude and 84º 15' 58" W longitude.

Site 13 - Bearden Creek: Samples are taken from the creek at point about 150 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 56' 05" N latitude and 84º 17' 01" W longitude.

Site 14 – Unnamed Stream: Samples are taken from the creek at a point about 50 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 54' 25" N latitude and 84º 16' 39" W longitude.

Site 15 – Unnamed Stream: Samples are taken from the creek at a point about 30 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 54' 21" N latitude and 84º 17' 06" W longitude.

Site 16 – Unnamed Stream: Samples are taken from the creek at a point about 120 feet from the confluence with the Clinch River. The coordinates are approximately 35º 53' 22" N latitude and 84º 18' 04" W longitude.

Site 17 – Unnamed Stream: Samples are taken from the creek at a point about 2000 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 14" N latitude and 84º 20' 12" W longitude.

Site 18 - Raccoon Creek: Samples are taken from the creek at point about 1000 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 12" N latitude and 84º 21' 05" W longitude.

Site 19 - Ish Creek: Samples are taken from the creek at a point about 1000 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 11" N latitude and 84º 21' 33" W longitude.

Site 20 - Grassy Creek: Samples are taken from the stream at a point about one half mile from the confluence with the Clinch River. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 55" W longitude.

Site 21 – Unnamed Stream: Samples are taken from the stream at point about one half mile from the confluence with the Clinch River. This site is very close to the Grassy Creek sampling site; these two creeks come together immediately before entering the Grassy Creek embayment. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 57" W longitude.

Site 22 – Unnamed Stream: Samples are taken from the stream at the opening of the culvert that brings water from the K-1515C lagoon, approximately 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 29" N latitude and 84º 23' 25" W longitude.

Site 23 – Unnamed Stream: This stream is located behind Warehouse Road in Oak Ridge. Samples are taken a short distance from the Clinch River embayment at Clinch River Mile 51.1. The approximate coordinates are 36º 02' 19" N latitude and 84º 12' 47" W longitude. This site is upstream of any possible DOE impacts and is a reference site in this respect. It may, however, show effects of any agricultural, industrial and residential activities upstream.

Site 24 – White Creek: This stream is located in the Chuck Swann Wildlife Management Area in Union County. Samples are taken about 1/3 mile downstream from an old TVA water monitoring facility about one mile upstream of Norris Lake. The approximate coordinates are 36º 20' 47" N latitude and 83º 53' 42" W longitude.

Site 25 – Clear Creek: This stream is located near Norris Dam near Clinch River Mile 77. Samples are taken near a water storage facility about one mile upstream of the river. The approximate coordinates are 36º 12' 49" N latitude and 84º 03' 33" W longitude. This is a background site.

Methods and Materials

Surface water samples were taken during June and October using the methods described in the 2000 Ambient Surface Water Sampling Plan. The Tennessee State Laboratories processed the samples, according to EPA approved methods.

Results and Discussion

Both of the two samples taken from site 10 (McCoy Branch) during 2000 had a level of arsenic that exceeded the TWQC for recreation. The source of the arsenic is the Filled

Coal Ash Pond (Operable Unit OU2) that is upstream. This coal ash disposal area was remediated in 1997.

Table 1.3 Arsenic in Surface Water at McCoy Branch - 2000

Site	CRM	Site #	Date	Parameter	Units	Data	Limit	>	TWQC *
McCoy Branch	37.5	10	6/8/00	Arsenic, As	ug/l	12.0	1	**X**	1.4 (r)
McCoy Branch	37.5	10	10/10/00	Arsenic, As	ug/l	11.0	1	**X**	1.4 (r)

*Tennessee Water Quality Criteria: (r)-recreation.

Conclusion

The elevated level of arsenic in the water sample from McCoy Branch is the only major concern revealed by the 2000 surface water sampling. Since the Filled Coal Ash Pond (FCAP) underwent remediation in 1997, levels of arsenic in the water at McCoy Branch are expected to decline over time. Negative results in ambient water monitoring give strength to an assumption that there is limited runoff impact to the surface water tested. Considering dilution and other factors, concentrations generally do not exceed water quality standards for the sampling year.

References

Ambient Water Standard Operating Procedure, Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1996.

Health, Safety, and Security Plan, Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1998.

State of Tennessee Water Quality Standards, Rules of the Department of Environment and Conservation, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3 General Water Quality Criteria, Chapter 1200-4-4 Use Classifications for Surface Waters, July 1995.

SURFACE WATER MONITORING

Special Project: Sediment/Surface Water Sampling Investigation of Highway 58 Bridge Construction

Principal Author: Roger Petrie

Abstract
During the construction of the State Highway 58 bridge over the Clinch River, concerns were raised regarding possible mobilization of contaminants in the river sediments. In response to these concerns, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) personnel conducted walk over surveys of spoils from the construction. In addition, water samples were collected from the Clinch River in the immediate vicinity of the construction activities. The results of these activities indicate that there was no apparent mobilization of contaminants as a result of the bridge construction.

Introduction
Recent concerns have surfaced regarding the disturbance of sediments in the Clinch River in the vicinity of construction activities associated with construction of a new bridge on Highway 58 in Roane County, Tennessee. The bridge is located approximately at Clinch River Mile (CRM) 14. The construction of the new bridge pilings has necessitated the disturbance of the river substrate. This disturbance has been in the form of blasting activities to prepare footings for the pilings. Historical evidence has shown that sediments in the Clinch River downstream of the confluence of White Oak Creek can have levels of Cs-137 that could be of concern. The possibility of disturbing such sediments has caused concern among members of the public.

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) investigated these concerns to evaluate if any contaminated sediments were being disturbed during construction operations. As part of the construction, new pilings are being put in place. To properly install the pilings, the substrate of the river must be prepared by blasting loose the rock that is present on the bottom of the river and removing the loose debris.

Methods
On March 17, 2000, TDEC personnel surveyed the spoil material removed from the river during this operation. The first survey was conducted on the spoil material on the southern side of the river. The spoil material was composed of approximately 100 cubic yards of shale rock. The survey was conducted by walking over the spoil material with a NaI meter and observing the resulting readings. The readings (8000-11000 cpm) indicated that there was no apparent contamination present. A second spoil area located on the northern side of the river was then surveyed. Preparation on the riverbed was still ongoing here. Construction personnel halted operations to allow the survey of the approximately 300 cubic yards of shale rock that had been removed. The readings (11000-14000 cpm) again indicated that there was no apparent contamination present. The geologic formations that are present in this area have a natural radioactivity range of 7000-14000 cpm. Observation of the spoil removal process failed to show any indication that sediment was being suspended in the water column. Investigation of the spoil material also failed to show any presence of sedimentary

type material. The spoil appeared to be composed entirely of pulverized rock. It should be noted that the relatively normal readings do not preclude the presence of contamination. Following the blasting and removal process, the areas where the footings are placed were "blown out" with compressed air to remove any debris that may remain in and around the footings. On March 20, 2000, this procedure was being conducted on the footing for the north piling. The process caused a visible disturbance of material. Since there was no appreciable current, the disturbed material was not dispersing. TDEC personnel obtained a water sample from within this area of visible disturbance. The sample was analyzed for radiological constituents.

Results

The results of the analysis of the sample collected on March 20, 2000, were compared to Safe Drinking Water Act Standards (Table 1). This comparison shows that the radiological constituents in the water do not pose a threat at this time.

Table 1. Results of Water Sample from Highway 58 Bridge Construction Area

Analysis	Result	Safe Drinking Water Act (SDWA) Standard
Gross Alpha	1.8 ± 2.1 pCi/L	15 pCi/L
Gross Beta	4.1 ± 2.5 pCi/L	50 pCi/L
Gamma Radionuclides		
Pb-214	18.6 ± 3.0 pCi/L	11800 pCi/L [a]
Bi-214	15.9 ± 3.5 pCi/L	18900 pCi/L [a]

[a] There are currently no standards in place. These are the proposed standards.

DOE surface water monitoring has collected samples at Clinch River Mile 14.3 for several years. The results of this sampling are comparable (Table 2) to the results of the recent sample collected by TDEC at the bridge site (CRM 14.0).

Table 2. Comparison of DOE Surface Water Results to Recent Sample Analysis

Analysis	Hwy 58 Bridge Site	DOE Surface Water Monitoring	SDWA Standard
Gross Alpha	1.8 ± 2.1 pCi/L	0.54 ± 0.62 pCi/L to 0.91 ± 0.82 pCi/L	15 pCi/L
Gross Beta	4.1 ± 2.5 pCi/L	3.40 ± 2.00 pCi/L to 7.10 ± 2.60 pCi/L	50 pCi/L

The TDEC has conducted radiological analysis on sediment samples collected at CRM 10.1 and CRM 17.9 as part of the Ambient Sediment Monitoring Program. The results of this sampling are compared to the recent sample analysis in Table 3. This comparison is made due to the fact that the objective of the recent sampling was to collect a sample that contained sediment disturbed by the construction activities. It is important to note that the sample was acidified prior to analysis, whereas sediment samples are not. This was done to release any contaminants that may have been attached to sedimentary material that was present in the sample. This treatment of the sample resulted in levels of Pb-214 and Bi-214, both of which are naturally occurring isotopes that are higher than typical sediment samples.

Table 3. Comparison of TDEC DOE-O Sediment Sampling Results[b]

	Results (± error)		
Analysis	Hwy 58 Bridge	TDEC/DOE-O CRM 10.1	TDEC/DOE-O CRM 17.9
Gross Alpha	1.8 ± 2.1 pCi/L	1.91 ± 0.61 pCi/L to 3.7 ± 1.6 pCi/L	0.7 ± 1.0 pCi/L to 3.58 ± 0.79 pCi/L
Gross Beta	4.1 ± 2.5 pCi/L	12.3 ± 1.8 pCi/L to 24.0 ± 1.4 pCi/L	5.7 ± 1.6 pCi/L to 32.2 ± 1.5 pCi/L
Gamma Radionuclides			
Pb-214	18.6 ± 3.0 pCi/L	0.495 ± 0.038 pCi/L to 1.014 ± 0.075 pCi/L	0.446 ± 0.033 pCi/L to 1.248 ± 0.069 pCi/L
Bi-214	15.9 ± 3.5 pCi/L	0.440 ± 0.035 pCi/L to 0.939 ± 0.061 pCi/L	0.441 ± 0.031 pCi/L to 1.149 ± 0.068 pCi/L

[b] These results are for the Ambient Sediment Monitoring Program.

Conclusion

Based on comparisons of these results with historical sampling and water quality standards, there is no threat posed by the mobilization of sediments as a result of the construction of the State Highway 58 Bridge.

References

Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1996 *Ambient Water Standard Operating Procedure*.

Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1998 *Health, Safety, and Security Plan.*

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SURFACE WATER MONITORING

Ambient Sediment Monitoring Program

Principal Author: John Peryam

Abstract

Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. The Tennessee Department of Environment and Conservation (TDEC), Department of Ennergy Oversight Division (DOE-O) conducted sediment sampling at 23 sites in 2000. The sediments were analyzed for inorganic and organic constituents. The levels of the compounds were compared to the Department of Energy's (DOE) Preliminary Remediation Goals (PRGs) for Use at the DOE Oak Ridge Operations (ORO) Office. Based on the designation of the water bodies involved, the values were compared to the recreational PRGs. Under recreational land use, individuals are assumed to be exposed to contaminated media while playing, fishing, hunting, or engaging in other outdoor activities. Exposure could result from ingestion of soil or sediment, inhalation of vapors from soil or sediment, dermal contact with soil or sediment, external exposure to ionizing radiation emitted from contaminants in soil or sediment, and consumption of fish.

Based on this comparison, the sediments showed no levels of concern for the contaminants that were analyzed for. Mercury levels in the samples taken in the Clinch River below the confluence of Poplar Creek increase as one goes downstream. Although the levels of mercury are well below the PRGs, they are higher than all of the other sediment sampling sites. For this reason, the investigation of sediment mercury in this region of the river will be expanded in 2001 to include two sampling sites at Clinch River Miles 4.0 and 0.0.

Introduction

Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. Samples can be collected for a variety of chemical, physical, toxicological, and biological investigations. The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducts an ambient sediment sampling program that includes 23 sampling sites, numbered 2 through 27. Sites 2 through 7 are located on the Clinch River and have been sampled since 1994. In 1997, fifteen sampling sites were added to the ambient sediment monitoring program. These new sites are tributaries of the Clinch River located on the Oak Ridge Reservation (ORR). The new sites are numbered 8 through 22 and listed in Figure 1.1. Three new stations were added in 1999. These three new sites are numbered 23 through 25; two of these are background streams (Clear Creek and White Creek) and the other unnamed stream is a tributary of the Clinch River that flows through Oak Ridge. In 2000, two sites on the Clinch River were added downstream of Brashear's Island. These new sites are 26 at Clinch River Mile (CRM) 9.0 and 27 at CRM 7.0.

The sampling stations were sampled once during 2000, with the exception of a few dry streams. Samples were analyzed for organic and inorganic parameters. Sediment data was compared with Department of Energy's (DOE) Preliminary Remediation Goals (PRGs) for use at the DOE ORO Office, ES/ER/TM-106/R1.

Analytical Parameters

Inorganics: aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc, and percent solids.

Organics (extractables): butylbenzylphthalate, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, di-n-octylphthalate, diethylphthalate, dimethylphthalate, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitroso-di-n-propylamine, isophorone, nitrobenzene, 2,4-dinitrotoluene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, napthalene, phenanthrene, pyrene, bis(2-chloroethyl) ether, bis(2-chloroethoxy)methane, bis(2-chloroisopropyl) ether, 4-bromophenylphenyl ether, 4-chlorophenylphenylether, hexachlorocyclopentadiene, hexachlorobutadiene, hexachlorobenzene, hexachoroethane, 1,2,4-trichlorobenzene, 2-chloronapthalene, 4-chloro-3-methyl phenol, 2-chlorophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 4,6-dinitro-o-cresol, 2-nitrophenol, 4-nitrophenol, pentachlorophenol, phenol, 2,4,6-trichlorophenol.

Organics (pesticides/PCBs): aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (lindane), technical chlordane, alpha-chlordane, gamma-chlordane, 4,4-DDD, 4,4-DDE, 4,4-DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, heptachlor, heptachlor epoxide, toxaphene, methoxychlor, PCB 1016/1242, PCB 1221, PCB 1232, PCB 1248, PCB 1254, PCB 1260, PCB 1262.

Sampling Stations

Site 2 - Anderson County Water Treatment Plant: Samples are taken from the Clinch River bottom with a Ponar mini-dredge from a boat in an area approximately 20 to 40 feet from the west bank of the river, just offshore from the water treatment plant. The coordinates are approximately 36º 03' 46" N latitude and 84º 11' 49" W longitude. This site is upstream of any possible DOE impacts and is a reference site in this respect. It may, however, show effects of any agricultural, industrial and residential activities upstream.

Site 3 - Melton Hill Park: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet from the west bank of the river approximately one half mile downstream of the Knoxville Utility Board's pumping station. The coordinates are approximately 35º 56' 39" N latitude and 84º 14' 21" W longitude.

Site 4 - Grubb Islands: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet from the west bank of the river approximately 100 to 200 feet downstream of the larger Grubb Island. The coordinates are approximately 35º 53' 52" N latitude and 84º 22' 24" W longitude.

Site 5 - Brashear Island: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet south of the last sandbar (going downstream) of the river approximately 400 to 500 feet upstream of Brashear Island. The coordinates are approximately 35º 55' 13" N latitude and 84º 26' 02" W longitude.

Site 6 - Bull Run Steam Plant: Samples are taken by the same methods as used at Site 2 in an area approximately 20 to 40 feet of the west bank of the river at a point near the upstream end of the skimmer wall. The coordinates are approximately 36º 01' 28" N latitude and 84º 10' 02" W longitude.

Site 7 - Water Treatment Plant: Samples are taken by the same methods as used at Site 2 in an area approximately one half mile downstream of the Water Treatment Plant Intake. The coordinates are approximately 35º 58' 30" N latitude and 84º 12' 30" W longitude.

Site 8 - Scarboro Creek: Samples are taken by scooping sediment from the creek bottom at a point where the creek begins forming soft sediment deposits (clay, silt, and organic matter) near the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 59" N latitude and 84º 13' 00" W longitude.

Site 9 - Kerr Hollow Branch: Samples are taken by scooping sediment from the creek bottom at a point where the creek begins forming soft sediment deposits (clay, silt, and organic matter) about 50 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 45" N latitude and 84º 13' 37" W longitude.

Site 10 - McCoy Branch: Samples are taken by scooping sediment from the creek bottom at a point where the creek begins forming soft sediment deposits (clay, silt, and organic matter) at the confluence with Melton Hill Lake. The coordinates are approximately 35º 57' 57" N latitude and 84º 14' 54" W longitude.

Site 11 - Western Branch: Samples are taken by scooping sediment from the creek bottom at a point about 150 yards from the confluence with Melton Hill Lake. The coordinates are approximately 35º 58' 00" N latitude and 84º 15' 05" W longitude.

Site 12 - East Fork of Walker Branch: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 150 feet in distance, beginning about 100 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 57' 22" N latitude and 84º 15' 58" W longitude.

Site 13 - Bearden Creek: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 150 feet in distance, beginning about 20 feet from the confluence with Melton Hill Lake. The coordinates are approximately 35º 56' 05" N latitude and 84º 17' 01" W longitude.

Site 14 – Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 30 feet in distance, beginning about 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 25" N latitude and 84º 16' 39" W longitude.

Site 15 - Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 30 feet in distance, beginning about 75 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 21" N latitude and 84º 17' 06" W longitude.

Site 16 - Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 30 feet in distance, beginning about 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 53' 22" N latitude and 84º 18' 04" W longitude.

Site 17 - Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 750 feet in distance, beginning about 1500 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 14" N latitude and 84º 20' 12" W longitude.

Site 18 - Raccoon Creek: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 50 feet in distance, beginning about 1000 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 12" N latitude and 84º 21' 05" W longitude.

Site 19 - Ish Creek: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 50 feet in distance, beginning about 1000 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 11" N latitude and 84º 21' 33" W longitude.

Site 20 - Grassy Creek: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 50 feet in distance, beginning about one half mile from the confluence with the Clinch River. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 55" W longitude.

Site 21 – Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 20 feet in distance, approximately 100 feet from the confluence with Grassy Creek. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 57" W longitude.

Site 22 – Unnamed Stream: Samples are taken by scooping sediment from the creek bottom in a length of the stream about 20 feet in distance, beginning at the opening of the culvert that brings water from the K-1515C lagoon, approximately 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 29" N latitude and 84º 23' 25" W longitude.

Site 23 - Unnamed Stream: This stream is located behind Warehouse Road in Oak Ridge. Samples are taken a short distance from the Clinch River embayment at Clinch River Mile 51.1. The approximate coordinates are 36º 02' 19" N latitude and 84º 12' 47" W longitude. This site is upstream of any possible DOE impacts and is a reference site in this respect. It may, however, show effects of any agricultural, industrial and residential activities upstream.

Site 24 – White Creek: This stream is located in the Chuck Swann Wildlife Management Area in Union County. Samples are taken about 1/3 mile downstream from an old TVA water monitoring facility about one mile upstream of Norris Lake. The approximate coordinates are 36º 20' 47" N latitude and 83º 53' 42" W longitude.

Site 25 – Clear Creek: This stream is located near Norris Dam near Clinch River Mile 77. Samples are taken near a water storage facility about one mile upstream of the river. The approximate coordinates are 36º 12' 49" N latitude and 84º 03' 33" W longitude. This is a background site.

Site 26 – Clinch River Mile 9.0: Samples are taken by the same methods as used at Site 2. The coordinates are approximately 35º 54' 36" N latitude and 84º 26' 15" W longitude.

Site 27 – Clinch River Mile 7.0: Samples are taken by the same methods as used at Site 2. The coordinates are approximately 35º 53' 37" N latitude and 84º 27' 46" W longitude.

Methods and Materials

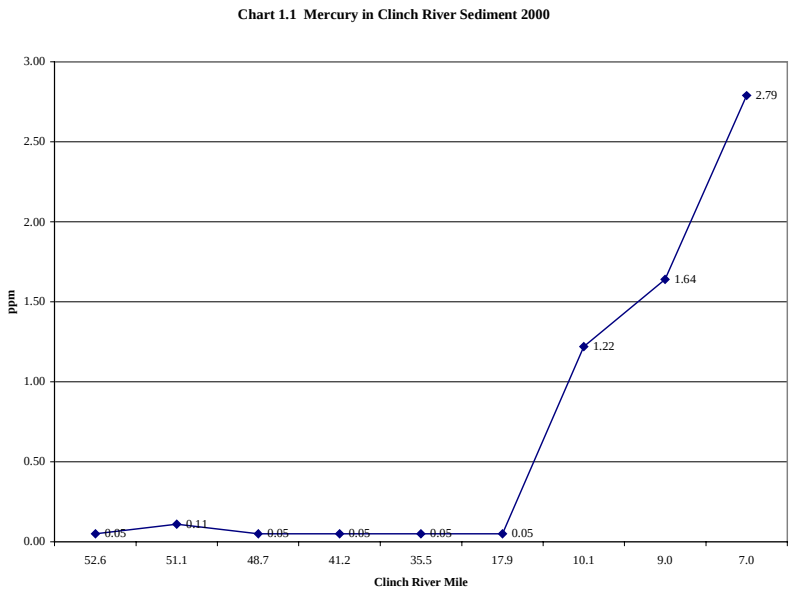
Sediment samples were taken during June using the methods described in the 2000 Ambient Sediment Monitoring Plan. The Tennessee State Laboratories processed the samples, according to EPA approved methods.

Results and Discussion

Inorganic Analyses

Inorganic analyses of sediment samples taken in 2000 showed no levels of concern based on comparisons with DOE's PRGs for recreation use of soils and sediments. Mercury levels in the samples taken in the Clinch River below the confluence of Poplar Creek (sites 5, 26, and 27: river miles 10.1, 9.0, and 7.0, respectively) increase as one goes downstream. Although the levels of mercury are well below the recreational PRG, they are higher than all of the other sediment sampling sites (see Chart 1.1).

Chart 1.1 Mercury in Clinch River Sediment 2000



Organic Analyses

Organic analyses of sediment samples taken in 2000 showed no levels of concern based on comparisons with DOE's PRGs for recreation uses of soils and sediments

Conclusion

Sediment data from 2000 samplings show no levels of contamination that exceed DOE PRGs for recreation. If in the future, these sediments are to be used for agricultural and/or other purposes, analysis may be performed to determine the suitability for these new purposes. Until that time, recreational PRGs will continue to be applied. Mercury levels in the samples taken in the Clinch River below the confluence of Poplar Creek increase as one goes downstream. Although the levels of mercury are well below the recreational PRG, they are higher than all of the other sediment sampling sites. For this reason, the investigation of sediment mercury in this region of the river will be expanded in 2001 to include two sampling sites at Clinch River Miles 4.0 and 0.0.

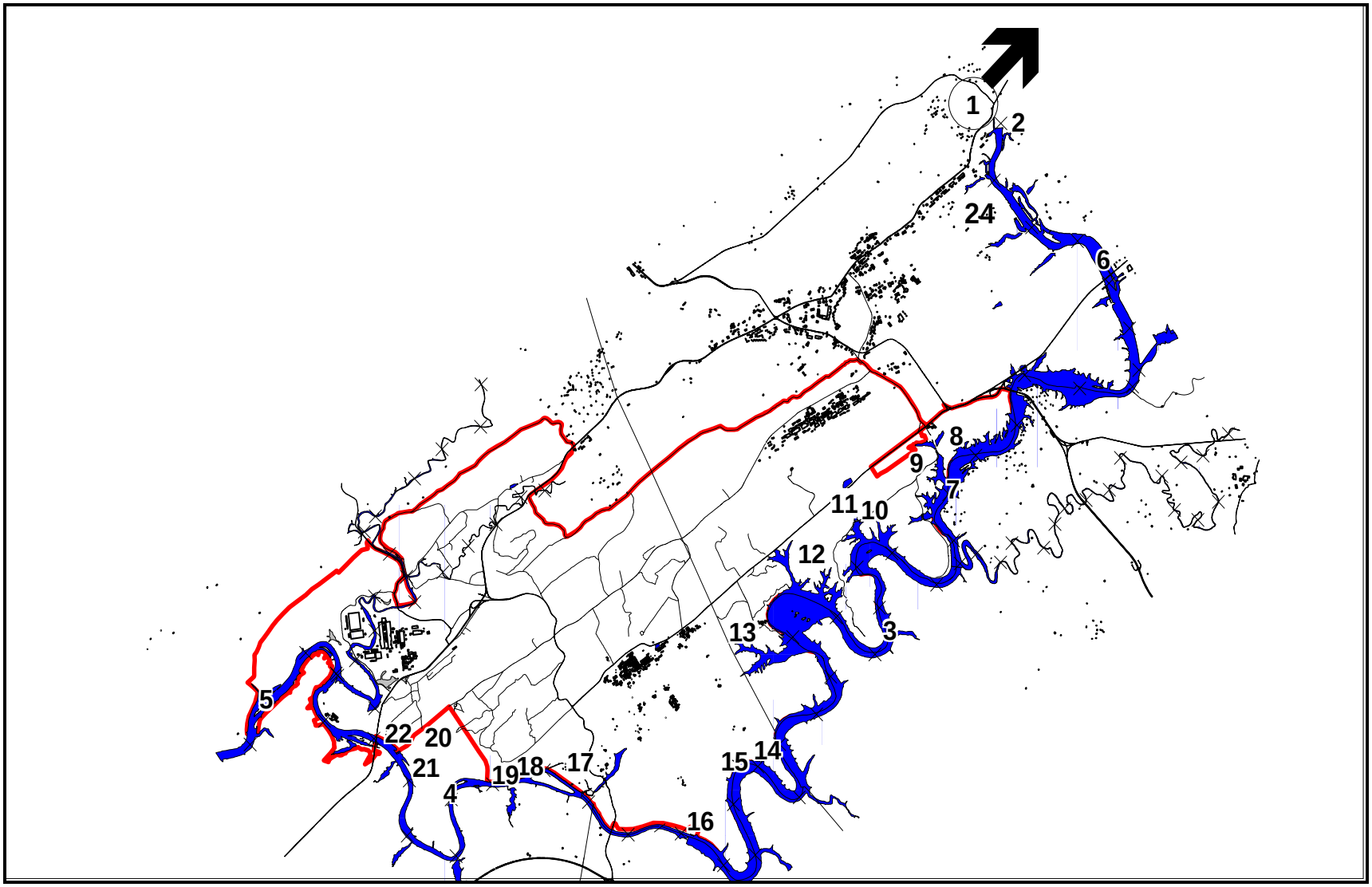
Table 1.1 Sample Locations

Site	Location	Clinch River Mile	Quarter(s) Sampled
2	Anderson County Water Treatment Plant	52.6	2
3	Melton Hill Park	35.5	2
4	Grubb Islands	17.9	2
5	Brashear Island	10.1	2
6	Bull Run Steam Plant	48.7	2
7	Water Treatment Plant	41.2	2
8	Scarboro Creek	41.2*	2
9	Kerr Hollow Branch	41.2*	2
10	McCoy Branch	37.5*	2
11	Western Branch	37.5*	2
12	East Fork of Walker Branch	33.2*	2
13	Bearden Creek	31.8*	2
14	Unnamed Stream	27.0*	None**
15	Unnamed Stream	26.6*	None**
16	Unnamed Stream	23.0*	2
17	Unnamed Stream	20.0*	2
18	Raccoon Creek	19.5*	2
19	Ish Creek	19.1*	2
20	Grassy Creek	14.55*	2
21	Unnamed Stream	14.55*	None**
22	Unnamed Stream	14.45*	2
23	Unnamed Stream	51.1*	2
24	White Creek	N.A.	2
25	Clear Creek	77*	2
26	Clinch River	9.0	2
27	Clinch River	7.0	2

*This figure is the approximate Clinch River Mile where the tributary meets the river.
**Stream was dry.

Note: Site 1, shown on Figure 1.1, is a water sampling only location

Figure 1.1. Ambient Sediment Monitoring Sites (See Table 1.1)



References

Environmental Compliance Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region 4, Environmental Services Division, Atlanta, GA, 1991.

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region 4, 960 College Station Road, Athens, GA, 1996.

Environmental Surveillance Procedures, ESH/sub/87-21706/1, Martin Marietta Energy Systems, Inc., Oak Ridge, TN, 1988.

Preliminary Remediation Goals for Use at the U.S. Department of Energy Oak Ridge Operations Office, ES/ER/TM-106/R1, Lockheed Martin Energy Systems, Inc., Oak Ridge, TN, 1995.

Standard Guide for collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing, E 1391-90, American Society for Testing and Materials, Philadelphia, PA, 1990.

Health, Safety, and Security Plan, Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1998.

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SURFACE WATER MONITORING

Coliform Concentration Levels On East Fork Poplar Creek

Principal Author: Brett Shaffer

Abstract

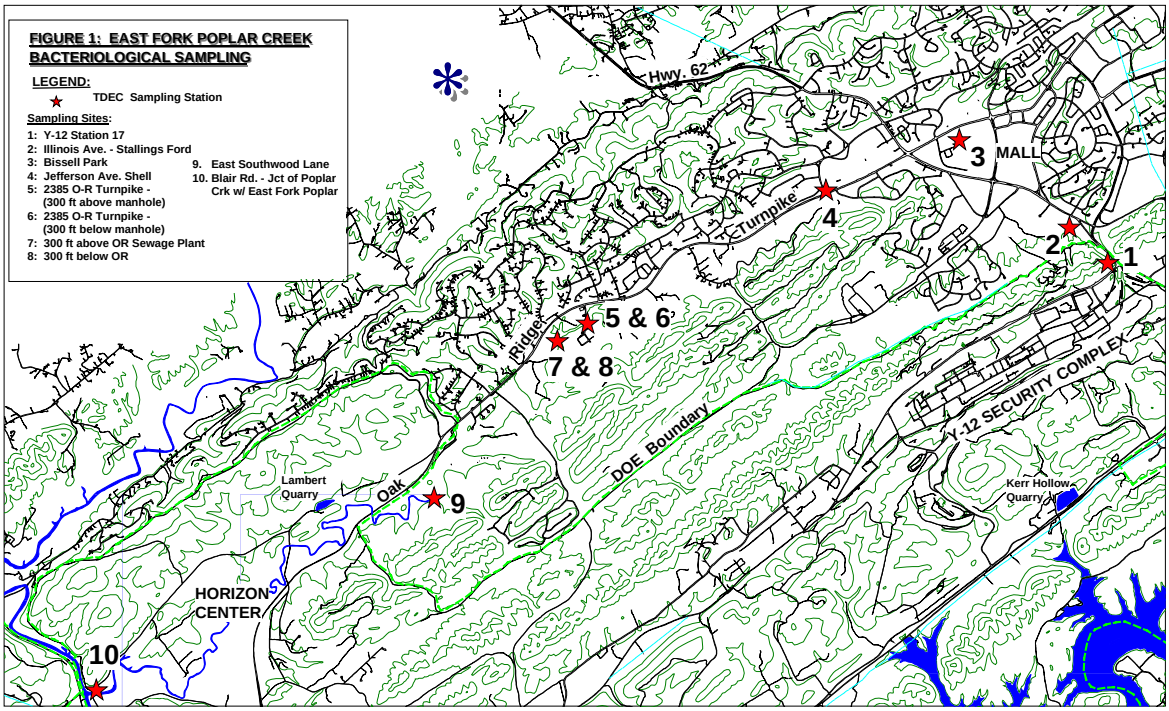
In 2000, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) performed sampling of ten locations along East Fork Poplar Creek (EFPC) as part of a project to determine if industrial operations at the Y-12 Plant have had any impact. Surface water samples were obtained over a fourteen week sampling period and analyzed for concentrations of Fecal coliform and Escherichia coli (E. coli). In accordance with the approved project plan, the Solid Waste Management Section of TDEC sampled EFPC from Y-12 Station 17 to the confluence of EFPC with the Clinch River.

During 2000, six sampling locations were not in compliance for Fecal coliform levels for Recreation Use compared to only two locations in the 1998 EFPC study. The increase in the number of sampling stations not in compliance may be due to the September 25, 2000, precipitation event which empirically raised Fecal coliform/E. coli sampling result values by an order of one magnitude. E. coli was not a measured parameter during the 1998 study. During 2000, E. coli results from surface water samples indicated that 9 of the 10 sampling locations were not in compliance for Recreation Use for the subject parameter. Based on the data collected during the 2000 study, and as per Rule 1200-4-3-.03(4)(f), the sign postings warning of contact with surface water along EFPC should remain in place.

Introduction

The project was designed to determine what environmental impacts, if any, operations at the Department of Energy (DOE) Y-12 Plant were having on East Fork Poplar Creek (EFPC) regarding concentration levels of Fecal coliform and Escherichia coli (E. coli). Fecal coliform is the measure of the total count of coliform bacteria in colonies per 100 ml of surface water sample and present in animal or human wastes. E. coli is a bacterium that is associated with the aforementioned as well, but is also known to cause disease in humans. Both parameters are measures of pollution in surface waters.

A total of 10 sampling locations were set up along EFPC from the Y-12 Plant boundary to the Blair Road Bridge in Roane County. The 10 sampling locations are listed below (Figure 1):



Methods and Equipment

The project entailed the obtaining of grab samples from the 10 aforementioned sampling locations along EFPC on a weekly basis for 14 consecutive weeks (July 17, 2000-October 16, 2000). At each sampling location, a surface water grab sample was collected in a 250 ml sterile plastic sampling bottle. The samples were placed and stored on ice at the time of collection. Upon completion of sampling, the subject samples were transported by vehicle to the Knoxville State Environmental Laboratory. After the reception of the sampling results from the Knoxville Environmental State Laboratory, the sampling results were evaluated and compared to applicable State Water Pollution Control Regulations by Division personnel.

Materials and Equipment used to perform the project included the following:

A. Approved sampling containers.
B. Cooler for transport and storage of samples.
C. Ice to maintain coolers at 4 degrees Celsius.
D. Sample paperwork and chain of custody forms.
E. Protective clothing
    1. Safety glasses.
    2. Steel toe boots.
    3. Sampling gloves.

The coliform concentration results reported from the project were evaluated and compared to applicable State Water Pollution Control Regulation 1200-4-3-.03. This regulation defines water quality criteria for water uses in the categories of domestic water supply, fish and aquatic life, recreation use, irrigation and livestock watering. The only

categories that apply to fecal coliform concentrations pertain to the domestic water supply, fish and aquatic life, and recreation use.

Regulatory concentration limits were the following at the time of the project:

Sampled Parameter	Resource Use Classification	Concentration Limit
Fecal coliform	Domestic Water Supply	≤1,000 colonies per 100 ml as a geometric mean and ≤5,000 colonies per 100 ml for an individual sample.
	Fish and Aquatic Life	≤1,000 colonies per 100 ml as a geometric mean and ≤5,000 colonies per 100 ml for an individual sample.
	Recreational	≤200 colonies per 100 ml as a geometric mean and ≤1,000 colonies per 100 ml for an individual sample.
Escherichia coli	Recreational	≤126 colonies per 100 ml as a geometric mean.

Results

The coliform study focused on sampling for two parameters: Fecal coliform and E. coli. The study, with the primary objective, was to determine the impact of Y-12 Plant operations upon EFPC. The study was performed by obtaining "grab" surface water samples from 10 locations along EFPC. The results were then compiled and evaluated in terms of a geometric mean for each sampled parameter from each sampling location. Please note that 2,419 colonies per 100 ml was the maximum measurable value when analyzing for the E. coli bacteriologic parameter even though that value may have been greater.

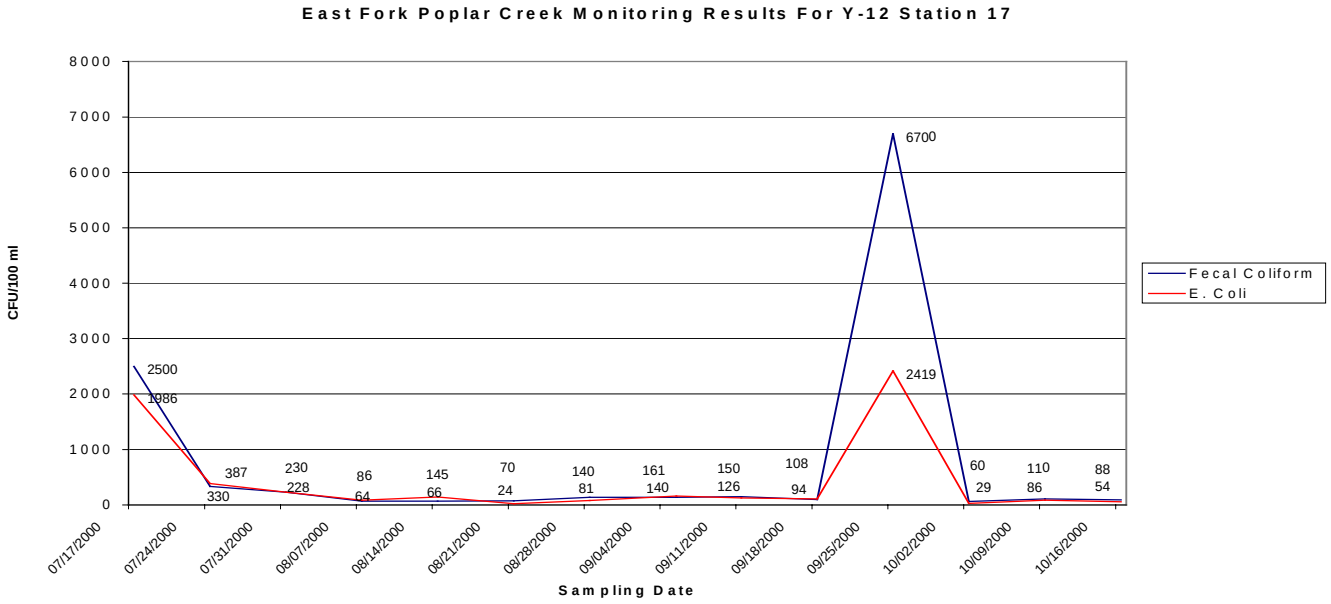
Y-12 Station 17

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
2,500	330	230	64	66
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
70	140	140	150	94
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
6,700	60	110	88	186

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
1,986	387	228	86	145
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
24	81	161	126	108
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	29	86	54	150



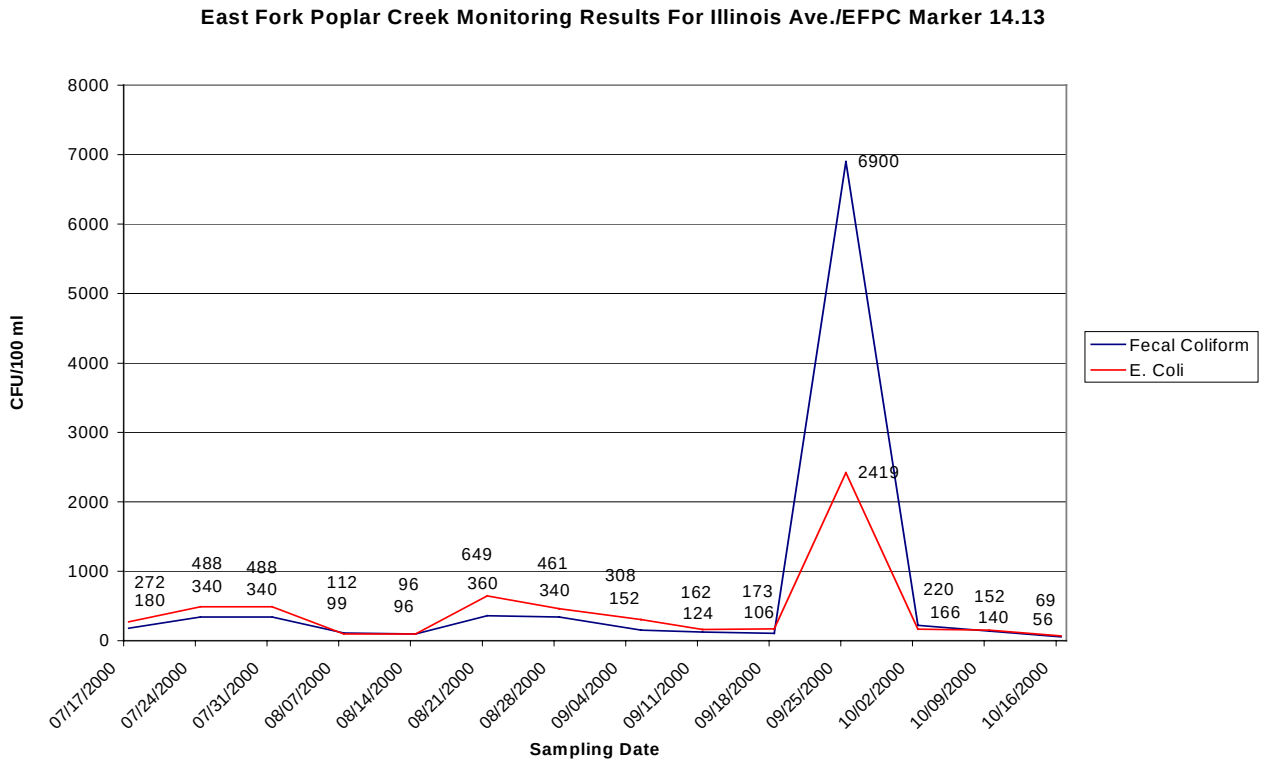
Illinois Avenue Behind Dean Stallings Ford

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
180	340	340	112	96
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
360	340	152	124	106
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
6,900	220	140	56	221

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
272	488	488	99	96
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
649	461	308	162	173
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	166	152	69	261



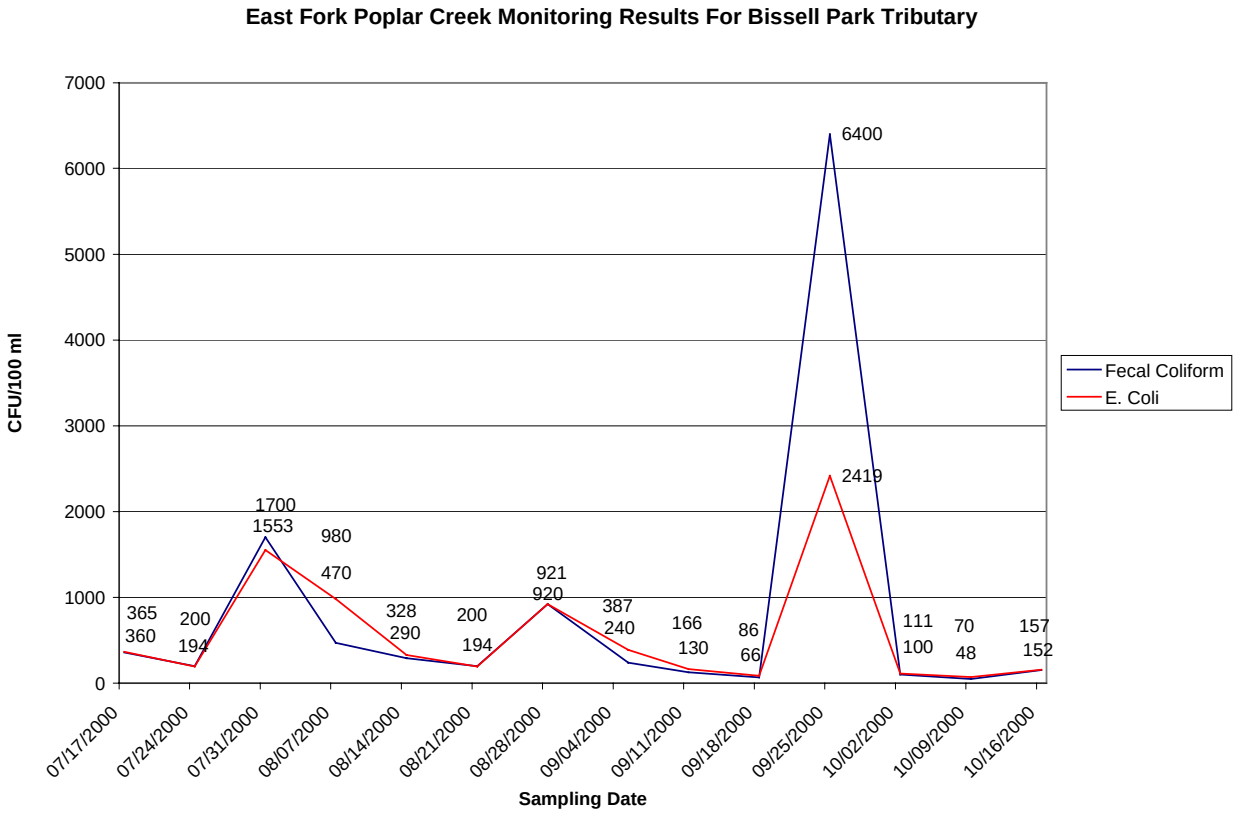
Bissell Park

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
360	200	1,700	470	290
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
200	920	240	130	66
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
6,400	100	48	152	290

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
365	194	1,553	980	328
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
194	921	387	166	86
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	111	70	157	317



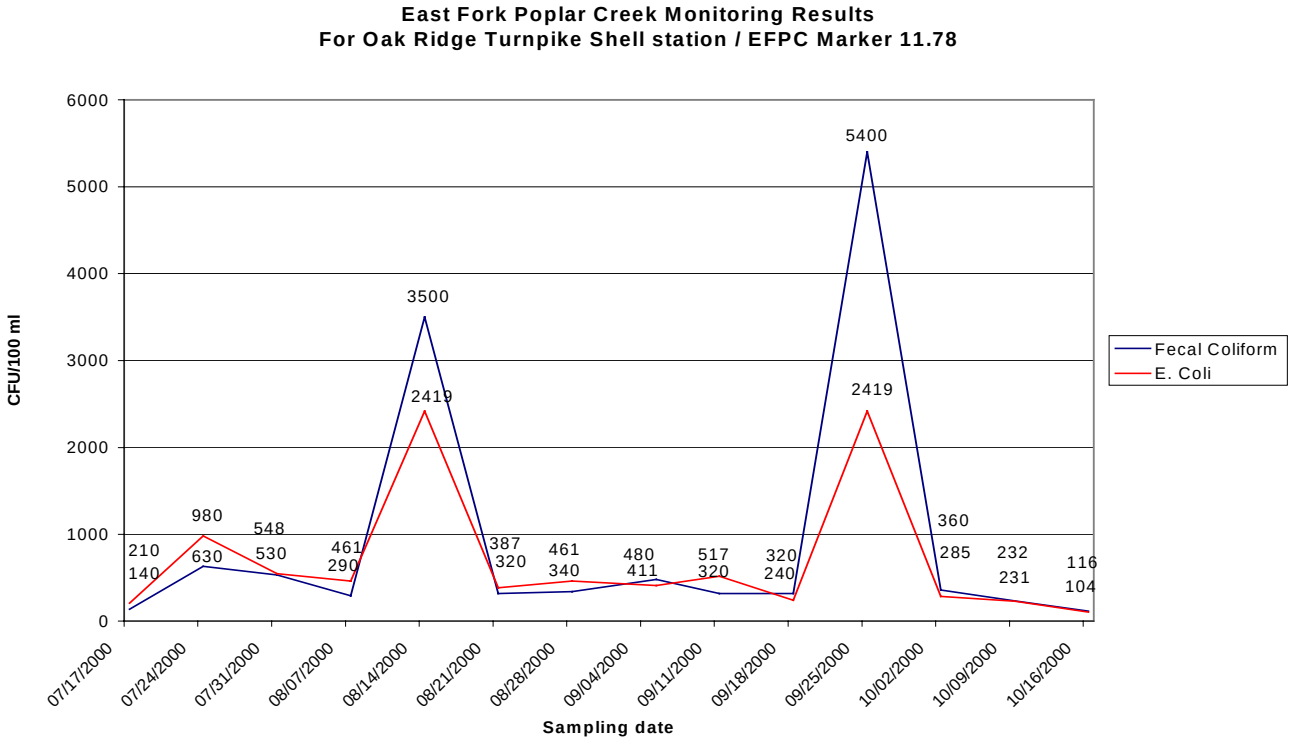
Oak Ridge Turnpike – Jefferson Street Shell Station

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
140	630	530	290	3,500
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
320	340	480	320	320
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
5,400	360	232	116	448

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
210	980	1,553	461	2,419
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
387	461	411	517	240
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	285	231	104	460



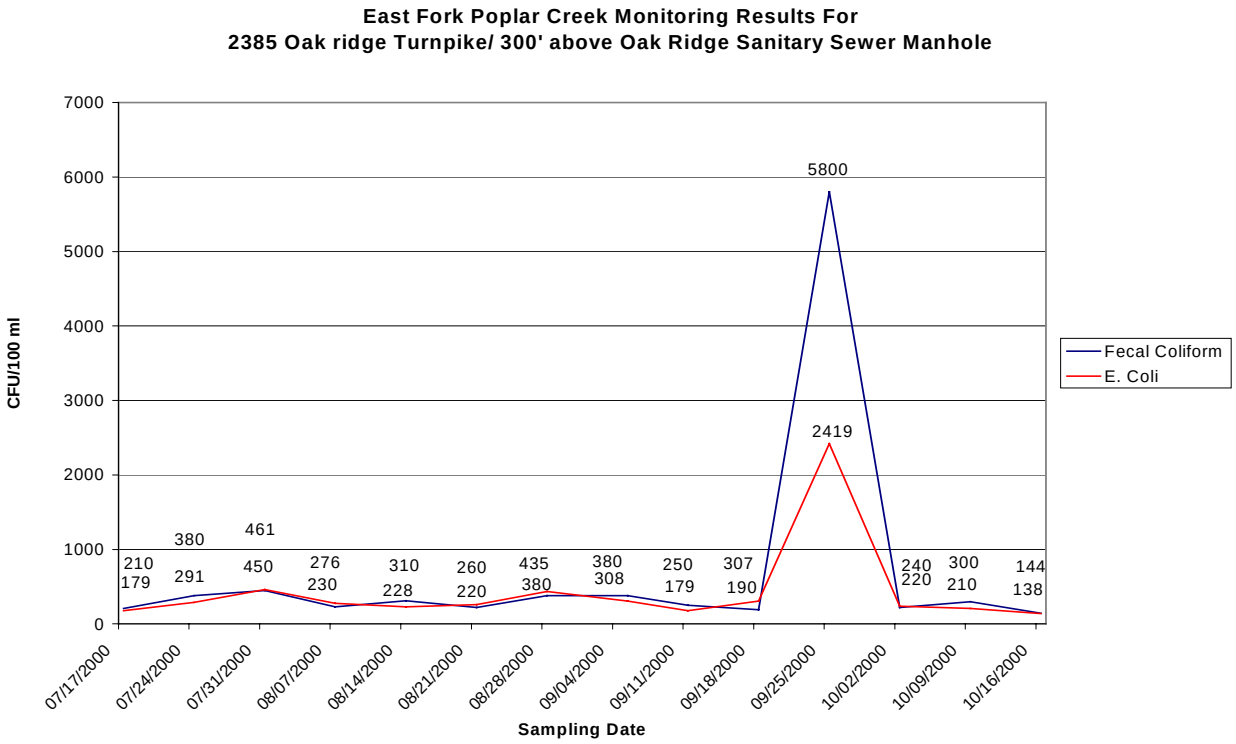
2385 Oak Ridge Turnpike 300 ft. above Oak Ridge Sanitary Sewer Manhole

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
210	380	450	230	310
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
220	380	380	250	190
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
5,800	220	300	144	334

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
179	291	461	276	228
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
260	435	308	179	307
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	240	210	138	300



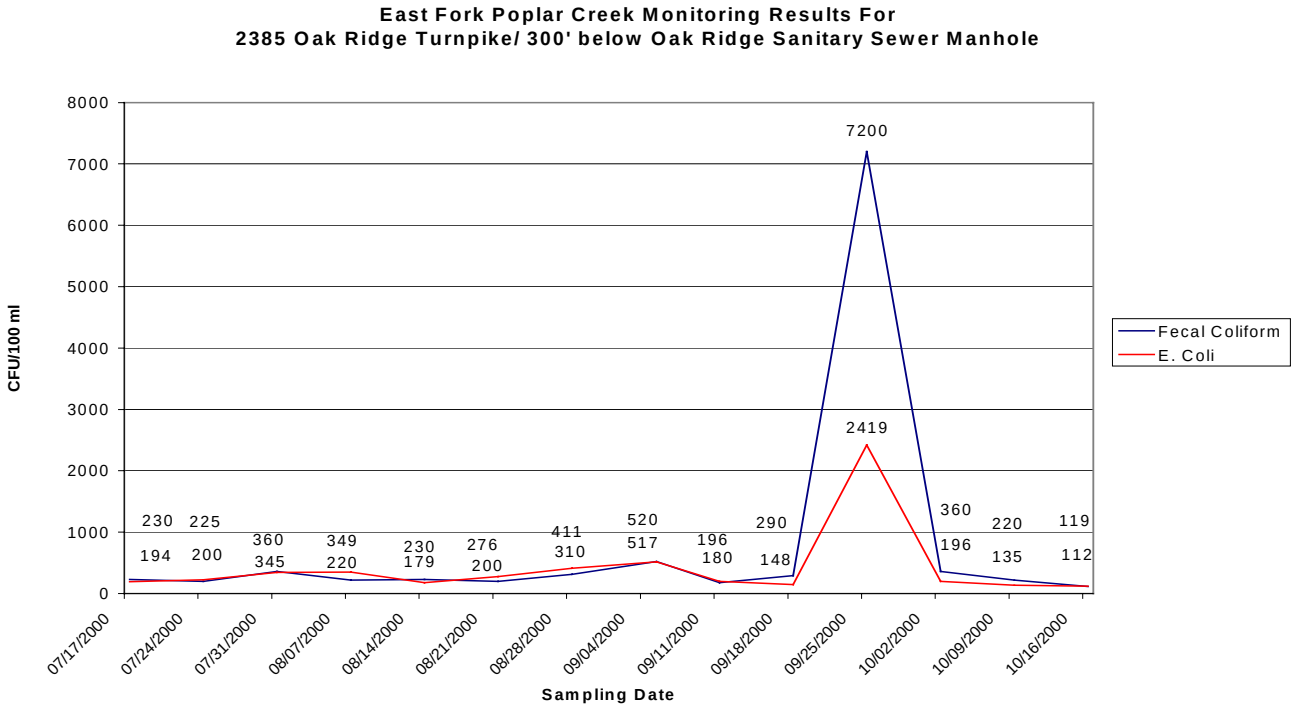
2385 Oak Ridge Turnpike 300 ft. below Oak Ridge Sanitary Sewer Manhole

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
230	200	360	220	230
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
200	310	520	180	290
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
7,200	360	220	112	314

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
194	225	345	349	179
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
276	411	517	196	148
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	196	135	119	272



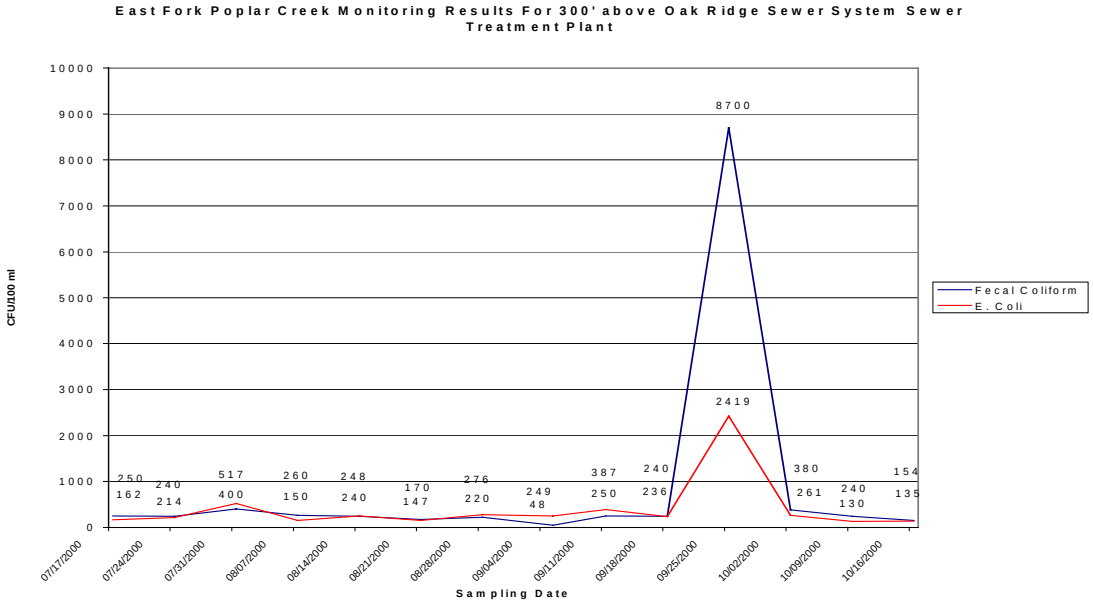
300 ft. above Oak Ridge Sewer Treatment Plant

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
250	240	400	260	240
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
170	411	517	196	240
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
8,700	380	240	154	282

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
162	214	517	150	248
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
147	276	249	387	236
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	261	130	135	261



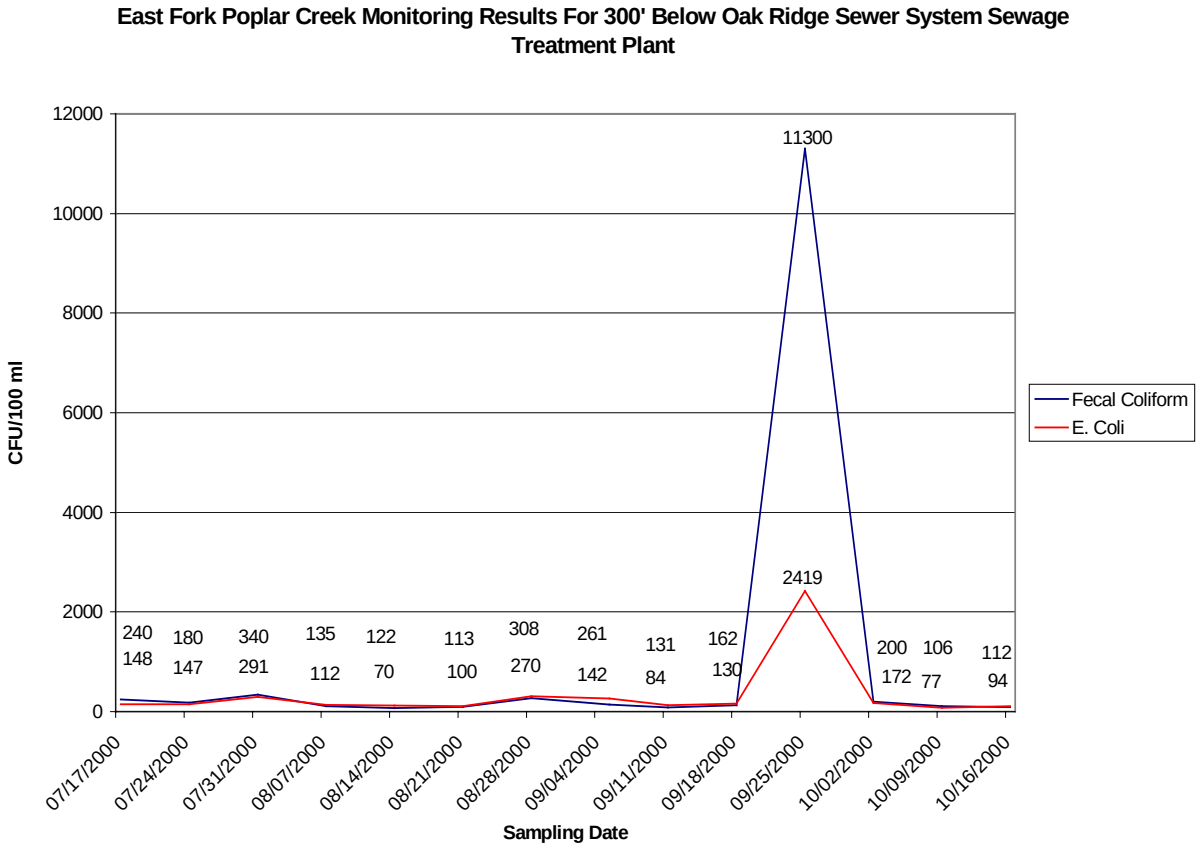
300 ft. below Oak Ridge Sewer Treatment Plant

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
240	180	340	112	70
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
100	270	142	84	130
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
11,300	200	106	94	194

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
148	147	291	135	122
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
113	308	261	131	162
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	172	77	112	189



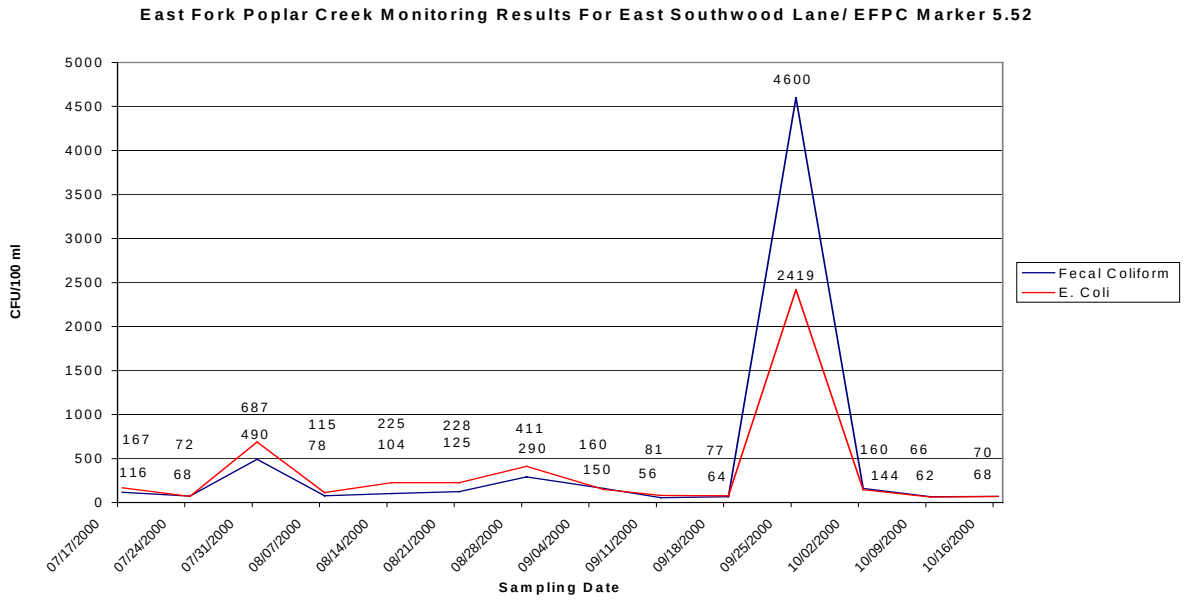
East Southwood Lane

Fecal coliform

7/17/00	7/24/00	7/31/00	8/7/00	8/14/00
116	72	490	78	104
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
125	290	160	56	64
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
4,600	160	66	68	147

E. coli

7/17/00	7/24/00	7/31/00	8/7/00	8/14/00
167	68	687	115	225
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
228	411	150	81	77
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
2,419	144	62	70	176



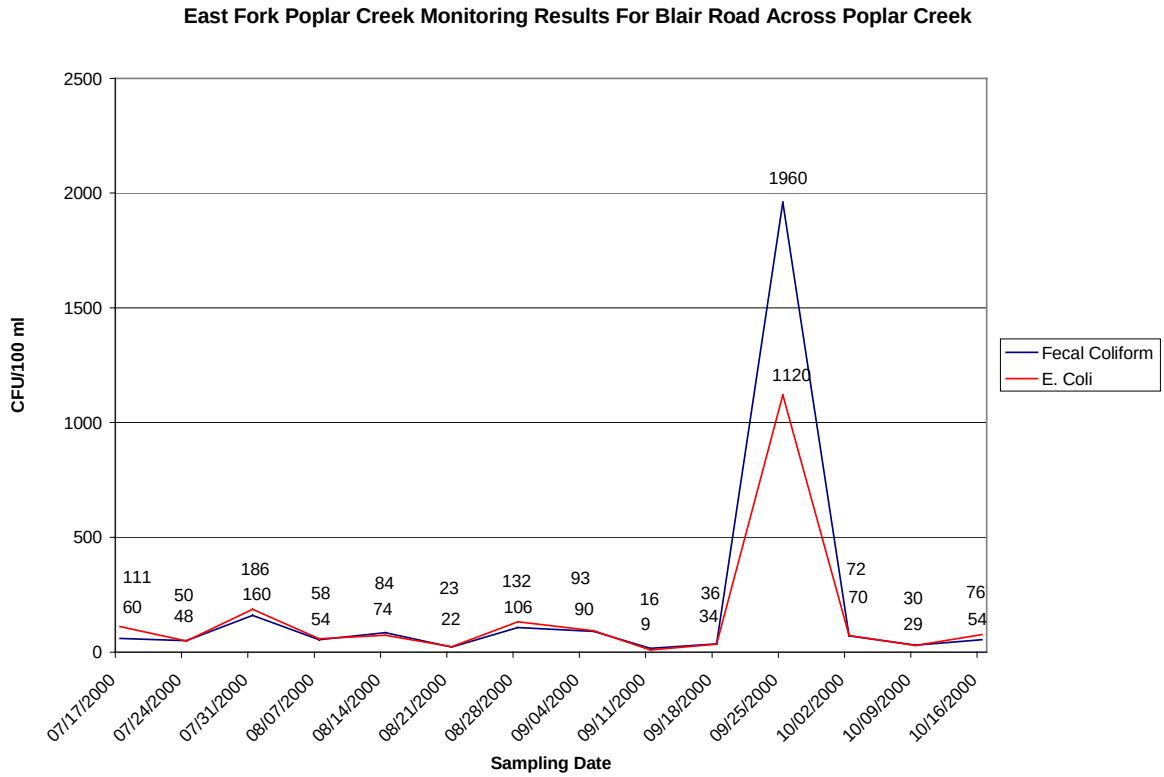
Blair Road at Confluence of East Fork Poplar Creek and the Clinch River

Fecal coliform

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
60	50	160	54	84
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
22	106	90	16	36
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
1,960	70	30	54	69

E. coli

7/17/00	**7/24/00**	**7/31/00**	**8/7/00**	**8/14/00**
111	48	186	58	74
8/21/00	**8/28/00**	**9/5/00**	**9/11/00**	**9/18/00**
23	132	93	9	34
9/25/00	**10/2/00**	**10/9/00**	**10/16/00**	**Geometric Mean**
1,120	72	29	76	70



Compliance Evaluation

The 10 sampled locations used in the project had the following geometric means when applied to the regulatory compliance limits for Fecal coliform and E. coli result in the following:

Sampling Location	Domestic Water Supply Compliance	Fish and Aquatic Compliance	Recreation Compliance
Y-12 Station 17	IC	IC	F.C.- IC E.C.- NIC
Behind Dean Stallings Ford	IC	IC	F.C.-NIC E.C.-NIC
Bissell Park Tributary	IC	IC	F.C.-NIC E.C.-NIC
Jefferson Street Shell Station	IC	IC	F.C.-NIC E.C.-NIC
300' above Oak Ridge Sewer Manhole	IC	IC	F.C.-NIC E.C.-NIC
300' below Oak Ridge Sewer Manhole	IC	IC	F.C.-NIC E.C.-NIC
300' above Oak Ridge Sewer Treatment Plant	IC	IC	F.C.-NIC E.C.-NIC
300' below Oak Ridge Sewer Treatment Plant	IC	IC	F.C.-IC E.C.-NIC
E. Southwood Ln.	IC	IC	F.C.-IC E.C.-NIC
Blair Rd. across Poplar Creek	IC	IC	F.C.-IC E.C.-IC

* IC= In Compliance NIC= Not In Compliance

Conclusion

In the 1998 report, the Bissell Park and the Shell Station sampling locations were not in compliance for Fecal coliform levels for Recreation Use. This compares to six sampling locations that were not in compliance for Fecal coliform levels for Recreation Use in the 2000 EFPC study. The increase in the number of sampling stations not in compliance may be due to the September 25, 2000, precipitation event which empirically raised Fecal coliform/E. coli sampling result values by an order of one magnitude.

E. coli was not a measured parameter during the 1998 study. During 2000, E. coli results from surface water samples indicated that 9 of the 10 sampling locations were not in compliance for the regulatory limit for the sampled parameter.

Body contact postings/warnings are typically posted for waters that contain or have the potential to contain bacteria and other pathogens associated with raw sewage. Based on the data collected during the 2000 study, and as per Rule 1200-4-3-.03(4)(f), the sign postings should remain.

References

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, TN. *Health, Safety, and Security Plan, 1998 and 1999.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, TN. *1998 Environmental Monitoring Report: Coliform and Lithium Concentrations in East Fork Poplar Creek.*

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SURFACE WATER MONITORING

Toxicity Biomonitoring of DOE Effluent Discharges

Principal Author: Chuck Campbell

Abstract

As required by the National Pollutant Discharge Elimination System (NPDES) operating permits, Department of Energy (DOE) conducts routine toxicity testing of the Oak Ridge Reservation (ORR) effluents discharging to the waters of the State of Tennessee.

The results of the toxicity tests are expressed as the concentrations of effluent that are lethal to 50% of the test organisms (LC_{50}) during a 96-hour period. Thus, the lower the value, the more toxic an effluent. The DOE NPDES permits specify effluent concentrations for which the (LC_{50}) is to be attained, as well as No Observable Adverse Effect Concentration (NOAEC), an effluent concentrations for which there should be no observable adverse effect on test organisms survival and/or reproduction.

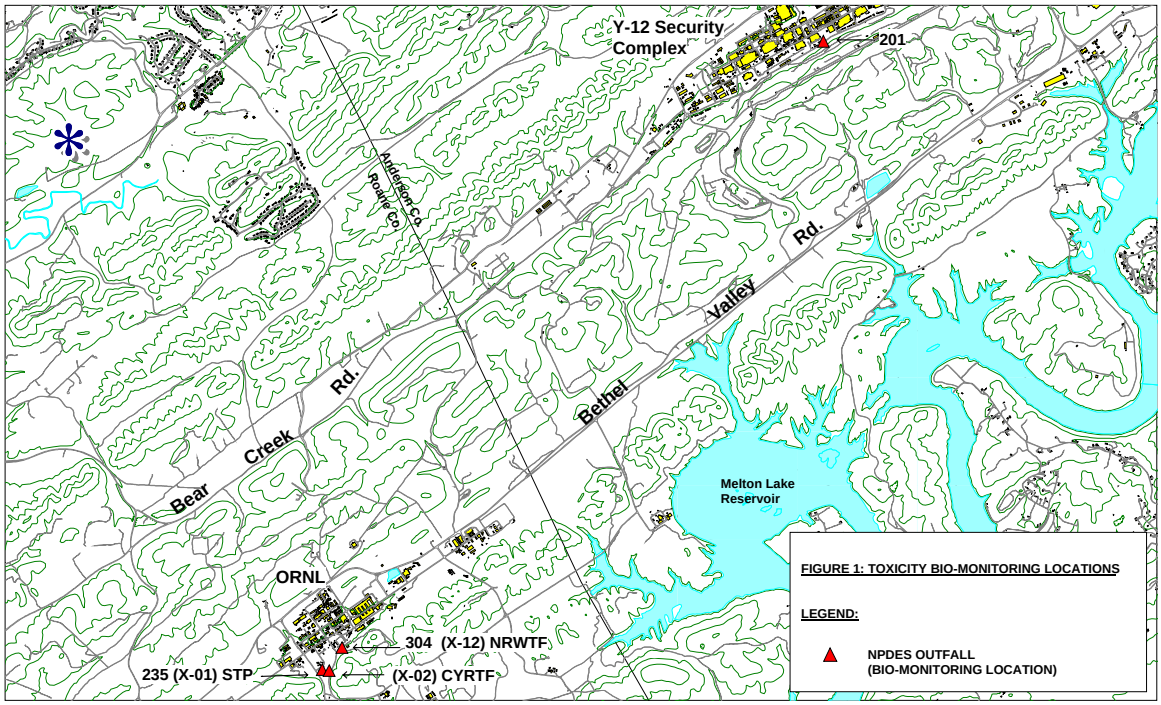
In 2000, during the period of June 5-9, 2000 and June 12-16, 2000, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducted an independent toxicity sampling at the following DOE locations depicted in items 1-4, and shown in Figure 1:

1. Oak Ridge National Laboratory (ORNL) - Outfall X-01, Sewage Treatment Plant (STP), NPDES Permit No. TN0002941,
2. Oak Ridge National Laboratory (ORNL) - Outfall X-02, Coal Yard Runoff Treatment Facility (CYRTF), NPDES Permit No. TN0002941,
3. Oak Ridge National Laboratory (ORNL), Outfall X-12, Non-Radiological Waste Treatment Facility (NRWTF), NPDES Permit No. TN0002941, and
4. Y-12 Plant-Outfall 201 (in-stream monitoring point, East Fork Poplar Creek, below North/South pipes), NPDES Permit No. TN0002968.

Based upon sample results, as shown in Tables 1-4, no DOE sites showed 96-hour lethal concentration (LC_{50}) for *Ceriodaphnia dubia* or *Pimephales promales.*

However, the effluent sample from Y-12 Outfall 201 failed to meet the permit requirements for the *Pimephales promales* in terms of NOAEC for growth.

In accordance with the NPDES permits, DOE must observe toxicity limits in its effluents discharging into the waters of the State. In addition to routine toxicity testing of final effluents, the permittee (DOE) must initiate a Toxicity Reduction Evaluation and Toxicity Identification Evaluation (TRE/TIE) when an effluent is determined to cause a significant reduction in growth or survival of test organisms.



At this time, a decision to initiate the Toxicity Reduction Evaluation and Toxicity Identification Evaluation (TRE/TIE) study is not justified. The 2000 TDEC independent testing of DOE's effluents showed an improvement over the 1999 results. TDEC will continue its independent toxicity sampling of DOE effluent discharges in 2001.

The results of the State's testing program will be compared to DOE's self-monitoring program results when they are published in the DOE Oak Ridge Reservation Annual Site Environmental Report (ASER).

The results of the toxicity tests of DOE outfalls are presented in Tables 1-4.

Introduction

In 1998, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) approved a project to conduct toxicity biomonitoring tests to verify Department of Energy's (DOE) adherence to National Pollution Discharge Elimination System (NPDES) operating permits. This project was conducted by the TDEC under the authority of the Tennessee Oversight Agreement (TOA) and was continued in 2000.

Toxicity of DOE effluents discharged into waters of the State was evaluated using a larval survival and growth test on *Pimephales promelas* (fathead minnow larvae) and *Ceriodaphnia dubia*. The data was used to calculate potential acute and chronic toxicity in the receiving water based on the 96-hour lethal concentration (LC_{50}) for 50% of the test organism and a NOAEC for survival and reproduction.

TDEC conducted the independent testing during the period of June 5-9, 2000 and June 12-16, 2000. The scheduling of TDEC's tests was dependent on the availability of the State

Toxicological Laboratory in Nashville and was not coordinated with the DOE toxicity testing schedules.

TDEC conducted an independent toxicity sampling at the following DOE locations depicted in items 1-4:

1. Oak Ridge National Laboratory (ORNL) - Outfall X-01, Sewage Treatment Plant (STP), NPDES Permit No. TN0002941,
2. Oak Ridge National Laboratory (ORNL) - Outfall X-02, Coal Yard Runoff Treatment Facility (CYRTF), NPDES Permit No. TN0002941,
3. Oak Ridge National Laboratory (ORNL), Outfall X-12, Non-Radiological Waste Treatment Facility (NRWTF), NPDES Permit No. TN0002941, and
4. Y-12 Plant-Outfall 201 (in-stream monitoring point, East Fork Poplar Creek, below North/South pipes), NPDES Permit No. TN0002968.

The quantities of effluents to be collected were determined by the State Aquatic Toxicity Laboratory in Nashville based upon each site's operating permit. Upon collecting each sample using clean Naglene bottles, it was transported to the Knoxville State Branch Laboratory for packaging and transport to the Aquatic Toxicity Laboratory in Nashville on the day of each collection. Due to technical difficulties, the tests on *Ceriodaphnia dubia* was performed by the EPA Ecological Assessment Branch laboratory, Athens, Georgia.

Methods and Materials

TDEC contacted pertinent personnel at DOE prior to sampling to ensure that a health physicist would be available to screen all equipment and samples for contamination prior to removing any materials from the facility.

Samples were collected over a three-day periods of time in June, transported to the Knoxville State Branch Laboratory, packaged, and prepared for transport via bus to the State Toxicological Laboratory in Nashville where procedural testing was completed.

The State laboratory processed the *Ceriodaphnia dubia* samples for transport and analyses to the Environmental Protection Agency (EPA) Ecological Assessment Branch laboratory in Athens, Georgia.

Equipment utilized to perform the project included:

A. Sampling equipment:
   1. ISCO sampler
   2. Safety glasses
   3. Proper footwear
   4. Disposable gloves
   5. Nylon line
   6. Extension poles for sampling bottles
   7. Approved sampling containers
   8. Coolers for storage and transport of samples
   9. Ice (samples must be maintained at <4 degrees C)
   10. Required forms/documentation

B. State vehicle

Test procedures were followed in accordance with EPA guidance documents (EPA/600/4-91/002) and the Tennessee Environmental Laboratories Standard Operating Procedures Manual 1998 with any exceptions noted. Various effluent concentrations were used as determined by each sites' NPDES permit Chronic Biomonitoring Requirements section. Each day the State/EPA Laboratories measured the dissolved oxygen and pH of the control and sample solutions prior to and after organism exposure. After dilutions were discarded on the second day of the test, readings of the water quality parameters were taken (conductivity, hardness and alkalinity).

Results and Discussion

The results of the toxicity tests are expressed as the concentrations of effluent that is lethal to 50% of the test organisms (LC_{50}) during a 96-hour period. Thus, the lower the value, the more toxic an effluent. The DOE NPDES permits specify effluent concentrations for which the (LC_{50}) is to be attained, as well as No Observable Adverse Effect Concentration (NOAEC), an effluent concentration for which there should be no observable adverse effect on test organisms survival and/or reproduction.

Summary Results from the TDEC 2000 Toxicity Tests

Table 1. ORNL Sewage Treatment Plant (Outfall X-01), NPDES Permit No. TN0002941

Date	Organisms	Test Results			
		Test	Permit Requirements	Results	
6/5-6/9 2000	*Ceriodaphnia dubia*	LC_{50}[1] @ 96 hrs	41.1%	NAT[3]	Pass
		NOAEC[2] Survival	12.3%	41.1%	Pass
		NOAEC[2] Reproduction	12.3%	41.1%	Pass
	Pimephales promales	LC_{50}[1] @ 96 hrs	41.1%	NAT[3]	Pass
		NOAEC[2] Survival	12.3%	41.1%	Pass
		NOAEC[2] Growth	12.3%	41.1%	Pass

[1] 96-hour lethal concentration for 50% of the test organisms.
[2] No Observable Adverse Effect Concentration, the highest effluent concentration at which survival/reproduction is not significantly different from the control.
[3] No Acute Toxicity.

Table 2. ORNL CYRTF (Outfall X-02), NPDES Permit No. TN0002941

Date	Organisms	Test Results			
		Test	Permit Requirements	Results	
6/5-6/9 2000	*Ceriodaphnia dubia*	LC_{50}[1] @ 96 hrs	4.2%	NAT[3]	Pass
	Pimephales promales	LC_{50}[1] @ 96 hrs	41.1%	NAT[3]	Pass

[1] 96-hour lethal concentration for 50% of the test organisms.
[3] No Acute Toxicity.
(As Outfall X-02 batch discharge did not last long enough for 2nd sample collection, the test was terminated at 48 hours as specified in the NPDES permit.)

Table 3. ORNL NRWTF (Outfall X-12), NPDES Permit No. TN0002941

Date	Organisms	Test Results			
		Test	Permit Requirements	Results	
6/5-6/9 2000	*Ceriodaphnia dubia*	LC_{50}[1] @ 96 hrs	100%	NAT[3]	Pass
		NOAEC[2] Survival	30.9%	100%	Pass
		NOAEC[2] Reproduction	30.9%	100%	Pass
	Pimephales promales	LC_{50}[1] @ 96 hrs	100%	NAT[3]	Pass
		NOAEC[2] Survival	30.9%	100%	Pass
		NOAEC[2] Growth	30.9%	100%	Pass

[1] 96-hour lethal concentration for 50% of the test organisms.
[2] No Observable Adverse Effect Concentration, the highest effluent concentration at which survival/reproduction is not significantly different from the control.
[3] No Acute Toxicity.

Table 4. Y-12 In-stream monitoring point (Outfall 201), NPDES Permit No. TN0002968

Date	Organisms	Test Results			
		Test	Permit Requirements	Results	
6/12-6/16, 2000	*Ceriodaphnia dubia*	LC_{50}[1] @ 96 hrs	100%	NAT[3]	Pass
		NOAEC[2] Survival	100%	100%	Pass
		NOAEC[2] Reproduction	100%	100%	Pass
	Pimephales promales	LC_{50}[1] @ 96 hrs	100%	NAT[3]	Pass
		NOAEC[2] Survival	100%	100%	Pass
		NOAEC[2] Growth	100%	80%	Fail

[1] 96-hour lethal concentration for 50% of the test organisms.
[2] No Observable Adverse Effect Concentration, the highest effluent concentration at which survival/reproduction is not significantly different from the control.
[3] No Acute Toxicity.

A failure to meet NOAEC permit requirements for *Pimephales promales* growth was noted at Y-12 In-stream monitoring point (Outfall 201). The test results indicated that in stream effluent concentration of 100% affected *Pimephales promales* growth.

At the time of this report the ORR Annual Site Environmental Report (ASER) for 2000 was not available.

In accordance with the NPDES permits DOE must initiate a TRE/TIE when an effluent is determined to cause a significant reduction in growth or survival of test organisms. A TRE/TIE is initiated in the event of two consecutive toxicity failures or three significant test failures within a twelve-month period. A TRE/TIE study is used to identify the toxic components of an effluent and to aid in the development and implementation of toxicity reduction plans.

The results from the previous year's (1999) TDEC's toxicity testing indicated acute toxicity to *Pimephales promales* at Y-12 Outfall 201. However, DOE toxicity testing results for the same

outfalls in 1999 did not result in similar findings, see ORR Annual Site Environmental Report (ASER) for 1999. In the 1999 ASER, DOE reported that for these respective outfalls, all NOAECs were 100% and the 96-hour LC_{50}s were all > 100% for both *Pimephales promales* and *Ceriodaphnia dubia*.

Conclusion

Based upon the TDEC's 2000 independent toxicity sample results, no DOE sites showed 96-hour lethal concentration (LC_{50}) for *Ceriodaphnia dubia* or *Pimephales promales.* However, the effluent sample from Y-12 Outfall 201 failed to meet the permit requirements for the *Pimephales promales* in terms of NOAEC for growth.

At this time, TRE/TIE study is not justified. The 2000 TDEC independent testing of DOE's effluents showed an improvement over the 1998 results. TDEC will continue its independent toxicity sampling of DOE effluent discharges in 2001.

The results of the 2000 State's testing program will be compared to DOE's self-monitoring program results when they are published in the DOE ORR ASER.

References

EPA Guidance Document for Toxicity Sampling EPA/600/4-91/002. Tennessee Environmental Laboratories Standard Operating Procedures Manual 1998.

Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN. *Environmental Monitoring Report, January through December 1999.*

ORO Annual Site Environmental Report for 1999, DOE/ORO.

Tennessee Oversight Agreement, May 13, 1991, as amended June 28, 1996.

Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN. *Health, Safety, and Security Plan*, 1998 and 1999.

DRINKING WATER

Sanitary Inspections and Cross Connection Control Plans

Principal Author: Kathleen Kitzmiller

Abstract
The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) monitors activities on the Oak Ridge Reservation (ORR) pertaining to safe drinking water, provides technical assistance as needed. Pertinent information regarding the implementation of directives for improvement is relayed to the State of Tennessee's Division of Water Supply (DWS) field office in Knoxville. TDEC reviewed DWS Sanitary surveys and responses by the Department of Energy (DOE) concerning the notice of violation issued by DWS after its December 1999 sanitary survey. TDEC also reviewed Cross Connection Control plans submitted by ETTP.

Introduction
TDEC has no authority to enforce State environmental regulations at the Oak Ridge Reservation (ORR). Regulatory authority belongs to the State of Tennessee's DWS field office in Knoxville (KEAC). The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) works closely with Knoxville Division of Water Supply (DWS). TDEC monitors activities on the ORR pertaining to safe drinking water, provides technical assistance as needed, and relays pertinent information regarding the implementation of directives for improvement to Knoxville DWS. During the past year Knoxville DWS conducted sanitary surveys of the East Tennessee Technology Park (ETTP) water treatment plant and distribution system and of the Y-12 distribution system. Representatives of the Oak Ridge National Laboratory (ORNL) distribution system responded to the notice of violation issued by Knoxville DWS subsequent to its December 1999 sanitary survey. The sanitary surveys followed guidelines set forth in the State's *Sanitary Survey Manual for Public Community Water Supplies*. Dating back to the mid-1980s, all three ORR sites have operated under State-approved cross-connection control plans. Representatives from ETTP and Y-12 met with Knoxville DWS and TDEC personnel to discuss development of updated, comprehensive plans. The process of updating such plans typically requires three to six months. The State's *Cross-Connection Control Manual* provides guidance for the design and implementation of such programs. Given certain conditions, such as, but not limited to, observed cross connections, low residual chlorine readings, or positive bacteriological test results, TDEC may elect to conduct independent sampling of ORR drinking water systems. During the course of oversight activities, TDEC personnel did not observe any conditions that warranted independent monitoring of ORR drinking water distribution systems.

Discussion

ETTP
Development of a Cross Connection Control Program for ETTP. On November 8, 2000, TDEC received a draft of a proposed cross connection control plan for ETTP. TDEC staff met November

27, 2000, with Knoxville DWS representatives to discuss comments and questions regarding the proposed plan. In turn these concerns were raised, and most of them addressed, at a November 29, 2000, meeting with the OMI Project Manager, who noted that DOE's Change Control Board reviews all plumbing/piping modifications proposed by CROET tenants only. Prime contractors at ETTP are excluded from this review process. Prime contractors occupy roughly half the available buildings at ETTP. OMI conducts walk-downs of buildings leased by CROET tenants. The primes do their own walk-downs. Bechtel Jacobs follows facility change procedures similar to those adopted by CROET. OMI inspects backflow prevention devices belonging to CROET lessees. The Equipment Testing and Inspection group (ET&I) inspects Bechtel Jacobs's devices.

Sanitary Survey of ETTP Water Treatment Plant and Distribution System. On Monday, December 11, 2000, Knoxville DWS representatives, accompanied by TDEC staff, conducted a sanitary survey of ETTP's potable water treatment plant and distribution system. In addition to general discussion and a review of records at OMI offices, ETTP's raw water intake, water treatment plant, and water storage tanks were inspected. On the previous inspection, done during March 1997, ETTP received an "Approved" rating, having scored of 98 out of 100 points possible. The two-point deduction was due to low chlorine residuals in some areas of the plant. Items discussed during this year's inspection included the following.

- The ETTP plant population now stands at roughly 2,000 including ED1, the Horizon Center.
- Only a few new taps have been made. One was at K-33 for the BNFL super-compactor. One tap has gone in and another is pending at ED1.
- The bacteriological sampling plan has been updated. Building K1001, having undergone demolition, has been removed from the list. ED1 has been added in its place.
- Triennial sampling for lead and copper took place in 1999. Due to building closures, the sampling plan will be updated for the next round of sampling.
- Next year's capital plan will include water meters.
- Water production was down at ETTP during the month of August. Since then, each succeeding month has shown increased usage. The production dip may correspond to worker concerns about drinking water safety. However, water production records for several years previous display the same trend.

Knoxville DWS noted some minor housekeeping problems at the K-1515 water treatment plant. Some water lines in the pipe gallery showed rust and peeling paint. This deficiency resulted in a one-point deduction, leading to an "Approved" rating of 99 out of 100 points. The minimum number of monthly regulatory bacteriological samples was reduced from four to two, corresponding to the estimated plant population of 2,000. Knoxville DWS also pointed out that the overall success of the cross-connection control program at ETTP requires participation by a number of parties, which now includes DOE, DOE contractors, and private companies. This necessitates the development of a new cross connection policy that clearly defines OMI's authority to conduct a comprehensive cross connection control program. This plan must also identify the responsibility and role of each stakeholder.

ORNL

Follow-Up to Sanitary Inspection of ORNL Distribution System. On December 2, 1999, Knoxville DWS conducted a sanitary survey of the ORNL potable water system. A "Provisional"

rating and subsequent notice of violation (NOV) were issued because distribution storage tanks deficiencies noted in previous TDEC surveys dating back to 1994 had not been remedied. The survey noted that Tank 902, a 3 million-gallon concrete tank, leaked about 9,000 gallons per day. Tanks 6551 and 6552, both having a 1.5 million-gallon capacity, exhibited rusting and pitting. ORNL's response to the NOV proposed the following.

- Tanks 6551 and 6552 will be repainted by December 31, 2000.
- Effective inspection and repair of Tank 902 requires that it be drained. To do so now would leave ORNL with less than one day's supply of water in the event flow through the single water main to the facility became disrupted. ORNL has obtained funding for a new, 1.5 million-gallon storage tank. Construction of the new tank should be completed by January 31, 2001. Once the new tank is in service, Tank 902 will be drained and evaluated for repairs. If the inspection reveals no unanticipated problems, repairs to Tank 902 should be finished by early 2002.

Y-12

Sanitary Survey of Y-12 Distribution System. On August 16, 2000, the Knoxville DWS conducted a sanitary survey of the Y-12 plant water system. The system received a "Provisional" rating based on a score of 95 out of 100 points. The following deficiencies were noted.

- Cross Connection Working Program. Due both to the lack of main-line backflow protection on the East 16-inch line at the entrance to the Y-12 facility and to the lack of a definitive repair schedule for faulty backflow devices, a four point deduction was taken from the survey score.
- Flushing Program. The Y-12 system's monitoring of free chlorine residual in the distribution system shows numerous instances over the past year of levels barely above the required 0.2 mg/L minimum. This indicates excessive dissipation of chlorine in the lines, which in turns suggests insufficient usage and flushing. The system has conducted a well-documented yearly flushing program. However, a biennial flushing program, supplemented by semi-monthly or even monthly flushing in some locations, appears necessary in order to maintain adequate chlorine residual levels. Inadequate flushing resulted in a one-point deduction from the survey score.

Development of a Cross Connection Control Program for Y-12. On October 31, 2000, TDEC and Knoxville DWS staff met with Y-12 representatives to discuss issues raised by the sanitary survey. The meeting focused upon the development of an acceptable and effective cross connection control program, as well as upon how best to protect the mainline.

- The Equipment Test and Inspection unit (ET&I) oversees annual testing of backflow prevention devices. Y-12's EIS system generates a "month's notice" report of which devices will come due for testing. For each device, a copy of the notice is sent to the distribution system operator, to ET&I, and to the facility manager. If a device fails testing, ET&I sends notice to the system operator and to the facility manager. A time-frame of 48 hours to correct the deficiency has now been established. If this is not done, service will be shut off until the device is repaired or replaced. All major complexes at Y-12 have parallel systems, so they would still be able to operate.

- The master list of backflow prevention devices tracks the units in service. No delinquent connections are open although some devices that have been isolated and valved off are still listed on the records. Most of the units at Y-12 are reduced pressure zone devices (RPZs). RPZs offer protection against high-hazard cross connections and often serve as substitutes for air gaps. Work is underway to standardize backflow prevention devices at Y-12. This will aid in maintaining inventory so the 48-hour time frame for repair work can be met.
- Using ORNL's cross connection control plan as a model, Y-12 plans to develop a streamlined version. Knoxville DWS noted that the plan must clearly identify who is responsible for what, and that it should lay out checks and balances. To meet state requirements, the purveyor must assess what is necessary to protect the mainline. OSHA requirements may dictate further protection internal to buildings. It was noted that the Y-12 distribution system operator has authority to lock and tag out internal devices if need be. Plant engineering reviews proposed tie-ins, which must be specified as whether they will be made to potable or process water supply lines.
- A committee has been set up to address cross connection control issues. Members include people from engineering, ET&I, and Industrial Hygiene. In addition, a water board with wider representation has also been established at Y-12.
- Several options for mainline protection have been identified. Cost estimates for each will be developed and compared. Fire protection needs will probably influence the final choice. The letter of transfer for the water treatment plant stipulates that the City of Oak Ridge will do the work and will bill Y-12 for the cost. The feasibility of valving off the East 16-inch line until mainline protection has been implemented is also under consideration. Knoxville DWS noted that Y-12 and Oak Ridge need to establish a time line for making and implementing the final choice.

Conclusion

TDEC monitored activities on the ORR pertaining to safe drinking water and provided technical assistance as needed. Pertinent information regarding the implementation of directives for improvement was relayed to the DWS field office in Knoxville. TDEC reviewed DWS Sanitary surveys and responses by the DOE concerning the notice of violation issued by DWS after its December 1999 sanitary survey. TDEC also reviewed Cross Connection Control plans submitted by ETTP. DWS has requested that TDEC conduct follow-up interviews to track the requested changes in the sanitary surveys at Y-12, ETTP, and ORNL. The water systems that DOE maintains have regulatory issues that are being addressed.

References

Tennessee Department of Environment and Conservation, Division of Water Supply, 1988. *Cross-Connection Control Manual.*

Tennessee Department of Environment and Conservation, Division of Water Supply, 1997. *Sanitary Survey Manual for Public Community Water Supplies.*

TDEC Department of Energy Oversight, November, 1998 *Health, Safety, and Security Plan.*

DRINKING WATER

Oversight of Distribution Lines

Principal Author: Kathleen Kitzmiller

Abstract
Burial grounds, contaminated soils, and contaminated groundwater, warrant evaluation of the integrity of potable water distribution systems at the three plant sites. The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) personnel reviewed distribution system plans, reviewed excavation procedures, and observed repairs of sanitary water distribution lines on the Oak Ridge Reservation (ORR) to help maintain that integrity. During the course of oversight activities, TDEC personnel did not observe any conditions that justified independent monitoring of ORR drinking water distribution systems. TDEC observed several line repairs at East Tennessee Technology Park (ETTP) and Oak Ridge National Laboratory (ORNL). No obvious violations of procedures were observed.

Introduction
The challenges presented by the Oak Ridge Reservation (ORR), which include burial grounds, contaminated soils, and contaminated groundwater, warrant continued evaluation of the integrity of potable water distribution systems at the three plant sites. Line repairs and construction activity provide an opportunity for the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) personnel to assess the current condition of the distribution system. In addition, determinations will be made as to whether these activities adhere to best management practices and to applicable drinking water regulations for the protection of the water supply. When observed conditions warrant, TDEC will conduct independent sampling. During the course of oversight activities, TDEC personnel did not observe any conditions that justified independent monitoring of ORR drinking water distribution systems. During the past year, oversight of ORR distribution lines focused upon the following areas.

- Review of Procedures for Excavation/Penetration
- Oversight of Water Line Maintenance and Repair
- Oversight of Water Main Relocation Activities at the Spallation Neutron Source Construction Site

Discussion

Review of Procedures for Excavation/Penetration. During the past year, TDEC obtained copies of procedures for the initiation, review, issuance, and termination of excavation/penetration permits at ETTP, ORNL, and Y-12. TDEC staff reviewed and compared the procedures in use at each facility. The permit process at each facility follows a formal sequenced set of steps requiring thorough review and sign-off by numerous parties including but not limited to the following: engineering, radiation control, employee safety, environmental protection, utilities, and facilities management. Each set of permit procedures allows latitude for situations that require quick action in order to restore system control. It is expected however that efforts will be made to conform as closely as possible to accepted operational practices, and that permits will be obtained for planned work in response to the triggering event.

Oversight of Water Line Maintenance and Repair

ETTP

- On January 31, 2000, TDEC staff observed repairs to a water line between Building K-1401 and the K-1008 series of change houses. The six-inch cast iron pipe had broken cleanly. The probable cause of this and other recent line breaks at ETTP was the sharp drop in temperature within the last few days.

- The ETTP Morning Report for June 16-17, 2000, noted that "OMI valved off the water to the K-1550 trailers for the weekend to evaluate a wet spot that may be a water leak." OMI workers subsequently confirmed the presence of a water leak in a two-inch galvanized line. They planned to use a full-circle clamp to repair the broken line. Moderately aggressive soil surrounding the line has contributed to corrosion problems in this area. The galvanized line was laid down when the trailers were moved in to serve as "temporary" buildings. The trailers are scheduled for removal so that the area can be converted to a parking lot. When this happens, the galvanized line will be abandoned in place.

- The K802 pump house for ETTP's firewater at one time also was used for the defunct recirculating cooling water system. Firewater from this site was collected on August 9, 2000, as part of the special water sampling effort at ETTP. This location had been identified as one of concern, i.e. a possible cross-connection site, by PACE and the sick-workers group. As part of an ongoing program to cut and cap out-of-service water lines and to replace lead fittings, on August 24, 2000, OMI workers excavated two sites adjacent to K802. At one of the sites, along the eastern side of the pump house, the work crew found that the four-inch potable water line had already been cut and capped. At the second site, across the street from the entrance to K802, a tee-connection ran from the four-inch line into the pump house. The work crew planned to cut the tee-connector from the out-of –service water line and to replace with a straight pipe section, thereby completely eliminating the possibility of a cross-connection.

- The ETTP Morning Report for November 19-20, 2000, noted that the sanitary water supply to K-1423 had been isolated due to an underground break. The OMI Project Manager stated that the two-inch service line would remain valved off pending repairs.

- On Monday, December 4, 2000, the OMI Project Manager called TDEC to report a break in one of several water mains leading into ETTP. At about 7 p.m. the previous Friday, workers in the bioassay building (K-1028-57) noticed that water had worked its way up through the building floor. The bioassay building sits between the Portal 2 guard shack (K-1028-59), and the ETTP Visitors Center (K-1000). The bioassay building also rests directly above a ten-inch water main. OMI workers valved off the main above and below the bioassay building in order to isolate the general vicinity of the leak. ETTP's grid-type sanitary water distribution system maintained system pressure above and below the isolated section. But this left the Visitors Center without potable water service.

  By late Monday afternoon the excavation, near the intersection of Avenue F and Second Avenue, had exposed a section of water main next to the north wall of the bioassay building. The actual location of the break was still not evident. In order to restore minimal water supply to

the Visitors Center, workers ran a length of hose from the nearest sanitary water source, building K-1580. Water supplied through the hose was for non-potable use only, e.g. to flush toilets. The connection between the hose and K-1580 was fit with a backflow preventer. On Tuesday morning, the work crew valved the water back on long enough to determine that the main had broken beneath the bioassay building. This ruled out quick and easy repair. The primary concern shifted to setting up an interim means to supply potable water to the ETTP Visitors Center. The plan was first to cut and cap the water main at the site excavated the previous day, then to run a two-inch service line from the capped end of the pressurized main to the Visitors Center.

By Thursday, December 7, 2000, the cutting and capping had been completed. Tie rods had been installed to restrain the new fittings. The service line, wrapped with insulation for protection from freezing temperatures, extended from the capped main up to and around the side of the bioassay building. From there the line ran overhead across the walkway between the bioassay building and the Visitors Center. The OMI Project Manager reported that bacteriological samples from the new line had been submitted to the State Laboratory in Knoxville. OMI will prepare cost/benefit comparisons of repair alternatives such as slip-lining the existing main or relocating the main around nearby buildings.

- The ETTP Morning Report for December 24-25, 2000, noted that sanitary water had been valved off to the entire TSCA area due to a water break. The OMI Project Manager noted that TSCA management had requested the shut off.

- The ETTP Morning Report for December 24 and 25 also mentioned that OMI had reported a sanitary water break at K-1098-F. OMI isolated the break, which turned out to be in a firewater line.

ORNL

On May 24, 2000, TDEC received notice that ORNL Utilities workers planned to remove a six-inch water valve. A water leak on a six-inch main in ORNL's East Support Area (7000 Area) had been traced to a valve located between three-inch firewater and potable-water lines leading into the Central Mechanical Shops Building (X-7012). The three-inch firewater line had been abandoned in place eliminating the need for a valve at this location. It was decided to replace the section of the water main that included the leaky valve with a new valveless section fabricated by ORNL pipe fitters.

Radiation readings had been taken of the soil prior to beginning the excavation. No radiation was detected, so the soil would be returned to its place. The exposed main and pipes had been scanned for radioactivity before their removal. Again, no radiation had been detected. The work crew cut out and removed the tee-shaped section that held the leaking valve. After the old section of the main had been lifted out, it was thoroughly scanned and then green-tagged. The crew swabbed out the new section with disinfectant. Disinfectant was also applied to the exposed edges of the water main. Next the crew eased the new section into place and tightened the bolts. Water to the main was turned back on. The fire hydrant was opened to flush out the new line. No leaks were observed. A bacteriological sample of the water running through the main would be

taken to determine water quality. The new configuration of the water main and status of the inactive line will be entered into ORNL's database for the water distribution system

Water Main Relocation at the Spallation Neutron Source Construction Site

ORNL obtains potable water through a 24-inch water main that passes across Chestnut Ridge. The water main as originally built followed a path that cut across the site of the future SNS facility. Preliminary construction activities, including those for the relocation of the water main, were under way by early May. The relocated water main wraps around the southeast perimeter of the SNS site. Tie-in work for the relocation was scheduled to take place during times of minimal water use at ORNL, during the weekend and/or while the High Flux Isotope Reactor Facility was down. Work on the first tie-in for the SNS water main relocation, nearest Bear Creek Valley, took place Saturday, July 22, 2000. The tie-in's tee-connection provided a way to get water up the hill to flush out and sanitize the new main prior to putting it into service. ORNL workers completed the second tie-in, nearest Bethel Valley, on Wednesday, August 23, 2000. Following completion of the second tie-in potable water for ORNL was routed through the relocated section of water main. The old section of water main between the tie-in points for the relocation has been abandoned in place.

Early July 22, 2000, City of Oak Ridge workers shut off water flow from the 24-inch main alongside Bear Creek Road. Enough water was drained from the existing main to allow work to proceed. Beyond Chestnut Ridge, water from the main was diverted to an open graded area where the chlorine could dissipate. Portable dechlorinators treated the water feeding into Bear Creek. Chlorine and dissolved oxygen measurements taken throughout the day established that the units operated effectively.

The excavation work had been completed previously. The work crew cut through the exposed water main at two points. The second cut finished, a crane lifted the section of water main and placed it on a waiting flatbed. The inner surface of the water main appeared clean and free of deposits. The section was scanned for radioactivity and then green-tagged. Prior to bolting the new tee-shaped section into place, disinfectant was applied to it as well as to the exposed ends of the water main. Water flow to ORNL was reestablished by mid-afternoon. The water main at the tie-in point remained exposed until the connection with the relocated main had been completed. Because work was proceeding quickly, the hole was open only a few weeks. Valve assemblies were fitted with tamper-proof covers. The tie-in point lay right beside a heavily used stretch of Chestnut Ridge Road. As a precaution, dirt barriers were bulldozed around the excavation area.

On Wednesday August 16, 2000, the new water main section was filled with chlorinated water. No leaks were detected. Pressure tests were conducted successfully on Friday, August 18, 2000. Water was drained from the new section of water main. The main was then refilled with highly chlorinated water, which remained in place over the weekend. Water samples for bacteriological testing were drawn on Monday, August 21, 2000, and sent to the State laboratory in Knoxville. The samples tested negative for total coliforms. The new section was drained for the second time on Tuesday, August 22, 2000.

Early Wednesday, August 23, 2000,the original water main was valved off. Water was drained from the section of the old main that lay near the second tie-in point. Most of it flowed eastward onto a large open area that had previously been cleared of vegetation. The remainder was directed through

a pair of portable dechlorinators placed at the head of a streambed located just below the intersection of Chestnut Ridge and McBee Roads. The dechlorinated water flowed downstream to the upper end of the retention pond area. Chlorinated water from the new section had been drained in a similar manner.

Excavation work for the second tie-in had been completed about 100 yards further east beside Chestnut Ridge Road. Concrete thrust blocks had been installed to support the ends of the old and new sections of water main to be joined together. By mid-morning, the work crew had completed both cuts to the original water main. A crane hoisted the cut section onto a flat bed truck. The interior of the old main appeared clean and free of deposits. The connector sections, a straight piece of 24-inch pipe and a 24-inch, 45-degree elbow, were sanitized and then lowered into the workspace. Fitting the connectors together took a long time and a lot of painstaking work. By mid-afternoon the work crew had finally rolled the 45-degree elbow into place, and bolted steel reinforcement rods in place. Next, as a backhoe began to move soil back into the excavation site, laborers packed the soil down around the thrust blocks and new section of water main. The water valve was opened slightly, to begin pushing out the air from the empty section of the water main. Water service to ORNL was successfully reestablished.

Conclusion

Burial grounds, contaminated soils, and contaminated groundwater, warrant continued evaluation of the integrity of potable water distribution systems at the three plant sites. TDEC personnel reviewed distribution system plans, reviewed excavation procedures, and observed repairs of sanitary water distribution lines on the ORR to help maintain that integrity. During the course of oversight activities, TDEC personnel did not observe any conditions that justified independent monitoring of ORR drinking water distribution systems. TDEC observed several line repairs at ETTP and ORNL. No obvious violations of procedures were observed. Based on observations the systems appear to be in good condition.

Reference

TDEC Department of Energy Oversight, November, 1998 *Health, Safety, and Security Plan.*

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DRINKING WATER

Oversight of Free Residual Chlorine and Bacteriological Sampling of Oak Ridge Reservation Sanitary Water Distribution Systems

Principal Author: Kathleen Kitzmiller

Abstract

As the three Department of Energy (DOE) Oak Ridge Reservation (ORR) plants become more accessible to the public, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) has expanded its oversight of the DOE facilities' safe drinking water programs. Oversight, where there is public access and limited public access, of all potable water quality on or impacted by the ORR is part of TDEC Oversight independent sampling. TDEC conducted oversight of total coliform bacteria and free residual chlorine sampling at various buildings on the DOE ORR. Oversight of routine, monthly sampling activities allowed TDEC personnel to become familiar with site potable water contacts in each plant's utility organization or subcontractor. In conjunction with these oversight activities, TDEC took independent samples of free chlorine residuals during site visits to monitor monthly sampling activities.

Introduction

Public consumption of the water on the Oak Ridge Reservation (ORR) continues to increase. In order to facilitate technology transfer, work for non-governmental sectors, and utilization of surplus buildings by private companies, security has been relaxed or reprioritized in recent years at some portions of the sites, most notably at East Tennessee Technology Park (ETTP). In turn the composition of the workforce at the ORR has changed substantially. Oak Ridge National Laboratory (ORNL) has always hosted foreign dignitaries and accommodated visiting scientists in an openly cooperative manner. The other two sites, ETTP and Y-12, until recently allowed only limited public visitation. Current facility use involves a substantial public presence at ETTP and ORNL, and to a lesser extent at Y-12.

During May 2000, Department of Energy (DOE) transferred the Y-12 water treatment plant to the City of Oak Ridge. Both the ETTP and the former Y-12 water treatment plants withdraw surface water from the Clinch River, add coagulants to precipitate suspended sediment, use chlorine disinfectant, and filter water prior to distribution. As prescribed by *Tennessee Regulations for Public Water Systems and Drinking Water Quality - Chapter 1200-5-1*, most sampling focuses upon finished water at the treatment plant prior to distribution. State regulations require relatively little sampling at locations within distribution systems. The ORR potable water systems have been classified as non-community, non-transient systems. *Rule 1200-5-1-.07(1)(d)(3)* states that non-community water systems using surface water must monitor for total coliforms with the frequency required of like-sized community water systems. *Rule 1200-5-1-.31(5)(c)(3)* directs that residual disinfectant concentration be measured at the same times and locations that monthly microbiological contaminant samples are collected. Requirements set forth by *Rule 1200-5-1-.17(4)* mandate that not more than five percent of samples taken each month for two consecutive months contain less than 0.2 mg/L free chlorine residual. Shown below are the minimum number of bacteriological samples required for each of the DOE distribution systems set forth by the sanitary surveys in effect for Calendar Year 2000.

Table 1. ORR Plant Populations and Required Samples

Facility	Estimated Population	Minimum Samples
ETTP	3,500	4
ORNL	5,000	6
Y-12	5,080	6

Methods and Materials

Although TDEC will conduct independent sampling when situations indicate that the quality of drinking water in an ORR distribution system may be compromised or that the general integrity of the system is in doubt, the objective of this task was to conduct oversight of routine regulatory bacteriological and free residual chlorine monitoring at ETTP, ORNL, and Y-12. Coliform bacteria serve to indicate the presence of pathogenic organisms. A positive microbiological sample signals that pathogens may have entered the water supply due to inadequate initial treatment, poor sanitation, faulty line repair work, or cross connections to potable water distribution lines. During calendar year 2000, TDEC did not observe conditions in ORR distribution systems that warranted collection of independent bacteriological samples, and instead conducted sampling for free residual chlorine only. TDEC used a Hach pocket colorimeter to measure free residual chlorine levels at all three facilities. Monitoring followed Method 4500-Cl G, DPD Colorimetric Method, outlined in the *Standards Methods for the Examination of Water and Wastewater, 20th Edition.* One of two small sample containers is reserved for a sample blank. A reagent, DPD powder, is added to the remaining container. The powder reacts with free chlorine present in the drinking water sample. A slight free chlorine residual results in a pale pink hue, whereas a high chlorine residual produces a deep cranberry color. The colorimeter then measures the concentration of free chlorine in the sample

Bound logbooks, databases, and trip reports serve collectively to document TDEC's potable water oversight activities.

Results and Discussion

Thirteen visits were made to oversee monthly bacteriological and free chlorine residual sampling. TDEC sampling for free residual chlorine was done using TDEC's colorimeter. Table 2 summarizes the sampling results.

Table 2. Oversight Visits - Observation of Monthly Sampling

Date of Visit	ORR Facility	Number of Bacteriological Samples Contractor	Lowest Free Chlorine Residual Contractor/TDEC (mg/L)
06/06/00	ETTP	4	0.38 / 0.51
06/12/00	ORNL	3	0.80 / no readings
07/10/00	ORNL	3	0.36 / 0.37
07/11/00	ETTP	4	0.73 / 0.79
08/07/00	ORNL	3	0.93 / 0.98
09/18/00	ORNL	3	0.77 / 0.98
10/09/00	ORNL	3	1.01 / 1.1
10/17/00	ETTP	4	1.1 / 1.03
11/06/00	ORNL	3	0.68 / 0.98
11/07/00	Y-12	6	0.5 / 0.91
11/13/00	ORNL	3	0.77 / 0.80
12/04/00	ORNL	3	0.70 / 0.81
12/11/00	ORNL	3	0.67 / 0.63

Conclusion

As can be seen in Table 2 no samples collected by the contractor or TDEC indicated chlorine levels to be below the regulatory limit of 0.2 mg/L. Also, there were no samples reported to have elevated levels of bacteria above the regulatory limits. TDEC will continue to monitor the sample collection activities and if conditions warrant will collect free chlorine and/or bacteriological samples for comparisons.

References

Clesceri, L.S., A.E. Greenberg, and A.D. Eaton, eds. Washington, D.C: American Public Health Association, American Water Works Association, and Water Environment Federation, 20th ed. 1998. *Standard Methods for the Examination of Water and Wastewater.*

Tennessee Department of Environment and Conservation, Division of Water Supply, 2001. *Regulations for Public Water Systems and Drinking Water*, Chapter 1200-5-1.

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DRINKING WATER

Review of Area Water Systems

Principal Author: Kathleen Kitzmiller

Abstract
In order to determine if there is or could be impacts to public water systems in the area by the Department of Energy (DOE), the Tennessee Department Of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) monitors the quality of water in local streams, the Clinch River and at area water treatment plants. This involves comparison of Consumer Confidence Reports (CCR's), independent sampling of raw and treated water, reviews of emergency operations plans, and review of regulatory inspection reports. None of the levels reported by any of the systems for any of the contaminants exceeded maximum contaminant level (MCLs). No health-based violations were found for any of these water treatment systems since 1993, the oldest year recorded in the Environmental Protection Agency (EPA) database.

Introduction
Pollution from past and current activities on the Oak Ridge Reservation (ORR) has the potential to impact public water supplies in the area. The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) program sections monitor the quality of water in local streams, in the Clinch River, and at area water treatment plants. In addition State regulations require public water suppliers to test for an array of contaminants on a regular basis. Should conditions warrant, TDEC might elect to conduct independent sampling of raw water entering area water treatment systems, however, the analytical results obtained by the various monitoring efforts did not indicate a need to do so. During the past year, oversight of area water systems focused upon the following items.

- Comparison of Consumer Confidence Reports for Surface Water Treatment and Distribution Systems in the Vicinity of the Oak Ridge Reservation
- Transfer of the Y-12 Water Treatment Plant to the City of Oak Ridge
- Clark Center Recreation Park

Discussion
Comparison of Consumer Confidence Reports for Surface Water Treatment and Distribution Systems in the Vicinity of the Oak Ridge Reservation. 1999 represented the first year that the EPA required community water suppliers to issue annual drinking water quality reports to their customers. These reports were due by October 1999. The 1999 reports provide information for calendar year 1998. Future CCRs will be issued by July 1 of subsequent years. Among other items, community water systems must report the level, or range of levels, of any contaminant found in local drinking water. They must also list the EPA's MCL for comparison, as well as the likely source of the contaminant. The water treatment systems listed below were selected from a list of surface-water systems within a fifty-mile radius of the ORR. One group of water treatment systems - Clinton through East Tennessee Technology Park (ETTP) - draws water from the Clinch River. The remaining water treatment systems - Kingston through Dayton - either lay directly downstream of the ORR or under certain conditions may be impacted by water that has passed through the ORR.

Table 1: Area Surface Water Systems

Water Treatment System	County	Location of Surface Water Intake
Clinton	Anderson	Clinch RM 66.2
Anderson County	Anderson	Clinch RM 52.5
West Knox U.D., Daugherty	Knox	Clinch RM 46.2
Oak Ridge / DOE (Y-12)	Anderson	Clinch RM 41.6
West Knox U.D., Williams Bend	Knox	Clinch RM 36.6
East Tennessee Technology Park	Roane	Clinch RM 14.5
Kingston	Roane	Tennessee RM 568.4
Harriman	Roane	Emory RM 12.8
Rockwood	Roane	King Creek embayment of TN River
Spring City	Rhea	Piney River embayment of Watts Bar Lake
Dayton	Rhea	Tennessee RM 504

TDEC obtained copies of the 1999 CCRs published by the nine public water systems listed above. ETTP, being a non-community system, was not required to issue such a document. However, using data obtained from reports submitted to TDEC's Division of Water Supply, TDEC constructed the equivalent of a CCR for ETTP. The table below shows the contaminants most frequently reported by the ten water treatment systems. None of the levels reported by any of the systems for any of the contaminants exceeded MCLs. The reported levels of contaminants did not appear to be linked to the geographic location of water systems.

According to May 2000, Safe Drinking Water Violation Reports listed by the EPA on the internet, no health-based violations were found for any of these water treatment systems since 1993, the oldest year recorded in the EPA database. A health-based violation indicates either that the amount of a contaminant found in a system's drinking water exceeded the MCL safety standard or that the water was not treated properly. Several water treatment systems, most notably Dayton and Spring City, did have reporting violations during this time frame. Reporting violations include failure to complete all samples or to sample in a timely manner.

Table 2: Maximum Contaminant Levels

Contaminant	MCL	Units	Source
Turbidity	95% < 0.5	NTU	Soil runoff
Total Coliform	5% of samples	None	Human and animal fecal waste
Gross Alpha	15	pCi/L	Erosion of natural deposits
Barium	2	ppm	Discharge of drilling wastes or from metal refineries, erosion of natural deposits
Beryllium	4	ppb	Discharge from metal refineries, coal-burning factories, electrical, aerospace, and defense industries
Copper	1.3	ppm	Corrosion of household plumbing, leaching of wood preservatives, erosion of natural deposits
Cyanide	0.2	ppm	Discharge from steel, metal, plastic, and fertilizer factories
Fluoride	4	ppm	Water additive, discharge from fertilizer and aluminum factories, erosion of natural deposits
Lead	15	ppb	Corrosion of household plumbing, erosion of natural deposits
Nitrate (as Nitrogen)	10	ppm	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits
Sodium	n/a	ppm	Erosion of natural deposits
Sulfate	n/a	ppm	Erosion of natural deposits
Thallium	2	ppb	Leaching from ore processing sites, discharge from electronics, glass, and pharmaceutical companies
Total Trihalomethanes	100	ppb	Byproduct of drinking water disinfection

Transfer of the Y-12 Water Treatment Plant to the City of Oak Ridge. In May, the Y-12 water treatment plant was transferred to the City of Oak Ridge. On July 1, 2000, DWS changed its records to show the plant under the Oak Ridge PWSID 522. DWS records will show DOE's PWSID 722 as inactive. All records and information on the plant were transferred to the Oak Ridge files. At the time of the transfer, State records listed Mr. Wynn Wilson as the certified plant operator, Mr. John Calvert as the certified distribution operator, and Mr. Jack Robinson as the Water and Wastewater Manager. On August 16, Knoxville DWS conducted a sanitary survey of the Oak Ridge water treatment plant.

Clark Center Recreation Park. Clark Center Recreation Park is located on the McCoy Branch embayment of the Clinch River at RM 37.5 between Gallaher Bend and Freels Bend. Formerly known as Carbide Park, Clark Center Park is roughly 80 acres in size. The park is open to the public for day use only. Although located on DOE land, it is considered a City of Oak Ridge Park. The park lies within the 30,000 acre Three Bends Scenic and Wildlife Management Area.

Historically, water treatment operations at Clark Center have fallen under the jurisdiction of the Y-12 facility. Earlier this year, the Y-12 water treatment plant was transferred to the City of Oak Ridge. However, the Clark Center water treatment systems were not included in the transfer. Two separate water treatment systems, one for the office center and the other for the swimming area bathhouse, are in operation at Clark Center Recreation Park. Both systems operate on a seasonal basis.

TDEC staff reviewed the results of annual sampling for the Clark Center Office and Bath House water treatment systems conducted July 13. The following inorganics were sampled: nitrates, arsenic, lead, copper, and selenium. All analytical results fell below current MCLs. Reported arsenic levels for both systems also fell below the proposed MCL of 0.005 mg/L. VOC samples were also collected on July 13. Total trihalomethanes (TTHMs) measured 49 ppb for the Clark Center Office water system and 82 ppb for the Bath House water system. Both readings fall below the current MCL of 100 ppb. However, the 82 ppb Bath House TTHM level slightly exceeds the 80 ppb MCL that will go into effect January 2004 for small surface water treatment systems.

Conclusion

TDEC monitored the quality of water in local streams, the Clinch River and at area water treatment plants. This involved comparison of CCR's, independent sampling of raw and treated water if warranted, reviews of emergency operations plans, and review of regulatory inspection reports. None of the levels reported by any of the systems for any of the contaminants exceeded MCLs. No health-based violations were found for any of these water treatment systems since 1993. The Y-12 treatment plant is now the responsibility of the City of Oak Ridge, while DOE has retained the distribution system at Y-12 and ORNL. The water quality on the ORR and in the area is well within regulatory limits and will continue to be monitored by this office and the Knoxville Environmental Assistance Center.

References

Clesceri, L.S., A.E. Greenberg, and A.D. Eaton, eds. Washington, D.C: American Public Health Association, American Water Works Association, and Water Environment Federation, 20th ed. 1998. *Standard Methods for the Examination of Water and Wastewater.*

Tennessee Department of Environment and Conservation, Division of Water Supply, 2001. *Regulations for Public Water Systems and Drinking Water*, Chapter 1200-5-1.

City of Clinton, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

Anderson County, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

West Knox Utility District, Daugherty, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

City of Oak Ridge/DOE (Y-12), 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

West Knox Utility District, Williams Bend, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

City of Kingston, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

City of Harriman, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

City of Rockwood, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

City of Spring City, 1999 *Consumer Confidence Report for Surface Water Treatment and Distribution System.*

TDEC DOE-O, 1996 *TDEC DOE-O Standard Operating Procedures*, Region IV EPA, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May, 1996.

TDEC Department of Energy Oversight, November, 1998 *Health, Safety, and Security Plan.*

DRINKING WATER

Implementation of EPA's Environmental Radiation Ambient Monitoring System (ERAMS) Drinking Water Program

Principal Author: John Sebastian

Abstract
The Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring System (ERAMS) is designed to monitor potential pathways for significant population exposures from routine and/or accidental releases of radioactivity from major sources (U.S. EPA, 1988). This program provides for radiochemical analysis of finished water at five public water supplies located near and on the Oak Ridge Reservation (ORR). In this effort, quarterly samples are taken by personnel from the Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) to be analyzed at the EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. While tritium results were noted to be higher for the Gallaher Water Treatment Plant than the four other systems monitored in the program, all the results received from EPA, to date, have been well below regulatory criteria.

Introduction
Radioactive contaminants released on the Oak Ridge Reservation (ORR) enter local streams and are transported to the Clinch River. While monitoring of these streams, the river and local water treatment facilities have indicated that concentrations of radioactive pollutants are below regulatory standards, there has remained a concern that area public water supplies could be impacted by ORR pollutants. In 1996, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) began participation in the Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring Systems (ERAMS). This program provides radiological monitoring of finished water at public water supplies near nuclear facilities throughout the United States. The ERAMS program is designed to:

1. Monitor pathways for significant population exposure from routine and/or accidental releases of radioactivity;
2. Provide data indicating additional sampling needs or other actions required to ensure public health and environmental quality;
3. Serve as a reference for data comparison (U.S. EPA, 1988).

The ERAMS program also provides a mechanism to evaluate the impact (if any) of DOE activities on area water systems and validate DOE monitoring in accord with the *Tennessee Oversight Agreement* (TOA) (TDEC, 1996).

Methods and Materials
In the Oak Ridge ERAMS Program, EPA provides radiochemical analysis of finished drinking water samples taken quarterly by TDEC's staff at five public water supplies located on and in the vicinity of the ORR. Samples are collected using procedures and supplies prescribed in

Environmental Radiation Ambient Monitoring System (ERAMS) Manual (U.S. EPA, 1988). Monitoring locations are: Kingston Water Treatment Plant (Tennessee River Mile 568.4), Gallaher (K-25) Water Treatment Plant (Clinch River Mile 14.5), West Knox Utility (Clinch River Mile 36.6), DOE Water Treatment Plant at Y-12 (Clinch River Mile 41.6), and Anderson County Utility District (Clinch River Mile 52.5). Figure 1 depicts the approximate locations of the raw water intakes for these facilities.

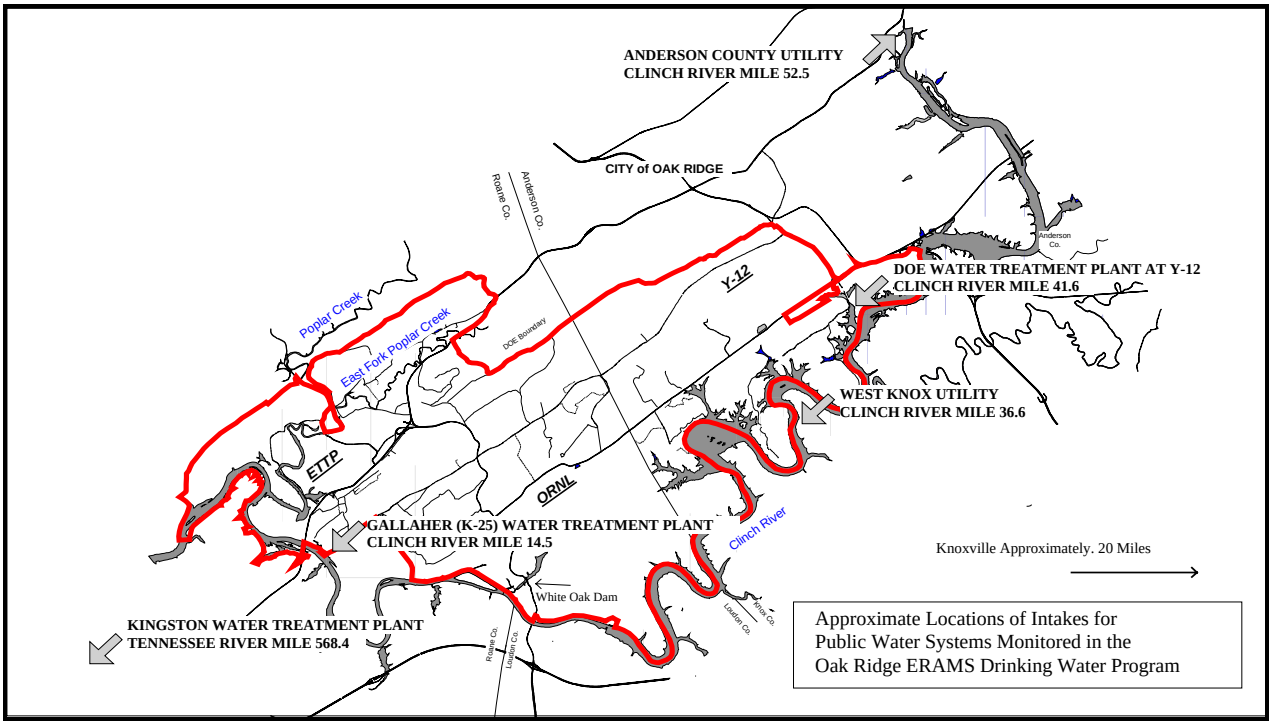

Figure 1: Approximate Locations of the Intakes for Public Water Systems Monitored in Association with EPA's Environmental Radiation Ambient Monitoring System (ERAMS) Drinking Water Program

ERAMS analysis is performed at EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. Analytical frequencies and parameters are provided in Table 1.

Table 1: Environmental Radiation Ambient Monitoring System Analysis for Drinking Water

ANALYSIS	FREQUENCY
Tritium	Quarterly
Gamma Scan	Annually on composite samples
Gross Alpha	Annually on composite samples
Gross Beta	Annually on composite samples
Iodine-131	Annually on one individual sample/sampling site
Radium-226	Annually on samples with gross alpha >2 pCi/L
Radium-228	On samples with Radium-226 between 3-5 pCi/L
Strontium-90	Annually on composite samples
Plutonium-238, Plutonium-239, Plutonium-240	Annually on samples with gross alpha >2 pCi/L
Uranium-234, Uranium-235, Uranium-238	Annually on samples with gross alpha >2 pCi/L

Results and Discussion

A large proportion of the radioactive contaminants that are transported off the ORR in surface water enter the Clinch River by way of White Oak Creek, which drains the Oak Ridge National Laboratory complex and associated waste disposal areas. When contaminants carried by White Oak Creek and other ORR streams enter the Clinch, their concentrations are significantly lowered by the dilution provided by the waters of the river. Contaminant levels are further reduced in finished drinking water by conventional water treatment practices used by area utilities. Consequently, the levels of radioactive contaminants measured in the Clinch and at area water supplies are far below the concentrations measured in White Oak Creek and some of the other streams on the ORR. Due to the Gallaher (K-25) Water Treatment Facility's proximity to White Oak Creek (approximately 6.5 River Miles downstream), it would be expected to exhibit the higher concentrations of radioactive contaminants of the five monitored water systems. Conversely, the Anderson County Facility (located upstream of the Reservation) would be expected to be the least vulnerable of the facilities to ORR pollutants.

While analysis of 2000, ERAMS samples have yet to be completed, the recently received results for tritium and iodine-131 were all well below applicable drinking water standards. Although results reported for tritium (a radionuclide not readily removed by conventional treatment processes) are higher for the Gallaher facility, the concentrations measured were well below the standard prescribed by the Safe Drinking Water Act. In this regard, the Safe Drinking Water Act specifies that the annual average concentration of tritium in community drinking water systems not exceed 20,000 pCi/L. The average concentration of tritium measured at the Gallaher facility for 2000 was 548 pCi/L.

Conclusion

Radioactive contaminants migrate from the ORR to the Clinch River, which serves as a raw water source for area public drinking water supplies. The impact of these contaminants is diminished by dilution provided by waters of the Clinch. Contaminant concentrations are further reduced in finished drinking water by conventional water treatment practices employed by area utilities. In 2000, ERAMS results reported for iodine-131 and tritium were all well below drinking water criteria. While below drinking water standards, tritium was reported at higher levels (as it was in 1999) in samples taken from the Gallaher Water Treatment Facility than the other facilities monitored in the Oak Ridge area. In this regard, the Gallaher plant is the closest facility downstream of White Oak Creek, the major pathway for radiological pollutants entering the Clinch from the ORR. Although gross alpha, gross beta, and gamma spectroscopy results were unavailable at the time of publication, it is expected that these results will be similar to those of previous years (i.e., well below drinking water standards).

Table 2: Environmental Radiation Ambient Monitoring System (ERAMS) Tritium Results from year 2000 Quarterly Analysis of Finished Water from Oak Ridge Area Water Treatment Facilities

Water Treatment Facility	Collection Date	Activity (pCi/L)	Error (+/- 2 σ) (pCi/L)	MDC[a] (pCi/L)	Standard[b] (pCi/L)
Anderson Co.	03/29/00	1	79	133	20,000
Anderson Co.	06/27/00	15	74	126	20,000
Anderson Co.	09/26/00	-7	73	131	20,000
Gallaher (K-25)	01/30/00	990	110	137	20,000
Gallaher (K-25)	06/27/00	389	91	129	20,000
Gallaher (K-25)	09/28/00	266	870	128	20,000
Kingston	03/29/00	96	82	134	20,000
Kingston	06/27/00	225	84	128	20,000
Kingston	09/25/00	-41	73	127	20,000
West Knox	03/29/00	18	74	125	20,000
West Knox	06/27/00	48	77	128	20,000
West Knox	09/25/00	30	74	129	20,000
Y-12	03/29/00	38	80	134	20,000
Y-12	06/27/00	72	79	130	20,000
Y-12	09/25/00	-14	75	129	20,000

[a]Minimum Detectable Concentration
[b]40 CFR Part 141—National Primary Drinking Water Regulations.
[c]Duplicate analysis

Table 3: Environmental Radiation Ambient Monitoring System (ERAMS) Iodine-131 Results from Year 2000 Annual Analysis of Finished Water from Oak Ridge Area Water Treatment Facilities

Water Treatment Facility	Collection Date	Activity (pCi/L)	Error (+/- 2 σ) (pCi/L)	MDC[a] (pCi/L)	Standard[b] (pCi/L)
Anderson Co.	09/26/00	0.09	0.28	0.46	3.0
Gallaher (K-25)	09/28/00	-0.06	0.15	0.26	3.0
Kingston					
West Knox	09/25/00	0.09	0.28	0.46	3.0
Y-12					

Note: The iodine-131 result for the Kingston and Y-12 Facilities were not reported in the ERAMS data received to date.
[a] Minimum Detectable Concentration
[b] The Safe Drinking Water Act prescribes beta and photon emitters in drinking water not exceed an annual dose equivalent of 4 mrem/year. The values referenced represent annual average concentrations yielding 4 millirem per year for a two liter daily intake from Appendix III in *Radioactivity in Drinking Water* (EPA, 1991).

References

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. *Health, Safety, and Security Plan*. May 2000.

U.S. EPA. 1988. *Environmental Radiation Ambient Monitoring System (ERAMS) Manual*. EPA 520/5-84-007, 008, 009. May 1988.

U.S. EPA. 1994. *Environmental Radiation Data Report 80*. EPA-402-R-97-004. February 1997.

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DRINKING WATER

Special Projects

Principal Author: Kathleen Kitzmiller

Abstract
During the calendar year 2000, several projects arose that were not covered under existing monitoring plans. These special projects allow for increased opportunities to monitor and evaluate Department of Energy (DOE) water system operations. This included a special water sampling effort at the East Tennessee Technology Park (ETTP), the impact of a reservoir leak at the Oak Ridge National Laboratory (ORNL) and the Environmental Protection Agency's (EPA) Multi-Media Inspection of the Y-12 Facility. Follow up work is required for these projects in the calendar year 2001.

Introduction
Special projects provided opportunities for the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) to further evaluate the operation and condition of water systems on the Oak Ridge Reservation (ORR) and to aid in regulatory compliance efforts. During the previous year, TDEC carried out the following special projects.

- Special Water Sampling Effort at East Tennessee Technology Park (ETTP)
- Impact of Reservoir Leak at Oak Ridge National Laboratory (ORNL)
- EPA Multi-Media Inspection of the Y-12 Facility

Discussion
Special Water Sampling Effort at East Tennessee Technology Park. In response to recent concerns about the current safety of drinking water at ETTP, the ETTP Sample Planning and Oversight Team (SPOT) was formed to develop and implement a plan to sample sanitary and fire water systems at the site. Team participants included representatives from the Bechtel Jacobs Company LLC (BJC), the Community Reuse Organization of East Tennessee (CROET), DOE, the ORR Local Oversight Committee Citizens Advisory Panel (LOC-CAP), Operations Management International, Inc. (OMI); the Paper, Allied-Industrial, Chemical, and Energy Workers Union (PACE); and the TDEC.

Drinking water samples were collected from nineteen sites, including the water treatment plant. These sites were selected for sampling in order to include areas where worker populations are present, areas at the far reaches of the distribution system, and areas of concern identified by current and former workers. The EPA collected replicate samples at seven of the drinking water sites. In order to ascertain potential impact upon the drinking water distribution system in the event of cross-connections, firewater was sampled at six locations. Raw water from the Clinch River was also sampled. TDEC elected not to collect independent samples.

OMI water sampling personnel collected the samples with oversight by representatives of LOC-CAP, PACE, and TDEC. The initial SPOT sampling effort took place over August 8-10, 2000. To ensure the chain of custody, TDEC staff placed tamper-resistant seals on sample containers and coolers. Between August 9-11, 2000, the EPA collected seven sets of replicate samples for analysis at their laboratory in Montgomery, Alabama. Several of the initial bacteriological samples tested positive for total coliform though not for fecal contamination. The suspect sites were re-sampled, one on August 11, 2000, and four on August 16, 2000. Locations upstream and downstream of each of these sites were also sampled. All the subsequent bacteriological samples yielded negative results. Environmental Sciences Corporation reported that one of several coolers shipped to a subcontractor lab had been lost by UPS. Replacements for these lost drinking water samples were collected on August 22, 2000.

The following State-certified laboratories performed analyses on the samples.

- Lockheed Martin Analytical Laboratory (Y-12) – radiological analyses
- State of Tennessee Public Health Laboratory (Knoxville) – bacteriological testing
- Environmental Services Corporation (Mt. Juliet) – chemical analyses for inorganics, volatile organic compounds, and synthetic organic compounds

The laboratory analyses for the SPOT sampling effort were completed by early September and the results forwarded to OMI, PACE, and LOC-CAP. TDEC subsequently received and reviewed the full set of results as well. With only a few exceptions, only low or no levels of analytes were detected. The analyses found levels of iron and manganese in excess of secondary maximum contaminant levels (SMCLs) at one drinking water site and one fire water site. SMCLs pertain to aesthetic – taste, color, odor, etc. – rather than health concerns. SPOT members prepared a summary report on the quality of ETTP's drinking water for release at a press conference held September 20, 2000. A comprehensive final report, *Special East Tennessee Technology Park Water Sampling Report*, was released in early November. TDEC has since received copies of the EPA's analyses for inorganics and radionuclides. The EPA results do not differ significantly from those for the SPOT samples.

Impact of Reservoir Leak at the Oak Ridge National Laboratory. On December 2, 1999, Knoxville Environmental Assistance Center (KEAC) Division of Drinking Water Supply (DWS) conducted a sanitary survey of the ORNL potable water system. A provisional rating and Notice of Violation were issued because distribution storage tanks deficiencies noted in previous TDEC surveys dating back to 1994 had not been remedied. The survey noted that Tank 902, a 3 million-gallon concrete tank, leaked about 9,000 gallons per day. Due to the daily water needs of ORNL, the reservoir cannot be taken off-line for repair work until additional water storage capacity is available. ORNL expects to take two years to construct the additional storage.

TDEC staff members made several field trips to the vicinity of the Tank 902 reservoir. On May 12, 2000, TDEC staff measured the free residual chlorine content of water leaking from the B0902 Reservoir. They observed a small steady stream of clear water running in a concrete culvert located on the backside of the reservoir. Residual chlorine contained in the leaking water may have adversely impacted plant and animal species within the culvert. Mosses below the culvert's water line had died away. No macroinvertebrates were detected in leaf litter gathered from the bottom of the culvert. A sample of water was drawn from water flowing about 10 feet below the iron grate

placed across the concrete culvert. The reading of 1.2 mg/L, comparable to that for tap water, was obtained using TDEC's Hach digital spectrophotometer.

On May 26, 2000, TDEC personnel traced the path taken by water leaking from the B0902 Reservoir. The leak emerged near the base of earthwork perimeter of the reservoir. A shallow concrete culvert, about one yard across at the top by fifty feet long directed the flow downhill. After reaching the end of the culvert, the leaking water continued downhill. In several spots it had cut a narrow channel several feet deep into the soil. In others, it bubbled over exposed rock outcrops. The water passed across an open area cleared for a power line. Near the bottom of the hill, the leaking water split into two channels. The eastern half dried up within a short distance. The western half intersected and flowed into an otherwise dry streambed that runs east to west near the base of the hillside. At the point where the streambed bent to run parallel to the substation road, the water from the leak first puddled up and then disappeared entirely. The dry streambed continued from this point. A short distance above the gate to the substation road, a thicket of shrubs and trees marks the location of Powerline Spring. A considerable volume of cold water flows rapidly from the spring.

TDEC staff used the department's Hach pocket colorimeter to measure the level of free residual chlorine. The water sample collected at the end of the concrete culvert contained a level of free residual chlorine comparable to that of the tap water sampled in the TDEC laboratory. The free residual chlorine content of samples was measured at several locations along the path taken by the leaking water. These samples and those taken of water from the spring and from a free-running stream nearby yielded far lower readings.

The pocket colorimeter readings are a function of the amount light that passes through the sample container. Small particles suspended in the water sample can influence the measurement process. It is quite likely that the low readings obtained from samples collected downstream of the culvert, at the spring, and from the nearby stream indicated the presence of sediments rather than of free residual chlorine. Several factors were present that would act in combination to remove chlorine from the leaking water as it made its way down the hill. These include aeration, exposure to sunlight, and percolation through the soil. The likelihood that the water leak introduces significant amounts of chlorine to natural waters in the vicinity appears quite remote.

EPA Multi-Media Inspection of Y-12 Facility. Over July 18-19, 2000, the USEPA conducted an unannounced multi-media inspection of the DOE Y-12 plant facilities. The inspection focused in part upon Y-12's potable water distribution system. TDEC staff assisted the representative from the EPA's Safe Drinking Water Act Enforcement Section, with this portion of the inspection. The physical inspection of the distribution system included examination of the Y-9201-3 backflow preventer, the Y-9404-21 and Y-9404-24 booster pump stations, and the Y-12 water tanks. The review of the distribution records focused on bacteriological testing and free residual chlorine measurements, lead and copper sampling and line-flushing activities.

The EPA issued its inspection report on the Y-12 water system in August. The system received satisfactory ratings on safety, security, and storage tanks. However, Y-12 received unsatisfactory ratings on its distribution system as well as its monitoring and records. Specific problems included the following items.

- The system does not have an effective water line flushing program. The inadequate chlorine residual in certain parts of the distribution system demonstrates this. The Y-12 plant water system has not improved its flushing program in response to a 1997 TDEC/Knoxville DWS directive to do so. The system should develop a flushing program that will maintain an adequate residual chlorine disinfectant level throughout the entire distribution system.
- The record review showed that the Y-12 facility failed to conduct lead monitoring in 1996 because it used an inadequate laboratory method (the detection limit was set higher than the EPA action level) which invalidated the monitoring.
- The Y-12 system failed to use a written sample siting plan for bacteriological monitoring as directed by TDEC/Knoxville DWS in 1997. The system should develop and use a written sample siting plan for bacteriological monitoring at sites which are representative of water throughout the distribution system, including the landfill and Bear Creek Road dead-end lines, and the storage tanks.

Steps have already been taken to address these items. The landfill water line has been flushed. The water fountain at 9720-6, a site with consistently low chlorine residuals, has been disconnected. The bacteriological sampling plan has been revised and implemented by the Y-12 system operator.

Conclusion

The special projects described above allowed for increased opportunities to monitor and evaluate DOE water system operations. This included a special water sampling effort at the ETTP, the impact of a reservoir leak at the ORNL and EPA Multi-Media Inspection of the Y-12 Facility. Follow up activities are required for these projects in the calendar year 2001. Specifically, the reservoir at ORNL will be monitored and the Y-12 distribution system will continue to be monitored to document the requested changes.

References

Department of Energy, Oak Ridge Operations, November 3, 2000. *Special East Tennessee Technology Park Water Sampling Report, Volumes 1 and 2.*

TDEC Department of Energy Oversight, November, 1998 *Health, Safety, and Security Plan.*

BIOLOGICAL/FISH AND WILDLIFE

Biological Monitoring Programs

Principal Author: Randall Hoffmeister

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) currently conducts a biological monitoring program consisting of diatom and benthic macroinvertebrate community assessments. These studies are used not only to independently assess the overall health of the streams impacted by Department of Energy (DOE) operations, but also to verify the findings reported by DOE contractors and add to baseline information in order to identify any impacts from future activities. The biological monitoring program is conducted in addition to other TDEC oversight activities such as the annual deer, goose, and turkey projects. Quarterly surface water grab sampling is conducted at the biological monitoring sites in order to more thoroughly assess stream conditions. A variety of analytes are examined such as radiological, metals, mercury, nutrients, routine, and microbiological. This surface water assessment is a separate entity from the ambient surface water and sediment sampling project conducted by TDEC in other streams on the Oak Ridge Reservation (ORR) and offsite. Currently, TDEC samples twelve locations on five streams impacted by past or current DOE operations. Six additional sites are sampled as references, and are located within the same watershed or geologic province for a total of eighteen sampling locations. The following summary includes the biological and surface water sampling locations on each of the study streams, sources of contaminants, and the name and location of the reference sites for the study stream. Figures 1 and 2 show the locations of the various sampling sites. Map coordinates for each of the sites sampled are available upon request from TDEC.

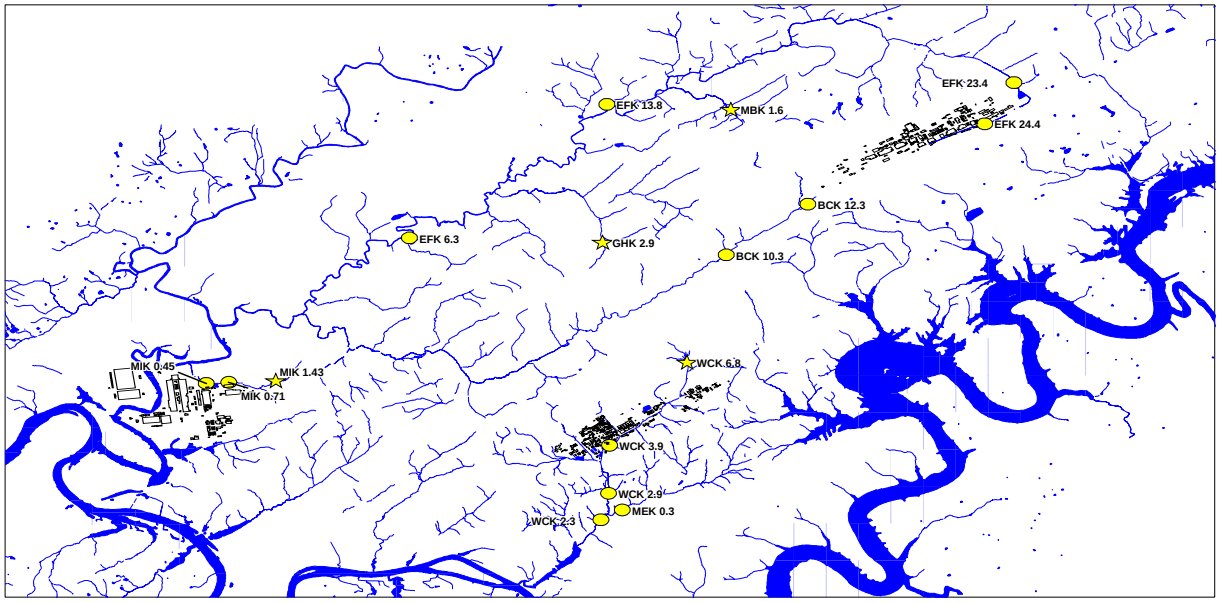


Figure 1. Locations of study and reference sites used in the TDEC's biological monitoring program.

East Fork Poplar Creek

Four sites on East Fork Poplar Creek (kilometers 24.4, 23.4, 13.8, and 6.3), were sampled, with EFK 24.4 located inside the Y-12 plant, and EFK 6.3 the farthest downstream (Figure 1). Two reference sites (Brushy Fork kilometer 7.6 and Hinds Creek kilometer 20.6) were sampled for comparison with the study sites (Figure 2). All sampling locations in these studies were also used by the Oak Ridge National Laboratory (ORNL) Biological Monitoring and Abatement Program (BMAP). ORNL BMAP reports document the presence of heavy metals including mercury, cadmium, chromium, copper, nickel, and zinc in Upper East Fork Poplar Creek (Hinzman, R.L., 1998). These metals have been detected in the surface water and sediment downstream of Y-12 plant discharges.

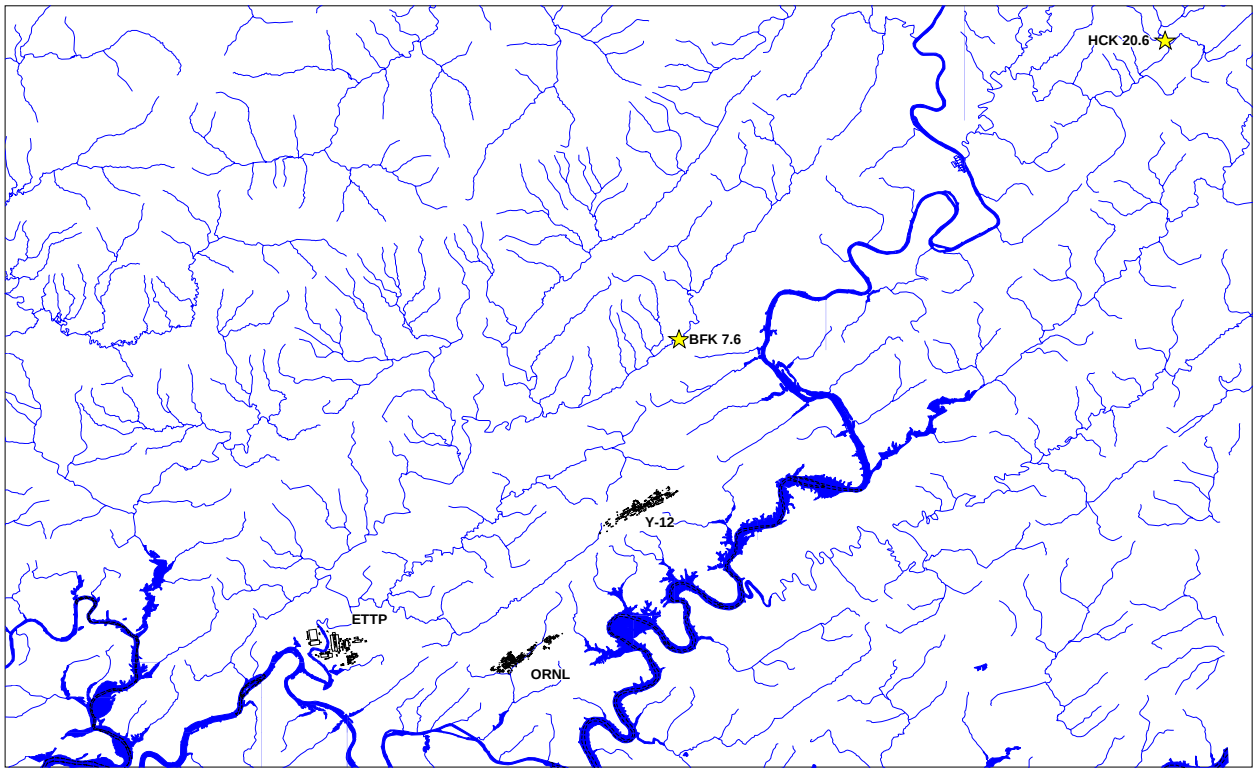


Figure 2. Locations of reference sites used for the East Fork Poplar Creek portion of the TDEC's biological monitoring program.

Bear Creek

Two sites on Bear Creek (kilometers 12.3 and 10.3) were sampled to assess the condition of the Creek and add to baseline information to document any changes in the benthic macroinvertebrate and diatom communities resulting from construction and operations associated with the Environmental Management Waste Management Facility (EMWMF). Construction of this facility has begun, with operations expected to begin in 2001. Two reference sites (Gum Hollow Creek kilometer 2.9 and Mill Branch Creek kilometer 1.6) were used for comparison (Figure 1). Surface water samples collected in Upper Bear Creek have shown high levels of nutrients and radiological activity (gross alpha and gross beta). The S-3 site, located at the west end of the Y-12 plant, has been identified as the primary source of these impacts (AJA Technical Services, Inc., 1999). Groundwater flow carries nitric acid and uranium-based waste products from the former treatment, storage, and disposal unit toward the creek.

Mitchell Branch Creek

Two study sites were selected for monitoring on Mitchell Branch Creek (kilometers 0.71 and 0.45), while a site located upstream of East Tennessee Technology Park (ETTP) (kilometer 1.43) served as the reference site (Figure 1). These sites were selected to document any changes in the benthic macroinvertebrate and diatom communities that may have occurred due to remedial activities. These included the installation of geosynthetic impermeable membranes in the creek and anchored with concrete blocks, and the pumping and treatment of groundwater that is contaminated with petroleum hydrocarbons (Bechtel Jacobs Company, LLC, 1998).

White Oak and Melton Branch Creeks

The White Oak Creek watershed consists of two major streams: White Oak and Melton Branch Creeks with both streams receiving discharges from operations at the ORNL (Figure 1). In addition, waste storage areas in the surrounding valley are scheduled for remediation. Sampling sites were selected downstream from these storage areas to add baseline information for use in assessing any future impacts. One site was sampled on Melton Branch Creek, at kilometer 0.3, while three study sites were sampled on White Oak Creek (kilometers 2.3, 2.9, and 3.9). White Oak Creek kilometer 6.8 served as the reference site. The presence of high nutrient levels has been documented in White Oak Creek inside ORNL boundaries (Ashwood, 1994). Chlorine toxicity has been problematic in sections of this creek as well.

Conclusion

The State's biological monitoring program for the ORR was developed to assess the impacts of DOE operations on aquatic communities, verify the findings reported by the DOE biological monitoring programs, and add baseline data to document any changes in aquatic communities that may result from future activities.

Because this program incorporates both plants (diatoms) and animals (benthic macroinvertebrates), impacts that may have been missed using only one Kingdom are more likely to be observed. Such may be the case in White Oak Creek, where the diatom community generally decreased in quality with distance from the ORNL, while the benthic macroinvertebrate community generally improved. This suggests a pollutant that is directly toxic to plants, but may only impact benthic macroinvertebrates indirectly, as through the food web. In contrast, in East Fork Poplar Creek and Bear Creek, trends in both diatom and benthic macroinvertebrate communities were similar, with both communities generally improving with distance from the Y-12 plant.

The study on Mitchell Branch, although begun after the remediation was initiated, has documented the initial recovery of the sites within and downstream of the relined stream channel. Future sampling will verify if this project results in full recovery of the aquatic communities present. These results have verified the quality of the biological monitoring undertaken by DOE and its contractors. Results from the quarterly surface water sampling events at the biological monitoring sites can be obtained from TDEC's Environmental Monitoring and Compliance section personnel.

References

AJA Technical Services, Inc. 1999. *Groundwater Protection Program Calendar Year 1998 Evaluation of Groundwater and Surface Water Quality Data for the Bear Creek Hydrogeologic Regime at the U.S. Department of Energy Y-12 Plant, Oak Ridge, Tennessee.* Prepared for Lockheed Martin Energy Systems, Inc. (Y/SUB/99-MVM64V/4).

Ashwood, T.L. (ed). 1994. Eighth Annual Report on the ORNL Biological Monitoring and Abatement Program, Draft ORNL/TM Report. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Bechtel Jacobs Company LLC. 1998. *Removal Action Report on the Mitchell Branch and K-1070-C/D Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee.* Prepared for the U.S. Department of Energy Office of Environmental Management (DOE/OR/01-1728& D2).

Hinzman, R.L. (ed). 1998. Third Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek. Report number Y/TS-889. Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, USA.

BIOLOGICAL/FISH AND WILDLIFE

Rapid Bioassessment Protocol III Sampling on Streams on the Oak Ridge Reservation

Principal Author: Randall P. Hoffmeister

Abstract

Semi-quantitative benthic macroinvertebrate samples were collected from twelve study sites on five streams impacted by past or current Department of Energy (DOE) operations, and six reference sites located on or near the Oak Ridge Reservation (ORR). Using the State of Tennessee Standard Operating Procedures (SOPs), samples were collected, processed, and analyzed using suggested metrics. Results indicated that all study sites continue to be impacted when compared to their respective reference sites.

Introduction

Benthic macroinvertebrates, are organisms visible to the unaided eye, which inhabit the bottom substrates of aquatic systems and include insects, crustaceans, annelids, and mollusks (Platts et al., 1983). Because of their relatively long life spans and sedentary nature, benthic macroinvertebrate community structure can be useful in assessing the condition of an aquatic system.

Benthic macroinvertebrate samples were collected from locations on five streams originating on the Oak Ridge Reservation (ORR) that have been impacted by past and/or present Department of Energy (DOE) operations. These included two streams impacted by the Y-12 plant (East Fork Poplar Creek and Bear Creek), one stream at the East Tennessee Technology Park (ETTP) (Mitchell Branch); and two streams affected by operations at the Oak Ridge National Laboratory (ORNL) (Melton Branch and White Oak Creek).

The objectives of this study were to conduct an independent assessment of the condition of streams on the ORR using benthic macroinvertebrates, confirm bioassessments conducted by the Biological Monitoring and Abatement Program (BMAP) and Integrated Water Quality Program (IWQP) contractors, and add to baseline data on reaches of streams potentially impacted by planned remedial projects.

Method and Materials

Semi-quantitative sampling of benthic macroinvertebrate communities was conducted during spring 2000, using the RBP III described in the Tennessee Biological Standard Operating Procedure (SOP) Manual: Volume I: Aquatic Macroinvertebrates (1996). Sampling consisted of using either a 1-meter kick net (for larger streams) or an 18-inch kick net (for smaller streams) to collect organisms from riffles at each site. Using the 1-meter kick net, two riffle kicks were collected and combined into a single sample for each site. The method using the 18-inch kick net consisted of collecting four separate riffle kicks from each site, and combining these into one sample per site.

Collection methods were modified for sampling in the White Oak Creek watershed, due to the presence of radioactive contamination in the stream sediments. Briefly, the two, 1-meter kick samples were combined in a 5-gallon bucket, creek water was added and the sample swirled to suspend the lighter material (including invertebrates) with the elutriate then being poured through a sieve. This process was repeated 5 times, which collected the majority of organisms. Any material not needed was returned to the Creek. Samples from radioactively contaminated sites were processed in laboratory space provided by the ORNL.

Using a dissecting scope and appropriate references (e.g., Merritt and Cummins 1996, Stewart and Stark 1993, Pennak 1989) organisms were identified to the genus level (with the exception of Diptera: Chironomidae and Oligochaeta) and enumerated. Metrics suggested in the Tennessee SOPs were used for data analyses. These included Comparative Taxa Richness, Indicator Assemblage Index, Dominants in Common, EPT Index, and the Index of Biotic Integrity using the North Carolina Biotic Index. Scores were calculated by comparing each study site with the appropriate reference site(s). The scores for individual metrics from each study site were added together, and then divided by the maximum possible score (30). The resulting percentage score was then used to rate the biological condition of each study site, when compared to the reference site(s).

Results and Discussion

The scores from each of the five metrics analyzed and the overall rating are presented for each site in Appendix A.

East Fork Poplar Creek

None of the four test sites rated better than slightly impaired when compared to the reference sites. EFK 24.4 and EFK 6.3 rated as moderately to slightly impaired when compared to the reference site at Hinds Creek, indicating a disrupted community structure, with low numbers of taxa present. Environmental degradation is even more evident at EFK 6.3 as it rated moderately impaired when compared to the Brushy Fork reference site. This overall assessment indicates that community structure in East Fork Poplar Creek continues to be impacted due to the loss of most intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera or EPT). Despite this, a comparison of the current year's results with those observed in 1999 (Smith) shows that overall there were some improvements in community structure, with the overall score for the community at EFK 6.3 remaining the same. Although the rating at EFK 6.3 remained consistent, the percent of EPT taxa decreased from 25.2% in 1999 to 18.4% in 2000.

The trend in number of EPT taxa was similar to total taxa richness in the TDEC samples (Figure 1 and Figure 2) but not in the BMAP results. A comparison of taxa richness between TDEC and the latest BMAP results shows only a slight trend in increasing numbers of taxa with distance from Y-12. Both data sets indicated lower numbers of the sensitive taxa in EFPC when compared to the reference sites.

Bear Creek

Due to the small size of Bear Creek, the State method for sampling small streams was used. The uppermost site on Bear Creek, BCK 12.3 rated as moderately impacted, while the site located below the area where the waste facility (EMWMF) is to be constructed (BCK 10.3) scored as

slightly and moderately impacted, when compared to the reference sites at Gum Hollow and Mill Branch, respectively. It is important to note that the habitat available for macroinvertebrates at BCK 12.3 continues to be less than optimal, and may have an impact on this site's score. However, quarterly surface water data indicate elevated levels of some substances (e.g., nitrates/nitrites), therefore the potential of toxicity related impacts cannot be eliminated.

A comparison of data obtained from the DOE Integrated Water Quality Program (IWQP) with TDEC results could not be completely addressed due to the lack of IWQP data results at the reference sites. This information was not included in the 2001 Remediation Effectiveness Report (RER) produced for DOE. TDEC recommends that reference data be incorporated in future RER publications. It should be noted that the IWQP benthic sampling site downstream of BCK 12.3 occurred at BCK 9.9, whereas the TDEC sampling location was at stream kilometer 10.3. The small difference in distance should not have a significant effect on sampling results based on environmental conditions since the available habitat is the same. TDEC results indicate that both test sites showed lower numbers of both EPT richness and total taxa richness when compared to the reference sites (Figure 1 and Figure 2).

White Oak Creek and Melton Branch

All three study sites on White Oak Creek and the Melton Branch sampling site were rated as moderately impaired compared to the reference site at WCK 6.8. These designations remain unchanged from the 1999 sampling results except at WCK 3.9 that rated as severely impaired last year. WCK 3.9 showed some improvement in community structure from last year as the percent EPT taxa increased from 10.2% in 1999 to 48.0% in 2000.

Total taxa richness at the study sites within the White Oak Creek watershed were common to both BMAP and TDEC investigations with the exception of WCK 2.9 and MEK 0.3 which were not sampled by BMAP for financial reasons. The sites in common showed substantially lower numbers of both EPT taxa richness and total number of taxa, when compared to the reference site (Figures 1 and 2).

Mitchell Branch

Two study sites were sampled on Mitchell Branch; one site (MIK 0.71) was located within the reach of stream that was lined and tiled, while the other site (MIK 0.45) was located below the remediated portion. Because MIK 0.71 is tiled with non-moving concrete interlocking blocks, a brush was used to loosen organisms clinging to the substrate surfaces. As in 1999, both sites scored as moderately impacted, when compared to the upstream reference site (MIK 1.43). Although the ratings remained unchanged, both sites showed some signs of environmental improvement from 1999 to 2000 with the percent EPT taxa increasing from 6.17% to 28.0% at MIK 0.71 and from 1.74% to 15.9% at MIK 0.45.

Both TDEC and BMAP had similar results in the number of EPT taxa present and total number of taxa (Figure 1 and Figure 2). The TDEC results showed slightly higher numbers of EPT taxa at the two study sites, while BMAP results indicated slightly higher total taxa richness. Both study sites had EPT richness and total taxa richness numbers well below the reference site.

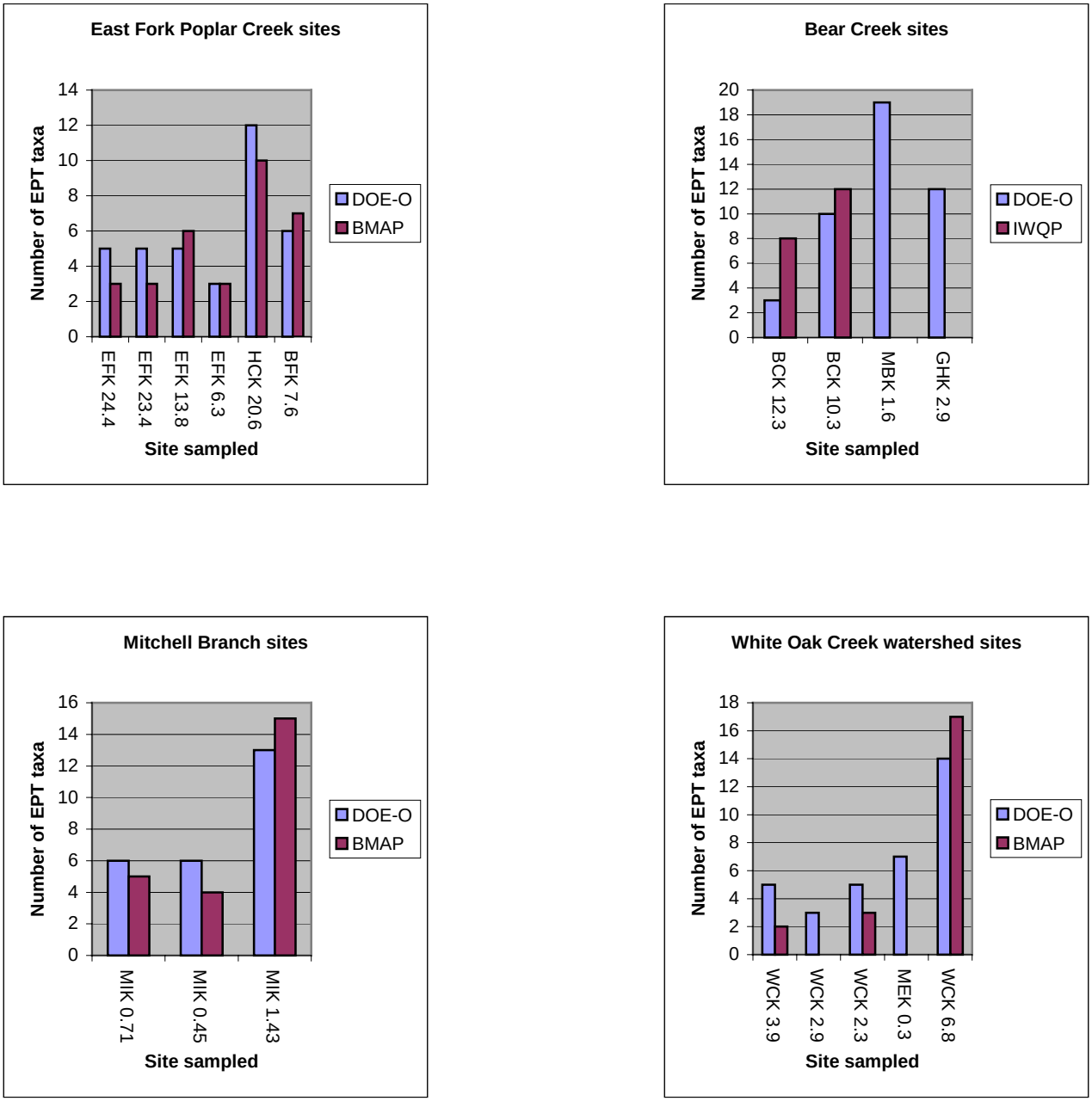
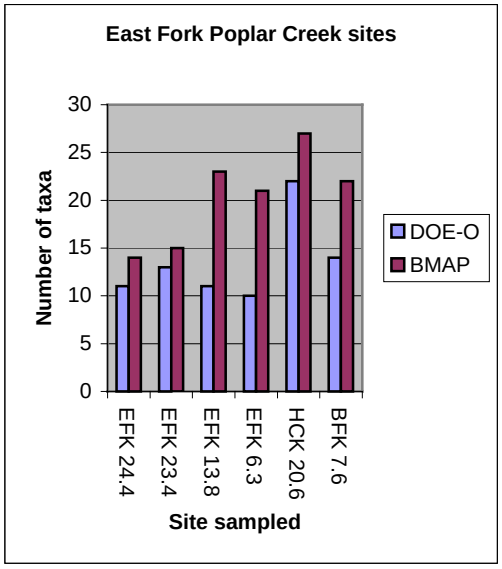
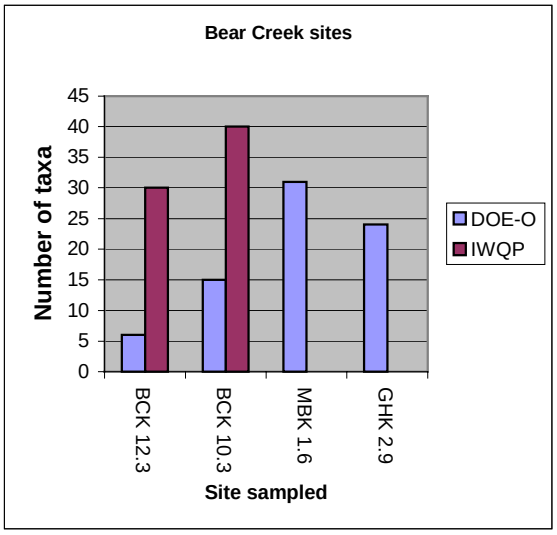
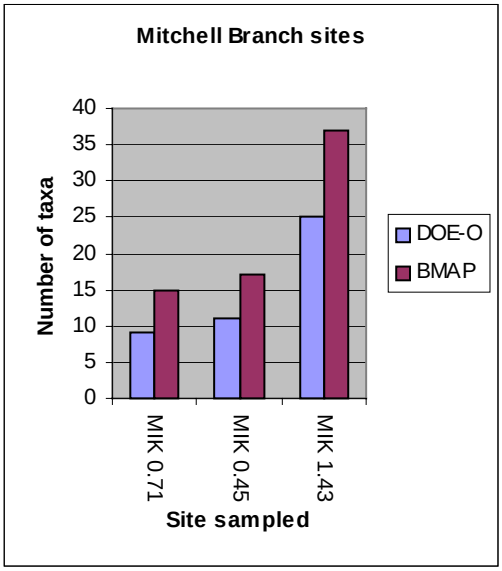


Figure 1. Comparison of EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera) reported by TDEC and DOE (BMAP or IWQP) in various streams associated with operations on the Oak Ridge Reservation.







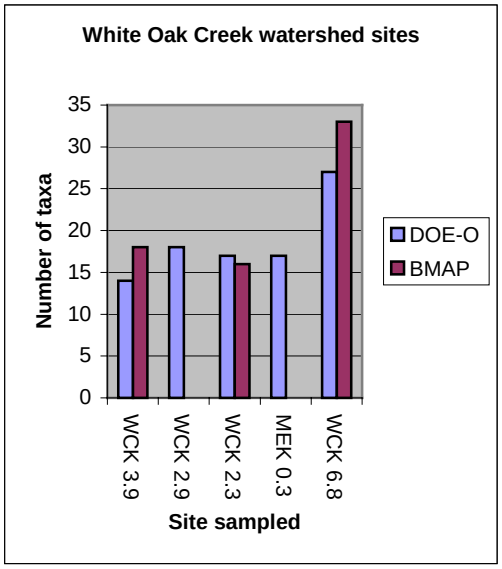


Figure 2. Comparison of total number of taxa reported by TDEC and DOE (BMAP or IWQP) in various streams associated with operations on the Oak Ridge Reservation.

Conclusion

Of the twelve study sites sampled during calendar year 2000, no site rated better than slightly impaired compared to the respective reference site. As was the case in 1999 (TDEC Environmental Monitoring Report, 1999), sites located on East Fork Poplar Creek showed no improvement in overall biological condition with distance from the Y-12 Plant based on the numbers of EPT taxa present. Results from the DOE benthic macroinvertebrate monitoring program showed some improvement with distance based on the total number of taxa. Both studies showed lower EPT taxa numbers in EFPC relative to the two reference sites.

There was some improvement in the benthic community in Bear Creek with distance from Y-12, although the difference was slight and variations in habitat may have played a role. These results in conjunction with future monitoring events will be useful in assessing any impacts resulting from the construction and operation of the EMWMF. The TDEC results for both EPT and total taxa numbers showed low numbers of taxa when compared to the reference sites.

Benthic communities in White Oak Creek showed a low EPT taxa richness at WCK 2.9 with improving conditions further downstream, suggesting discharges from the plant between WCK 3.9 and WCK 2.9 continue to have a negative impact on stream health. Further TDEC investigations will be conducted to more closely define the sources of these impacts. The total numbers of taxa remained relatively unchanged at the downstream sites. An overall trend assessment based on DOE BMAP results are difficult to ascertain since WCK 2.9 and MEK 0.3 were not sampled. Melton Branch, the major tributary to White Oak Creek, also appeared to be negatively impacted by ORNL processes compared to the reference site.

Both study sites within Mitchell Branch were moderately impacted, when compared to the upstream reference site. However, the recolonization of benthic macroinvertebrates in the stream at MIK 0.71 indicates some recovery continues to occur. Continued sampling in Mitchell Branch will aid in determining the effectiveness of the stream remediation project on overall water quality.

References

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region 4, 960 College Station Road, Athens, GA, 1996.

Merritt, R.W. and K.W. Cummins. 1996. *Aquatic Insects of North America.* Kendall/Hunt Publishing, Dubuque, IA.

Pennak, R.W. 1989. *Fresh-water Invertebrates of the United States, 3rd Edition.* John Wiley & Sons, New York.

Platts, W. W., W.F. Meghan, and G.W. Minshall. 1983. *Methods for evaluating stream, riparian, and biotic conditions. U.S. Forest Service General Technical Report INT 138. Intermountain Forest and Range Experimental Station, Ogden, UT.*

Stewart, K.W. and B. P. Stark. 1993. *Nymphs of North American Stornefly Genera (Plecoptera).* University of North Texas Press, Denton, TX.

Smith, M. 1999. *Biological/Fish and Wildlife: Rapid Bioassessment Protocol III Sampling on Streams on the Oak Ridge Reservation. TDEC DOE-O Environmental Monitoring Report, 1999.*

Tennessee Biological Standard Operating Procedures Manual: Volume I: Freshwater Aquatic Macroinvertebrates, Final Version, 1996.

Appendix A.

Scores for Each of Five Metrics Analyzed

(1) Comparative Taxa Richness (CTR)

$$CTR = \frac{\text{Species richness at study site}}{\text{Species richness at reference site}} \times 100$$

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	2	4
EFK 23.4	2	6
EFK 13.8	2	4
EFK 6.3	2	4

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	0	0
BCK 10.3	2	4

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	4
WCK 2.3	4
MEK 0.3	4

Mitchell Branch

Site Sampled	Scored with MIK 1.43
MIK 0.71	0
MIK 0.45	2

2) Indicator Assemblage Index (IAI)

$IAI = CA_r/CA_s$

where: CA_r = Total relative abundance of chironomids and annelids at reference site
CA_s = Total relative abundance of chironomids and annelids at study site

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	2	0
EFK 23.4	4	0
EFK 13.8	4	0
EFK 6.3	4	0

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	2	4
BCK 10.3	6	6

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	2
WCK 2.3	6
MEK 0.3	4

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	2
MIK 0.45	2

(3) Dominants in Common (DIC)

where: DIC = five most abundant taxa common to study and reference site

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	6	4
EFK 23.4	6	4
EFK 13.8	6	4
EFK 6.3	4	2

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	2	0
BCK 10.3	2	0

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	2
WCK 2.3	2
MEK 0.3	2

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	2
MIK 0.45	2

(4) EPT Index

$$\text{EPT Index} = \frac{\text{Number of distinct EPT taxa at study site}}{\text{Number of distinct EPT taxa at reference site}} \times 100$$

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	0	4
EFK 23.4	0	6
EFK 13.8	0	6
EFK 6.3	0	0

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	0	0
BCK 10.3	0	4

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	0
WCK 2.9	0
WCK 2.3	0
MEK 0.3	0

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	0
MIK 0.45	0

(5) Index of Biotic Integrity (IBI)

$$NCBI = \Sigma \frac{x_i t_i}{n}$$

$$IBI = \frac{\text{NCBI of reference site}}{\text{NCBI of study site}} \times 100$$

Where: NCBI = North Carolina Biotic Index
and: x_i = number of individuals within a taxa
t_i = tolerance value of a taxa
n = total number of organisms in the sample

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	6	6
EFK 23.4	6	6
EFK 13.8	6	6
EFK 6.3	6	6

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	4	4
BCK 10.3	4	4

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	2
WCK 2.3	2
MEK 0.3	0

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	6
MIK 0.45	6

Combined Scores for Each Study Site

SITE	SCORE (out of a possible of 30)	RATING
EFK 24.4	16 vs. Hinds, 18 vs. Brushy Fork	Moderately to slightly impaired
EFK 23.4	18 vs. Hinds, 22 vs. Brushy Fork	Slightly impaired
EFK 13.8	18 vs. Hinds, 20 vs. Brushy Fork	Slightly impaired
EFK 6.3	16 vs. Hinds, 12 vs. Brushy Fork	Moderately to slightly impaired
BCK 12.3	8 vs. Mill Br., 8 vs. Gum Hollow	Moderately impaired
BCK 10.3	14 vs. Mill Br., 18 vs. Gum Hollow	Moderately to slightly impaired
WCK 3.9	8	Moderately impaired
WCK 2.9	10	Moderately impaired
WCK 2.3	14	Moderately impaired
MEK 0.3	10	Moderately impaired
MIK 0.71	10	Moderately impaired
MIK 0.45	12	Moderately impaired

BIOLOGICAL/FISH AND WILDLIFE

Diatom Community Responses to Environmental Impacts: A Water Quality Assessment

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Abstract

Diatom communities colonizing artificial substrates were sampled to assess the water quality and ecological condition of streams impacted by Department of Energy (DOE) activities on the Oak Ridge Reservation (ORR). A total of twelve study sites located on five streams: East Fork Poplar Creek, Bear Creek, White Oak Creek, Melton Branch, and Mitchell Branch were evaluated based on diatom species richness. A siltation index and a disturbance index were also used as measures of environmental impairment in characterizing stream conditions. Results from the impacted study sites were compared to six reference locations in the same watershed or geophysical province as the associated study sites. Suppressed species richness values at stream sites closer to DOE discharges reflect the impact to diatom communities. Greater siltation and disturbance indices at these sites support the assessment of impaired water quality. Future investigations are needed to more thoroughly assess water quality conditions and identify stream impairments thereby documenting any changes to the aquatic system resulting from DOE related activities. The diatom biological monitoring program will be suspended for 2001. The project may be reinstated in the future.

Introduction

Periphyton is commonly described as an assemblage of benthic microorganisms that inhabit almost every available aquatic system (Stoermer & Smol, 1999). Many of these organisms are algal in nature including bluegreens and a special group of unicellular organisms called diatoms. Unlike the soft-bodied algae, diatoms have hard cell walls composed of silca (opaline). The cell wall's structure, size, and shape are the diagnostic features in determining a diatom's taxonomic classification (Stoermer & Smol, 1999).

Diatoms have been used intensely for decades as indicators of water quality impairment (Kolkwitz & Marsson, 1908; Patrick, 1973; Stevenson & Lowe, 1986; Round, 1991). By examining diatom community assemblages and identifying shifts in species composition and structure over time, inferences regarding stream conditions can be made. Incorporating a diatom biological monitoring program permits an assessment of the ecological integrity (i.e., the "health") of a stream.

Many factors are included in the rationale for using diatoms in water quality studies. Diatoms make excellent bioindicators due to their varying sensitivities to pollution. Kolkwitz and Marsson (1908) were the first investigators to determine that diatoms could be used as environmental indicators and provided a classification scheme based on pollution tolerance. Being primary producers and on the base of the foodchain, diatoms are especially vulnerable to

perturbations. The relatively short generation times and rapid immigration rates make diatoms excellent study organisms in detecting acute impacts.

In 2000, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) Environmental Monitoring and Compliance Section (EMC) conducted field and laboratory activities as part of an ongoing diatom biological monitoring project. The goal of this project was to build on current baseline information in order to assess the water quality of streams within the Oak Ridge Reservation (ORR) that have received and may be receiving impacts from Department of Energy (DOE) related activities. The objectives were to colonize diatom assemblages on artificial substrates for a predetermined period of time and examine the species that were present compared to reference sites. This biomonitoring project complements the Rapid Bioassessment Program (RBP) that addresses the same water quality issues using benthic macroinvertebrates as study organisms.

Method and Materials

Five streams within the ORR were examined in 2000 to assess potential water quality impacts from DOE related activities. Locations in East Fork Poplar Creek, Bear Creek, White Oak Creek, Melton Branch, and Mitchell Branch were sampled for diatom analysis. Associated reference sites included Brushy Fork Creek, Hinds Creek, Gum Hollow Branch, and Mill Branch. Reference sites are located within the same watershed or geophysical province as the study sites. The locations of the eighteen diatom sampling sites are shown in Figures 1 and 2 of the biological monitoring program introduction. These sites were selected, in part, because of the wealth of chemical and biological information gathered from the Oak Ridge National Laboratory (ORNL) Biological Monitoring and Abatement Program (BMAP). Below is a list of the sampling sites in stream kilometers (miles).

- East Fork Poplar Creek (EFK): EFK 24.4 (15.2), EFK 23.4 (14.5), EFK 13.8 (8.6), and EFK 6.3 (3.9)
  Reference Sites: Brushy Fork Creek BFK 7.6 (4.7) and Hinds Creek HCK 20.6 (12.8)

- Bear Creek (BCK): BCK 12.3 (7.6) and BCK 10.3 (6.4)
  Reference Sites: Gum Hollow Branch GHK 2.9 (1.8) and Mill Branch MBK 1.6 (1.0)

- White Oak Creek (WCK): WCK 3.9 (2.4), WCK 2.9 (1.8), WCK 2.3 (1.4), and MEK 0.3 (0.2)
  Reference Site: WCK 6.8 (4.2)

- Mitchell Branch (MIK): MIK 0.71 (0.44) and MIK 0.45 (0.28)
  Reference Site: MIK 1.43 (0.89)

Artificial substrates were constructed by mounting four 2 inch x 2 inch, unglazed ceramic tiles to a brick using silicon glue. These tiles provided the surface for diatom assemblage. Three bricks were deployed near each other at each site so that diatom communities could be sampled. An instream exposure period of four weeks, March 27, 2000 through April 26, 2000, provided sufficient time for diatom colonization of artificial substrates. The position of each brick was

maintained by securing the brick to a rebar stake, tree root, or other fixture. Once a week each site was visited to check the integrity of the substrates and to clear debris that may have collected. Physical parameters including water depth and stream flow were measured at each artificial substrate location and recorded in the field logbook. Ambient water temperature and pH measurements were also collected. After four weeks of diatom colonization, all artificial substrates were retrieved and tiles containing representative assemblages of diatom communities were scraped using a toothbrush. The diatoms dislodged from the tiles were transferred into a collection bottle containing tap water. Internal and external labels with site specific collection information were included with each sample container. Duplicate samples were collected at 10% of the sites for quality assurance/quality control (QA/QC) purposes. The diatom samples were transported to the TDEC laboratory and stored in a refrigerator for future sample processing. Artificial substrates were returned to the laboratory for storage. Quarterly surface water samples (grab samples) were collected at all diatom sampling locations for water chemistry analysis.

Laboratory analysis of diatom samples was conducted by an independent facility under contract with the State of Tennessee. Laboratory methodologies included diatom sample preparation, microscope slide construction, and taxonomic identification and enumeration of diatom species. All methodologies including QA/QC procedures are outlined in the independent laboratory's standard operating procedures manual (Pennington & Associates, Inc., 1998). Specific metrics was applied to the generated data for site characterization and water quality assessments. Metrics included species richness and two indices of environmental impairment, the siltation index and disturbance index. These metrics have been widely used to quantitatively characterize stream periphyton communities (Bahls, 1993; Barbour et al., 1999).

Results and Discussion

Weekly field measurements including stream water temperature, pH, depth, and flow were averaged over the four-week colonization timeframe to arrive at means for the entire exposure period. Field data results and laboratory sample analysis results including site species lists, enumeration datasheets, and statistical applications are available upon request at the TDEC office. Also available are the GPS map coordinates for all eighteen sampling sites and results from the quarterly surface water sampling.

Three metrics based on species composition were used to characterize site conditions and assess the ecological integrity of each ecosystem. Species richness, or the total number of different species, is the simplest measure of species composition. In general, a more "healthy" stream has greater species richness. The siltation index is the relative abundance of three motile diatom genera, *Navicula, Nitzschia, and Surirella* that are capable of living on sediments and maintaining their positions on unstable substrates. The disturbance index is the percent abundance of *Achnanthes minutissima* within a community. This diatom attaches itself to the substrate and is capable of withstanding varying degrees of physical, chemical, and biological stressors. In general, a more "healthy" stream has low siltation and disturbance index values.

East Fork Poplar Creek

A downstream trend toward increasing species richness is exhibited in East Fork Poplar Creek (EFPC) (Figure 1). The species richness observed in the samples ranged from 10 at the most

upstream site, EFK 24.4, to 13 species at the lower most site, EFK 6.3. The total number of species at the reference sites, BFK 7.6 and HCK 20.6 was s=13 and s=14, respectively. The trend of increasing species richness with distance downstream was also observed in the 1999 sampling event.

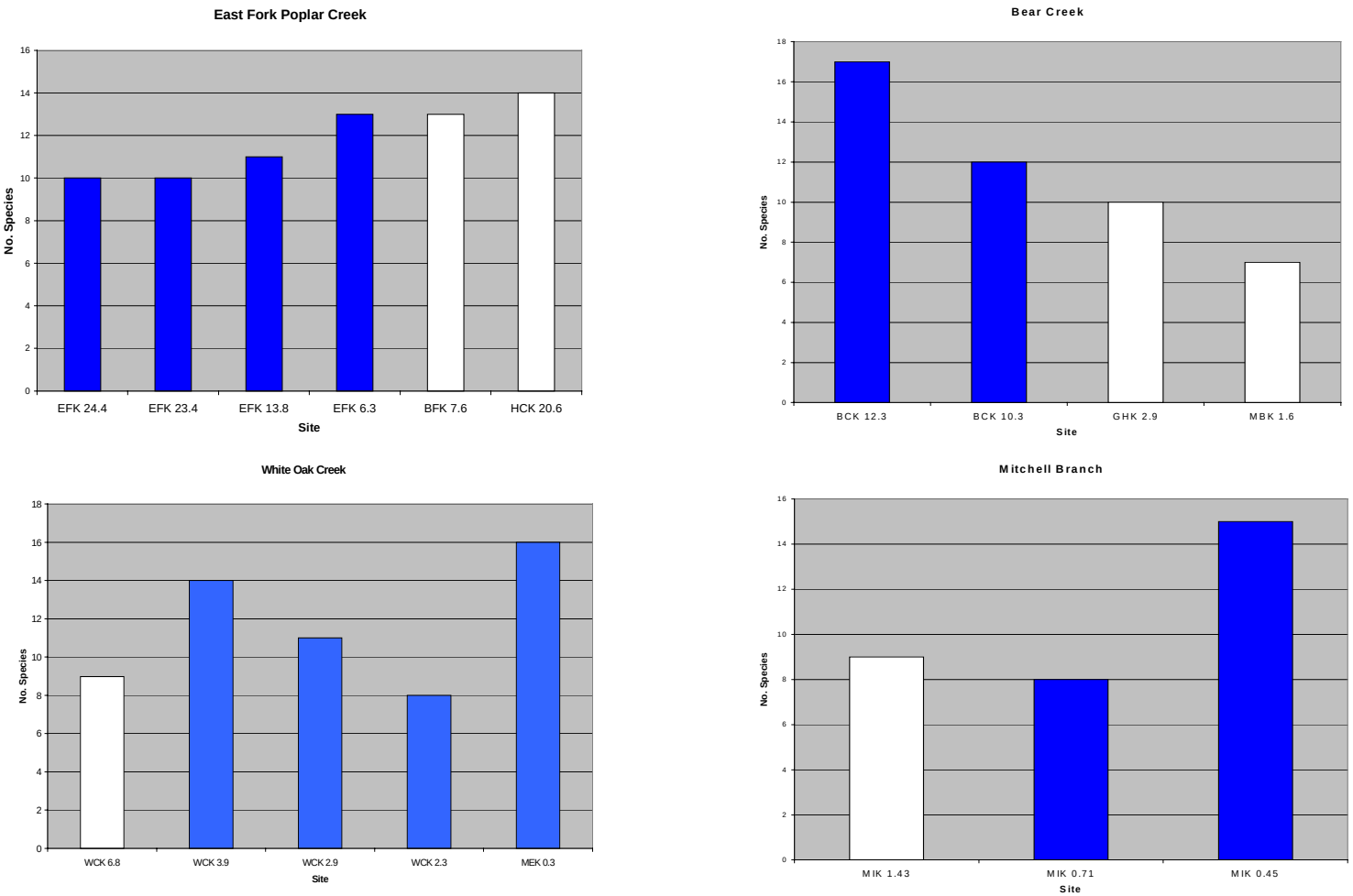
The siltation and disturbance indices for EFPC are presented in Table 1. The siltation index decreased sharply with distance downstream (I_S=83% at EFK 24.4 to I_S =14% at EFK 6.3). The Brushy Fork reference site had a siltation index similar to EFK 6.3 (I_S=12%) while the Hinds Creek reference site only had an index of 6%. The disturbance index decreased from 21% at EFK 23.4 to 0% at EFK 6.3. The reference site, BFK 7.6, had disturbance index of 5% while that at HCK 20.6 was 0%. These general trends of decreasing siltation and disturbance indices with distance downstream of the Y-12 Plant were also observed in 1999.

Historically, high metal concentrations of mercury (Hg), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), and zinc (Zn) downstream of Y-12 plant discharges indicates a source or sources within Y-12 Plant boundaries (Hinzman, R. L., 1998). Mean surface water sampling results from EFPC show a trend towards decreasing metal concentrations downstream of the Y-12 Plant. The two sites closest to possible sources, EFK 24.4 and EFK 23.4, had mercury levels greater than two times those measured at EFK 13.8 and EFK 6.3 (1.02 μg/l, 0.55 μg/l, 0.3 μg/l, and undetectable values, respectively). Zinc also showed decreasing concentrations with distance downstream with a moderate increase at EFK 6.3 (EFK 24.4 = 30 μg/l, EFK 23.4 = 23 μg/l, EFK 13.8 = 9 μg/l, and EFK 6.3 = 18 μg/l). The general trends in the mean surface water results for 2000 closely resembled those observed in 1999.

Numerous studies have been conducted on the species and community levels showing the effects of metals on diatoms (Deniseger et al., 1986; Takamura et al., 1989; Kelly et al., 1995; Pérès et al., 1997; Medley & Clements, 1998). The trend toward increasing diatom species richness with distance downstream suggests a correlation with the decrease in metal concentrations within East Fork Poplar Creek. Medley and Clements (1998) observed similar trends of increasing species richness with distance in metal contaminated streams.

Studies by Deniseger et al. (1986) and Takamura et al. (1989) indicate that *Achnanthes minutissima* has a tolerance for metals and tends to be the dominant species in streams that have metal impacts. A laboratory study by Pérès et al. (1997) showed that *A. minutissima* was able to tolerate high concentrations of organic mercury (MeHg) in the water column and sediments. This is a significant observation since the methylated form of mercury has a far more toxic effect on the structure, function, and abundance of a diatom than the inorganic elemental form (Peres et al., 1997). The tolerance of *A. minutissima* to high metal concentrations is evident in the high disturbance index at EFK 23.4. *A. minutissima* was absent in the sample collected from the most distant EFPC site, EFK 6.3 as well as the reference site, Hinds Creek. An apparent relationship exists in EFPC where diatom species richness increases with distance downstream in accord with a decline in metal concentrations. The degrees of siltation and relative disturbance decrease in EFPC as distance increases from the Y-12 Plant.

Figure 1. Diatom species richness in Oak Ridge Reservation streams, Spring 2000



Footnote: White bars represent reference sites.

Table 1. Siltation (I_S) and disturbance (I_D) indices of diatom communities in Oak Ridge Reservation streams, Spring 2000

	East Fork Poplar Creek					
Index	EFK 24.4	EFK 23.4	EFK 13.8	EFK 6.3	BFK 7.6*	HCK 20.6*
I_S (%)	83	46	41	14	12	6
I_D (%)	0	21	7	0	5	0

	Bear Creek			
Index	BCK 12.3	BCK 10.3	GHK 2.9*	MBK 1.6*
I_S (%)	18	7	25	16
I_D (%)	25	73	10	0

	White Oak Creek				
Index	WCK 6.8*	WCK 3.9	WCK 2.9	WCK 2.3	MEK 0.3
I_S (%)	10	38	8	4	36
I_D (%)	47	0	0	0	11

	Mitchell Branch		
Index	MIK 1.43*	MIK 0.71	MIK 0.45
I_S (%)	18	3	9
I_D (%)	0	0	40

* = reference site

Footnote: In general, higher siltation and disturbance indices indicate greater degrees of disturbance or impact.

Bear Creek

As shown in Figure 1, the uppermost Bear Creek site, BCK 12.3, had five more species present than just downstream at BCK 10.3 (s=17 and s=12, respectively). The Gum Hollow and Mill Branch reference sites had lower numbers of species present (GHK 2.9, s=10; MBK 1.6, s=7).

Table 1 shows that the siltation index at BCK 12.3 was greater than that calculated for BCK 10.3 (I_S=18% and I_S=7%, respectively). Conversely, the disturbance index at BCK 12.3 was much less than that calculated at BCK 10.3 (I_D=25% and I_D=73%, respectively). The Mill Branch reference site had a siltation index similar to BCK 12.3 (I_S=16%). The disturbance indices were lowest at both the Gum Hollow and Mill Branch reference sites: I_D=10% and I_D=0%, respectively. The effect of the lower species richness at BCK 10.3 compared to BCK 12.3 is magnified by the threefold increase in the disturbance index at BCK 10.3 compared to the more upstream site.

The surface water of upper Bear Creek can be characterized as being nutrient enriched with relatively high gross alpha and gross beta activity compared to reference streams. Much of the influx of nitrates and radiological activity in upper Bear Creek has been attributed to groundwater flow from the S-3 site (AJA Technical Services, Inc., 1999). From 1951 to 1984, this site, formerly a series of ponds, was used as an Y-12 treatment, storage, and disposal unit for various types of nitric and uranium based waste (HSW Environmental Consultants, Inc., 1994).

Mean surface water sampling results from BCK 12.3 and BCK 10.3 show high concentrations of nitrates in the form of inorganic NO_3 and NO_2 nitrogen. The mean nitrate concentration decreased from 19.3 mg/L at BCK 12.3 to 1.21 mg/L at BCK 10.3. Nutrient loading at BCK 12.3 was suspected from the observation of heavy filamentous algal matting within the stream during the sampling period. Mean gross alpha and beta values were greater at BCK 12.3 (79 pCi/L and 126 pCi/L, respectively) compared to BCK 10.3 (39.8 pCi/L and 10.2 pCi/L, respectively). It is important to note that the mean values at BCK 10.3 only represent the first two sampling events as the creek experienced seasonally dry periods in the summer and fall. Nitrate concentrations and radiological activity were measured in much greater quantities at the impacted sites of Bear Creek compared to the reference locations in Gum Hollow Branch and Mill Branch. The trends of decreasing nitrate concentrations and gross alpha and gross beta activity with distance downstream in Bear Creek was also seen in the surface water results from 1999.

White Oak Creek

White Oak Creek exhibited a general trend toward decreasing species richness with distance downstream of WCK 3.9 (Figure 1). The greatest number of diatom species was seen at the Melton Branch tributary (MEK 0.3) to lower White Oak Creek (s=16). The sampling results in 1999 also showed an increase in species richness at MEK 0.3.

Table 1 shows a high siltation index at WCK 3.9 (I_S=38%) while WCK 2.9 and WCK 2.3 had the lowest indices (8% and 4%, respectively). Even though the upstream reference

site, WCK 6.8, had a low siltation index of 10%, the site had a large disturbance index of 47%.

Results from White Oak Creek surface water samples at the diatom sampling sites show high levels of nitrates and total phosphate downstream of the reference site. An increase in radiological constituents and higher gross beta activity were also observed at the test sites compared to the upstream reference site. Heavy filamentous algal growth was noticed at WCK 3.9, a likely indication of nutrient loading from plant wastewater discharges near this site. *Cocconeis placentula* is a species of diatoms that is commonly found in the presence of organic pollution. This diatom was the dominant species present at WCK 2.9 and WCK 2.3. In 1999, *Cocconeis placentula* represented 99% of the relative abundance at both sites. The results from the 2000 sampling event indicate that the relative abundance remained high: 71% at WCK 2.9 and 83% at WCK 2.3. These observations suggest heavy organic and inorganic nutrient loading continued in White Oak Creek from various sources including seeps, runoff, and plant discharges. The high disturbance index calculated at the reference site, WCK 6.8, may be an indication of the degree of impact this section of the creek is experiencing from construction activities associated with the Spallation Neutron Source site nearby.

Mitchell Branch

The species richness was greatest (s=15) at the lower most site on Mitchell Branch, MIK 0.45 (Figure 1). The upstream reference site, MIK 1.43, had a species richness of s=9 while that at MIK 0.71 was s=8.

As was observed in 1999, the siltation indices decreased with distance from the reference site while the disturbance indices increased with distance. From Table 1, the siltation index was greatest at MIK 1.43 (I_S=18%) and the disturbance index was greatest at MIK 0.45 (I_D=40%). A series of storm drains exists in the reach of Mitchell Branch between MIK 0.71 and MIK 0.45. Storm drain 170 (SD170) is just upstream of MIK 0.71, SD 180 exists just downstream of MIK 0.71, and SD 190 appears just upstream of MIK 0.45. Historical data indicates these storm drains are sources of petroleum hydrocarbons, in particular, PCBs. The surface water results from the 2000 sampling events closely resembled those results obtained in 1999.

In 1997, remedial activities were initiated in a section of Mitchell Branch inside the East Tennessee Technology Park (ETTP) to pump and treat groundwater contaminated with petroleum hydrocarbons. Project activities involved relining Mitchell Branch by installing geosynthetic membranes, including an impermeable membrane, anchored by interlocking concrete blocks (Bechtel Jacobs Company LLC, 1998). One of the diatom sampling sites (MIK 0.71) lies within the remediated section of Mitchell Branch. MIK 0.45 is located downstream of the relined portion. The low siltation and disturbance indices at MIK 0.71 suggest that the remedial activities in this section of the creek are having an impact on the diatom communities.

Conclusion

The use of diatoms as biological indicators has shown to be an effective and viable method of assessing the water quality of streams. By examining the species composition and diversity of diatoms based on their ecological preferences and pollution tolerances, inferences can be made regarding the ecological integrity (i.e., stream "health") of the system. With the availability of specific water quality data, further inferences could be developed suggesting certain environmental stressors.

The data collected in 2000 was compared to that gathered in 1999 and permitted continued assessments of water quality in streams on the ORR. All four stream systems examined, East Fork Poplar Creek, Bear Creek, White Oak Creek, and Mitchell Branch showed indications of continued water quality impairments through suppressed species richness values, high siltation and disturbance indices, and elevated surface water chemical concentrations compared to reference values.

Continued biological monitoring will ensure more complete and accurate assessments of the water quality in ORR streams. Impacts to these streams from DOE related activities would be evaluated on a temporal and spatial scale, thereby more closely defining the impact. A long-term study will also permit an opportunity to monitor the effectiveness of DOE site remedial activities that are occurring near and within these streams.

References

AJA Technical Services, Inc. 1999. *Groundwater Protection Program Calendar Year 1998 Evaluation of Groundwater and Surface Water Quality Data for the Bear Creek Hydrogeologic Regime at the U.S. Department of Energy Y-12 Plant, Oak Ridge, Tennessee.* Prepared for Lockheed Martin Energy Systems, Inc. (Y/SUB/99-MVM64V/4).

Bahls, L.L. 1999. *Periphyton Bioassessment Methods for Montana Streams.* Department of Health and Environmental Sciences, Helena, MT: Water Quality Bureau.

Barbour, M.T., J.Gerritsen, B.D. Snyder, & J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.* Second. Edition. EPA/841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Bechtel Jacobs Company LLC. 1998. *Removal Action Report on the Mitchell Branch and K-1070-C/D Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee.* Prepared for the U.S. Department of Energy Office of Environmental Management (DOE/OR/01-1728& D2).

Deniseger, J., A. Austin, & W. P. Lucey. 1986. Periphyton communities in a pristine mountain stream above and below heavy metal mining operations. *Freshwater Biology*, 16, 209-218.

Hinzman, R.L. (ed). 1998. Third Report on the Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek. Report number Y/TS-889. Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, USA.

HSW Environmental Consultants, Inc. 1994. *Calendar Year 1993Groundwater Quality Report for the Bear Creek Hydrogeologic Regime, Y-12 Plant, Oak Ridge, Tennessee.* Prepared for Lockheed Martin Energy Systems, Inc. (Y/SUB/94-EAQ10C/1/P1).

Kelly, M.G., C. J. Penny, & B. A. Whitton. 1995. Comparative performance of benthic diatom indices used to assess river water quality. *Hydrobiologia,* 302, 179-188.

Kolkwitz, R. & M. Marsson. 1908. Ökologie der pflanzliche Saprobien. *Berichte der Deutsche Botanische Gesellschaften,* 26, 505-519.

Medley, C. N., & W. H. Clements. 1998. Responses of diatom communities to heavy metals in streams: the influence of longitudinal variation. *Ecological Applications,* 8(3) 631-644.

Patrick, R. 1973. Use of algae, especially diatoms, in the assessment of water quality. In *Biological Methods for the Assessment of Water Quality,* ASTM STP 528, pp.76-95. Philadelphia, PA: American Society for Testing and Materials Publication.

Pennington & Associates, Inc. 1998. *Specifications For Processing, Identification, And Enumeration Of Phytoplankton, Zooplankton, and Periphyton Samples.* Cookeville, TN.

Pérès, F., M. Coste, F. Ribeyre, M. Ricard, & A. Boudou. 1997. *Journal of Applied Phycology,* 9: 215-227.

Round, F.E. 1991. Diatoms in river water-monitoring studies. *Journal of Applied Phycology,* 3, 129-145.

Stevenson, R.J. & R.L. Lowe. 1986. Sampling and interpretation of algal patterns for water quality assessment. In *Rationale for Sampling and Interpretation of Ecological Data in the Assessment of Freshwater Ecosystems,* ed. B.G. Isom, ASTM STP 894. pp. 118-149. Philadelphia, PA: American Society for Testing and Materials Publication.

Stoermer, E.F. & J.P. Smol. 1999. Applications and uses of diatoms: prologue. In: *The Diatoms: Applications for the Environmental and Earth Sciences,* ed. E.F. Stoermer and J.P. Smol, p 3.

Takamura, N., F. Kasai, & M. M. Watanabe. 1989. *Journal of Applied Phycology,* 1: 39-52.

TDEC Department of Energy Oversight, November, 1998, *Health, Safety, and Security Plan*

BIOLOGICAL/FISH AND WIILDLIFE

TWRA Fish Tissue Sampling and Advisories

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Abstract

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) currently participates in posting those advisories on waters of the State, which are impacted or could potentially be impacted by Department of Energy (DOE) operations in Oak Ridge, Tennessee. This work is conducted in cooperation with the TDEC Knoxville Environmental Assistance Center (EAC) and the TDEC Chattanooga EAC. These activities are categorized into two groups. The first is the posting of fish tissue advisory signs on Melton Hill Reservoir and Watts Bar Reservoir as part of the statewide effort to protect public health. These postings advise against the consumption of certain fish species in specified quantities. The second group is the posting of fish tissue advisory signs on East Fork Poplar Creek in Oak Ridge, Tennessee. These postings are related to the hazards of fish consumption and bodily contact with the water. Advisory signs are located at points where public access is likely, such as public boat ramps, designated fishing areas, and public parks and recreation areas. Advisories are issued when levels of contaminants in samples of fish tissue reach predetermined levels. Depending on the contaminant, these levels vary from parts per trillion (ppt) to parts per million (ppm). The primary contaminants of concern in fish tissue around the Oak Ridge Reservation (ORR) are polychlorinated biphenyls (PCBs) and mercury. In general, levels of PCBs exceeding 1 ppm in fish tissue are considered to be sufficient to warrant the issuance of an advisory for a body of water. Levels of mercury exceeding 0.5 ppm have been used to issue fish tissue advisories. The Environmental Protection Agency has recently issued a proposed rule that would lower this level to 0.3 ppm. The information presented in this report reflects current regulatory standards.

In addition to the posting of fish tissue advisories, TDEC has contracted the Tennessee Wildlife Resources Agency (TWRA) to conduct annual independent sampling of fish in bodies of water in proximity to the ORR that may show effects of impact from ORR Operations. This sampling was initiated in 1991 and continued through 1999. The choice of sampling locations was conducted in conjunction with other agencies that also conduct fish tissue sampling in an effort to reduce duplication of effort and increase interagency cooperation. Wright State University has analyzed the tissue samples collected as part of this contract for a suite of organic contaminants.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) of Water Pollution Control posts warning signs on streams or lakes in which public health is endangered. In Tennessee, the most common reasons for a river or lake to be posted are the presence of sewage bacteria or other contaminants in the water, sediment, or fish of a waterbody. The authority for posting State waters is derived from the Tennessee Water Quality Act.

> "The Commissioner shall have the power, duty, and responsibility to...post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters."

When fish tissue samples show levels of a contaminant higher than established criteria, the waterbody is posted and the public is advised of the danger. If needed, Tennessee Wildlife Resources Agency (TWRA) can enforce a fishing ban. Approximately 84,100 lake acres and 142 river miles are currently posted due to contaminated fish.

When the Department issues new advisories or provides an updated list, signs are placed at significant public access points and a press release is submitted to local newspapers. The list of current advisories has historically been published in TWRA's fishing regulations guide.

Under the rules and regulations for TDEC (Rule 1200-4-3-.03 (4)(j)), a risk based assessment is used to determine the criteria for fish tissue advisories where a cancer risk is suspected. Where toxicity is an issue, the advisories are based on US Food and Drug Administration Action Levels. In part, the Rule reads:

> "Fish Consumption Advisories – A public fishing advisory will be considered when the calculated risk of additional cancers exceeds 10^{-4} for typical consumers or 10^{-5} for atypical consumers. A "do not consume" advisory will be issued for the protection of typical consumers and a "precautionary advisory" will be issued for the protection of atypical consumers."
>
> "For substances for which the public health concern is based on toxicity, a "do not consume" advisory will be considered warranted when the average levels of the substance in the edible portion of fish exceed U.S. Food and Drug Administration (FDA) Action Levels."

In addition, the State is required by Section 303(d) of the Federal Clean Water Act to compile a list of waters within the State that need additional pollution controls in order to meet water quality standards. This compilation, commonly referred to as the 303(d) List, typically includes advisories regarding fish tissue consumption. The following table is an excerpt from the main 303(d) List showing impacted waters in the vicinity of the Oak Ridge Reservation (ORR) and fish tissue advisories for those waters.

Table 1. Current Fish Tissue Advisories in the Vicinity of the ORR

Stream	County	Portion	Pollutant	Comments
East Fork of Poplar Creek incl. Poplar Creek embayment	Anderson, Roane	Mile 0.0 - 15.0	Mercury, PCBs	Fish should not be consumed. Avoid contact with water also.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (46 miles)	PCBs	Commercial fishing for catfish prohibited by TWRA. Catfish, largemouth bass over two pounds, or any largemouth bass from the Little River embayment should not be consumed.
Tellico Lake	Loudon	Entirety	PCBs	Catfish should not be consumed.
Melton Hill Reservoir	Knox, Anderson	Entirety	PCBs	Catfish should not be consumed.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion	PCBs	Catfish, striped bass, & hybrid striped bass-white bass should not be consumed. Precautionary advisory* for whitebass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm	PCBs	Striped bass should not be consumed. Precautionary advisory for catfish and sauger.*

*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month.

The presence of disease-causing pathogens affect the public's ability to safely swim, wade, and fish in streams and lakes. TDEC's current water quality standards for bacteria are based on levels of total fecal coliforms and *E. coli* (200 and 126 colonies per 100 ml, respectively, as a mean).

While neither of these tests is considered direct proof of human health threats, they are relatively simple, inexpensive tests that may indicate the presence of more dangerous viruses and other water-borne diseases.

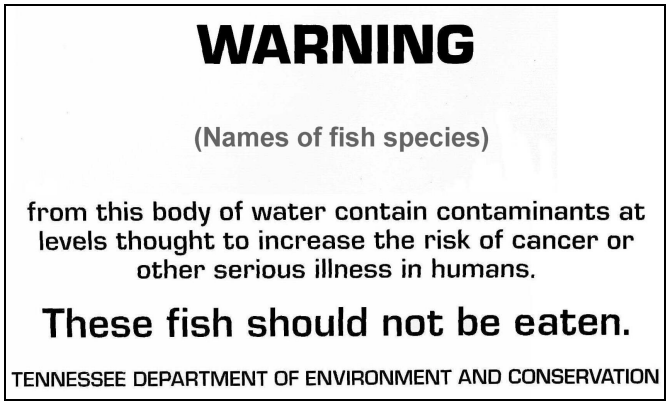
Research is underway to find better indicators of risk and to differentiate between human and animal sources of bacteria. The presence in streams of caffeine and hormones have been suggested as potential markers for contamination by human waste.

More than 110 river miles are posted due to bacterial contamination. Many of these miles are due to bypassing of inadequately treated wastewater from municipal collection systems. Fewer streams are posted due to bacteria levels from other sources such as septic tanks and failing animal waste systems.

Melton Hill Reservoir Advisories

In support of the State of Tennessee's continuing efforts to protect the public health, fish tissue advisories are maintained on Melton Hill Reservoir by TDEC. These advisories are related to the levels of polychlorinated biphenyls (PCBs) and the pesticide chlordane found in fish collected from the reservoir. These postings currently advise against the consumption of any catfish (Figure 1).

Figure 1. Example of Fish Consumption Advisory Sign on Melton Hill Reservoir



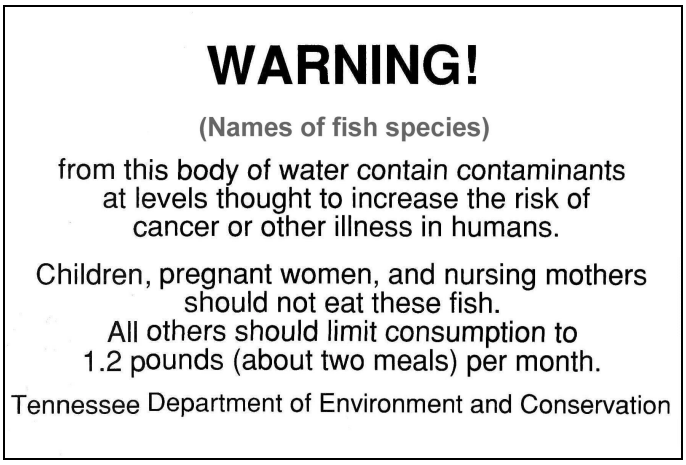
Watts Bar Reservoir Advisories

The posting of fish tissue advisories on Watts Bar Reservoir serves a two-fold purpose. One is the continuing effort, by the State, to protect public health. The second purpose is compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Lower Watts Bar Reservoir (LWBR) Record of Decision (ROD) between the State of Tennessee and DOE. The ROD states that DOE will continue to work with the appropriate statutory agencies, in this case TDEC, to coordinate and support the implementation of existing institutional controls and advisories. The advisories on Watts Bar Reservoir can be classified into three areas.

Watts Bar (Clinch River Arm)

The first area is the Clinch River arm of Watts Bar Reservoir from Melton Hill Dam to the confluence of the Clinch and Tennessee Rivers at Kingston, Tennessee. TDEC currently conducts fish tissue advisory sign posting in this area. These postings advise against any consumption of striped bass. There is also a precautionary fish tissue advisory for catfish and sauger on this arm of the reservoir (Figure 2). A precautionary advisory means, that children, pregnant women, and nursing mothers should not consume the fish species named and all other persons should limit consumption of the named species to 1.2 pounds per month. These advisories are issued due to the presence of elevated levels of PCBs found in fish tissue of these species.

Figure 2. Example of Precautionary Fish Consumption Advisory Sign on Watts Bar Reservoir



Watts Bar (Tennessee River Arm)

The second area is the Tennessee River arm of Watts Bar Reservoir from Fort Loudon Dam to the Roane County line. The Knoxville EAC and TDEC cooperatively conduct fish tissue advisory sign posting in this area. These postings advise against any consumption of catfish, striped bass and hybrid striped bass-whitebass. There is also a precautionary fish tissue advisory for whitebass, sauger, carp, smallmouth buffalo, and largemouth bass. These advisories are issued due to the presence of elevated levels of PCBs found in fish tissue of these species.

Watts Bar (Lower Tennessee River Arm)

The third area is Watts Bar Reservoir from the Roane County line to Watts Bar Dam. The Chattanooga EAC currently conducts fish tissue advisory sign posting in this area. These postings advise against any consumption of catfish, striped bass and hybrid striped bass-whitebass. There is also a precautionary fish tissue advisory for whitebass, sauger, carp, smallmouth buffalo, and largemouth bass. These advisories are issued due to the presence of elevated levels of PCBs found in fish tissue of these species.

East Fork Poplar Creek Advisories

Currently, TDEC conducts the fish tissue advisory sign posting on East Fork Poplar Creek (EFPC). The creek is posted with advisories warning against fishing, swimming, and wading (Figure 3). These postings are a result of elevated mercury, PCBs, and fecal coliform. The posting of EFPC extends from East Fork Kilometer (EFK) 23.4 downstream to EFK 6.1. This

effectively covers the residential area of the City of Oak Ridge. The sites for posting were selected based on ease of public accessibility and proximity to residential areas. The posting of advisory signs on EFPC was covered in the Lower EFPC ROD. Although the selected remedial action (Alternative 3) does not specifically address this issue, formal comments received from the public (Issue 13: Advisory Signs) prompted the response that the State will reevaluate the need for advisory signs upon completion of the cleanup.

Figure 3. Example of East Fork Poplar Creek Advisory Sign

TWRA Fish Tissue Sampling

The TWRA has conducted fish tissue sampling as part of a contract with TDEC. These samples were analyzed by Wright State University for a range of organic and inorganic contaminants. A review of the results of the data indicates that the primary contaminants of concern in the samples analyzed were PCBs and chlordane. These results are consistent with sampling done by other agencies in the same areas. Analysis of concentrations of Channel catfish composite samples collected from sites influenced by the ORR (Table 2) show that the levels of PCBs in these fish are consistent with the levels of PCBs in Channel catfish composite samples collected from sites beyond the influence of the ORR (Table 3). The only other contaminant tested for in these samples that showed levels of concern was chlordane. Levels of chlordane in the composite sample collected in 1992 from TRM 601 (0.386 ppm) were above the regulatory level. This site is considered to be outside the influence of the ORR. It is also important to note that these samples were not analyzed for mercury.

Table 2. PCB Concentrations in Channel Catfish Composite Samples Influenced by the Oak Ridge Reservation

Site	Year	PCB Concentration (ppm)
TRM 531	1996	0.666
TRM 545	1991	0.0636
TRM 545	1992	ND
TRM 560	1992	0.0728
TRM 560	1996	1.315
CRM 1.0	1992	0.0213
PCM 1.0	1992	0.0905

Samples were composites of fillets from five fish.
ND = non detect

Table 3. PCB Concentrations in Channel Catfish Composite Samples Not Influenced by the Oak Ridge Reservation

Site	Year	PCB Concentration (ppm)
TRM 472	1997	0.640
TRM 490	1997	0.604
TRM 526	1992	0.0063
TRM 529	1997	0.791
TRM 529	1996	0.988
TRM 529.5	1995	0.0354
TRM 600	1991	0.0681
TRM 600	1996	1.366
TRM 601	1992	0.0779
TRM 602	1994	0.185
TRM 602	1996	0.248
TRM 624	1991	0.06
TRM 624	1992	0.0586
CRM 24	1996	0.652
CRM 39	1992	0.0779
CRM 45	1996	0.735
CRM 51	1991	0.0035
CRM 145	1992	ND

Samples were composites of fillets from five fish.
ND = non detect

Fish tissue advisories are not based solely on the data shown here. The TDEC gathers information collected by numerous programs by multiple agencies. The TVA collects fish tissue samples as part of their Valley Wide sampling program. The DOE collects fish tissue data as part of numerous compliance programs associated with operations on the ORR. This data is regularly shared and utilized as a basis to make decisions on the need for fish tissue advisories on the waters of the State.

Conclusion

Based on analysis of fish tissue data collected by TWRA under contract with TDEC and other available data, the levels of contaminants in fish tissue around the ORR are comparable to those in areas outside the influence of the ORR. The only exception to this is the elevated levels of mercury in fish tissue at sites immediately down stream of the ORR. These findings do not mean that unrestricted consumption of fish caught in these areas is safe. Many of the waters in East Tennessee are posted with some form of fish tissue advisory. These results only indicate that, with the exception of mercury, the ORR is most likely not contributing additional levels of contaminants above and beyond those that are present due to non-DOE sources.

References

Ambient Water Standard Operating Procedure, Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1996.

Health, Safety, and Security Plan, Tennessee Department of Environment and Conservation, Department of Energy, Oversight Division, Oak Ridge, TN, 1998.

BIOLOGICAL/FISH AND WILDLIFE

Canada Geese Monitoring

Principal Author: Roger Petrie

Abstract
On June 27, 2000 the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducted oversight of the annual Canada Geese (*Branta canadensis*) monitoring project on the Oak Ridge Reservation (ORR). The objective of this study is to determine if geese are becoming contaminated on the ORR. The captured geese were transported to the Tennessee Wildlife Resources Association (TWRA) game check station on Bethel Valley Road and tested for radioactive contamination. None of the geese showed elevated gamma counts.

Introduction
A large population of Canada geese, both resident and transient, frequents the Oak Ridge Reservation (ORR) (Crabtree 1998). The thriving goose population in this area makes this animal an easily accessible food for area residents. Geese with elevated levels of Cs137 in muscle tissue have been found on the ORR (MMES 1987 and Loar 1994). Studies in the 1980s demonstrated that geese associated with the contaminated ponds/lakes on the ORR can accumulate radioactive contaminants quickly and that contaminated geese frequent off site locations (Loar 1990, Waters 1990, MMES 1987))

Every year the Department of Energy (DOE) and Tennessee Wildlife Resource Agency (TWRA) capture geese on the ORR during the annual "Goose Roundup" and perform whole body counts on them to determine if the birds are radioactively contaminated. During the 1998, goose roundup, 38 geese at Oak Ridge National Laboratory (ORNL) contained Cesium 137 concentration that exceeded the game release limit of 5 pCi/g (ORNL 1998). A subsequent study in September 1998 found elevated levels of Cs137 in grass and sediment at two reaches of White Oak Creek south of 3513 Pond and in grass around the 3524 pond (ORNL 1998). Results of the 1999 sampling showed that no geese captured on the reservation had elevated levels of Cs137.

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy (DOE-O) has a sampling plan that is implemented when geese with elevated gamma readings are detected during the regular goose roundup. If any geese with elevated gamma readings are detected then arrangements are made to sample geese that are found in the vicinity of the ORR on private property. This is to determine if contaminated geese are leaving the reservation and are presenting a risk to area hunters.

Results and Discussion
During the 2000 sampling, a total of 141 birds were captured. Of the 31 birds captured at the East Tennessee Technology Park (ETTP) on June 27, 2000, twenty were measured for gamma contamination. Twenty-seven birds were captured on June 27, 2000, in the vicinity of the ponds located near the 1500 area of ORNL, eighteen of which were analyzed. In addition, 44 birds were captured the same day near the swan pond at ORNL, twenty of which were analyzed. On

June 28, 2000, thirty-nine birds were captured from the park located at Melton Hill Dam, twenty of which were analyzed. None of the birds analyzed had levels of gamma above the 5pCi/g game release level.

Conclusion

Since none of the birds analyzed showed signs of contamination, no additional offsite sampling was conducted. Although this does not preclude the possibility of contaminated geese being present off the ORR, it does indicate that there is a reduced likelihood of this situation existing.

References

Ashwood, T.L. ed. 1993. Seventh Annual Report on the ORNL Biological Monitoring and Abatement Program, Environmental Sciences Division Publication No. 4074. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Blaylock B. G., M.L. Frank, F.O. Hoffman, L.A. Hook, G.W. Suter, J. A. Watts. 1992. Screening of Contaminants in Waste Area Grouping 2 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. ORNL/ER-62/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Crabtree, H., TDEC DOE-Oversight, 1998. Personal communication.

Evans, J., TWRA, Personal communication.

Loar, J. M., ed. 1990, Fourth Annual Report on the ORNL Biological Monitoring and Abatement Program, ORNL/TM- (Draft). Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Loar, J. M., ed. 1994. Fourth Report on the Oak Ridge National Laboratory Biological Monitoring and Abatement Program for White Oak Creek Watershed and the Clinch River, ORNL/TM-11544. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

MMES 1987, Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1986, Volume 2: Data Presentation, ES/ESH-1/V2,

ORNL 1994. Third Report on the Oak Ridge National Laboratory Biological Monitoring and Abatement Program for White Oak Creek Watershed and the Clinch River. ORNL/TM-11358, Environmental Sciences Division Publication No. 4255.

ORNL 1998. Study Plan and Analysis Results from Contamination Study on Soils and Vegetation Around 3524 and 3513 Ponds, First Creek and White Oak Creek

Waters, A. E. 1990. Radioactive and Non-radioactive Contaminants in Migratory and Resident Waterfowl Inhabiting the Oak Ridge Reservation, East Tennessee, Master of Science Degree Thesis.The University of Tennessee, Knoxville, Tennessee.

BIOLOGICAL/FISH AND WILDLIFE

Determination of Sr-90 and Cs-137 Pathways to White Tail Deer on the ORR

Principal Authors: Robert Storms and Gerry Middleton

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) performed a walkover radiological survey for the purpose of determining ecological pathways responsible for the radiological contamination of white-tail deer on the Oak Ridge Reservation (ORR). Through managed hunts on the Reservation, deer are confiscated due to elevated levels of radionuclides in the deer. The most prevalent contaminants are cesium 137, a gamma emitter, accumulating in the tissue, and strontium 90, a beta emitter and bone seeker.

TDEC set out to determine where deer are ingesting contaminants. Based on maps created by Tennessee Wildlife and Resource Agency (TWRA) and Oak Ridge National Laboratories (ORNL), depicting quadrants where the most deer have been confiscated during the hunts, and survey maps created during footprint surveys of the reservation depicting high radiological areas, TDEC created a blueprint to work from.

It was determined that the deer are breaching contaminated areas, deterred only by fences or posted signs on chains. Based on this, attention should be focused to remediate those areas already documented, to help prevent further contamination of wildlife, and humans through consumption due to hunting. Present institutional controls are not functioning as a deterrent to deer incursions into radiological areas. The deer checks after hunts do however prevent human consumption of potentially contaminated venison harvested from the ORR.

Introduction

The purpose of this project was to identify the ecological pathways through which contamination is introduced to the white tail deer on the Oak Ridge Reservation (ORR). Contamination in this sense of the word is limited to radiological constituents.

The concerns of this project are based on the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division's mission to protect human health and the environment. If the state can determine where the deer are encountering contamination, hopefully the state can press for remediation of these sites. Not only does this protect the deer and other animals, but humans as well, who may consume them.

This report will focus on two radionuclides, strontium 90 and cesium 137, which are ingested by the deer. These two radionuclides are prevalent on the ORR and are known to accumulate in deer. Strontium 90, a beta emitter, has a half-life of 29 years and bioaccumulates in the deer bones. Strontium 90 in bone is correlated with concentration in muscle tissue (meat). Cesium 137, a gamma emitter, has a half-life just over 30 years and is absorbed by soft tissue. Other radionuclides are present in the environment but have not been found accumulated in deer in appreciable amounts. This is based on analysis of the deer, taken during the hunts on the ORR, at

the Tennessee Wildlife Resource Agency (TWRA) check station by Oak Ridge National Laboratory (ORNL) personnel.

Cesium 137 and strontium 90 are both present on the ORR as a contaminant. Both are very mobile in multiple environmental media and have been absorbed by vascular flora, including deer forage, through soil uptake. Because most terrestrial wildlife are mobile, moving about from one habitat to another, exposure is not limited to a single location. The deer may incorporate contamination from several spatially discrete sources.

Methods, Materials, and Deer Biology

The first step in the project was to evaluate the maps put together by TWRA, depicting the location of all deer killed on the ORR, during scheduled hunts, since 1985 and the number retained from that area due to radiological contamination (fig. 1). This was then compared to maps created during the Footprint Reduction project in which areas with radiological concerns were identified on a map (fig 2). These quadrants were then labeled for consideration of future visits and evaluation.

Background research was then performed on the white tail deer to learn about their habits including preferred foods, habitats, movements, etc. A deer's behavior is directly related to its environment. Native Americans believed the moon, wind, and rain affected deer movements. Current studies confirm that deer activity indeed varies depending on the temperature, moon phases, and even barometric pressure. White tails, especially mature bucks, are active at night, preferring to feed, mingle, and mate under a cloak of darkness. Deer remain active at dawn, typically bed down at midday, and start to motivate again at dusk. Studies indicate that they rarely, if ever, bed in the same exact spot twice; perhaps this deters predators from catching their scent and lying in wait for an easy meal the next day. Deer do not sleep for long periods of time, rather they doze, always trying to stay alert (Sutton1987).

Although white tails are social animals that are found in herds, the sexes are largely divided. Outside the breeding season, a mature buck almost never stays with a doe unit or a group of does and fawns, bucks travel alone or band together in small groups. White-tails communicate with vocalizations and scents. A buck paws out a scrape and urinates over his tarsal glands to lay down scent that might attract a doe or challenge another male for dominance. (Nebraska 2000)

Deer are herbivores. Although primarily nocturnal, deer may be active at any time, grazing on green plants (*Euonymus* & *Leucothoe* spp. are favorites). This includes aquatic plants in the summer. In fall and winter, the high priority deer foods are evergreen browse, hard and soft mast, herbaceous vegetation, and fungi. While their diet consists primarily of acorns, beechnuts, other nuts (mast), and corn in the fall; they browse on woody vegetation, including the twigs and buds of viburnum, birch, maple, and many conifers in winter. Deer eat grasses, fungi and leaves, but will also eat mushrooms, succulent fruit, and berries. Also, they will eat the grain that is left in the farmer's fields after the harvest.

Adult deer require 6-8 pounds of green food per 100 pounds of body mass daily. Reproductive rates and survival of adverse winter conditions depend on the relative body fat stored during summer and fall feeding. It follows that the abundance and quality of summer-fall foods largely

govern the reproductive condition of deer. Nutrition, age, and genetics govern antler development. Antlers emerge in the spring and grow throughout the summer. Antler rubbing (velvet) begins in August and ends by mid-October. Breeding activity peaks from late October through December. Antlers are shed from late December to mid April.

The white tail deer eats its food twice. It has four stomachs. When it starts eating early in the morning, it gobbles down grass and leaves to fill the first stomach. While the deer rests, the food goes into the second stomach where it turns into little balls. The deer then brings the food back up to its mouth and chews it well. Afterwards the food goes into the third and fourth stomachs for digestion. (From R. A. Royo, 1999, and North Carolina State Univ., 1995)

Cover varies somewhat depending on the time of the year. During the summer deer may be found wherever sufficient food, water, cool shade, and seclusion are available, which is usually in creek bottoms in drainage basins or ravines. Oak stands are probably the best cover, as long as other habitat elements are available. Winter cover consists of evergreen thickets, dense young timber stands, cut over slash, broom sedge fields, old beaver ponds, or thick hardwood swamps. The edges of tall grasses or hay fields, along with brushy overgrown fields, are frequently used by does for fawning cover.

Deer require water occasionally which lactating females need daily. Succulent green plants only partially meet a deer's water needs so a lack of free water may deter deer from using certain parts of otherwise suitable range. (From North Carolina State University, 1995)

Using the information gathered from previous deer hunt data and known contamination areas amassed during Footprint Reduction surveys, the state created a map for this project (fig. 3). The state visited areas most likely suited for deer habitat looking for signs of deer activity. Close attention was drawn to those sites noted with elevated radiation and high deer retention numbers. Staff used a Ludlum 2x2 sodium iodide (44-10) detector and Ludlum scaler/ratemeter to detect gamma in the field. A pancake probe (beta/gamma) and zinc Sulfide (alpha) were brought along to verify if needed. Positions in the field were verified with the use of a Global Positioning System (GPS) (fig. 4).

Staff traversed the areas while continuously monitoring the environment. Deer footprints and scat, as well as mineral licks, watering holes, and favorite cuisine were all noted in the field with relation to contamination. Table one depicts random points selected for coverage in the field.

Results

Figures 1 and 3 illustrate the main impacted areas of the ORR relating to the compromise of certain wildlife habitats. The main radionuclides of concern detected in retained deer during the TWRA managed Oak Ridge Wildlife Management Area hunts are strontium-90 and cesium-137. The main source areas on the ORR for these radionuclides and others are at ORNL. These areas are suggested as sources of uptake by vegetation and ingestion by wildlife. Wildlife on the ORR including the white tail-deer may become contaminated by uptake of radiologically-impacted foliage by the drinking of impacted surface waters such as springs, streams and ponds, and from soil ingestion at mineral licks. As far as institutional controls are concerned, TDEC contends the current chain-link fence is not a hindrance for deer to successfully jump across. The following

facilities and locations on the reservation are suggested as likely candidates for radionuclide uptake in habitats accessible to the local white-tail herd population for foraging.

1. ORNL Waste Area Groupings (WAGs) and Solid Waste Management Units (SWMUs) and associated WAG 1 Ponds at ORNL
2. Bethel Valley Administrative Watershed and associated ponds such as 3513 and 3524
3. Melton Valley Administrative Watershed
4. White Oak Creek, White Oak Creek Embayment, and White Oak Lake - Sediment, Surface Water & Vascular Plants (Cs-137 & Sr-90)
5. Northwest Tributary - WAG 1
6. High Flux Isotopic Reactor vicinity and surrounding woods
7. HRE and local impacted springs
8. "Cesium Contaminated Forest"
9. WC7500 Bridge - Melton Valley
10. WAG 4 Seeps and trenches (Strontium-90)
11. WAG 5 burial grounds, TRU waste burial trenches, and seeps
12. WAG 5 Seep C and WAG 5 Seep D (Strontium-90)
13. Molten Salt Reactor Experiment
14. Melton Valley Storage Tanks (Former New Hydrofracture Facility)
15. Old Hydrofracture Facility and associated Ponds – WAG 5
16. WAG 6 burial grounds, seeps, and trenches
17. SWSA 7 and surface water
18. WAG 11 White Wing Scrap Yard (Historical)
19. WAG 13 Cesium Plots and associated Experimental Areas (Historical)
20. Clinch River shoreline sediments contaminated with Cs-137 along the exposed low water mark - principally downstream of the White Oak Creek and Clinch River confluence
21. Numerous impacted springs, seeps, streams, and ponds in Melton & Bethel Valleys
22. Bear Creek Burial Grounds/S-3 discharge to NT-1 & NT-2, and springs/Boneyard/Burnyard at Y-12 Security Complex
23. K-1070 C/D, Mitchell Branch, K-1407 B/C Ponds, K-1070-A Burial Ground, K-901 Pond and K-1407 C/D areas of ETTP

For the most part, cesium 137 and strontium 90 occur together in the same waste streams released into Melton Branch and White Oak watersheds. Thus, if cesium 137 is detected, strontium 90 is probably tied up in associated water via transport. Thus we were able to use the sodium iodide (gamma detector) as a first line instrument for detection of radionuclides.

A gamma level of 7,500 counts per minute was established as background. This was determined based on over 2000 points taken on the reservation during the Footprint Reduction survey (figure 2). This number may vary, generally as high as 14,000 cpm due to soil and rock type, which may contain shale, naturally high in radiological constituents. An action limit of twice background was established for assessment.

Of particular note is the "Cesium Contaminated Forest," a radioecological research site, located in the Copper Ridge Footprint Study Area, about 0.5 mile west of the DOSAR/HPRR facilities. The site, appropriately marked by radiological control ropes and signs, is still active

radiologically and is significantly detectable due to uptake of cesium-137 through the vascular system of the trees and the associated leaf litter deposited in the vicinity. TDEC, utilizing the sodium iodide instrument, observed readings in excess of 200,000 counts per minute at one corner of the site and readings approaching 500,000 counts per minute at the opposite corner of this radiological-posted area. It would be very easy for the deer to ingest the contaminated leaf litter, understory and plants at this site during selective feeding and browsing.

The main radionuclides of concern in radiologically-impacted deer retained on the ORR are strontium-90 and cesium-137. Both these radionuclides are primarily present in the environment in the vicinity of the Bethel Valley and Melton Valley watershed administrative divisions of ORNL. This is not to say other source areas for these radionuclides do not exist outside these watershed boundaries. It is certain that the most likely impacted habitats and more highly concentrated amounts of these sources (strontium-90 and cesium-137) are found here. Radionuclides of concern for uptake by animals and plants on the ORR include:

(A) Strontium-90
(B) Cesium-137
(C) Cobalt-60
(D) Iodine-129
(E) Iodine-131
(F) Americium-241
(G) Uranium-234

Discussion

The white tail deer on the ORR may drink or wade in contaminated water, ingest impacted vegetation or impacted mineral licks. Terrestrial wildlife has several pathways for integration of contamination from several spatially discrete sources.

In the context of ecological risk assessment (beyond the scope of this document), receptors include all endpoint species or communities identified for a site. In the context of hazardous waste site assessments, stressors are chemical contaminants (and/or radionuclides) and the contact and interaction represented by the uptake of the contaminant by the receptor. Unlike some other endpoint assemblages, terrestrial wildlife is significantly exposed to contaminants in multiple media. They may drink or swim in contaminated water, ingest contaminated food and soil, and breathe contaminated air. Refer to figure 5 for exposure pathways considered. Exposure models (PATHWAY, and other models such as USRADS & MARSSIM) for terrestrial wildlife must therefore include multiple media. In addition, because most wildlife is mobile, moving among and within habitats, exposure is not restricted to a single location. They may integrate contamination from several spatially discrete sources. As a consequence, the accurate estimation of wildlife exposure requires the consideration of habitat requirements and spatial movements (from B. E. Sample, et al, 1997).

In addition to consuming food and water, various wildlife consume soil. Soil ingestion may occur inadvertently while foraging, grooming, or purposefully to meet nutrient requirements since diets of many herbivores are deficient in sodium and other trace nutrients. For example, ungulates, such as white-tailed deer (*Odocoileus virginianus),* have been observed to consume

soils with elevated sodium levels, presumably to meet sodium needs. Because soils at waste sites may contain high contaminant concentrations, direct ingestion of soil is potentially a significant exposure source (from B. E. Sample, 1994).

In estimating internal radiological doses to herbivorous wildlife such as deer, measurements of radiological activity in vegetation browsed by deer are preferable to estimates of vegetation activity extrapolated from measured activity in soil.

In determining pathways from soil, to plant, to animal transfers, where unique exposure pathways exist, high soil acidity and low soil clay content promote uptake of radionuclides and other contaminants by plants. Such soils are poor sites for agriculture but can support diverse natural ecosystem populations. In addition, some organisms may have unusual life histories that lead to anomalous high exposures to environmental radionuclides.

Three types of exposure must be considered when considering radiological dose calculations for biota: (1) radiated external dose, the dose received from radioactive particles not in direct contact with the organism itself; (2) deposited external dose, the dose received from radioactive particles deposited directly on the surface of the organism; and (3) internal dose, the dose received from radionuclides ingested or inhaled by the organism. Only one of these three doses, the radiated external dose, can be reliably measured in the field. For the other two sources, dosimetric models are needed to relate measurements of radionuclide activity to the dose absorbed by target tissue. The geometry of the organism, the ability of different radioactive particles to penetrate various tissues, and the partitioning of radionuclides within the organism all influence the dose received by target tissues (from Barnthouse, 1995).

2000 Oak Ridge Deer Hunt Information

The three TWRA managed hunts during the 2000 season (held on weekends in October, November and December) on the ORR yielded 370 deer. This is slightly up from the 1999 hunt season where only 349 deer were harvested. Five (5) deer were retained by TWRA and DOE officials for the three 2000 hunts combined, because they exceeded the release criteria**. The 1.4 percent retained is lower compared to the 16 year average of 2.1 percent (165 retained out of 7842 harvested since 1985). The released deer had an average field-dressed weight of about 84.3 pounds. Because about 55% of the dressed weight is edible, the average deer would yield about 46.4 pounds of meat. Most of the bucks killed on the ORR are between 1-1/2 to 3-1/2 years old.

** Any bone sample that consistently reads 1.5 (about 20 pCi/g) times the background level (net counts) results in retention of the deer. See appendix 1 for complete procedures.

Offsite Baseline Deer Hunt Data

TDEC collected offsite deer hunt samples from hunts for the purpose of establishing background radiation data for comparison with ORR deer hunt radiological scanning data. These hunts were held during the fall/winter of 1999. It was determined from data quality objectives determined for this project, that these locations had little, if any likelihood of resident deer relocating to these areas from the Oak Ridge Wildlife Management Area. TDEC staff collected bone and tissue samples at the following offsite TWRA managed hunts:

1. Chuck Swan Wildlife Management Area Hunt – Near Sharps Chapel and Tazewell, Tennessee
2. Rhea County (Cottonport) Hunt – Near Ten Mile, Tennessee (samples collected by Jim Evans, TWRA)
3. Catoosa Wildlife Management Area Hunt – Near Crossville, Tennessee

TDEC performed in-house screenings for Sr-90 on bone and tissue samples to obtain background data. Next, TDEC had the offsite samples of bone and tissue analyzed by DOE's Radioactive Materials Analysis Laboratory with the assistance of Mr. Larry Bible, ORNL, Chemical and Analytical Sciences Division.

Generally, the TDEC offsite deer hunt data for all three areas compare to the unretained deer data collected for the ORR (table 2 and 3). This supports the hypothesis that the deer population as a whole is not contaminated, but that individual deer are contaminated by frequenting certain "hot spots."

Conclusions

1. The white tail deer populations on the ORR are free to roam unencumbered over their various habitats onsite, which averages about 59 hectares (145.8 acres) "home range" size. The deer can easily jump most, if not all, of the institutional control fences and barriers on the ORR. This allows the deer to forage, drink and occupy the most contaminated sites and source points, such as the WAGs, White Oak Lake, etc., without impediment. Therefore, terrestrial wildlife on the reservation have the potential to be significantly exposed to contaminants in several environmental media. Radionuclide uptake from these areas by the plants and animals is unavoidable. The data suggests that the deer retained are contaminated by the eating of foliage, the browsing at mineral-licks (ingestion), swimming or wading in contaminated ponds or streams (dermal exposure), and drinking surface pond and creek water (oral) in these impacted areas of the ORR.

2. The percentage of deer retained during the ORR hunts averaged 2.1% over the past 16 years for the record-keeping of hunt data. The most recent 2000 hunts averaged 1.4% retained (5 kept out of 370 bucks & does harvested).

3. TDEC's offsite sampling and onsite co-sampling analytical data of bone and tissue samples roughly correlates with the Oak Ridge Wildlife Management Area released deer data. Tables 2 and 3 list the data for comparative observations. This indicates that the whole deer population is not homegeneously contaminated.

4. Deer retentions are highest on the following DOE/TWRA map quadrants (see Figure 5 for locations) for total deer retained from 1985-2000:

   - Quadrant G-6: 20.8% retained (20 out of 96) and quadrant G-7: 10.2 % retained (5 out of 49); quadrants G-6 and G-7 covers a large part of White Oak Lake, Melton Valley, and the area of WAG 13
   - Quadrant F-6: 7.9% retained (21 out of 266) and quadrant F-5: 4.1% retained (11 out of 268); quadrants F-5 and F-6 covers Bethel Valley west of Highway 95, north of Haw Ridge and westward to the Clinch River

5. Research and field observations at ORNL with beta-gamma monitoring equipment have determined several contaminated ponds in Melton Valley. At ORNL in the 1980s, a migration study was done on ducks inhabiting the various ORNL ponds (reference). The migration study was a 3-year study to determine how radioactive materials are being transferred from the contaminated ponds, i.e., determination of exit pathways. Researchers already know that insects, such as dragonflies, mosquitoes, and gnats, are uptaking cesium-137, cobalt-60, and strontium-90 (products from nuclear fission) during their larval developmental stages in the ponds. Dissections of the stomachs of sacrificed waterfowl reveal that they have been feeding on these insects. Therefore, there is a transfer of radioactive material from the ponds to the insects to the waterfowl. About a dozen bodies of water on the ORR, including White Oak Lake, have enough nuclear waste in them to allow transfer of radioactivity via insects into the food chain. The radioactive material tends to concentrate as the material is passed up the chain, a factor called bioaccumulation (Oak Ridger, "Radioactive Ducks", Friday, September 21, 1984). The white-tail deer, as most other wildlife living local to these ponds, have access to these waters for drinking, etc. as well.

6. Institutional controls protecting the DOE facilities in Melton Valley and Bethel Valley have little or no effect retarding white-tail deer ingress/egress from contaminated facilities and ponds. The deer can easily jump most, if not all, of the institutional control fences and barriers on the ORR. In essence, they can forage, drink and occupy the most contaminated sites and source points, such as the WAGs, White Oak Lake, etc., without impediment. Therefore, terrestrial wildlife on the reservation have the potential to be significantly exposed to contaminants in several environmental media.

7. Selected muscle samples were analyzed from seven deer harvested in 1999. In addition to the routine analyses of Cesium-137 and Strontium-90, additional radionuclides were requested for analysis. The contribution to the dose from the radionuclides, other than Cesium-137 and Strontium-90, ranged from about 10% to 100%. The primary contributors were Americium-241 and Uranium-234. It is recommended that in addition to the analyses for Cesium-137 and Strontium-90 in tissue that other radionuclides also be analyzed for in deer tissue (from White, 1999).

8. TDEC field teams located six deer "mineral licks" during the course of the field reconnaissance. All six of these sites exhibited normal, background radiation levels and were not a concern. The TDEC field identifications of these mineral licks are "Deer12", "Deer19", "Deer21", "Deer24", "Deer25", and "Deer26". See Table 1 - TDEC Field Survey Data for descriptions of these sites and see Figure 4 – TDEC Field Survey Points for the map locations.

9. TDEC field teams noted six field locations with gamma radiation readings in excess of twice local background. Field sodium iodide instrument readings at these field sites ranged from a low of 20,004 cpm ("Deer4") at a Clinch River bank location adjacent to the WAG 13 Cesium Plots, to a high of 210,500 cpm ("Deer16") along Melton Branch Road, adjacent to White Oak Creek, south of WAG 5. A soil sample was collected at the "Deer4" site but results of the analytical data are still outstanding. The high gamma reading at location

"Deer16" is among several stations ("Deer15-Deer18") where gamma shine is detectable on rad instrumentation from the operations at the Melton Valley Storage Tanks, the Old and New Hydrofracture facilities, WAGs 5 & 6, and contamination in White Oak Lake mainly from cesium. Tritium, strontium and TRU radionuclides also pervade the environment in Melton Valley. These are areas where the white-tail deer and other animal species live and feed on the vegetation and lower life forms down the food chain. See Table 1and Figure 4 for site descriptions and map locations.

10. Recent years' Oak Ridge deer hunt raw data (1997-2000) for retained deer reveals that strontium-90 activity ranged from a low of 62 net counts to a high of 853 net counts (TWRA Managed Deer Hunt Data Base).

Tennessee Road Kill Law (TCA Section 70-4-115)

The Tennessee Legislature recently passed a new law regarding the possession of white-tail deer accidentally killed by a motor vehicle on Tennessee highways/ interstates and commonly referred to as the "Tennessee road-kill law." Under this law, a citizen can immediately pick up a road-killed deer for their personal use but must notify the Tennessee Wildlife Resources Agency (TWRA) or any law enforcement agency within 48 hours and supply their name and address. This opens a new pathway for public consumption of contaminated game animals. The DOE – Oak Ridge Operations has asked the TWRA and TDEC for help in notifying the citizens of Tennessee of the need to have the deer, which are killed by a motor vehicle on or near the ORR, tested for possible radiological contamination. While the probability of a deer being radiologically contaminated is low, it has been the practice for many years to test all game for contamination, prior to their release for human consumption from the ORR. This new law has created "a hole" in the DOE process. A citizen could pick up the road-kill on DOE land and start consuming the animal within the 48 hour notification period without the test being administered for radiological contamination (from TDEC correspondence, 1999). If a citizen should pick up a road-killed deer or other game animal on or near DOE property in the Oak Ridge area, then he or she should notify the ORNL Shift Superintendent at (865) 574-6606. Arrangements will be made to test the animal. In addition, the Region III office of TWRA at Crossville can be notified at (931) 484-9571.

Appendix 1

Discussion of Sampling and Monitoring Techniques and Guidelines
Standard Analytical Method: Deer Hunt Radiation Monitoring Guidelines - Procedure Number CASD-AM-RML-RA01 -Oak Ridge National Laboratory – Chemical and Analytical Sciences Division.

The deer hunt monitoring program (DHMP) has two components – a field screening monitoring program and a confirmatory laboratory analysis program of both retained and randomly selected released deer samples. Each hunter is required to field dress the deer and take it to the deer checking station on Bethel Valley Road. Furthermore, it is of concern to keep track of the body count, age, number of points, sex, and weight of deer, as well as the percentage of contaminated deer on the ORR.

The radiological monitoring performed during managed deer hunts on the Oak Ridge Reservation Wildlife Management Area is conducted to provide assurance that harvested (killed-in-action) animals do not contain levels of radiation which would result in significant internal exposure to humans consuming meat from the animals (i.e., to eliminate the possibility of humans being compromised).

Soft tissue radionuclide concentrations (mainly Cs-137) are determined by gamma-ray spectrometry. Beta-emitting radionuclides (Sr-90) in bone are detected by use of a sensitive plastic scintillation phosphor. Following review of the counting data and health physics surveillance for external contamination of each deer carcass, those animals found to be free of external contamination, and meet the acceptance criteria, are released to the hunter. All radioactivity determinations are performed in as “near real-time” as possible in order to allow the hunters to leave the area as soon as possible. The apprehensive hunter remains at the checking station until the harvested animal has been cleared since it is difficult to recall an animal after it has been removed from the ORR.

The requirement that the dose from all sources of radiation exposure be less than 100 mrem/year to the general public is used as a guideline (DOE Order 5400.5, “Radiation Protection of the Public and the Environment,” US DOE, June 5, 1990). An administrative EDE limit to the whole body from consumption of a harvested deer has been set at less than 25 mrem/year.

The Administrative Limits are 20 pCi/g for Sr-90 in bone and 5 pCi/g for Cs-137 in tissue. These translate to an EDE of 5 mrem and 1.6 mrem, respectively. If the deer contained both Cs-137 and Sr-90 at the administrative limit, the total EDE would be 7 mrem. Consequently, screening guidelines have been established to detect Cs-137 and other gamma-emitting radionuclides at levels of 1 pCi/g with counting periods of 5 minutes on samples of 40-50 grams of soft tissue. A sample of liver is chosen to be representative of soft-tissue (if unavailable a muscle sample is taken). If the liver sample contains more than 5 pCi/g of Cs-137, the deer will be retained. Screening of bone samples from harvested deer is performed to detect Sr-90. Strontium behaves like calcium in the body, and accumulates in the bone (bone seeker). The bone samples are measured for Sr-90 using a beta scintillation detector. Any bone sample that consistently reads 1.5 (about 20 pCi/g) times the background level (net counts) results in retention of the deer.

The guidelines were established to keep the dose as low as reasonably achievable (ALARA) as well as concerns for releasing a hunter's deer in a reasonable time period.

Other radionuclides have been detected in deer harvested from the ORR, most notably I-129 and I-131 in the thyroid glands and Co-60 in tissue. I-129 has been the most frequently detected radioiodine. Co-60 has been infrequently detected.

In addition to radiation measurements made in the field at the deer hunt checking station on Bethel Valley Road, analysis of soft tissue and bone from deer are performed at the Radioactive Materials Analysis Laboratory (RMAL) at ORNL. These analyses are performed to verify and validate the results obtained from measurements made at the checking station. The analysis in the laboratory consists of radiochemical analysis of bone and tissue, as well as iodine isotope analysis of the thyroids from retained deer.

Radioactive Material Analysis Laboratory (RMAL) personnel are responsible for the transfer of retained deer carcass (waste) to Waste Management Division personnel for disposal. The "disposal path" for biological deer waste can go to either GTS Duratek or to the TSCA Incinerator (Bonine, 2000).

(The information contained in this section above was taken primarily from "Standard Analytical Method - Deer Hunt Radiation Monitoring Guidelines", [CASD-AM-RML-RA01], January 17, 1995, ORNL, Chemical and Analytical Sciences Division).

References

Awl, D.J., et al, 1996, *Survey of Protected Vascular Plants on the Oak Ridge Reservation, Oak Ridge, Tennessee,* ES/ER/TM-194, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Barnthouse, Lawrence W., December 1995, *Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report,* Environmental Sciences Division Pub. No. 4494, ORNL/TM-13141, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Birmingham Zoo, (Updated 1/7/1997), *White-tailed Deer,* Retrieved 11/27/2000 (using BIRMINGHAMZOO database) on the World Wide Web, http://www.birminghamzoo.com/ao/mammal/whtaildr.html.

Bonine, Terry (personal communication, November 27, 2000), re *Disposal Path for Biological (Deer) Waste.*

Britannica Encyclopedia, (1999-2000), *White-tailed Deer,* encyclopedia article from Britannica.com, Retrieved 11/27/00 (using BRITANNICA database) on the World Wide Web, http://search.britannica.comsearch?miid=1266987&query=white-tailed+deer.html.

Express Page, (Updated 6-9-99), *The White-tailed Deer,* Retrieved 11/27/2000 (using EXPAGE database) on the World Wide Web, wysiwyg://184/http://www.expage.com/page/mrsganimaldeer.html.

Garten Jr. C.T. and Lomax R.D., June 1987, Strontium 90 Contamination in Vegetation from Radioactive Waste Seepage Areas at ORNL and Theoretical Calculations of Sr90 Accumulation by Deer, Environmental Sciences Division Publication No 2924, ORNL/TM-10453, Oak Ridge Laboratory, Oak Ridge Tennessee.

Lockheed Martin Energy Systems, July 1997, *1997 Remediation Effectiveness Report for the U. S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-1584&D2, prepared by Advanced Integrated Management Services, Inc.

Martin Marietta Energy Systems, 1993, *Annual Report on the Background Soil Characterization Project on the Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-1136, Prepared by ORNL Environmental Sciences Division.

Maurer, R. J., 1993, *An Aerial Survey of the Oak Ridge Reservation, Oak Ridge, Tennessee: Date of Survey 1992,* EGG 10617-1229, EG&G Energy Measurements, Las Vegas, Nevada.

Mississippi State University, Extension Service, 1998, (Updated August 12, 1998), *Virginia White-tailed Deer,* Retrieved 1/12/2001 (using MSSTATE database) on the World Wide Web, http://ext.msstate.edu/pubs/is621.ntml.

Nebraska Game Program, 2000, *The White-tailed Deer,* Retrieved 1/12/2001 (using WILDLIFE database), http://ngp.ngpc.state.ne.us/wildlife/wtdeer.html.

North Carolina State University, (Updated 8/30/95), *White-tailed Deer,* NCCES – Working With Wildlife, Retrieved 11/27/2000 (using STEWARD database) on the World Wide Web, http://www.ces.ncsu.edu/nreos/forest/steward/www3.html.

Oak Ridger, Friday, September 21, 1984, *Radioactive Ducks, ORNL Traces 'Hot' Waste in Waterfowl,* Frank Munger article, The Oak Ridger newspaper, Oak Ridge, Tennessee.

Oak Ridge National Laboratory, (Updated 12/11/2000), *2000 Deer Hunt Information,* Retrieved 12/12/2000 (using ORNL Database) on the World Wide Web, http://www.ornl.gov/rmal/Deer_Summary_Historical.html.

Oak Ridge National Laboratory, 1995, *Deer Hunt Radiation Monitoring Guidelines,* Standard Analytical Method, CASD-AM-RML-RA01, Oak Ridge National Laboratory, Chemical & Analytical Sciences Division, January 17, 1995.

Royo, A. R., (1999), *White-tailed Deer (Odocoileus virginianus),* Retrieved 10/23/2000 (using DESERTUSA database) on the World Wide Web, wysiwyg://28/http://www.desertusa.com/mag99/june/papr/wtdeer.html

Sample, B. E. and G. W. Suter II, September 1994, *Estimating Exposure of Terrestrial Wildlife to Contaminants,* ES/ERTM-125, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B. E., et al, September 1996, *Preliminary Assessment of the Ecological Risks to Wide-ranging Wildlife Species on the Oak Ridge Reservation, 1996 Update*, DOE/OR/01-1407&D2, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B. E., et al, October 1997, *Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants*, Environmental Sciences Division Pub. No. 4650, ORNL/TM-13391, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Scofield, P. A., and N. A. Teasley, Jr., September 1999, *ORR Deer Hunt Monitoring Program*, ORNL/TM-13719, Office of Environmental Protection and Chemical and Analytical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Storms, Robert, 1999, *Radiological Monitoring: Determination of Sr-90 and Cs-137 Pathways to White-tail Deer on the ORR*, Workplan, Tennessee Department of Environment & Conservation, Radiological Monitoring & Oversight Program, Environmental Restoration Support Section.

Taylor, F. G., June 1986, *Inventory of ORNL Remedial Action Sites: 6. Environmental Research Areas*, Letter Report RAP86-18/R1, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Tennessee Department of Environment & Conservation, 2000, *Evaluation of the Boeing Floodplain Study Area*, Environmental Restoration Footprint Reduction Process, Department of Energy - Oversight Division, Radiological Monitoring and Oversight Program.

Tennessee Department of Environment & Conservation, Department of Energy Oversight Division, 1998, *Health and Safety Plan.*

Tennessee Department of Environment & Conservation – correspondence, October 14, 1999, Earl Leming, TDEC DOE-Oversight Division, to Mr. Robert W. Poe, Assistant Manager, U. S. Department of Energy-ORO, Oak Ridge, Tennessee, re *Contaminated Deer on DOE Property and How They Pertain to the New Tennessee Road Kill Law (TCA Section 70-4-115), and Economic Development Properties*

Weigel, Anastasia S., (2000), *All About Deer*, Retrieved 11/21/00 (using SIMMONS database) on the World Wide Web, http://artemis.simmons.edu/~weigle/BioDeer.html.

White, M. G., et al., September 2000, *Oak Ridge Reservation Annual Site Environmental Report for 1999*, prepared by Oak Ridge National Laboratory, Oak Ridge, Tennessee, managed by UT-Batelle, LLC.

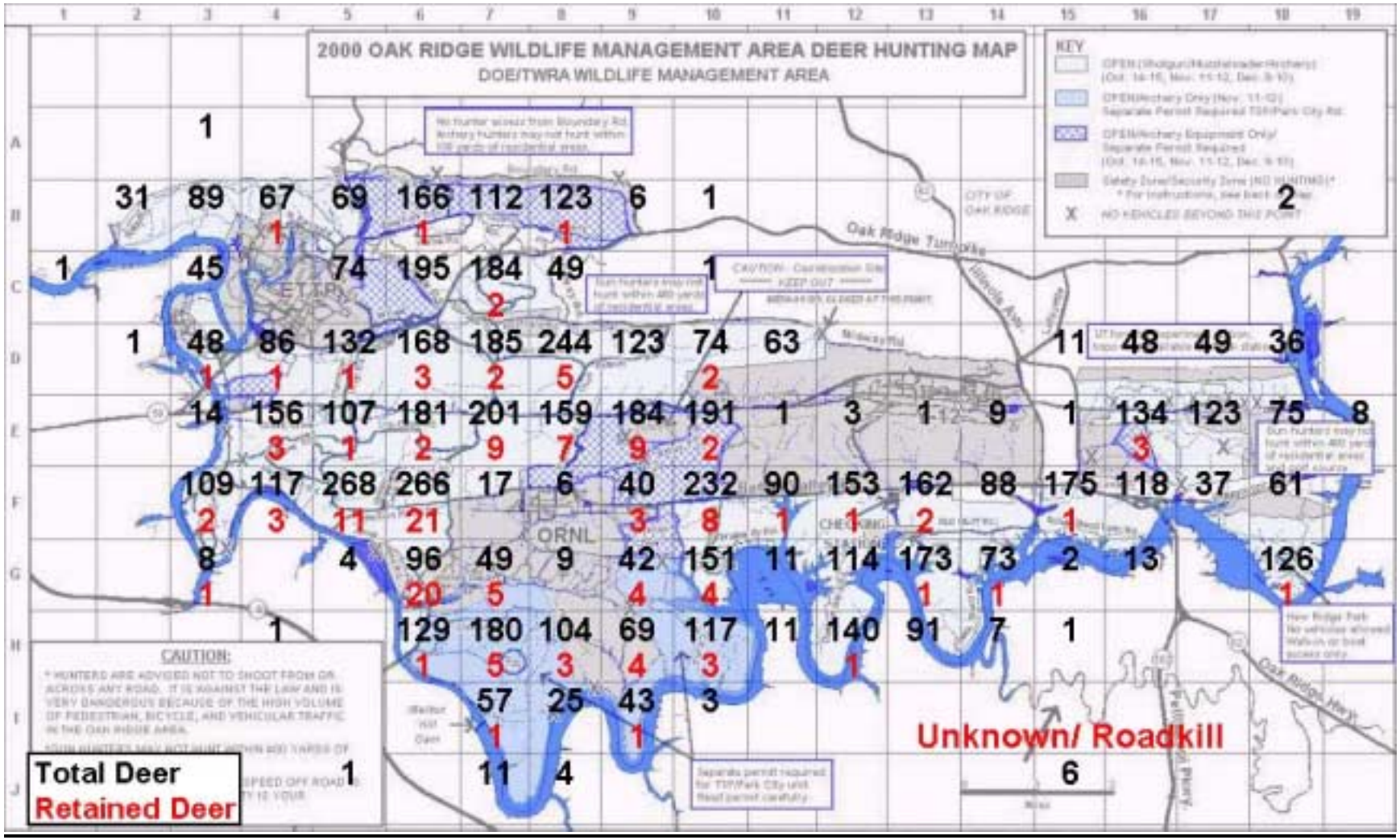


Figure 1: 1985-2000 Deer Hunt Map

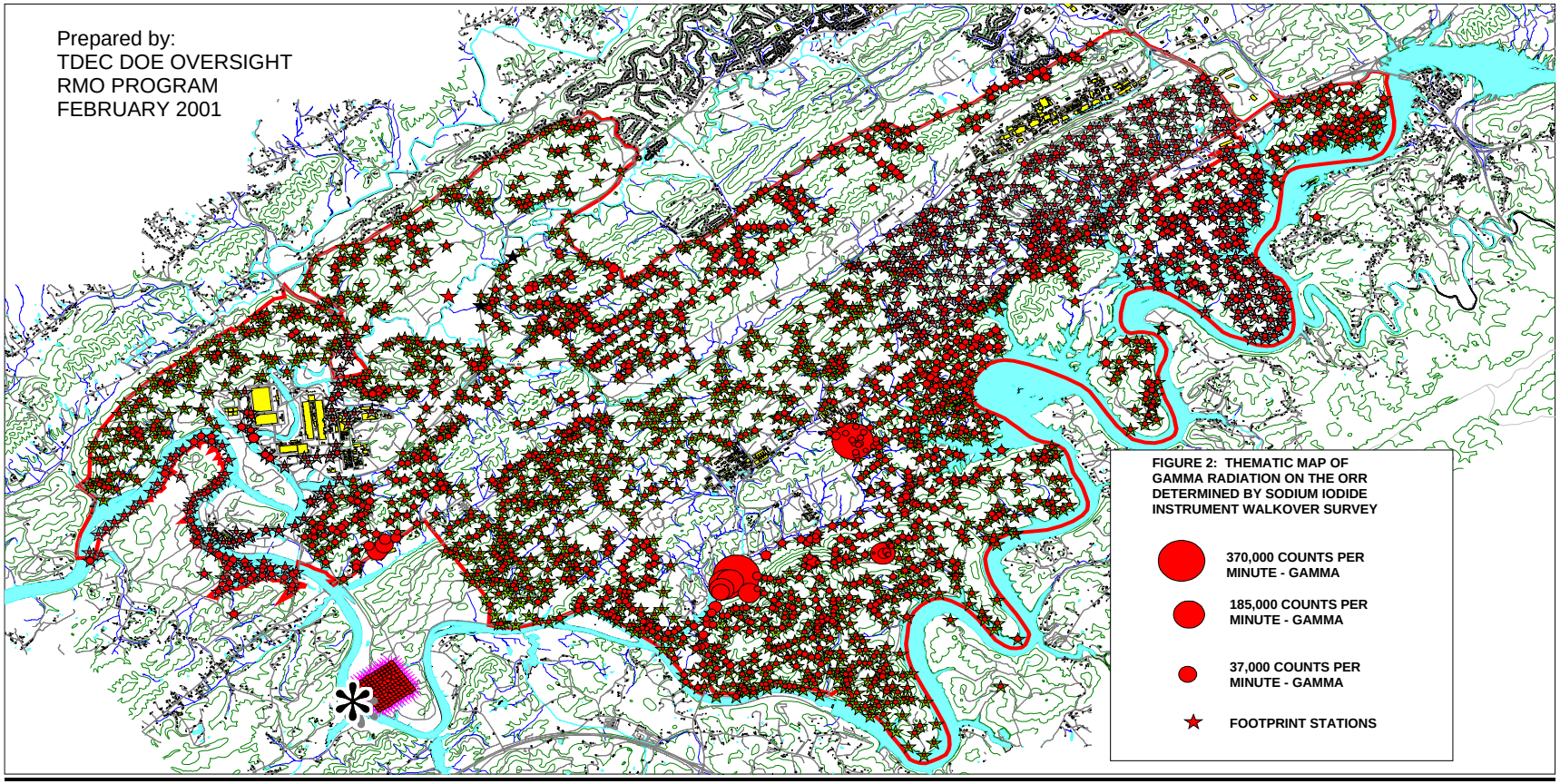


Figure 2: Thematic Map Of Gamma Radiation On The ORR Determined By Sodium Iodide Instrument

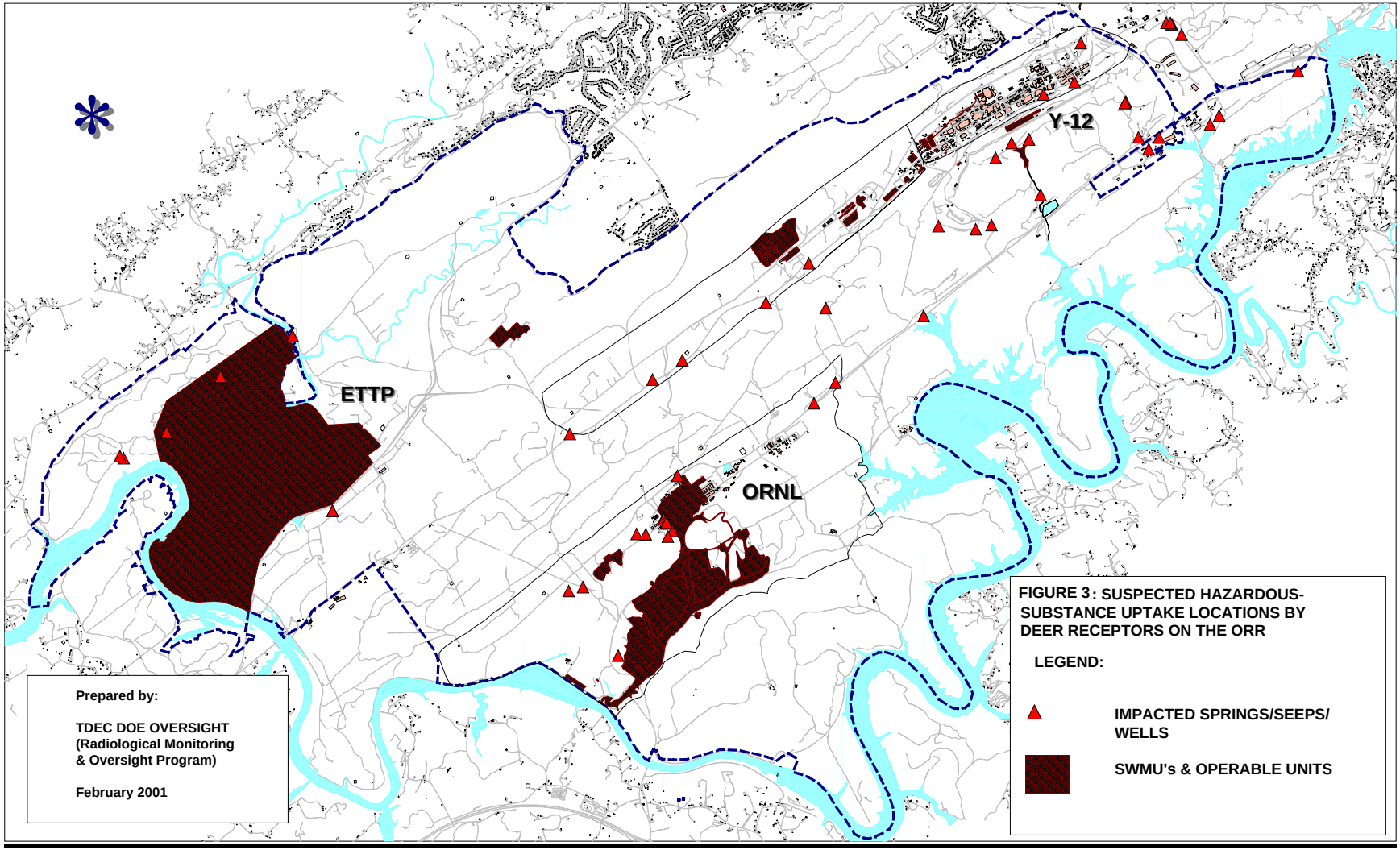


Figure 3: Suspected Hazardous Substance Uptake Locations By Deer Receptors On The ORR

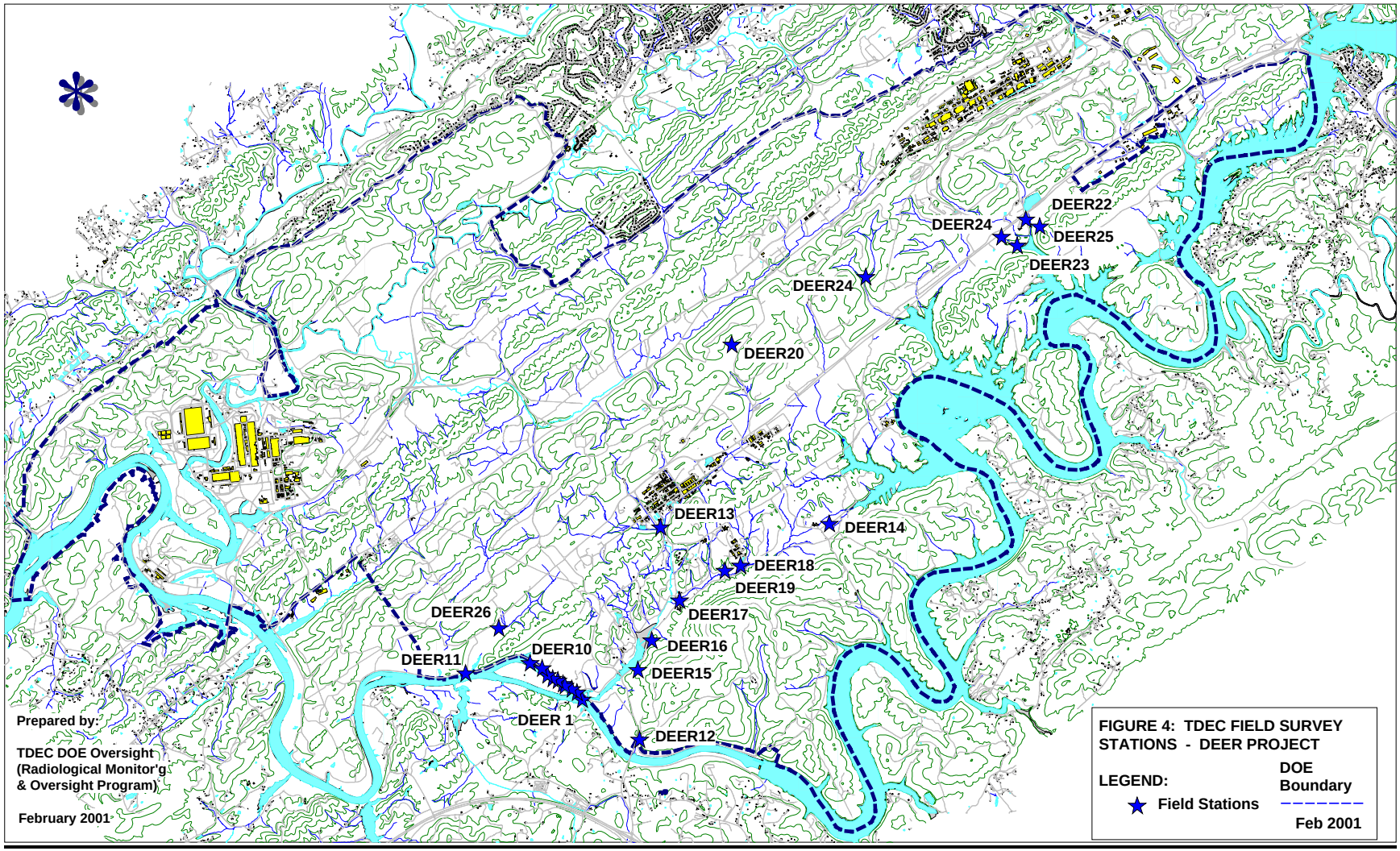
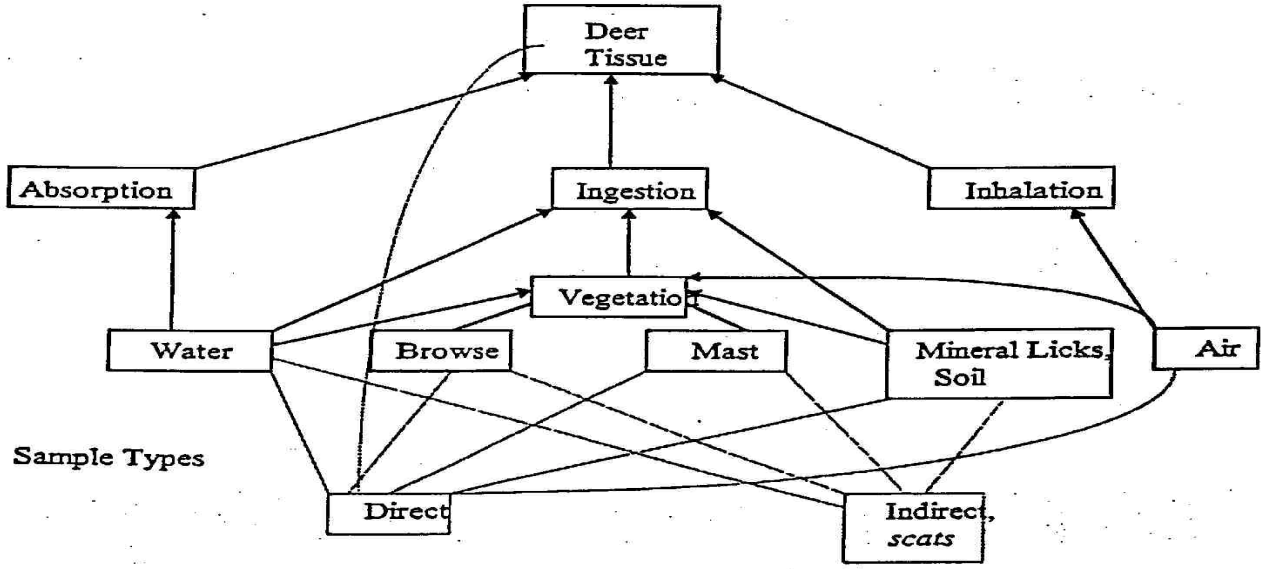


Figure 4: TDEC Field Survey Stations – Deer Project



Contaminant Pathways to White Tail Deer on the Oak Ridge Reservation.

FIGURE 5

Table 1: Survey Data

TDEC Station	Easting	Northing	cpm1	cpm2	cpm3	FIELD DESCRIPTION
Deer1	-84.3336	35.8965	8591	8359	8301	Beside White Oak Creek embayment at location of animal trail leading through underbrush to the water.
Deer2	-84.33501	35.8973	10460	10552	10684	Along Jones Island Road (gravel) adjacent to Clinch River bank along small animal trail leading to the river; across from Jones Island in WAG 13 vicinity.
Deer3	-84.33583	35.89783	8567	8633	9046	Along gravel access road adjacent to Clinch River in WAG 13 vicinity (across from Jones Island); animal trail leads into thin patch of young woods/understory towards river.
Deer4	-84.3375	35.89916	20138	20004	20128	Clinch River bank across from Jones Island and downslope from the Cesium plot facility of WAG 13; pancake probe indicated 100 cpm; took soil sample at this location identified as "Deer 1".
Deer5	-84.3377	35.89919	9153	9088	8993	Small animal trail leads from roadside into small overgrown thicket adjacent to the Clinch River.
Deer6	-84.3378	35.89922	8093	8117	8165	River bank in overgrown area across from Jones Island.
Deer7	-84.33801	35.89933	9058	9126	8899	River bank in overgrown area across from Jones Island.
Deer8	-84.3393	35.8833	10860	10804	10759	Small animal trail leads from roadside into small overgrown thicket adjacent to the Clinch River.
Deer9	-84.3405	35.90066	15547	15566	16182	Small animal trail leads from roadside into small overgrown thicket adjacent to the Clinch River.
Deer10	-84.34193	35.9016	17711	17626	17620	Elevated gamma due to area being underlain by Rome Formation. Small animal trail leads from roadside into small overgrown thicket between road and riverbank.

Table 1: Continued. Survey Data

TDEC Station	Easting	Northing	cpm1	cpm2	cpm3	FIELD DESCRIPTION
Deer11	-84.35425	35.90025	9199	9092	9002	Clinch River bank near the junction of Raccoon Road with Jones Island Road.
Deer12	-84.32233	35.89066	10531	10551	10477	"Mineral lick" located just north of the Tower Shielding Facility guard shack (off Hwy. 95); carbonate rock outcroppings in the vicinity at edge of woodline adjacent to open field.
Deer13	-84.3176	35.9195	75,000	75,000	75,000	Lagoon Road at 7500 Bridge beside White Oak Creek near water gap of Haw Ridge between ORNL WAG 1 and Melton Valley. Readings increase to 125,000 cpm approaching the creek bank water; rad-control yellow-roped area nearby.
Deer14	-84.2864	35.9216	12754	12650	12900	Location of NPDES outfall (383 CAT 111) south of HFIR facility; site is downslope of fenced ponds and cooling towers; 50 feet east of this location is a rad-control (yellow roped-off area) with readings over 125,000 cpm with the NaI instrument.
Deer15	-84.3202	35.9018	40667	41500	40050	Roadside on south side of White Oak Lake in the vicinity of the construction site of the TRU facility.
Deer16	-84.3188	35.9066	210,423	210,500	210,000	Melton Branch Road adjacent to White Oak Creek south of WAG 5.
Deer17	-84.3145	35.9096	97727	95900	96850	Access road in front of Melton Valley Storage Tank (New Hydrofracture facility) site.
Deer18	-84.3027	35.916266	22299	21552	22075	Location of NPDES outfall (383 CAT 111) south of HFIR facility; site is downslope of fenced ponds and cooling towers; 50 feet east of this location is a rad-control (yellow roped-off area) with readings over 125,000 cpm with the NaI instrument.
Deer19	-84.30565	35.915283	9480	9842	9590	Junction of HFIR South Access road and HFIR SW Access Road adjacent to culvert with good stream flow; "mineral lick" nearby.

Table 1: Continued. Survey Data

TDEC Station	Easting	Northing	cpm1	cpm2	cpm3	FIELD DESCRIPTION
Deer20	-84.304	35.949166	9800	9500	9600	On wooded ridgetop in the Spallation Neutron Source area west of some wetlands in a small cove; deer scree pellets sampled (sample ID "T-1); no mineral licks observed.
Deer21	-84.2788	35.9602	7500	8000	7800	"Mineral lick" observed in the Walker Branch vicinity on wooded ridge between the two weir-dams.
Deer 22	-84.250446	35.9658	7500	8000	8500	TWRA Deer-Checking Station barns south of Bethel Valley Road.
Deer23	-84.250916	35.9636	8922	8992	8668	McCoy Branch beaver dam in woodline adjacent to large open field.
Deer24	-84.2533	35.96466	10056	10145	10017	"Mineral lick" along TVA powerline cut (right-of-way) in small drainage; adjacent to gas pipeline right-of-way in open field adjacent to a small patch of woods.
Deer25	-84.246	35.9655	9000	9500	8500	"Mineral lick" between spring and McCoy Branch tributary in a clearing located south of the TWRA Deer-checking Station.
Deer26	-84.34833	35.9075	8200	9100	8500	"Mineral lick" south of New Zion Patrol Road in west Bethel Valley along treeline adjacent to road.

Table 2: Offsite Baseline Deer Hunt Data (TDEC)

TDEC Sample Ident. Number	TDEC* Bone Sample CPM 1	TDEC* Bone Sample CPM 2	TDEC* Bone Sample CPM 3	TDEC* Avg. CPM	TDEC* Back-ground	TDEC NET	DOE Data Sample Weight (grams)	DOE Data (Tissue) Cs-137 Activity (pCi/g)	DOE Data (Bone) Net Sr-90 Counts**	COMMENTS/INFORMATION
										11/21/99 Rhea Co. Hunt
RHEA-1	26	29	27	27.3	21.3	6	48.5	0.09	0	2-1/2 year 6-point buck (112 #)
RHEA-2	33	27	23	27.7	21.3	6.4	34.8	-0.02	0	2-1/2 year 3-point buck (117#)
RHEA-3	27	23	28	26	21.3	4.7	31	-0.18	0	1-1/2 year 5-point buck (94#)
RHEA-4	18	23	26	22.3	21.3	1	42	0.24	0	1-1/2 year 2-point buck (87 #)
RHEA-5	22	37	26	28.3	21.3	7	34.2	0.08	3	1-1/2 year 6-point buck (109#)
RHEA-6	19	15	21	18.3	21.3	-3	39.6	0.17	4	1-1/2 year 4-point buck (93 #)
RHEA-7	23	27	17	22.3	21.3	1	52.9	0.3	0	2-1/2 year 14-point buck (123#)
RHEA-8	31	21	29	27	21.3	5.7	46	0.31	6	2-1/2 year 8-point buck (118 #)
										11/19/99 Catoosa Hunt
CAT-1	16	20	19	18.3	26	-7.7	35.8	0.23	2	3-1/2 year 11-point buck(148 #)
CAT-2	31	29	35	31.7	26	5.7	47.2	0.05	5	3-1/2 year 9-point buck (150 #)
CAT-3	27	22	30	26.3	26	0.3	49	0.28	7	2-1/2 year 8-point buck (120 #)
CAT-4	22	25	29	25.3	26	-0.7	48.4	0.28	9	2-1/2 year 8-point buck (107 #)
CAT-5	14	20	23	19	26	-7	51.2	0.02	12	3-1/2 year 8-point buck (155 #)
CAT-6	35	31	26	30.7	26	12.4	48	0.16	0	2-1/2 year 7-point buck (148#)

Table 2: Offsite Baseline Deer Hunt Data (TDEC)

TDEC Sample Ident. Number	TDEC* Bone Sample CPM 1	TDEC* Bone Sample CPM 2	TDEC* Bone Sample CPM 3	TDEC* Avg. CPM	TDEC* Back-ground	TDEC NET	DOE Data Sample Weight (grams)	DOE Data (Tissue) Cs-137 Activity (pCi/g)	DOE Data (Bone) Net Sr-90 Counts**	COMMENTS/INFORMATION
CAT-7	23	23	24	23.3	26	-2.7	45.6	0.3	0	3-1/2 year 8-point buck (133 #)
CAT-8	25	29	24	26	26	0	37.4	0.61	15	1-1/2 year 8-point buck (111 #)
CAT-9	32	22	25	26.3	26	0.3	45.4	0.16	0	2-1/2 year 8-point buck (120 #)
CAT-10	25	32	25	27.3	26	1.3	61.5	0.23	0	2-1/2 year 7-point buck (116 #)
SWAN-1	20	14	20	18	22.3	-4.3	61.2	-0.1	4	**Chuck Swan Hunt 12/3/99** 2-1/2 year 3-point buck (83 #)
SWAN-2	22	22	35	26.3	22.3	4	52	0.38	0	2-1/2 year 4-point buck (79 #)
SWAN-3	22	18	18	19.3	22.3	-3	55.2	0.09	4	2-1/2 year 7-point buck (86 #)
SWAN-4	27	26	22	25	22.3	2.7	42.4	0.12	0	2-1/2 year 7-point buck (82 #)
SWAN-5	23	29	28	26.6	22.3	4.3	55.8	0.56	9	1-1/2 year 2-point buck (56 #)
SWAN-6	16	23	24	21	22.3	-1.3	53.8	0.1	1	2-1/2 year 6-point buck (82 #)
SWAN-7	25	25	26	25.3	22.3	3	51.2	0.13	0	1-1/2 year 2-point buck (65 #)
SWAN-8	34	19	23	25.3	22.3	3	62.9	0.18	0	2-1/2 year 6-point buck (80 #)
SWAN-9	18	24	24	22	22.3	-0.3	56.6	-0.13	0	2-1/2 year 4-point buck (88 #)
SWAN-10	21	26	33	26.6	22.3	4.3	64	-0.03	0	3-1/2 year 6-point buck (106 #

*Sr-90detection (beta)
**DOE Background = 33 Counts

Table 3: DOE/TWRA Managed Deer Hunt (12/11/99) Oak Ridge Reservation

DOE Deer Ident. Number	TDEC * Bone Samp CPM1	TDEC * Bone Samp CPM2	TDEC* Bone Samp CPM3	TDEC* Avg. CPM	TDEC * Bkgrd	TDEC * Net	DOE Data (Tissue) Cs-137 Activity (pCi/g)	DOE Data (Bone) Net Sr-90 Counts**	Comments/Information
									ORR Hunt 12/11/99
ORR-295	28	22	21	23.6	19	4.6	0.89	1	1-1/2 year 3-point buck (88#)
ORR-296	19	23	20	20.6	19	1.6	0.02	0	1-1/2 year doe (59#)
ORR-297	26	24	27	25.6	19	6.6	0.46	2	3-1/2 year 9-point buck (153 #)
ORR-298	35	29	30	31.3	19	12.3	0.29	0	2-1/2 year doe (94#)
ORR-299	25	21	27	24.3	19	5.3	0.26	1	2-1/2 year 8-point buck (90#)
ORR-300	30	24	18	24	19	5	0.43	0	2-1/2 year 9-point buck (103#)
ORR-301	18	27	18	21	19	2	0.36	1	2-1/2 year 6-point buck (97#)
ORR-302	26	30	25	27	19	8	0.05	2	2-1/2 year 8-point buck (105#)
ORR-303	NA	NA	NA	NA	19	NA	0.32	1	1/2 year buck (55#)
ORR-304	30	30	23	28	19	9	-0.03	0	3-1/2 year 8-point buck (155#)
ORR-305	26	26	23	25	19	6	0.85	0	1/2 year doe (55#)

FOOTNOTES:
Bone samples counted for 1 Minute

*Sr-90 detection (Beta)

**DOE deer retention criteria:

1-1/2 times background (equals + 70 cpm for this hunt date)

GROUNDWATER MONITORING

Oversight and Split Sampling of DOE Ambient Sampling and Analysis

Principal Author: Donald F. Gilmore

Abstract

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) in an effort to evaluate the Department of Energy's (DOE) monitoring and surveillance programs on the Oak Ridge Reservation (ORR), perform oversight activities of those programs. This includes analysis of replicate samples taken when conditions warrant. During the calendar year 2000 the Groundwater Oversight section took four samples for analysis. Two wells and a manhole were sampled. The locations of the samples were planned from each facility. However, Oak Ridge National Laboratory (ORNL) sampling could not be scheduled. The sampling of wells and other locations on the reservation is conducted using established procedures. All of the samples collected during this project were collected correctly according to the Environmental Investigation Standard Operating Procedure and Quality Assurance Manual (EPA, Region IV, 1996). The analyses were conducted using established procedures and the results were within acceptable limits. All locations are in areas that are scheduled for remediation or evaluation for remediation.

Introduction

This monitoring program is composed of oversight of the Department of Energy (DOE) and DOE contractors' monitoring and surveillance programs on the Oak Ridge Reservation (ORR). Oversight consisted of reviewing monitoring protocols, system design, construction, operations and maintenance, sampling methodology, locations, frequency, procedures and parameters; quality assurance and quality control (QA/QC) methodology, plans and implementation; data collection, verification and management systems; chain-of-custody procedures and implementations; and reporting methods. Split and confirmation sampling were performed as needed to verify DOE monitoring results.

Results and Discussion

This oversight program included oversight of surveillance activities for surface water, soil, sediments, groundwater, drinking water, food crops, fish and wildlife, biological systems, underground storage tank compliance and well plugging and abandonment activities. Split sampling was performed for groundwater. Justifications for sampling during oversight of surface water, soil, sediments, food crops, fish and wildlife, biological systems, underground storage tanks compliance were not met. Therefore, only the groundwater samples were taken.

The purpose of sampling was to verify sampling and QA/QC procedures, laboratory methods and results. Three locations were sampled under this project. Two wells, one at Y-12 and one at East Tennessee Technology Park (ETP), and one abandoned electrical power duct at the ETTP were sampled. One of the wells, GW-706, was sampled twice due to low amount of water for split samples during the first sampling event. The electrical power duct was sampled due to anecdotal evidence and lack of requested sampling by DOE contractors promised during the Remedial Investigation.

ETTP

The duct is one of several that run from the now demolished powerhouse to the main plant area of ETTP. Access to the duct is on the bank of Poplar Creek where it crosses under the water. Sampling of the duct was conducted on May 8, 2000, using established procedures. The water in the duct contained high levels of metals and the presence of radiological constituents. Aluminum, copper, iron, lead, nickel and zinc were very abundant in the sample taken, and are the main contaminants, see Table 1 for the results of the analysis. The origin of these analytes is unclear.

UNW-8 was also sampled during the year as part of the QA/QC oversight. Sampling of UNW-8 was uneventful as it followed established sampling procedures. UNW-8, which gets its water from the unconsolidated zone or above bedrock, is near Mitchell Branch north of old K-1407B pond. The analysis of the well (Table 1) showed that the well contains Trichloroethene, Tetrachloroethene and their degradation by-products. Gross alpha and gross beta activities were measured but not considered elevated and the presence of radon daughters Pb 214and Bi 214 were also not elevated and do not constitute a health threat. The presence of these contaminants signals a small but constant reminder of the contaminants that once were in K1407B pond.

Y-12

Well GW-706 in Bear Creek Valley is on the south side of the valley across Bear Creek from the burial grounds. Contaminants come from S-3 ponds that were used to neutralize acids from the uranium manufacturing process. The well is one of many wells in Bear Creek Valley that serve as monitoring points for ground water. The sampler's methods used in obtaining the sample followed standard operating procedures developed for Y-12 and the reservation. There was no obvious breakdown of these procedures.

GW-706 contains elevated gross alpha and gross beta activities, see Table 1. The gross alpha readings for both sample events at GW-706 are well above the Maximum Contaminant Level (MCL) as set by the Environmental Protection Agency (EPA). The February sampling event showed 9 times the MCL of 15 pCi/L and the January event was almost three times higher than the MCL. The gross beta activity for both sampling events was approximately 1.5 times the MCL of 50 pCi/L which translates to 4mrem/yr. Tritium is also present but not at levels to be a health threat. The presence of radon daughters Pb 214 and Bi 214 is also not a health threat. Volatile organic compounds such as Trichloroethene, Tetrachloroethene and their degradation by-products are present. Nickel was present in the analyzed water but no other analyzed metal was present. Nitrates were found in both sampling events above the MCL of 10 parts per million (ppm), 28 and 16 ppm respectively. The nitrates and the radioactivity come from the old unlined S-3 ponds that held radioactive waste nitric acid. The S-3 ponds are currently undergoing remediation and this sampling is part of an effort to characterize the effectiveness of that remediation.

Conclusion

The sampling of wells and other locations on the reservation is conducted using established procedures. All of the samples collected during this project were collected correctly. The analysis is also conducted using established procedures. The EPA has set most of the procedures and DOE has set certain others where EPA has not. At this time, the contamination seen in the

Manhole and the well at ETTP are in areas that are to be evaluated and remediated. The same can be said for GW-706 in Bear Creek Valley. A Record of Decision (ROD) has been reached between DOE, EPA, and the state concerning the clean up of portions of the valley. The results from GW-706 show that there are areas on the ORR that warrant special attention.

References

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee*.

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region 4, 960 College Station Road, Athens, GA, 1996.

Environmental Compliance Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region 4, Environmental Services Division, Atlanta, GA. 1991.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, TN. *Health, Safety, and Security Plan*, 1998.

Tennessee Department of Health (TDH) Organic, Inorganic and Radiological Laboratory Standard Operating Procedures, Current revision.

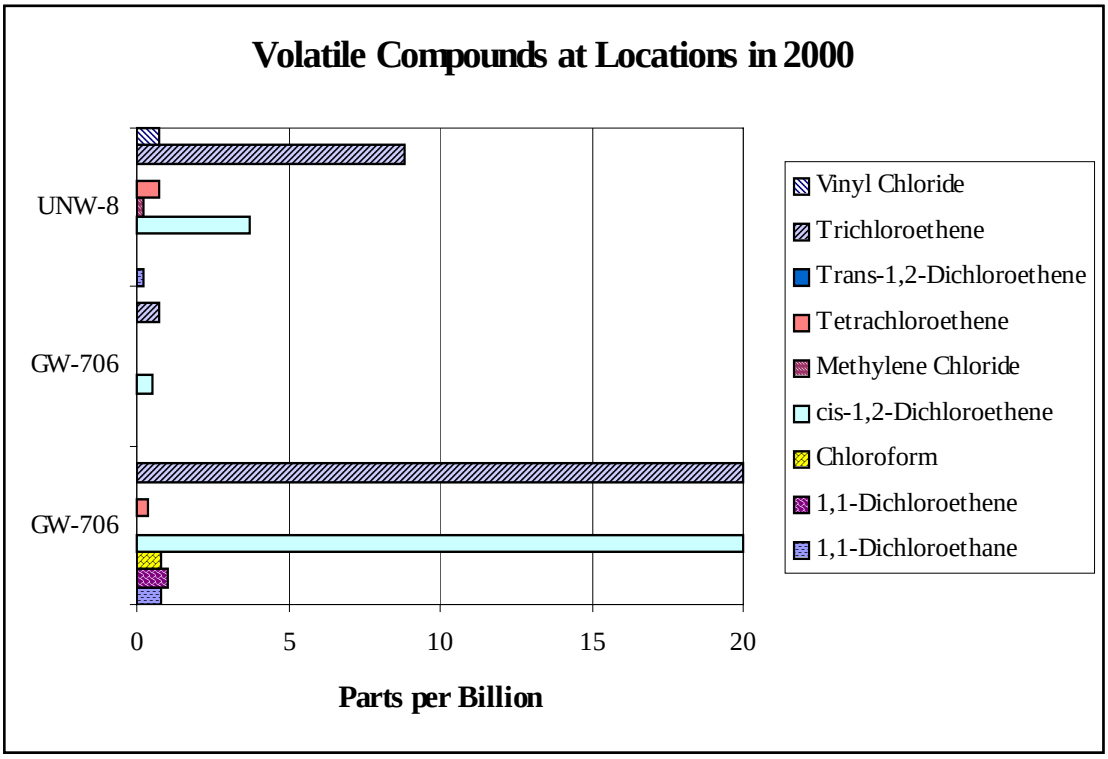
Table 1: Sample Analysis of Sampled Locations

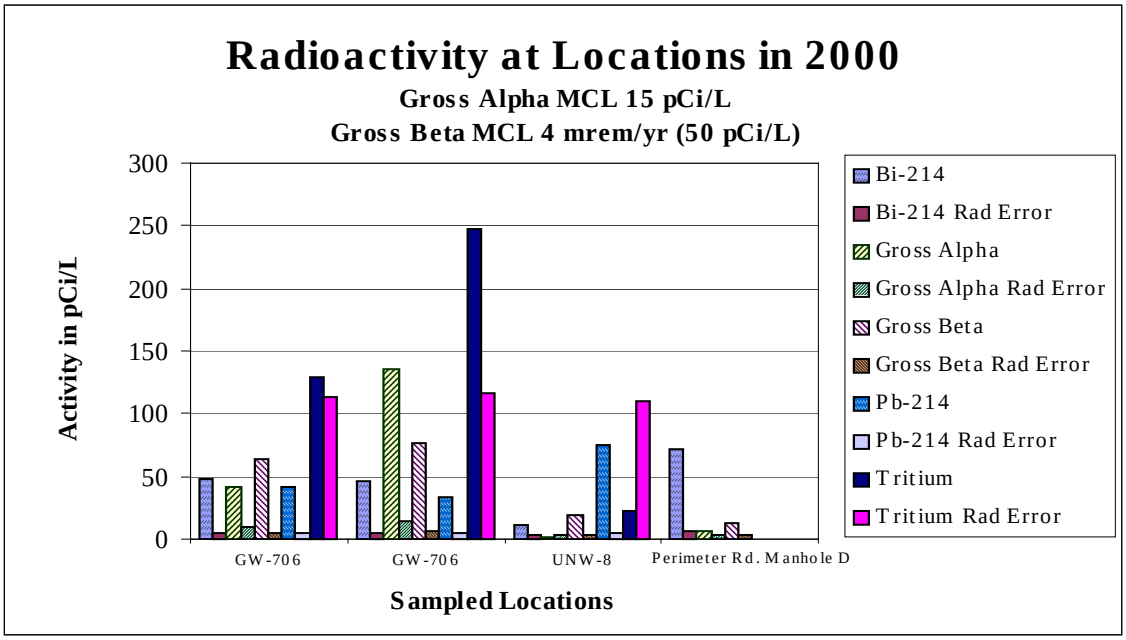
LOCATION	Site	Date	PARAMETER	Results	Units	Rad Error	MCL
Perimeter Road Manhole D	ETTP	05/08/00	Aluminum	1140.00	ppb		50 ppb
Perimeter Road Manhole D	ETTP	05/08/00	Arsenic	4.00	ppb		50 ppb
Perimeter Road Manhole D	ETTP	05/08/00	Barium	ND	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Beryllium	ND	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Cadmium	4.00	ppb		5 ppb
Perimeter Road Manhole D	ETTP	05/08/00	Copper	446.00	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Iron	2910.00	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Lead	3890.00	ppb		15ppb
Perimeter Road Manhole D	ETTP	05/08/00	Nickel	142.00	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Selenium	ND	ppb		50 ppb
Perimeter Road Manhole D	ETTP	05/08/00	Silver	ND	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Chromium	7.00	ppb		100 ppb
Perimeter Road Manhole D	ETTP	05/08/00	Zinc	4160.00	ppb		
Perimeter Road Manhole D	ETTP	05/08/00	Bi-214	10.40	pCi/l	3.10	24000 pCi/L
Perimeter Road Manhole D	ETTP	05/08/00	Gross Alpha	1.30	pCi/l	3.20	15 pCi/L
Perimeter Road Manhole D	ETTP	05/08/00	Gross Beta	19.40	pCi/l	3.40	4 mrem/yr.(50 pCi/L)
Perimeter Road Manhole D	ETTP	05/08/00	Tc-99	1.05	pCi/l	0.62	4 mrem/yr.(50 pCi/L)
UNW-8	ETTP	09/05/00	1,1-Dichloroethane	0.20	ppb		
UNW-8	ETTP	09/05/00	Cis-1,2-DCE*	3.70	ppb		
UNW-8	ETTP	09/05/00	Trans-1,2-DCE*	0.10	ppb		
UNW-8	ETTP	09/05/00	Methylene Chloride	0.20	ppb		
UNW-8	ETTP	09/05/00	Tetrachloroethene	0.70	ppb		
UNW-8	ETTP	09/05/00	Trichloroethene	8.80	ppb		
UNW-8	ETTP	09/05/00	Vinyl Chloride	0.70	ppb		
UNW-8	ETTP	09/05/00	Pb-214	74.50	pCi/l	5.30	8000 pCi/L
UNW-8	ETTP	09/05/00	Bi-214	72.00	pCi/l	5.60	8000 pCi/L
UNW-8	ETTP	09/05/00	Gross Alpha	6.60	pCi/l	3.20	15 pCi/L
UNW-8	ETTP	09/05/00	Gross Beta	12.20	pCi/l	2.80	4 mrem/yr.(50 pCi/L)
UNW-8	ETTP	09/05/00	Tritium	22.00	pCi/L	110.00	20,000 pCi/L
GW-706	Y-12	02/01/00	Cis-1,2-DCE*	0.50	ppb		
GW-706	Y-12	02/01/00	Trichloroethene	0.70	ppb		
GW-706	Y-12	02/01/00	Chloride	34.40	ppm		
GW-706	Y-12	02/01/00	NO3&NO2 Nitrogen	16.00	ppm		10 ppm
GW-706	Y-12	02/01/00	Sulfate	41.00	ppm		
GW-706	Y-12	02/01/00	Suspended Residue	13.00	ppm		
GW-706	Y-12	02/01/00	Total Alkalinity	195.00	ppm		
GW-706	Y-12	02/01/00	Arsenic	ND	ppb		50 ppb
GW-706	Y-12	02/01/00	Cadmium	ND	ppb		5 ppb
GW-706	Y-12	02/01/00	Chromium	ND	ppb		100 ppb
GW-706	Y-12	02/01/00	Lead	ND	ppb		15ppb
GW-706	Y-12	02/01/00	Mercury	ND	ppb		2 ppb
GW-706	Y-12	02/01/00	Nickel	12.00	ppb		
GW-706	Y-12	02/01/00	Selenium	ND	ppb		50 ppb
GW-706	Y-12	02/01/00	Thallium	ND	ppb		2 ppb
GW-706	Y-12	02/01/00	Zinc	5.00	ppb		
GW-706	Y-12	02/01/00	Pb-214	34.00	pCi/l	4.00	8000 pCi/L

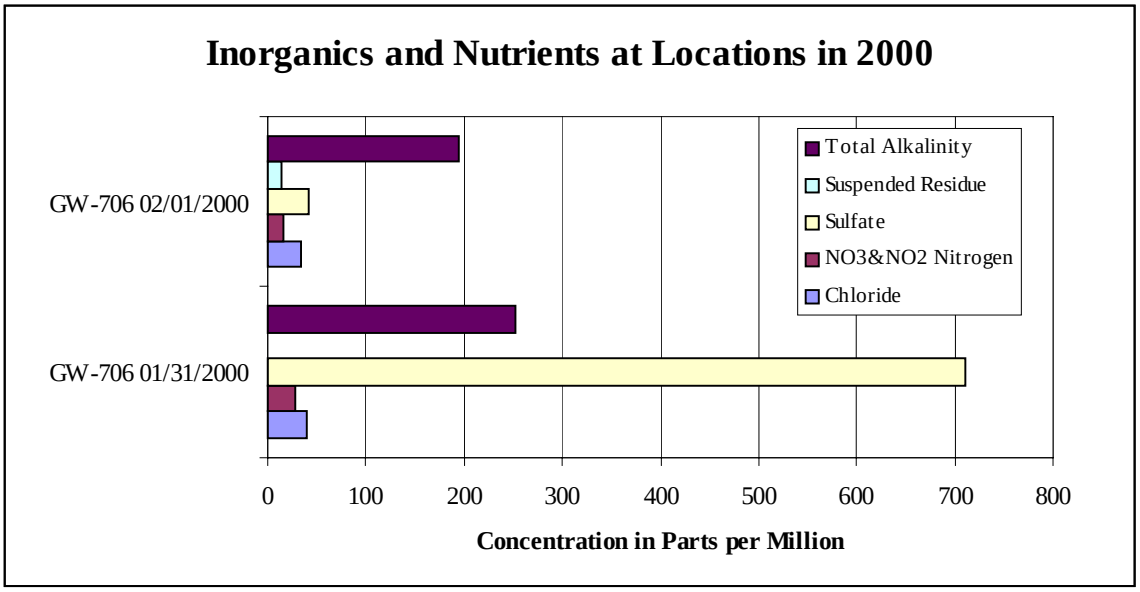
Table 1: Continued. Sample Analysis of Sampled Locations

LOCATION	Site	Date	PARAMETER	Results	Units	Rad Error	MCL
GW-706	Y-12	02/01/00	Bi-214	46.10	pCi/l	4.80	24000 pCi/L
GW-706	Y-12	02/01/00	Gross Alpha	135.00	pCi/l	14.00	15 pCi/L
GW-706	Y-12	02/01/00	Gross Beta	76.90	pCi/l	5.80	4 mrem/yr.(50 pCi/L)
GW-706	Y-12	02/01/00	Tritium	248.00	pCi/l	116.00	20,000 pCi/L
GW-706	Y-12	01/31/00	Chloroform	0.80	ppb		
GW-706	Y-12	01/31/00	1,1-Dichloroethane	0.80	ppb		
GW-706	Y-12	01/31/00	1,1-Dichloroethene	1.00	ppb		7 ppb
GW-706	Y-12	01/31/00	cis-1,2-DCE*	20.00	ppb		
GW-706	Y-12	01/31/00	Tetrachloroethene	0.40	ppb		
GW-706	Y-12	01/31/00	Trichloroethene	20.00	ppb		
GW-706	Y-12	01/31/00	Dissolved Residue		ppm		
GW-706	Y-12	01/31/00	Chloride	39.30	ppm		
GW-706	Y-12	01/31/00	NO3&NO2 Nitrogen	28.00	ppm		10 ppm
GW-706	Y-12	01/31/00	Sulfate	710.00	ppm		
GW-706	Y-12	01/31/00	Suspended Residue	ND	ppm		
GW-706	Y-12	01/31/00	Total Alkalinity	252.00	ppm		
GW-706	Y-12	01/31/00	Arsenic	ND	ppb		50 ppb
GW-706	Y-12	01/31/00	Cadmium	ND	ppb		5 ppb
GW-706	Y-12	01/31/00	Chromium	ND	ppb		100 ppb
GW-706	Y-12	01/31/00	Lead	ND	ppb		15ppb
GW-706	Y-12	01/31/00	Mercury	ND	ppb		2 ppb
GW-706	Y-12	01/31/00	Nickel	13.00	ppb		
GW-706	Y-12	01/31/00	Selenium	ND	ppb		50 ppb
GW-706	Y-12	01/31/00	Thallium	ND	ppb		2 ppb
GW-706	Y-12	01/31/00	Zinc	15.00	ppb		
GW-706	Y-12	01/31/00	Pb-214	42.00	pCi/l	5.40	8000 pCi/L
GW-706	Y-12	01/31/00	Bi-214	47.70	pCi/l	5.00	24000 pCi/L
GW-706	Y-12	01/31/00	Gross Alpha	41.60	pCi/l	8.90	15 pCi/L
GW-706	Y-12	01/31/00	Gross Beta	64.50	pCi/l	5.30	4 mrem/yr.(50 pCi/L)
GW-706	Y-12	01/31/00	Tritium	129.00	pCi/l	114.00	20,000 pCi/L

*Cis-1,2-DCE=cis-1,2-Dichloroethene, Trans-1,2-DCE=Trans-1,2-Dichloroethene ppb = parts per billion, ppm = parts per million, pCi/L = pico Curies per Liter, mrem=millirem


Volatile Compounds at Locations in 2000
UNW-8
GW-706
GW-706
0
5
10
15
20
Parts per Billion
Vinyl Chloride
Trichloroethene
Trans-1,2-Dichloroethene
Tetrachloroethene
Methylene Chloride
cis-1,2-Dichloroethene
Chloroform
1,1-Dichloroethene
1,1-Dichloroethane


Radioactivity at Locations in 2000
Gross Alpha MCL 15 pCi/L
Gross Beta MCL 4 mrem/yr (50 pCi/L)
Activity in pCi/L
300
250
200
150
100
50
0
GW-706
GW-706
UNW-8
Perimeter Rd. Manhole D
Sampled Locations
Bi-214
Bi-214 Rad Error
Gross Alpha
Gross Alpha Rad Error
Gross Beta
Gross Beta Rad Error
Pb-214
Pb-214 Rad Error
Tritium
Tritium Rad Error


Inorganics and Nutrients at Locations in 2000
GW-706 02/01/2000
GW-706 01/31/2000
Total Alkalinity
Suspended Residue
Sulfate
NO3&NO2 Nitrogen
Chloride
0
100
200
300
400
500
600
700
800
Concentration in Parts per Million

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GROUNDWATER MONITORING

Groundwater Basin Delineation Report

Principal Author: Donald F. Gilmore

Abstract
The Oak Ridge Reservation (ORR) contains burial grounds, contaminated soil, and contaminated groundwater and active nuclear facilities. The most definitive method of determining the receptors and travel time of contaminants in groundwater basins is by using dye trace studies. The receptors can be both on and off site. Highly detectable fluorescent dye will be introduced in a sinkhole, swallet or other injection point to delineate the basin and to determine the groundwater velocity, flow paths and direction of groundwater flow. The proposed dye studies were not completed due to a variety of reasons. Further studies are proposed for the calendar year 2001.

Introduction
The goal of this project is to delineate groundwater basins on the Oak Ridge Reservation (ORR). Information obtained from this project will be used to determine if contaminants can be carried in groundwater at depth from the disposal facilities on the ORR to springs/ seeps on and possibly off-site. This information will also be used in the decision making process for future land use of Department of Energy (DOE) property. To obtain this information, dye traces are used. These traces will determine groundwater velocity, flow paths and direction of groundwater flow. A highly detectable fluorescent dye will be introduced in a sinkhole, swallet or other injection point. Monitoring of springs and wells, seeps and surface water streams with collection of small vials of water at those locations would be required. The individual dye traces will be prioritized based on importance as an exit pathway to determine which trace is conducted first.

Dye traces involve the introduction of a highly detectable fluorescent dye into a sinkhole, swallet or other injection points in a specified area. It would also require monitoring of selected monitoring wells, springs, and seeps with collection of small vials of water at those locations. The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) does this in accordance with the Tennessee Oversight Agreement (TOA) Attachment A, Section A.1, which requires a joint assessment of ongoing monitoring. It also calls for a joint assessment of surveillance programs for all media, Section A.7.2.1, which calls for a TDEC monitoring work plan, and Attachment E E.28 Groundwater Basin(s) Determination.

Methods and Materials
A highly detectable fluorescent dye was proposed to be introduced into a sinkhole, swallet or other injection point. Monitoring of selected springs, seeps and possibly wells, with collection of small amounts of water at those locations was proposed. Also, automated sampling of surface water and/or springs by an ISCO automated sampler may be necessary.

Dye Study Procedures

A series of tasks must be performed before a dye test is initiated. Background data were to be collected from selected wells, springs and surface water in the study area. A survey of spring locations in the study area has been performed and locations for monitoring were selected. Monitoring of background levels for traces of various dyes were planned for all monitoring points and dye introduction locations would then be selected.

Monitoring locations to collect samples for dye recovery were to be selected after a minimal field update survey of springs. Monitoring points were to include springs; surface streams, and monitoring wells in the study area. TDEC will discuss all monitoring locations with UTBattelle/Bechtel Jacobs's personnel.

Dye Selection

Water soluble, highly fluorescent dye was to be used for dye traces. Concentrations of these dyes normally used in tracer studies are safe to the environment. Smart (1983) has shown that all tracing dyes in concentrations used in tracing are nontoxic. The selection of the particular dye depends on results from background studies.

Sampling Methodology and Quality Control

During the background study and the dye trace proper, TDEC personnel are to prepare sampling materials prior to leaving the office. Appropriate DOE or UTBattelle/Bechtel Jacobs personnel are to be notified of intent to visit the site, and the materials are transported to and from the site in a State vehicle. Water samples were to be collected in new, glass or plastic culture tubes and closed using appropriate plastic caps. These are given a code identifier on an attached adhesive label with a waterproof marker. Those samples were to be transported in a cooler or other suitable container.

Conclusion

Dye traces to delineate ground water basins have had a mixed success rate on the ORR. Due to a shift in priorities, scheduling, and manpower, this project was not completed. It is carried over to the year 2001 where delineation of groundwater basins will be one of the focus areas for the Environmental Monitoring Groundwater Oversight Section.

References

"A Study of Groundwater Flow from Chestnut Ridge Security Pits Using a Fluorescent Dye Tracer" (Y/SUB/90-00206C/6) by Geraghty & Miller, Inc.

"Water Temperature Variation at Springs in the Knox Group near Oak Ridge, Tennessee" by Gareth J. Davies, Proceedings of the 3rd Conference on Hydrogeology, Ecology, Monitoring, and Management of Groundwater in Karst Terrains. Nashville, TN p. 197, yr. 1991.

"Hydrology and Geochemistry in Bear Creek Valleys near Oak Ridge, Tenn." by Bailey & Lee (USGS WR190-4008).

"Aspects of Oak Ridge Karst Hydrology and Geomorphology" (unpublished report for MMES/DOE by Rubin and Lemiszki, 1992).

"Status Report on the Geology of the Oak Ridge Reservation" (ORNL/TM-12074).

Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley (ORNL/TM-10112).

Spring Monitoring Data-1994-1999, TDEC/DOE-O (unpublished data).

Smart, P L, and Laidlaw, I. M. S. (1977). An evaluation of some fluorescent dyes for water tracing. Water Resources Research. Vol. 13, No. 1, pp. 15-33.

Final Report of the Second Dye Tracer Test at the Chestnut Ridge Security Pits. Prepared by SAIC. November 1992. (Y/SUB/93-99928c/Y10/1).

Work Plan for Dye Trace Study at the Chestnut Ridge East Borrow Area Y-12 Plant Oak Ridge, Tennessee Prepared by TDEC/DOE-O April 1995.

TDEC DOE-O Standard Operating Procedures, TDEC DOE-O 1996.

Region IV EPA, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

Health, Safety, and Security Plan, Tennessee Department of Environment and Conservation, Department of Energy Oversight, November 1998.

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GROUNDWATER MONITORING

Residential Well Sampling Program Project Report

Principal Author: Donald F. Gilmore

Abstract

During the calendar year 2000, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducted a routine program of sampling residential wells. The purpose of the project is to identify groundwater users in areas off of the Oak Ridge Reservation (ORR) that might use groundwater impacted by Department of Energy (DOE) activities. To achieve this a well user survey was conducted by going house to house and determining the location of families using well water for consumption and bathing. Wells to be sampled were selected using geology, geographic location and depth of well. Sampling was performed throughout the year.

Analysis of the results showed no discernible impact from the activities of DOE on the ORR. The general groundwater quality of the 11 residential wells appears to be good. Most homeowners interviewed during the 1996 house to house survey indicated no problem with groundwater quality. The analytical results from sampling these wells indicated that groundwater quality in these wells is adequate for drinking and household uses.

Introduction

In 1996, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) initiated a residential well sampling program. The purpose of this project was to identify areas of groundwater use for consumption and bathing in the areas off site from the Oak Ridge Reservation (ORR) and determine the environmental impact on groundwater in these areas from past ORR operations. Two major tasks were included in this project: identify residences with drinking water wells and collect groundwater samples for analysis from selected wells. In 1996 and 1997 a house to house survey was conducted.

The user survey was conducted in the area southwest and within two miles of the ORR boundary. This survey was concentrated in areas in line and along geologic strike with the Department of Energy (DOE) X-10 and Y-12 facilities. A total of 69 residential wells have been identified. A well survey form was completed for each well. It should be noted that the ORR is over 30,000 acres and the City of Oak Ridge and Knox County supply water for a large area north and southeast of the ORR. Typical distances from residential wells to active DOE facilities are two miles.

During 2000, TDEC collected water samples from 11 residential wells. Most of these wells were identified during the house to house survey. These residential wells are separate from and in addition to TDEC sampling on and off-site exit pathway springs and wells that are or might be impacted by DOE activities. Figure 1 shows the location of these wells. Two of the wells were added as a result of a notice that was released to the news media in 1999 concerning well sampling. Each of these wells was sampled and then analyzed for chemical and radiological analytes.

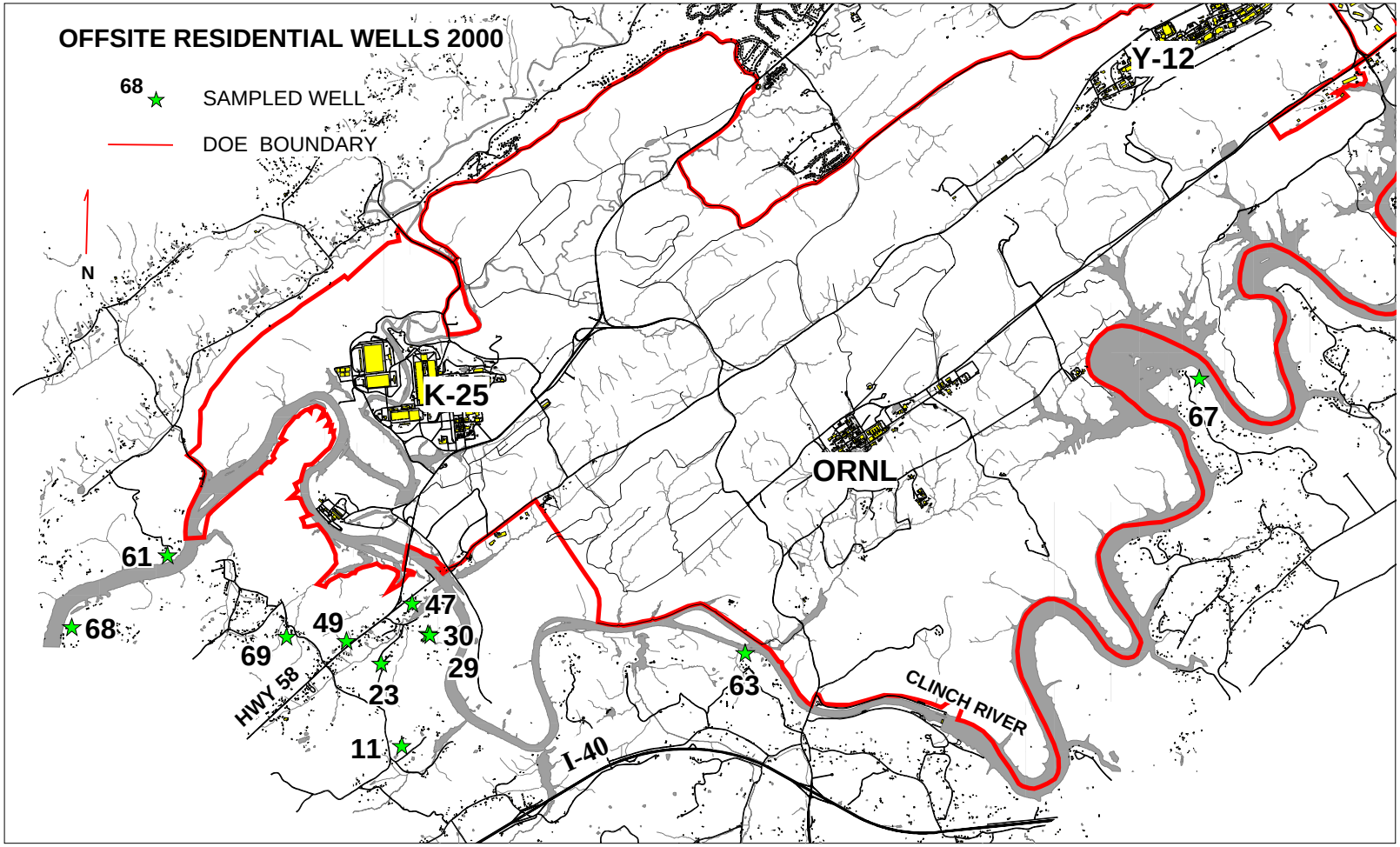


Figure 1. Residential Wells Sampled in 2000

Methods and Materials

A work plan was prepared for standardizing the collection of groundwater samples from residential wells identified during the house to house survey. The locations of the 68 wells identified during this survey were reviewed. From this review, 11 residential wells were selected to be sampled. These wells were located generally along a line or transect normal to geologic strike in the area across the Clinch River and southwest of the X-10 and Y-12 facilities. Other wells were selected to test for the effects of DOE across Melton Hill Lake and north of the ORR. See Figure 1 for the location of the 11 wells. These wells were selected along this transect to possibly locate contaminants migrating off site from the ORR via groundwater.

The well samples were analyzed for volatile organic compounds (VOCs), nutrients, radiochemistry, general inorganics, and selected metals. These analytes were selected to identify general groundwater quality in these wells and identify chemical and radiological substances used in past ORR operations. The results were compared to established regulatory maximum contaminant levels (MCLs).

The residential wells were generally sampled from a water tap located outside the property owner's house. Prior to sampling, water was run until pH, temperature and conductivity readings stabilized. The water quality parameters were constantly checked using portable meters. Water was normally run from the tap for at least 10 minutes before these parameters were stabilized. Water samples were taken immediately after these parameters stabilized.

Samples were collected in laboratory prepared bottles using clean surgeon's gloves. Immediately after sample collection, water samples were placed on ice in a cooler. The time of sample collection and other pertinent information was recorded in a field logbook on site. Chain of custody forms were filled out from this information. Sample tags were completed and placed on the sample containers immediately after each sample was collected. Water samples were delivered to the State of Tennessee analytical laboratory in Knoxville, Tennessee for analysis.

TDEC sent the analytical results to the owner of each sampled residential well. The analytical results from each well were entered into a computer database, and a cover letter was drafted to be included with the analytical results.

Results and Discussion

The analytical results from sampling the 11 residential wells were compared with regulatory MCLs. These results, see Table 1, indicate that water samples taken from these wells did not exceed these regulatory limits. Trace amounts of suspect contaminants were noted in few of these wells. These amounts were not conclusive, however. Two charts were constructed to illustrate the levels of constituents in sampled wells. The charts are for gross alpha and beta activity and nutrients and selected metals. These are found in Figures 2 through Figure 3.

Gross alpha and gross beta activity measure the amount of radioactivity in a sample attributable to the two energy types. Nutrients such as potassium, sulfate and Nitrogen are normally found near areas of agricultural activity, which also includes the fertilization of lawns. However, on the ORO there have been occurrences of Nitrogen from some of DOE activities. Metals are found in all soils as rocks and vegetable matter degrades to form the soil. These metals move into the

groundwater. In the sampling done this year there are no constituents that are above drinking water limits or at levels nearing the MCL.

Conclusion

The general groundwater quality of the 11 residential wells appears to be good. Most homeowners interviewed during the 1996 house to house survey indicated no problem with groundwater quality. Well users, contacted by TDEC since the survey, have also indicated no concerns about their water quality. The analytical results from sampling these wells indicated that groundwater quality in these wells is adequate for drinking, bathing and household uses.

References

U.S. Environmental Protection Agency, Region 4, 960 College Station Road, Athens, GA, 1996 *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*.

U.S. Environmental Protection Agency, Region 4, Environmental Services Division, Atlanta, GA. 1991 *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, TN. *Health, Safety, and Security Plan*, 1998.

Tennessee Department of Health (TDH) *Organic, Inorganic and Radiological Laboratory Standard Operating Procedures*, Current revision.

Table 1: Detected Analytes at Sampled Locations

Analyte	Num. Of Detects	Total Analyses	Top 5 Results					Units	MCL
Acetone	3	8	38.00	23.00	20.00			ppb	
Chloride	8	8	3.60	3.50	3.10	2.80	2.60	ppm	
Dissolved Residue	11	11	257	255	220	206	196	ppm	
NO3&NO2	7	8	1.06	0.97	0.95	0.49	0.38	ppm	10 ppm
Suspended Residue	0	11	ND					ppm	
Total Alkalinity	1	1	161.00					ppm	
Arsenic	0	8	ND					ppb	50 ppb
Cadmium	0	8	ND					ppb	5 ppb
Calcium	8	8	68.10	49.10	44.80	43.40	43.40	ppm	
Chromium	0	1	ND					ppb	100 ppb
Iron	5	7	309.00	309.00	52.00	48.00	35.00	ppb	
Lead	2	11	3.00	3.00				ppb	5 ppb
Magnesium	8	8	27.10	26.90	26.90	20.10	19.00	ppm	
Manganese	1	8	18.00					ppb	
Mercury	0	11	ND					ppb	2 ppb
Potassium	8	8	3.00	1.61	1.16	1.15	1.13	ppm	
Selenium	0	8	ND					ppb	50 ppb
Sodium	8	8	5.30	5.01	4.08	1.16	0.90	ppm	
Sulfate	7	8	11.00	11.00	7.00	4.00	4.00	ppm	
Thallium	0	11	ND					ppb	2 ppb
Uranium	0	9	ND					ppb	
Zinc	7	8	142.00	14.00	12.00	9.00	9.00	ppb	
Bi-214	11	11	220.10	218.80	182.60	139.50	124.20	pCi/L	8000 pCi/L
Pb-214	11	11	229.00	214.00	183.50	133.30	131.20	pCi/L	24000 pCi/L
Gross Alpha	9	11	7.60	1.90	1.40	1.30	1.20	pCi/L	15 pCi/L
Gross Beta	11	11	7.90	3.60	3.50	3.30	3.10	pCi/L	4 mrem/yr(50 pCi/L)
K-40	1	11	62.00					pCi/L	4 mrem/yr(50 pCi/L)
Sr-89	2	10	0.45	0.22	-0.02	-0.08	-0.13	pCi/L	8 pCi/L
Sr-90	4	10	0.41	0.39	0.24	0.21	0.07	pCi/L	8 pCi/L
Tc-99	2	10	1.42	1.01	0.59	0.44	0.42	pCi/L	4 mrem/yr(50 pCi/L)
Tritium	4	11	138.00	133.00	122.00	131.00	91.00	pCi/L	20000 pCi/L

Note: ppb parts per billion, ppm parts per million, pCi/L pico Curies per liter, mrem millirem or 1/1000 of a REM

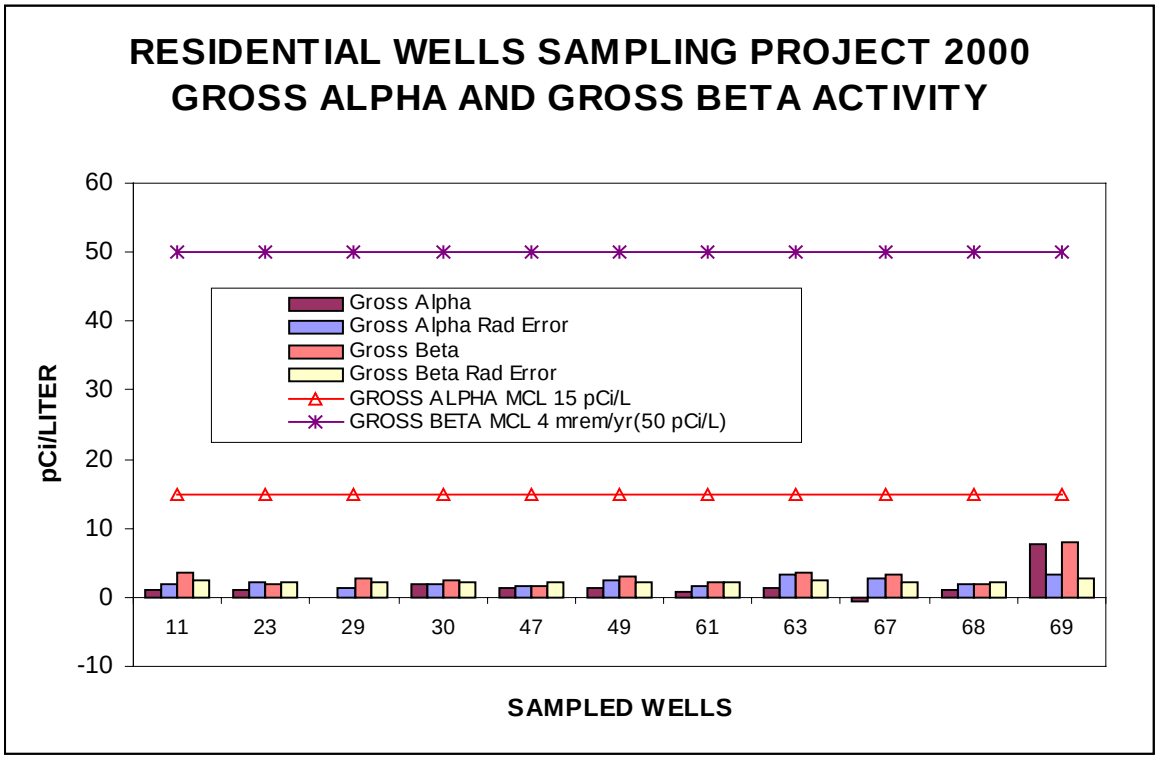


Figure 2: Residential Well Sampling Project 2000, Gross Alpha and Gross Beta Activity

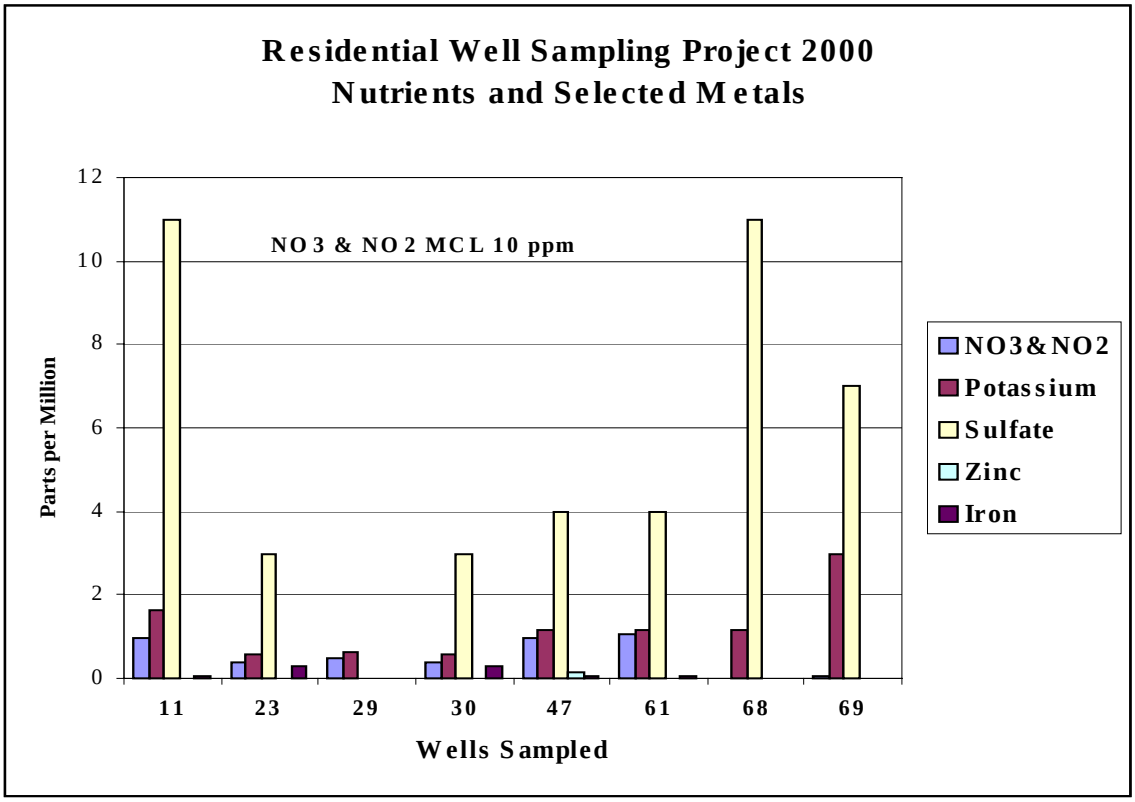


Figure 3: Residential Well Sampling Project 2000 Nutrients and Selected Metals

GROUNDWATER MONITORING

Oak Ridge Reservation and Vicinity Spring and Seep Monitoring Project Report

Principal Author: Donald F. Gilmore

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) conducts independent sampling of springs and seeps on the Oak Ridge Reservation (ORR) as part of the Tennessee Oversight Agreement (TOA). This sampling has been ongoing since 1992. This report provides a status review of the sampling performed during calendar year 2000. Samples were taken at different times of the year all over the ORR. Springs and seeps act as opportune exit pathway monitoring points. Some of these points are close to burial grounds and others are some distance away. TDEC is always looking for springs and seeps that act as inexpensive monitoring opportunities.

The sampling for 2000 provided some insights into the behavior of contaminants in the subsurface and their movement in the groundwater. Springs in Bear Creek Valley down gradient from the Bear Creek Burial Grounds continue to be impacted by radiochemical, metal as well as volatile organic constituents. Several springs at East Tennessee Technology Park (ETTP), Y-12 and Oak Ridge National Laboratory (ORNL) are impacted as well. The most prevalent contaminant is iron, which is a natural constituent of the underlying rock formations. Volatile Organics, Nitrates, Gross Alpha and Gross Beta activity are the contaminants of greatest concern. The levels of the contaminants with some exceptions are very low and the general quality of the groundwater on the ORR is good.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducts independent sampling of springs and seeps on the Oak Ridge Reservation (ORR) as part of the Tennessee Oversight Agreement (TOA). The State Environmental Laboratory tests the samples for radionuclides, volatile organic compounds, selected metals, nutrients, and inorganic analytes (Table 1). During 2000, TDEC sampled 30 springs, seeps on the ORR (Figure 1) and tabulated the results. Several of these have been found to contain contaminants, which indicate high probability of a connection with the Department of Energy's (DOE) activities on the ORR.

Methods and Materials

TDEC's spring/seep sampling activities typically include the following:

1. Locating. Springs/seeps are normally found along the lower edge of slopes near streams, often emerging in streambeds. Reviewing a topographic map of the area of concern will allow the investigator to narrow the search area areas and to mark the map location with considerable accuracy. During 2000, TDEC used a GPS instrument to determine latitude and longitude of most of the springs.

2. Analysis. A list of analytes was selected consisting of parameters that would be consistent with constituents of groundwater found on the ORR. These parameters included radionuclides, volatile organic compounds (VOCs), and inorganic constituents, nutrients and metals A list of the analytes and their sampling frequencies is in Table 1.

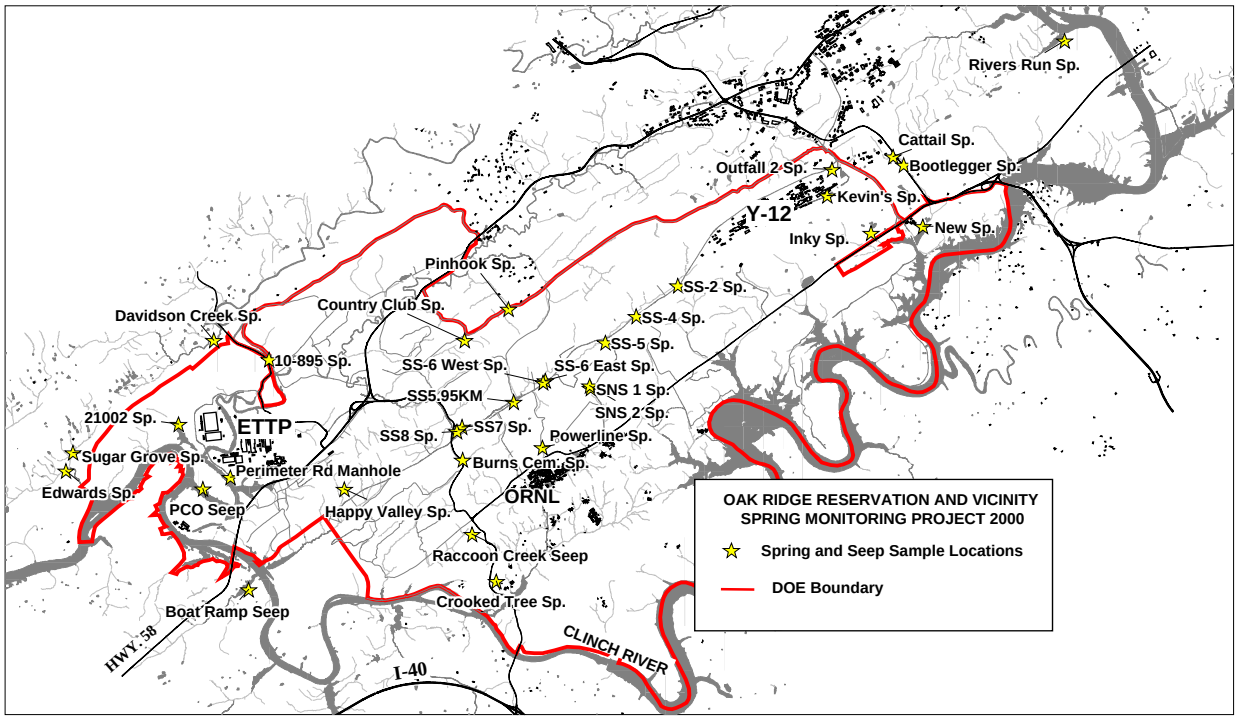


Figure 1: 2000 Sampling Locations Spring and Seep Monitoring Project

3. Field Sampling. A sampling team normally consisting of two TDEC personnel, locates the spring, and collects the prescribed number of samples. The personnel wear disposable vinyl gloves while collecting samples. Sample labels (tags) and analysis request/chain of custody forms are completed. Samples are transported in coolers to TDEC offices for temporary storage, or may be taken directly to the Knoxville Branch Laboratory (KBL).

Duplicate samples, trip blanks, and field blanks are taken as directed by the sampling plan.

4. Data Storage. Analytical results are stored in 3-ring binders in the TDEC office, and the results are entered in a computer database. Eventually this data will be placed onto DOE's OREIS database. Copies of the lab analyses are periodically provided to DOE.

Table 1
List of Analytes and Frequencies for Springs Sampled in 2000
Analytes and Sampling Frequency

Initial sampling	Each event	Conditional
Calcium***	Gross Alpha */Beta	Tc-99
Iron***	Gamma Spec	Tritium
Magnesium***	VOCs (TAL)**	Sr-90
Manganese***	Arsenic	Thorium (Metal)
Potassium***	Cadmium	Uranium (Metal)
Sodium***	Chromium	Strontium (Metal)
Chloride***	Lead	
Sulfate***	Selenium	
	Thallium	
	Zinc	
	Mercury	
	TSS	
	TDS	
	Nitrate	

**TAL Volatiles-8260A

Chloromethane	trans-1,2-Dichloroethene	Trichloroethene	1,1,2,2-Tetrachloroethane
Bromomethane	1,2-Dichloroethane	Dibromochloromethane	Chlorobenzene
Vinyl Chloride	Chloroform	1,1,2-Trichloroethane	Ethyl benzene
Chloroethane	2-Butanone	Benzene	Styrene
Methylene Chloride	1,1,1-Trichloroethane	Trans-1,3-Dichloropropene	0-Xylene
Acetone	Carbon Tetrachloride	Bromoform	M-Xylene
Carbon Disulfide	Vinyl acetate	4-Methyl-2-pentanone	P-Xylene
1,1-Dichloroethene	Bromodichloromethane	2-Hexanone	
1,1-Dichloroethane	1,2-Dichloropropane	Tetrachloroethene	
cis-1,2-Dichloroethene	cis-1,3-Dichloropropane	Toluene	

*** Initial sampling only, continued analysis to be determined

Results and Discussion

TDEC considers the 30 seeps and springs listed in Table 2 and shown on Figure 1 as being representative of the many springs on the Reservation, and yet it should not be considered a complete list. Additional sampling locations may be added, and possibly some of the present ones may be deleted. Several were selected for their location, as being likely candidates for exit pathway monitoring points

Table 3 illustrates the ranges of analyzed constituents in the samples taken for this project during 2000. The table shows how many samples were collected and analyzed for each constituent or analyte. Table 3 also lists the five highest concentrations or radiological activities for each analyte, the maximum contaminant level (MCL), the units and the lowest result.

In considering the springs/seeps within the reservation, several are considered to have elevated levels of contaminants of concern (COCs), see Table 4. Not only do their analyses show elevated radionuclides and/or presence of polychlorinated solvents, but also they have appropriate locations with respect to subsurface structure and groundwater movement.

This list (Table 4) does not preclude from future consideration those springs, found to have COCs in previous years. Some of those springs may have been eliminated from the list for various reasons or may have shown lowered levels of contaminants in the 2000 sampling/analysis program. Also, because of the unusually hot and dry weather conditions, some were found to be too low to sample, or even completely dry.

Using the data collected, graphs were constructed showing the relative concentrations for each analyte in the sampled springs. Several analytes consistently were not detected, cadmium, selenium, thallium and mercury. Applicable graphs are included in this report (Figures 2 - 7). The graphs are for Volatile Organics, NO_3 & NO_2 as Nitrogen, Tritium, Gross Alpha and Gross Beta Activity. These were picked for the range of constituent levels as well as the constituent.

The springs listed below should be considered as candidates for continued monitoring for the foreseeable future.

1. In the ETTP area, spring USGS 10895 and 21002 and PCO Seep are considered to contain elevated COCs.
    - Spring 21002 has consistent detection of Trichloroethene, 1,1,1-Trichloroethane, 1,1-Dichloroethene, Carbon Tetrachloride, and Gross Beta.
    - Spring USGS 10895 has consistent detection of Trichloroethene
    - PCO Seep has consistent detection of Cis-1,2-Dichloroethene, Trichloroethene and Iron.
2. In the ORNL area, Crooked Tree spring (west of WAG 6), and Raccoon Creek Seep are considered to contain elevated COCs.
    - The Crooked Tree Spring sample contained Chromium and Lead.
    - The Raccoon Creek Seep sample contained Sulfate and Gross Beta.
3. In the Y-12 area, (including the adjacent portion of Union Valley), Bootlegger Spring, Cattail, Kevin's, Outfall 2 Spring contain elevated COCs. Westward, in Bear Creek Valley, SS-4, SS-5 and SS-7 springs all contain elevated COCs.
    - Bootlegger Spring samples contained 1,1,1-Trichloroethane, 1,1-Dichloroethene, 1,1-Dichloroethane, Cis-1, 2-Dichloroethene, Tetrachloroethene, Trichloroethene, Trichlorofluoromethane, Methylene Chloride and Chloroform.
    - Cattail Spring samples contained Tetrachloroethene, Trichloroethene, Chloroform and Carbon Tetrachloride.
    - Kevin's Spring samples contained Tetrachloroethane and NO3&NO2 as Nitrogen.
    - The Outfall 2 Spring sample contained Chloroform.
    - SS-4 samples contained Carbon Tetrachloride, Chlorobenzene, Tetrachloroethene, Trichloroethene, Chloroform, 1,1 Dichloroethane, 1,1 Dichloroethene, Cis-1, 2 Dichloroethene, Trans-1, 2-Dichloroethene, 1,1,1 Trichloroethane, Vinyl Chloride, Gross Beta, Gross Alpha, and NO3&NO2 as Nitrogen.
    - SS-5 samples contained Cis-1, 2-Dichloroethene, Tetrachloroethene, Trichloroethene, Gross Beta, Gross Alpha, Nickel and NO3&NO2 as Nitrogen.
    - SS-7 samples contained Sulfate, Nitrates, Gross Alpha and Gross Beta.

Table 2
List of Spring and Seep Locations Sampled in 2000

Location Name	Location Name
21002 Spring	New Spring
10895	Outfall 2 Spring
Inky Spring	SS 2 Spring
Boat Ramp	Raccoon Creek Seep
Bootlegger Spring	Rivers Run Spring
Cattail Spring East	SNS 2 Spring
Crooked Tree Sp.	SNS 1 Spring
Edwards Spring	SS-4
Gaston Spring	SS-5
Davidson Creek Spring	SS 5.95 KM
Happy Valley Spring	SS-7
Country Club Spring	SS-8
Kevin's Spring	Substation
PCO Spring	Sugar Grove Spring
Pinhook Spring	SS 3 Spring
Powerline Spring	

Table 3. Detected Analytes in Sampled Locations

PARAMETER	Total Analyses	Num.Of Detects	Minimum	Top 5 Results					MCL	Units
1,1,1-Trichloroethane	51	5	0.40	1.90	1.50	1.60	0.70	0.40	200.00	ppb
1,1-Dichloroethane	51	4	0.20	1.30	1.10	0.80	0.50	0.20		ppb
1,1-Dichloroethene	51	5	0.60	3.40	1.40	1.00	1.00	0.60	7.00	ppb
Acetone	51	1	20.00	20.00						ppb
Cis-1,2,Dichloroethene	51	8	0.10	20.00	15.00	3.70	2.80	2.50	70.00	ppb
Carbon Tetrachloride	51	6	0.50	5.10	5.00	1.10	0.90	0.50	5.00	ppb
Chlorobenzene	51	5	0.30	0.30						ppb
Chloroform	51	1	0.40	0.80	0.80	0.60	0.50	0.40		ppb
Methylene Chloride	51	5	0.10	0.20	0.20	0.10	0.10	0.10		ppb
Tetrachloroethene	51	9	0.30	3.20	2.60	1.00	0.80	0.70	5.00	ppb
Trans-1,2-Dichloroethene	51	2	0.10	0.10	0.10				100.00	ppb
Trichloroethene	51	11	1.00	32.00	24.00	21.00	20.00	8.80	5.00	ppb
Trichlorofluormethane	51	1	0.40	0.40						ppb
Vinyl Chloride	51	1	0.30	0.30					2.00	ppb
Chloride	44	44	1.40	39.30	36.60	34.40	20.70	17.70		ppm
Dissolved Residue	8	8	47.00	167.00	165.00	153.00	97.00	80.00		ppm
Suspended Residue	46	8	10.00	139.00	40.00	37.00	30.00	28.00		ppm

Table 3 Continued. Detected Analytes in Sampled Locations

PARAMETER	Total Analyses	Num.Of Detects	Minimum	Top 5 Results					MCL	Units
Sulfate	38	38	4.00	710.00	147.00	114.00	54.00	44.00		ppm
NO3&NO2 Nitrogen	46	46	0.02	26.00	18.40	12.80	6.30	6.10		ppm
Total Alkalinity	44	44	45.00	332.00	282.00	259.00	256.00	255.00		ppm
Arsenic	50	2	1.00	4.00	2.00	1.00			50.00	ppb
Cadmium	50	0	NA	NA	NA	NA	NA	NA	5.00	ppb
Calcium	7	7	8.91	106.00	48.90	30.00	20.50	14.00		ppm
Chromium	49	14	1.00	11.00	4.00	3.00	2.00	1.00	100.00	ppb
Iron	10	8	29.00	1370.00	1350.00	650.00	97.00	88.00		ppb
Lead	50	8	1.00	10.00	5.00	2.00	2.00	1.00	5.00	ppb
Magnesium	8	8	12.00	21.70	16.70	11.20	9.77	6.05		ppm
Manganese	10	5	5.00	98.00	37.00	13.00	6.00	5.00		ppb
Mercury	49	0	NA	NA	NA	NA	NA	NA	2.00	ppb
Nickel	49	10	12.00	19.00	18.00	16.00	14.00	14.00	100.00	ppb
Potassium	7	7	1.00	6.20	1.64	1.64	0.67	0.61		ppm
Selenium	50	0	NA	NA	NA	NA	NA	NA	50.00	ppb
Silver	1	0	NA	NA	NA	NA	NA	NA		ppb
Sodium	8	8	0.44	4.77	1.68	1.43	1.35	0.57		ppm
Thallium	49	0	NA	NA	NA	NA	NA	NA	2.00	ppb
Zinc	47	46	2.00	22.00	18.00	18.00	17.00	10.00		ppb
Ac-228	56	1	16.90	16.90						pCi/L
Be-7	56	1	23.60	23.60						pCi/L
Bi-214	56	50	10.40	453.00	164.60	162.20	162.10	160.00		pCi/L
Pb-212	56	1	12.20	12.20						pCi/L
Pb-214	56	43	18.50	489.00	184.70	162.70	148.00	147.00		pCi/L
Gross Alpha	56	52	-0.60	130.00	122.00	89.00	42.50	41.60		pCi/L
Gross Beta	56	53	-0.90	81.30	76.90	64.50	61.40	52.60		pCi/L
Tc-99	1	1	1.05	1.05						pCi/L
Tritium	52	38	-100.00	742.00	610.00	457.00	394.00	342.00		pCi/L

Several of the above springs/seeps may not be considered as being seriously contaminated, but do contain substances believed to be the result of past activities on the ORR.

Table 4.
2000 Table of Springs with Elevated COCs

SITE	SPRING	DATE	CONTAMINANT	LEVEL
ETTP	21002 Spring	3-15-00	1,1,1-Trichloroethane	0.70 ppb
ETTP	21002 Spring	3-15-00	1,1-Dichloroethene	1.40 ppb
ETTP	21002 Spring	3-15-00	Trichloroethene	7.10 ppb
ETTP	21002 Spring	3-15-00	Carbon tetrachloride	0.90 ppb
ETTP	21002 Spring	3-15-00	Gross Beta	10.20 pCi/L
ETTP	21002 Spring	10-17-00	Carbon Tetrachloride	5.10 ppb
ETTP	21002 Spring	10-17-00	Chloroform	0.50 ppb
ETTP	21002 Spring	10-17-00	Cis-1.2-Dichloroethene	0.10 ppb
ETTP	21002 Spring	10-17-00	1,1-Dichloroethene	3.40 ppb
ETTP	21002 Spring	10-17-00	Tetrachloroethene	0.50 ppb
ETTP	21002 Spring	10-17-00	1,1,1-Trichloroethane	1.90 ppb
ETTP	21002 Spring	10-17-00	Trichloroethene	32.00 ppb
ETTP	USGS 10-895 Spring	3-14-00	Trichloroethene	1.80 ppb
ETTP	PCO Seep	3-14-00	Iron	1350 ppb
ETTP	PCO Seep	3-14-00	Trichloroethene	21 ppb
ETTP	PCO Seep	3-6-00	Cis-1,2-Dichloroethene	0.6 ppb
ORNL	Crooked Tree Spring	3-8-00	Chromium	4.00 ppb
ORNL	Crooked Tree Spring	10-24-00	Chromium	11 ppb
ORNL	Crooked Tree Spring	10-24-00	Lead	5 ppb
ORNL	Raccoon Creek Seep	3-8-00	Gross Alpha	3 pCi/L
ORNL	Raccoon Creek Seep	3-8-00	Gross Beta	26.30 pCi/L
Y-12	Bootlegger Spring	2-22-00	1,1,1-Trichloroethane	1.50 ppb
Y-12	Bootlegger Spring	2-22-00	1,1-Dichloroethane	1.00 ppb
Y-12	Bootlegger Spring	2-22-00	1,1-Dichloroethane	1.30 ppb
Y-12	Bootlegger Spring	2-22-00	1,1-Dichloroethene	1.00ppb
Y-12	Bootlegger Spring	2-22-00	Cis-1,2-Dichloroethene	1.70 ppb
Y-12	Bootlegger Spring	2-22-00	Tetrachloroethene	2.60 ppb
Y-12	Bootlegger Spring	2-22-00	Trichloroethene	0.20 ppb
Y-12	Bootlegger Spring	10-2-00	1,1 Dichloroethane	1.10 ppb
Y-12	Bootlegger Spring	10-2-00	1,1 Dichloroethene	0.60 ppb
Y-12	Bootlegger Spring	10-2-00	Chloroform	0.40 ppb
Y-12	Bootlegger Spring	10-2-00	Cis-1,2-Dichloroethene	2.50 ppb
Y-12	Bootlegger Spring	10-2-00	Methylene Chloride	0.10 ppb
Y-12	Bootlegger Spring	10-2-00	Tetrachloroethene	3.20 ppb
Y-12	Bootlegger Spring	10-2-00	1,1,1- Trichloroethane	1.60 ppb
Y-12	Bootlegger Spring	10-2-00	Trichloroethane	0.30
Y-12	Bootlegger Spring	10-2-00	Trichlorofluormethane	0.40 ppb
Y-12	Country Club Spring	5-10-00	Iron	1370 ppb
Y-12	Cattail Spring	2-23-00	Tetrachloroethene	0.60 ppb
Y-12	Cattail Spring	4-20-99	Carbon Tetrachloride	5.00 ppb
Y-12	Cattail Spring	2-23-00	Trichloroethene	1.90 ppb
Y-12	Cattail Spring	2-23-00	Chloroform	0.60 ppb
Y-12	Cattail Spring	10-2-00	Carbon Tetrachloride	1.10 ppb

Table 4. Continued
2000 Table of Springs With Elevated COCs

SITE	SPRING	DATE	CONTAMINANT	LEVEL
Y-12	Cattail Spring	10-2-00	Cis-1,2 Dichloroethene	0.10 ppb
Y-12	Cattail Spring	10-2-00	Tetrachloroethene	0.40 ppb
Y-12	Cattail Spring	10-2-00	Trichloroethene	1.70 ppb
Y-12	Kevin's Spring	3-21-00	NO3&NO2	6.10 ppb
Y-12	Kevin's Spring	3-15-99	Gross Alpha	2.00 pCi/L
Y-12	Kevin's Spring	3-21-00	Tetrachloroethene	0.50 ppb
Y-12	Kevin's Spring	10-11-00	Chloroform	0.50 ppb
Y-12	Kevin's Spring	10-11-00	Methylene Chloride	0.10 ppb
Y-12	Kevin's Spring	10-11-00	NO3 and NO2	18.40 ppb
Y-12	Outfall 2 Spring	3-8-00	Chloroform	0.80 ppb
Y-12	SS-4	2-29-00	NO3&NO2	16.20 ppm
Y-12	SS-4	4-18-00	Gross Alpha	98.00 pCi/L
Y-12	SS-4	2-29-00	Gross Alpha	130 pCi/l
Y-12	SS-4	4-18-00	Gross Beta	36.20 pCi/L
Y-12	SS-4	2-29-00	Gross Beta	46.50 pCi/L
Y-12	SS-4	2-29-00	Cis 1,2-Dichloroethene	1.20 ppb
Y-12	SS-4	2-29-00	Tetrachloroethene	0.30 ppb
Y-12	SS-4	2-29-00	Trichloroethene	6.70 ppb
Y-12	SS-4	10-3-00	Carbon Tetrachloride	0.50 ppb
Y-12	SS-4	10-3-00	Chlorobenzene	0.30 ppb
Y-12	SS-4	10-3-00	Chloroform	0.40 ppb
Y-12	SS-4	10-3-00	1,1 Dichloroethane	0.50 ppb
Y-12	SS-4	10-3-00	1,1 Dichloroethene	0.50 ppb
Y-12	SS-4	10-3-00	Cis-1,2 Dichloroethene	15 ppb
Y-12	SS-4	10-3-00	Trans-1,2 Dichloroethene	0.10 ppb
Y-12	SS-4	10-3-00	Tetrachloroethene	0.80 ppb
Y-12	SS-4	10-3-00	1,1,1 Trichloroethane	0.40 ppb
Y-12	SS-4	10-3-00	Trichloroethene	24 ppb
Y-12	SS-4	10-3-00	Vinyl Chloride	0.30
Y-12	SS-4	10-3-00	NO3 and NO2	26.00 ppb
Y-12	SS-5	2-29-00	Cis-1,2,Dichloroethene	2.80 ppb
Y-12	SS-5	2-29-00	Tetrachloroethene	1.00 ppb
Y-12	SS-5	2-29-00	Trichloroethene	3.10 ppb
Y-12	SS-5	2-29-00	Gross Alpha	33.30pCi/L
Y-12	SS-5	2-29-00	Gross Beta	19.30 pCi/L
Y-12	SS-5	2-29-00	NO2&NO3	5.70 ppm
Y-12	SS-5	4-18-00	Gross Alpha	21.10 pCi/l
Y-12	SS-5	4-18-00	Gross Beta	11.30 pCi/l
Y-12	SS-5	10-3-00	Cis-1,2-Dichloroethene	1.20 ppb
Y-12	SS-5	10-3-00	Tetrachloroethene	0.30 ppb
Y-12	SS-5	10-3-00	Trichloroethene	1.50 ppb
Y-12	SS-5	10-3-00	Gross Alpha	37.90 pCi/L
Y-12	SS-5	10-3-00	Gross Beta	52.60 pCi/L
Y-12	SS-7	10-4-00	Gross Alpha	14 pCi/L
Y-12	SS-7	10-4-00	Gross Beta	15.80 pCi/L

The following springs/seeps show elevated levels of substances such as Gross Alpha, Gross Beta, nitrates/nitrites, Nickel, Chromium etc. which considered alone, do not necessarily indicate a direct impact from the reservation, but are sufficient to place them in a "suspect" category. Table 5 delineates the contaminants of concern and their levels. TDEC feels that these locations merit further investigation:

- In the ETTP area, Happy Valley Spring.
- In the Y-12 area, SS 5.95KM, and Inky Spring.
- In the Off Site area, Rivers Run Spring.

Conclusion

Certain ORR springs/seeps monitored during 2000 show traces of contaminants, which indicate an impact from past activities on the ORR. The location of the impacted springs relative to waste burial grounds suggests that the preferential direction of groundwater movement is generally along geologic strike (northeast/southwest). TDEC plans to continue monitoring many of these springs/seeps.

Table 5. List of Springs That Contain Contaminants of Concern

SITE	SPRING	DATE	CONTAMINANT	LEVEL
ETTP	Happy Valley Spring	3-14-00	Gross Beta	6.0 pCi/L
Y-12	SS5.95KM	3-21-00	Gross Beta	4.30 pCi/L
ETTP	Substation Spring	3-14-00	Gross Beta	3.40 pCi/L
Off	Rivers Run Spring	10-12-00	Chromium	3.00 ppb
Off	Rivers Run Spring	12-12-00	Nickel	10.00 ppb
Y-12	Inky	2-23-00	NO3 & NO2	6.37 ppm

Notes: ppb, Parts per Billion; ppm, Parts per Million; pCi/l, Picocuries per liter;

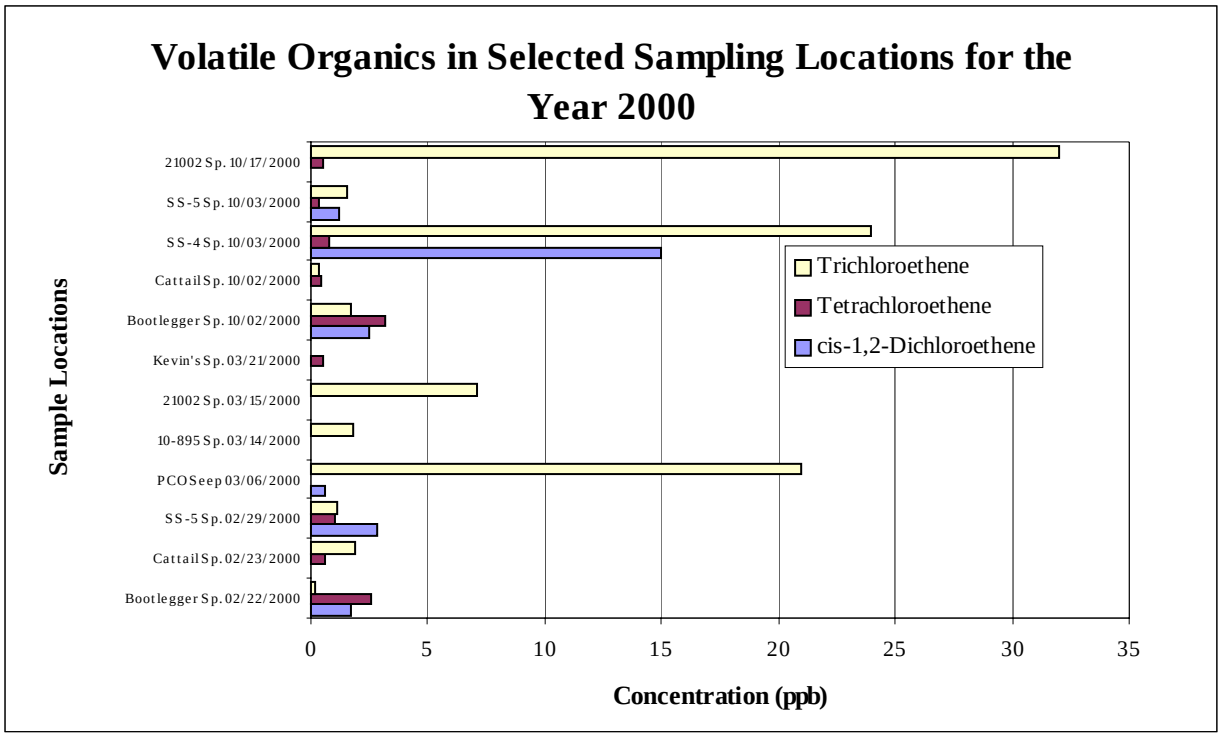


Figure 2: ORR and Vicinity Spring Monitoring Project 2000 Detected Volatile Organics

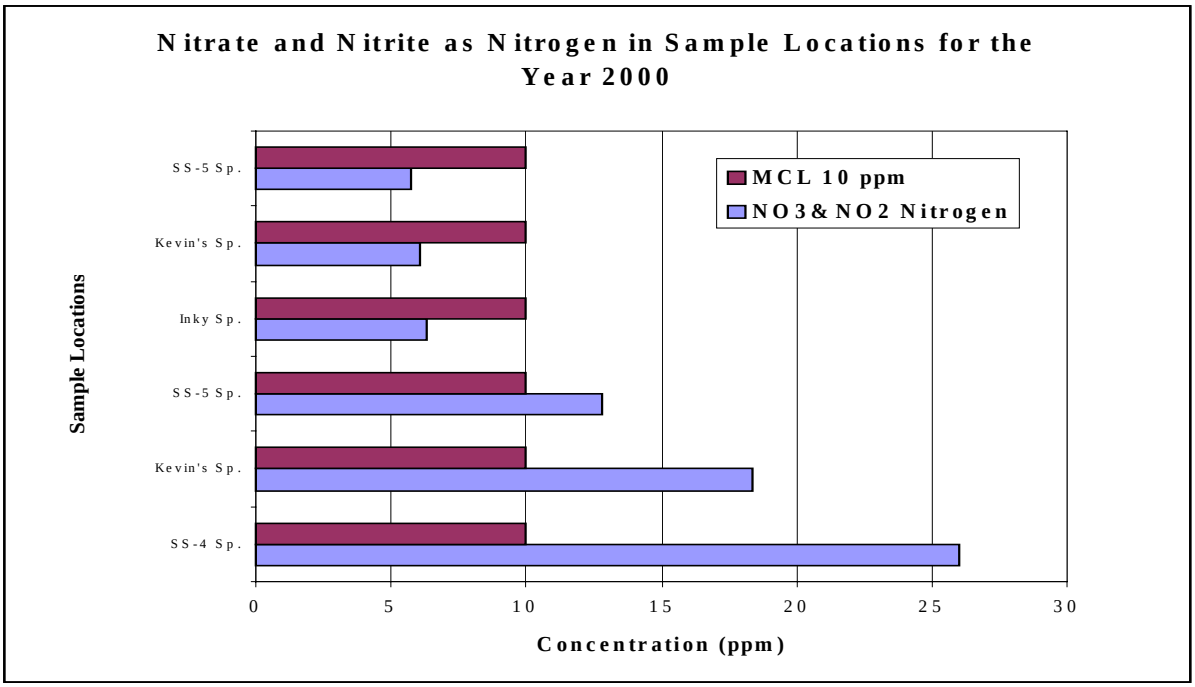


Figure 3: ORR and Vicinity Spring Monitoring Project 1999 NO_3 & NO_2 in Groundwater

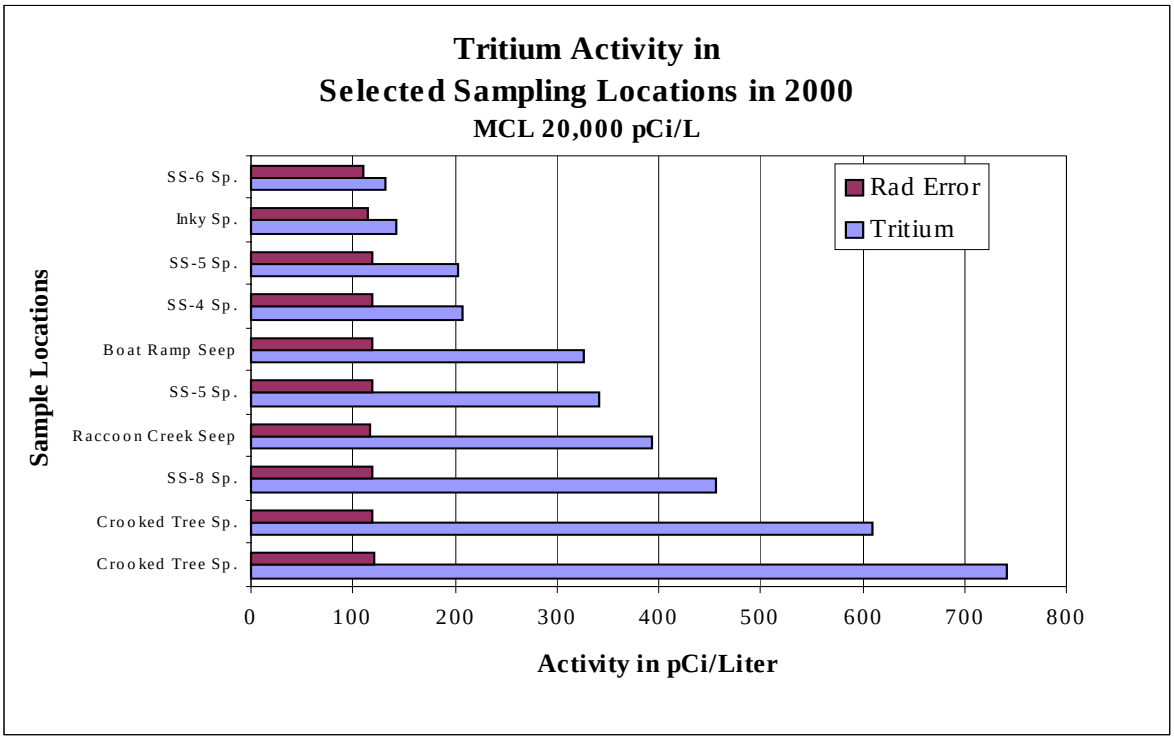


Figure 4: ORR and Vicinity Spring Monitoring Project 2000 Tritium

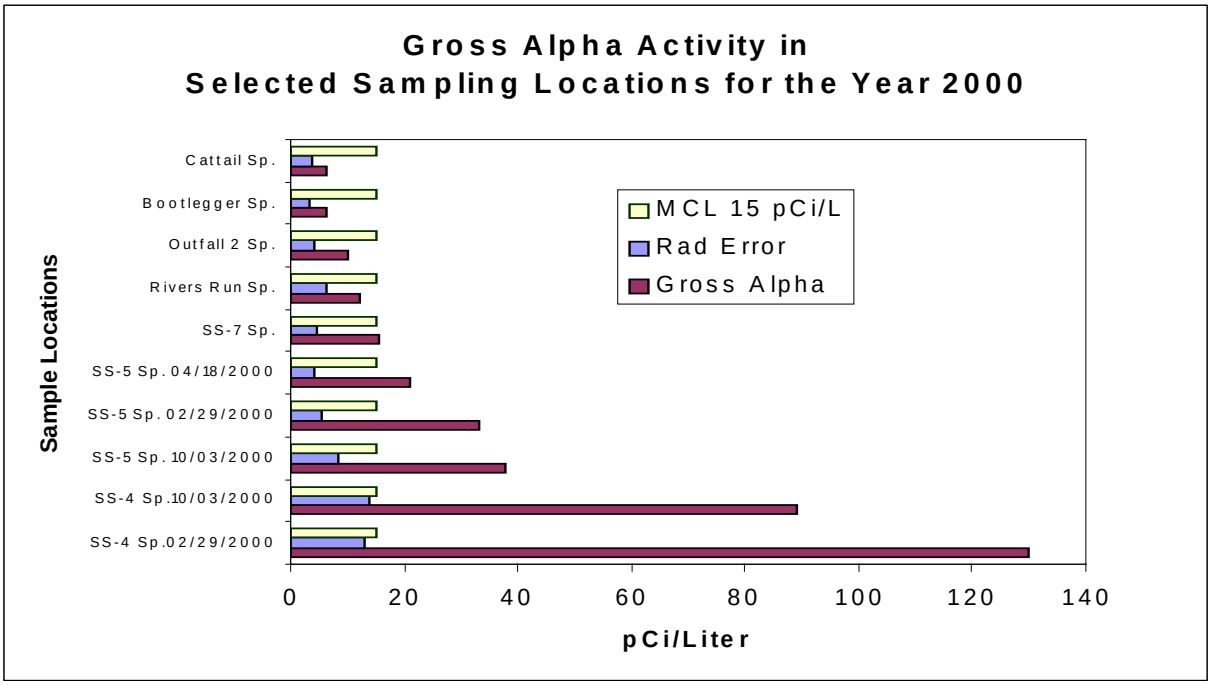


Figure 5: ORR and Vicinity Spring Monitoring Project 2000 Gross Alpha Activity

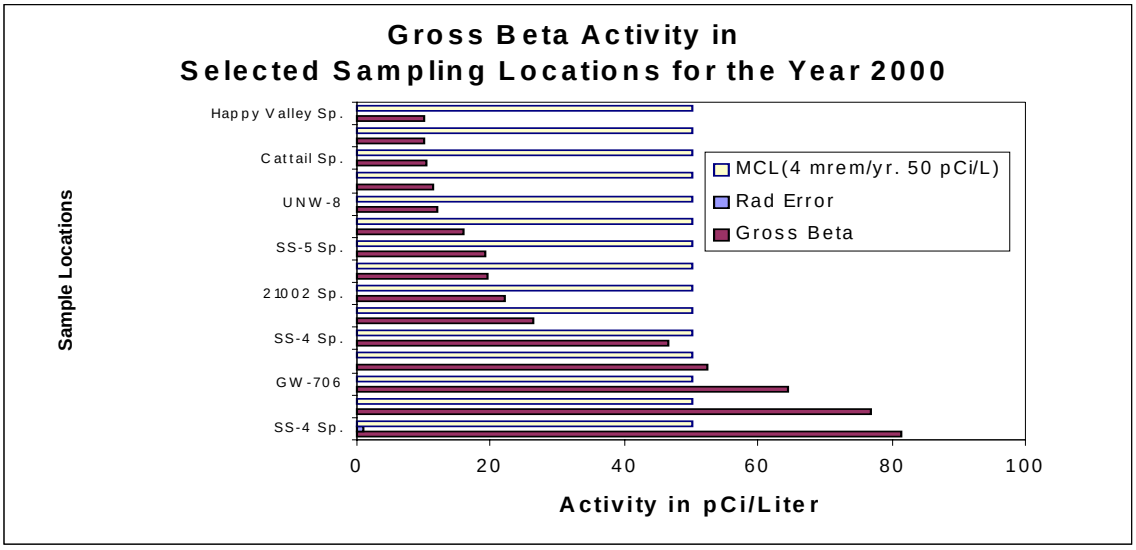


Figure 6: ORR and Vicinity Spring Monitoring Project 2000 Gross Beta Activity

References

Geraghty & Miller, Inc. "A Study of Groundwater Flow from Chestnut Ridge Security Pits Using a Fluorescent Dye Tracer" (Y/SUB/90-00206C/6).

Gareth J. Davies, Proceedings of the 3rd Conference on Hydrogeology, Ecology, Monitoring, and Management of Groundwater in Karst Terrains. Nashville, TN p. 197, yr. 1991 "Water Temperature Variation at Springs in the Knox Group near Oak Ridge, Tennessee."

Rubin and Lemiszki, 1992 (unpublished report for MMES/DOE) "Aspects of Oak Ridge Karst Hydrology and Geomorphology."

ORNL/TM-12074 "Status Report on the Geology of the Oak Ridge Reservation."

King and Haase, ORNL/TM-10112Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley.

TDEC/DOE-O (unpublished data) Spring Monitoring Data-1994.

SAIC. November 1992. (Y/SUB/93-99928c/Y10/1) *Final Report of the Second Dye Tracer Test at the Chestnut Ridge Security Pits.*

TDEC/DOE-O April 1995 Work Plan for Dye Trace Study at the Chestnut Ridge East Borrow Area Y-12 Plant Oak Ridge, Tennessee.

TDEC DOE-O 1996 TDEC DOE-O Standard Operating Procedures.

Region IV EPA, May, 1996, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.

TDEC Department of Energy Oversight, November, 1998 Health, Safety, and Security Plan.

GROUNDWATER MONITORING

Determination of Liner Breaching by Groundwater in Y-12 Non-operational Sanitary Landfill 2

Principal Author: Brett Shaffer

Abstract

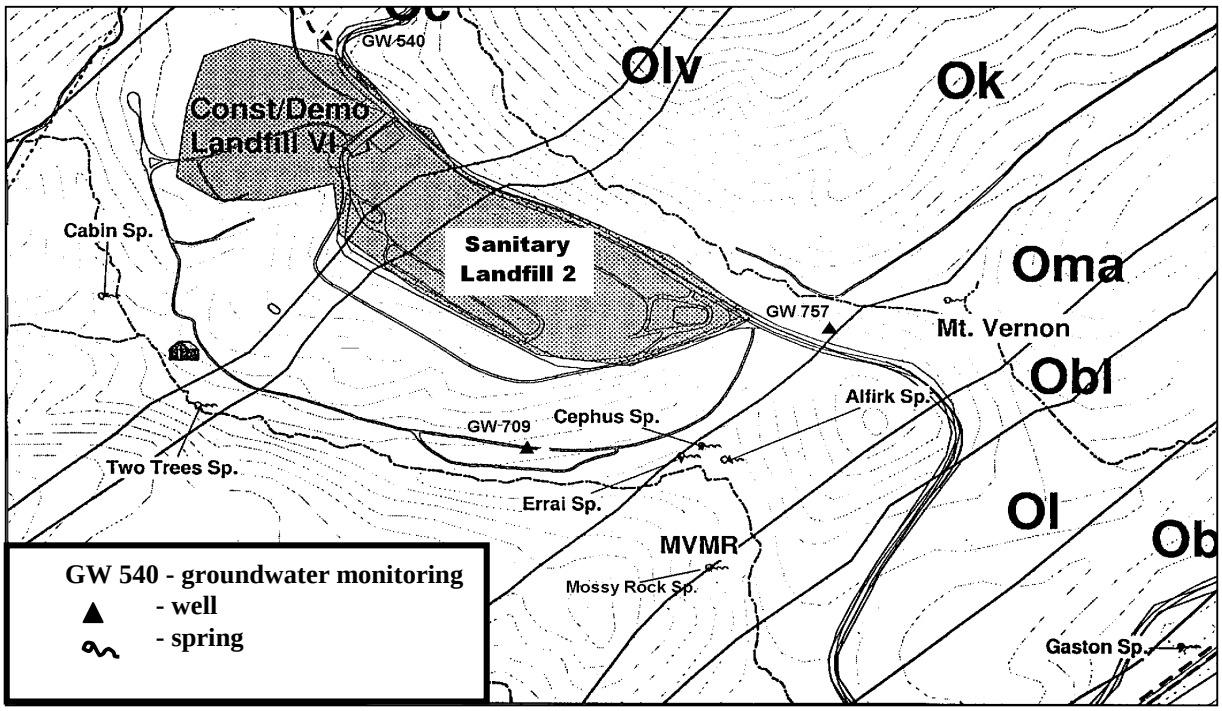
In 2000, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight (DOE-O) performed sampling of springs and wells located in the vicinity of the non-operational Y-12 Sanitary Landfill 2 (SLF2). This independent monitoring program was initiated in 1998 to identify potential breaches in the liner of the landfill. During 2000, in accordance with the approved project plan, the Solid Waste Management Section of TDEC collected groundwater samples from Cabin Spring, Two Trees Spring, Cephus Spring, Mossy Rock Spring, Well GW-709, Well GW-757, and Well GW-540 (Figure 1).

The results of this monitoring campaign indicate that concentrations of the sampled groundwater parameters are well below TDEC action levels for any of the regulated compounds of concern (TDEC GWQC, pp. 14-15). The sampling results from this independent monitoring project, in conjunction with Department of Energy (DOE) quarterly Resource Conservation and Recovery Act (RCRA), groundwater monitoring reports provide insight into the groundwater path-ways down gradient of SLF2. This groundwater data, together with the data obtained from 1998 and 1999 groundwater sampling events will be used as a benchmark for the future groundwater monitoring efforts in the vicinity of SLF2. The project was authorized during calendar year 2001 to continue and to expand to cover additional Y-12 landfill units.

Introduction

In 1998, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) approved an independent environmental project under the Tennessee Oversight Agreement (TOA) to monitor the potential migration of contaminants below a non-operational landfill unit. The purpose of this project was to identify potential breaches in liners of the non-operational Y-12 landfill SLF2 by obtaining grab groundwater samples from springs and groundwater monitoring wells and analyzing them for various groundwater parameters. Non-operational landfills may have a greater potential for developing liner breaches since constant observation of these sites usually does not occur. This project was continued in 1999 and 2000.

Figure 1: Spring and Well Sampling Locations (Not to scale)



For 2000, the monitoring project selected Cabin Spring, Two Trees Spring, Cephus Spring, Mossy Rock Spring, located both physically down gradient of SLF2 and potentially in a path of groundwater migration, served as the grab sampling locations for groundwater samples obtained during 2000. Similarly, selected groundwater monitoring wells GW-709, GW-757 are located down gradient, and well GW-540 up gradient of the SLF2 (Figure 1). The sampling of groundwater monitoring wells was conducted by obtaining split samples with DOE's subcontractors.

Methods and Materials

The preliminary sampling locations were selected through: reviews of well location maps, reviews of groundwater documents and existing analytical data, and by performing site visits by TDEC personnel. Cabin Spring, Two Trees Spring, Cephus Spring, Mossy Rock Spring, Well GW-709 and GW-757 were sampled on a semi-annual basis. During 2000, TDEC collected two grab groundwater samples from each spring monitoring location. The monitoring well locations were split sampled twice except for well GW-540, which was sampled only once. Sampling parameters included Dissolved Residue, Nitrate, Nitrite, pH, Specific Conductivity, Total Alkalinity, Total Hardness, Arsenic, Barium, Cadmium, Chromium, Cobalt, Lead, Mercury, Nickel, Zinc, Volatile Organics, Gasoline Range Organics, Pesticides, PCBs, Gross Alpha and Gross Beta Radioactivity.

Materials and Equipment used to perform the project included the following:

A. Approved sampling containers.
B. Coolers for storage and transport of samples.
C. Ice to maintain coolers at 4 degrees Celsius.
D. Sample paperwork and chain of custody forms.
E. Protective clothing
    1. Safety glasses.
    2. Steel toe boots.
    3. Sampling gloves.

Collected samples, together with the completed chain of custody forms, were delivered to the State Environmental Laboratory in Knoxville, Tennessee for analyses.

Results

The sampling results, based on the analytical reports from the State Laboratory, were compiled and are provided below.

Table 1: Calendar Year 2000 Spring Sampling Results

Parameters	Cephus Spring		Cabin Spring		Mossy Rock Spring		Two Trees Spring	
	04/05/2000	10/31/2000	04/05/2000	10/31/2000	04/05/2000	10/30/2000	04/05/2000	10/31/2000
Volatile Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
GR-Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Dissolved Residue	153 mg/L	185 mg/L	55 mg/L	177 mg/L	107 mg/L	151 mg/L	15 mg/L	156 mg/L
Nitrate	.29 mg/L	2.5 mg/L	.12 mg/L	.15 mg/L	.05 mg/L	.18 mg/L	.04 mg/L	.05 mg/L
Nitrite	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Nitrate and Nitrite	.29 mg/L	2.5 mg/L	.12 mg/L	.15 mg/L	.05 mg/L	.19 mg/L	.04 mg/L	.05 mg/L
pH	6.9	7.1	6.8	7.7	7.4	7.7	5.7	8
Specific Conductivity	312 umho	341 umho	122 umho	320 umho	219 umho	286 umho	31 umho	287 umho
Total Alkalinity	147 mg/L	183 mg/L	57 mg/L	172 mg/L	110 mg/L	153 mg/L	8 mg/L	159 mg/L
Total Hardness	165 mg/L	193 mg/L	65 mg/L	179 mg/L	121 mg/L	159 mg/L	17 mg/L	160 mg/L
Arsenic	Non-detect	2 ug/L	Non-detect	2 ug/L	Non-detect	Non-Detect	Non-detect	1 ug/L
Barium	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Cadmium	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Cobalt	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Lead	Non-detect	2 ug/L	Non-detect	2 ug/L	Non-detect	Non-Detect	1 ug/L	Non-detect
Mercury	Non-detect	Non-detect	Non-detect	No Data *	Non-detect	Non-Detect	Non-detect	No Data *
Nickel	Non-detect	13 ug/L	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect
Total Chromium	Non-detect	2 ug/L	Non-detect	2 ug/L	Non-detect	1 ug/L	Non-detect	1 ug/L
Zinc	5 ug/L	5 ug/L	4 ug/L	14 ug/L	6 ug/L	5 ug/L	7 ug/L	7 ug/L
Gross Alpha	0.4	6.8	-1.2	0.7	-0.3	5	-0.8	-1
Gross Beta	2.7	4.6	0.8	2.4	-0.9	3.8	0	1.9
Pesticides/PCBs	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-Detect	Non-detect	Non-detect

No Data * - The parameter was not analyzed due to the laboratory error

Table 2: Calendar Year 2000 Well Sampling Results

Parameters	GW - 540	GW - 709		GW - 757	
	07/26/2000	02/03/2000	08/01/2000	02/03/2000	08/01/2000
Volatile Organics:	Non-detect	Non-detect	Non-detect		Non-detect
Methylene Chloride				.9 ug/L	
Toluene				1.4 ug/L	
Other				Non-detect	
GR-Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Dissolved Residue	410 mg/L	90 mg/L	126 mg/L	139 mg/L	145 mg/L
Nitrate	.04 mg/L	.1 mg/L	.33 mg/L	.12 mg/L	.19 mg/L
Nitrite	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Nitrate and Nitrite	.04 mg/L	.1 mg/L	.33 mg/L	.12 mg/L	.19 mg/L
pH	7.93	9.5	8.4	9.8	9.8
Specific Conductivity	383 umho	231 umho	263 umho	289 umho	272 umho
Total Alkalinity	205 mg/L	134 mg/L	142 mg/L	133 mg/L	117 mg/L
Total Hardness	192 mg/L	125 mg/L	145 mg/L	59 mg/L	44 mg/L
Arsenic	Non-detect	Non-detect	Non-detect	2 ug/L	3 ug/L
Barium	Non-detect	160 ug/L	674 ug/L	Non-detect	Non-detect
Cadmium	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Cobalt	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Lead	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Mercury	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Nickel	29 mg/L	Non-detect	15 ug/L	Non-detect	Non-detect
Total Chromium	Non-detect	Non-detect	Non-detect	9 ug/L	Non-detect
Zinc	1 mg/L	1 ug/L	Non-detect	Non-detect	3 ug/L
Gross Alpha	0.5	1.6	0.3	0.5	4.4
Gross Beta	-0.6	10.3	0.9	17.9	17.2
Pesticides/PCBs	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect

Analysis of the data indicated variation in the concentrations for the following physical parameters: Dissolved Residue, Specific Conductivity and Total Alkalinity, and pH. These results can be observed in the following graphs.

Figure 2

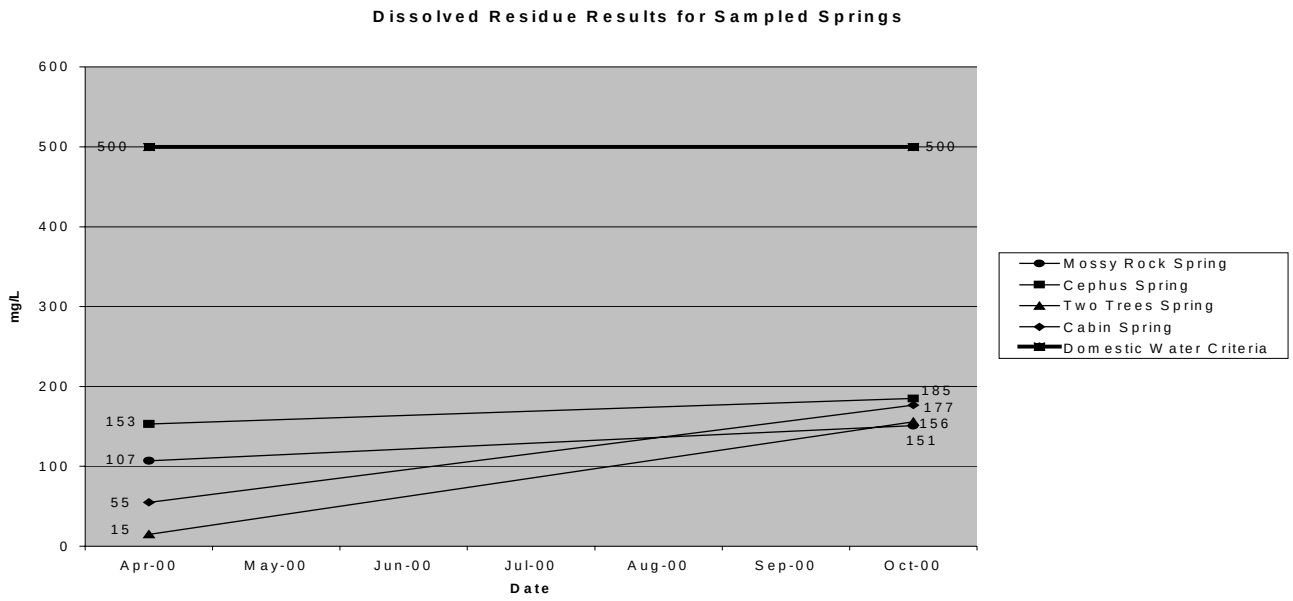
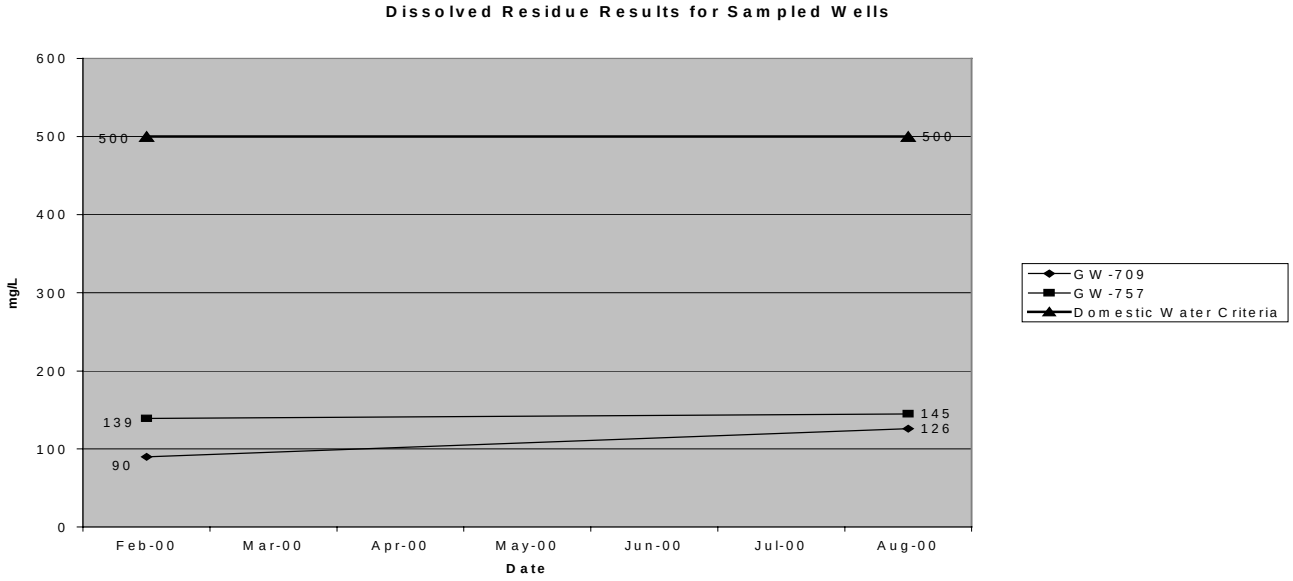
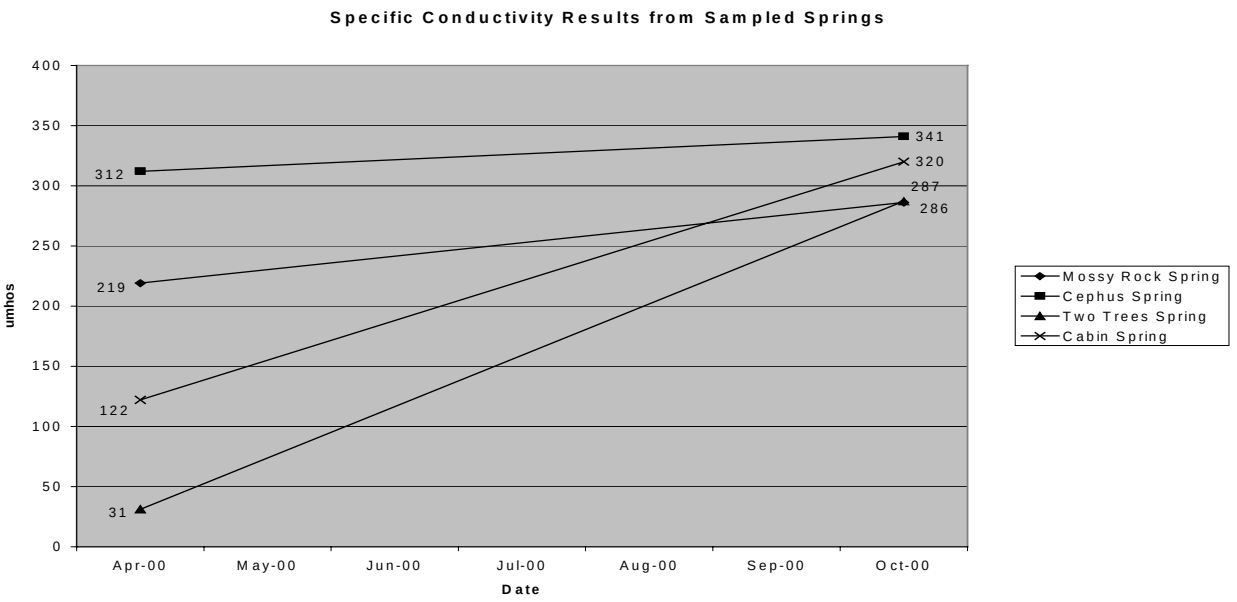


Figure 3



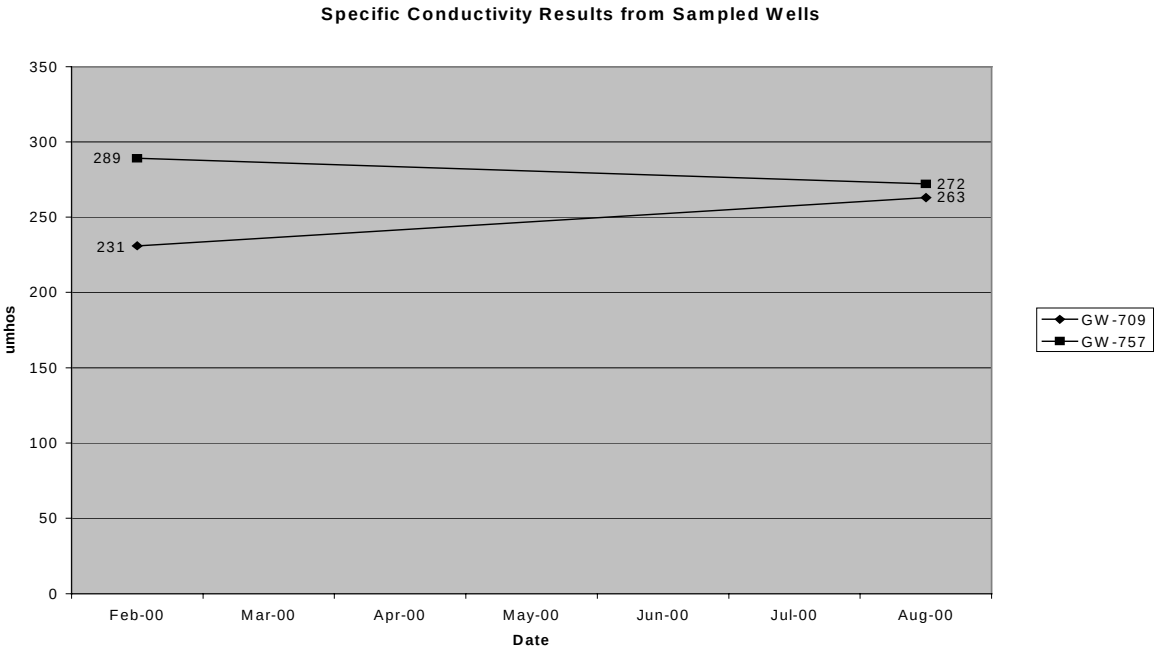
Dissolved residue results for the sampled springs ranged between 15 and 185 mg/L and for wells between 90 and 145 mg/L. The observed results were well below the General Water Quality Criteria regulatory limit of 500 mg/L for Domestic Water.

Figure 4



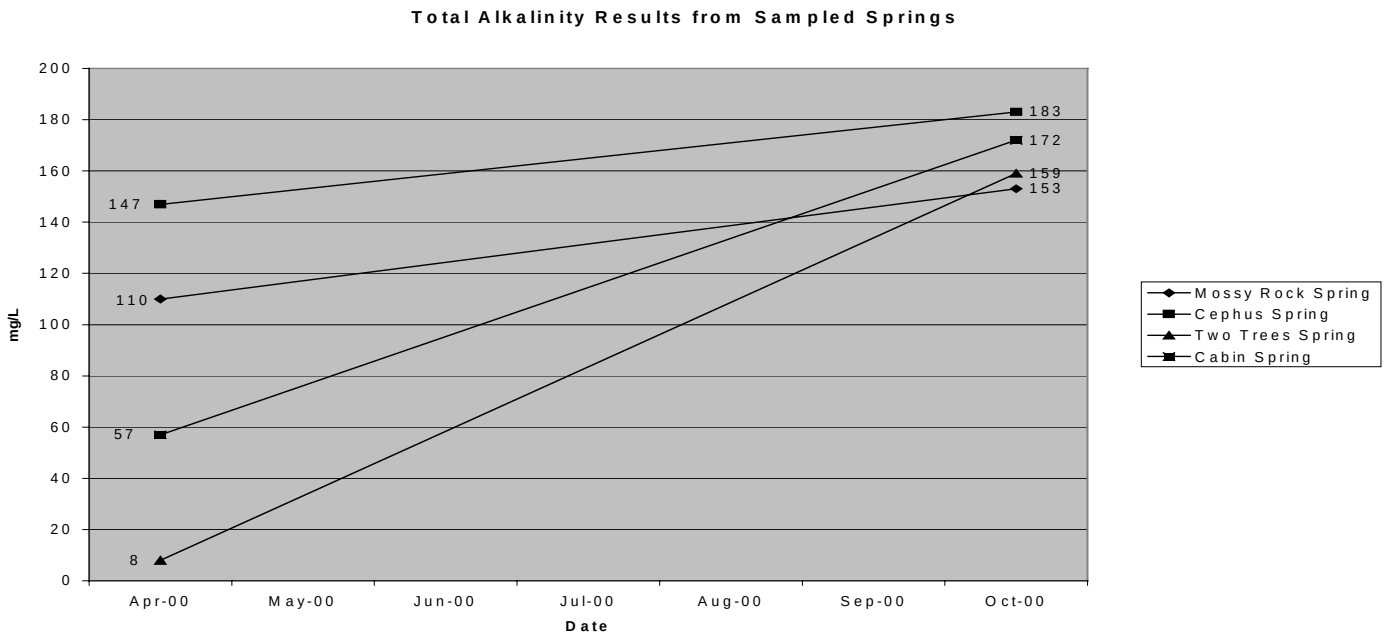
Specific conductivity results for the sampled springs ranged between 31 and 341 umhos. The observed results were with in normal parameters for conductivity.

Figure 5



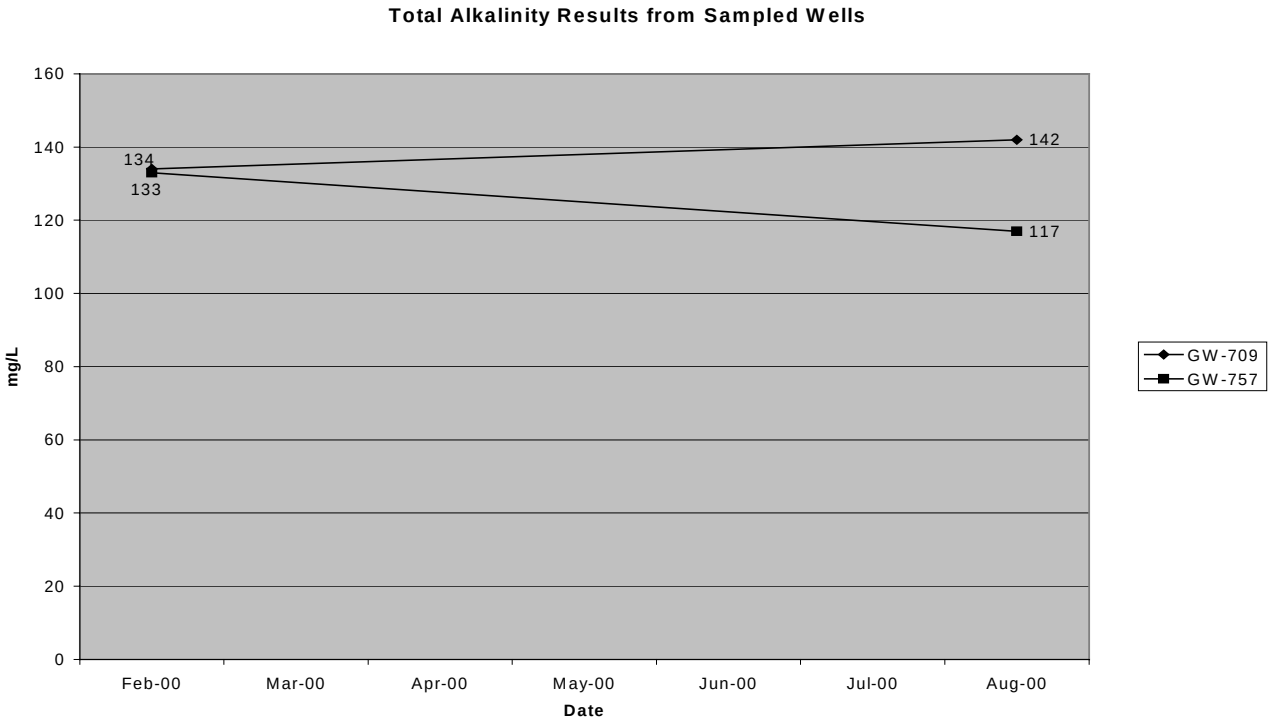
Specific conductivity results for the sampled wells ranged between 231 and 289 umhos. The observed results were with in normal parameters for conductivity.

Figure 6



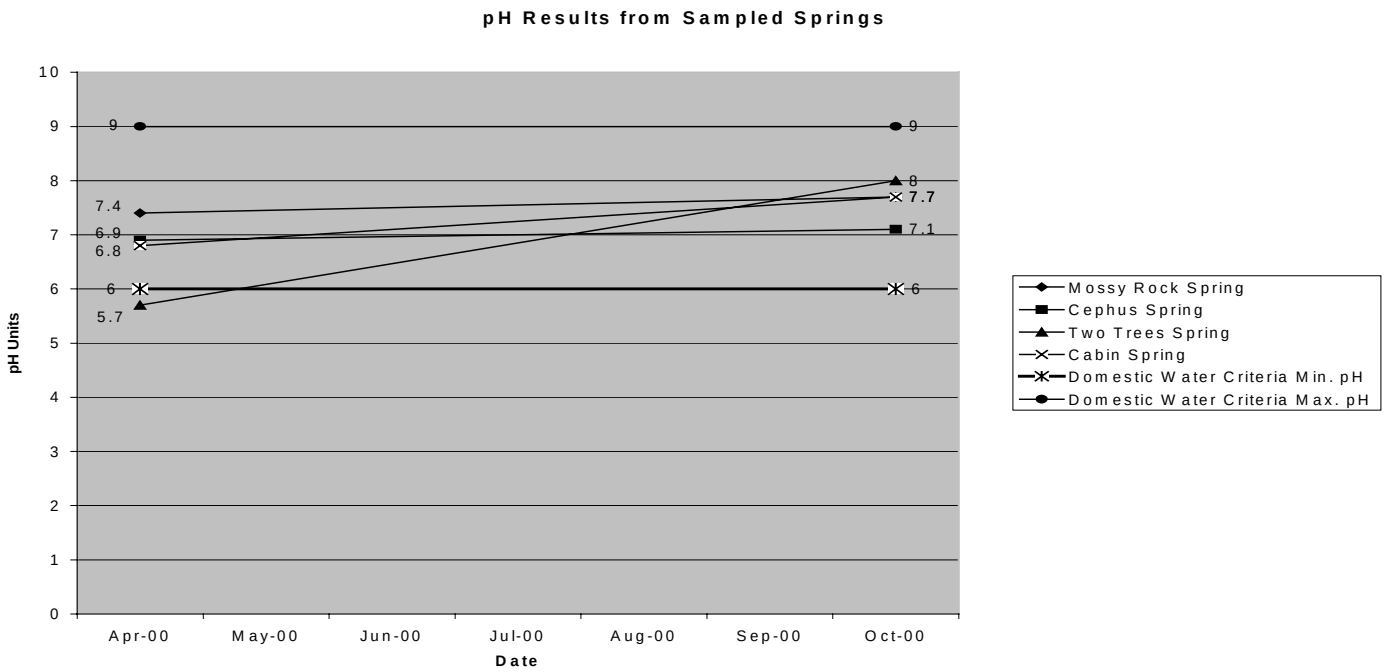
Total alkalinity results for the sampled springs ranged between 8 and 183 mg/L.

Figure 7



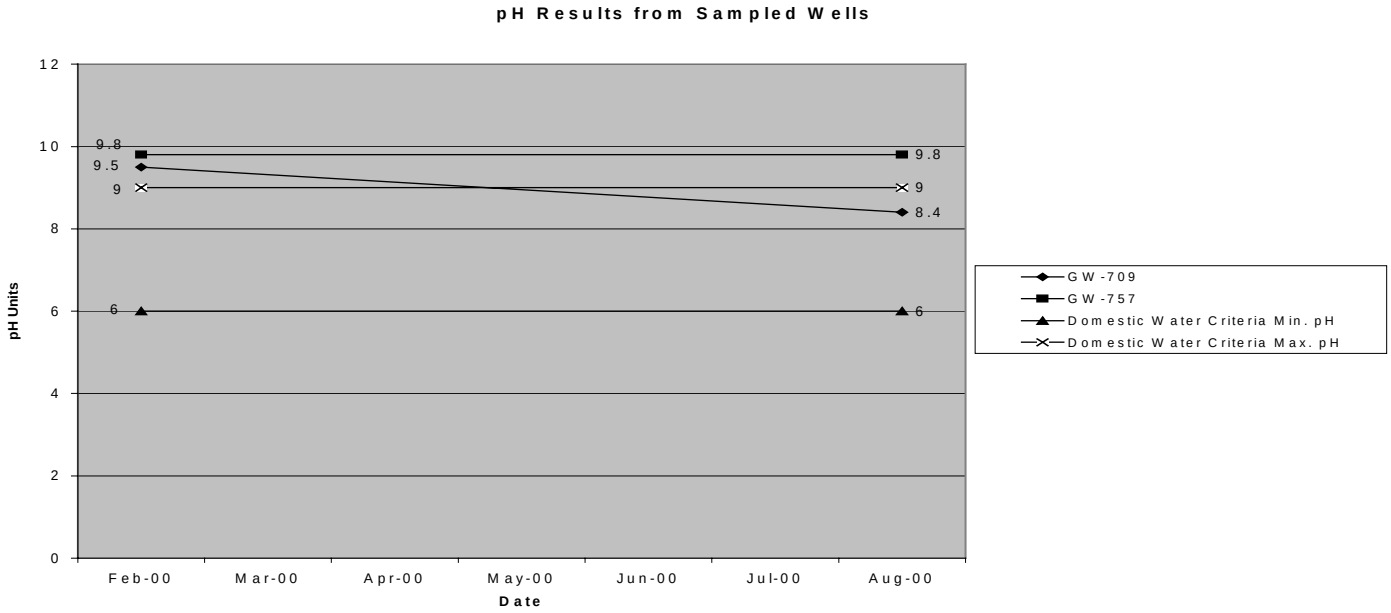
Total alkalinity results for the sampled wells ranged between 117 and 142 mg/L.

Figure 8



The pH results for the sampled springs ranged between 5.7 and 8 pH units. Only one observed result (Two Trees Spring) that was below the General Water Quality Criteria regulatory minimum pH limit of 6.0 pH units for Domestic Water. Other observed results were within the acceptable regulatory range of 6.0 to 9.0 pH units.

Figure 9



The pH results for the sampled wells ranged between 8.4 and 9.8 pH units. The observed results from both wells had results above the General Water Quality Criteria regulatory maximum pH limit of 9.0 pH units for Domestic Water. One observed result from well GW-709 was within the acceptable regulatory range of 6.0 and 9.0 pH units.

There were some isolated instances of trace concentrations of metals observed in the springs and wells: Lead, Nickel, and total Chromium were the main metal parameters that had trace amounts reported well below the water quality criteria for domestic water. July-August, 2000 sampling results indicated Nickel concentrations in wells GW-540 and GW-709. Trace volatile organic concentrations were observed from February 2000 sampling results from well GW-757 for Methylene Chloride and Toluene. The volatile organic results may have been the result of laboratory sample contamination.

Table 3: Water Quality Criteria for Domestic Water

Lead	5 ug/L
Nickel	100 ug/L
Total Chromium	100 ug/L

Comparison To 1998/1999 Monitoring Efforts

Table 4: Comparison of Spring Sample Results from 1998 and 1999 Sampling Efforts

Parameter	Errai Spring			Alfirk Spring	Mount Vernon Spring
	April-99	July-99	November-99	May-98	Oct-98
Volatile Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
GR-Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
Dissolved Residue	96 mg/L	105 mg/L	119 mg/L	176 mg/L	192 mg/L
Nitrate	.02 mg/L	No Data Available	<.01 mg/L	No Data Available	No Data Available
Nitrite	Non-detect	No Data Available	<.01 mg/L	No Data Available	No Data Available
Nitrate and Nitrite	No Data Available	.08 mg/L	Non-detect	.21 mg/L	.23 mg/L
pH	7.2	7.1	7.5	No Data Available	No Data Available
Specific Conductivity	177 umhos	251 umhos	282 umhos	No Data Available	No Data Available
Total Alkalinity	93 mg/L	120 mg/L	137 mg/L	178 mg/L	202 mg/L
Total Hardness	No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
Arsenic	<1 ug/L	<1 ug/L	<1 ug/L	Non-detect	Non-detect
Barium	<100 ug/L	<100 ug/L	<100 ug/L	No Data Available	No Data Available
Cadmium	<1 ug/L	<1 ug/L	<1 ug/L	Non-detect	Non-detect
Cobalt	<5 ug/L	<10 ug/L	<15 ug/L	No Data Available	No Data Available
Lead	<1 ug/L	<1 ug/L	< 1ug/L	Non-detect	2 ug/L
Mercury	<.2 ug/L	<.2 ug/L	<.2 ug/L	Non-detect	Non-detect
Nickel	<10 ug/L	<10 ug/L	<10 ug/L	No Data Available	No Data Available
Total Chromium	<1 ug/L	<1 ug/L	< 1ug/L	Non-detect	Non-detect
Zinc	10 ug/L	3 ug/L	<1 ug/L	11 ug/L	3 ug/L
Gross Alpha	0.9 pCi/L	1.8 pCi/L	4.3 pCi/L	2.5 pCi/L	4.4 pCi/L
Gross Beta	2.1 pCi/L	3.1 pCi/L	1.9 pCi/L	0.5 pCi/L	No Data Available
Pesticides/PCBs	Non-detect	Non-detect	Non-detect	No Data Available	No Data Available

Errai, Alfirk, and Mount Vernon Springs, as depicted in Figure 1, are within vicinity of SLF-2 to the south and east respectively.

A comparison of calendar year 2000 and 1998 spring sampling results for Alfirk and Mount Vernon springs reveals that for the parameters similarly sampled, the observed results were within the ranges observed from the 2000 spring sampling effort around SLF-2.

Comparison of calendar year 2000 and 1999 spring sampling results for Errai spring indicates that the specific conductivity, dissolved residue, and total alkalinity concentrations for Errai spring ranged in between the resultant ranges reported for other springs.

Comparison of 2000 Well Sampling Results to Department of Energy Analyzed Split-samples

Well sampling results from monitoring wells in the vicinity of SLF-2 indicate concentrations for metals and volatile organic compounds below the water quality criteria for domestic water. The DOE split-sampling results from the July-August 2000 sampling event for well GW-709 indicated a trace concentration of Nickel as observed in the project sample results for well GW-709 as well. Concentrations of Acetone were observed in wells GW-709 and GW-757 from the same sampling event. Laboratory results from the DOE split-samples are illustrated in Table 5. In general, the results from the DOE split-samples were comparable to results from the State analysis of split-samples.

Table 5: DOE Split-sampling Results For Calendar Year 2000

Parameters	GW-709	GW-709	GW-757	GW-757	GW-540
	02/03/2000	08/01/2000	02/03/2000	08/01/2000	07/26/2000
Volatile Organics	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
GR-Organics	Non-detect	Non-detect	150 mg/L	142 mg/L	Non-detect
Dissolved Residue	120 mg/L	131 mg/L	.2 mg/L	.66 mg/L	195 mg/L
Nitrate	<.1 mg/L	<.5 mg/L			
Nitrite					
Nitrate and Nitrite					<.5 mg/L
pH	9.06	8.3	9.83	9.7	8.1
Specific Conductivity	247 umho	272 umho	286 umhos	277 umho	385 umho
Total Alkalinity	124 mg/L	198 mg/L	66 mg/L	159 mg/L	264 mg/L
Total Hardness					
Arsenic	<1.073 ug/L	.25 ug/L	2.6 ug/L	2.4 ug/L	.22 ug/L
Barium	398 ug/L	480 ug/L	103 ug/L	92 ug/L	8.1 ug/L
Cadmium	<.053 ug/L	<.057 ug/L	<.053 ug/L	<.057 ug/L	<.057 ug/L
Cobalt	<.425 ug/L	<1.0 ug/L	<.425 ug/L	<1.0 ug/L	<1.0 ug/L
Lead	<.846 ug/L	<10 ug/L	<.846 ug/L	<10 ug/L	<10 ug/L
Mercury	<.029 ug/L	<.2 ug/L	.026 ug/L	>.028 ug/L	<.2 ug/L
Nickel	1.36 ug/L	<40 ug/L	<.825 ug/L	<40 ug/L	<40 ug/L
Total Chromium	<.318 ug/L	<10 ug/L	10.2 ug/L	<10 ug/L	<10 ug/L
Zinc	<.725 ug/L	<20 ug/L	<.725 ug/L	<20 ug/L	<20 ug/L
Gross Alpha	0.617	1.45	2.77	2.09	0.623
Gross Beta	1.91	2.51	1.44	17.1	1.76
Pesticides/PCBs					
Acetone		11 ug/L		14 ug/L	

Conclusion

The calendar year 2000 results from groundwater monitoring wells and springs samples obtained in the vicinity of Y-12 Sanitary Landfill 2 were almost all below water quality criteria regulatory limits for domestic water.

Nickel concentrations observed in monitoring wells GW-540 and GW-709 can be attributed to the decomposition of the stainless steel casing that can cause concentrations of nickel to be present in the water column. Acetone concentrations observed in DOE split-samples results may be the result of the decomposition of vegetative debris from SLF-2. Acetone is an unregulated organic compound.

The results of this monitoring campaign indicate that concentrations of the sampled groundwater parameters are well below TDEC action levels for any of the regulated compounds of concern (TDEC GWQC, pp. 14-15).

The sampling results from this independent monitoring project in conjunction with DOE quarterly RCRA groundwater monitoring reports provide insight into the groundwater path-ways down gradient of SLF2. This groundwater data, together with the data obtained from 1998 and 1999 groundwater sampling events will be used as a benchmark for the future groundwater monitoring efforts in the vicinity of SLF2. The project was authorized during calendar year 2001 to continue and to expand to cover additional Y-12 landfill units.

References

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, TN. *Health, safety, and security Plan, 1998 and 1999.*

Tennessee Department of Environment and Conservation (TDEC), General Water Quality Criteria (GWQC), Rule 1200-4-3-.05, pp. 2-4.

Bechtel Jacobs LLC. *Semi-annual Groundwater Monitoring Report for Y-12 Landfill Units for 2nd Half of Calendar Year 2000.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, TN. *Environmental Monitoring Report, January through December 1999.*

AIR QUALITY MONITORING

Hazardous Air Pollutants Metals Monitoring on East Tennessee Technology Park

Principal Author: Randy Meyer

Abstract

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division's (DOE-O) Hazardous Air Pollutant (HAPs) Monitoring Program was developed to provide continued independent monitoring at the East Tennessee Technology Park (ETTP) and to verify the Department of Energy's (DOE) reported monitoring results. Monitoring was conducted for Arsenic, Beryllium, Cadmium, Total Chromium, Lead, Nickel, and Uranium as a metal. In order to ensure conservative values, detection limits were utilized when averaging results below the detection limits of the laboratory analysis except for Background Data.

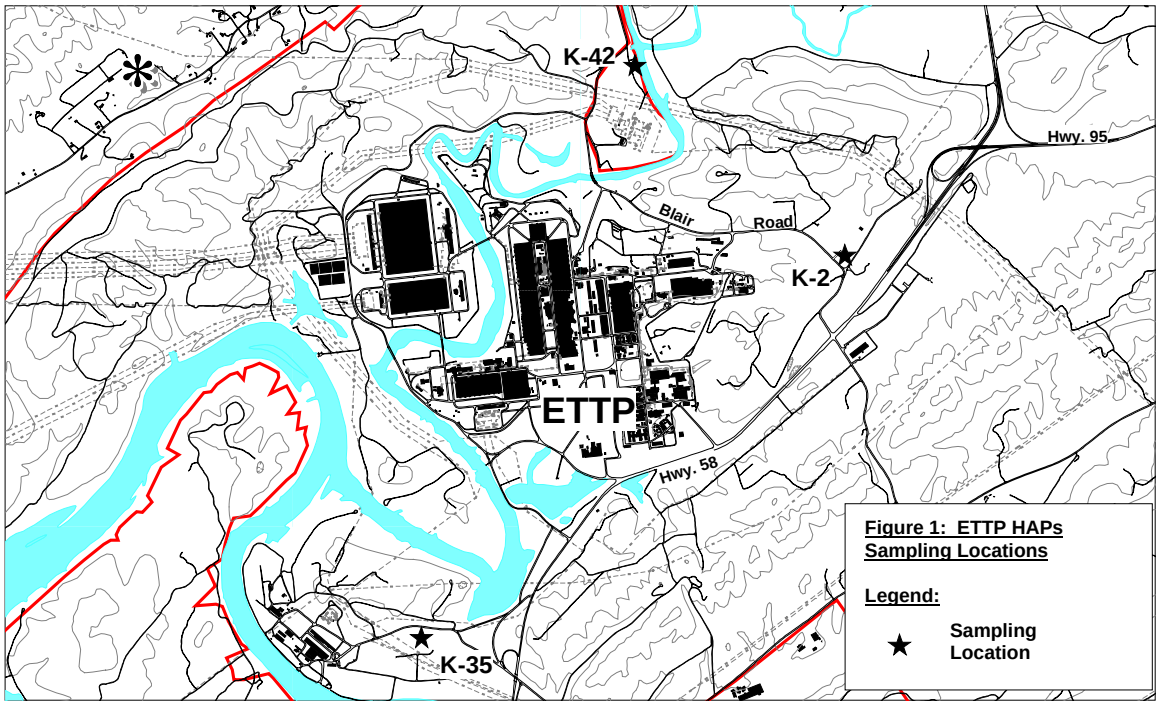
As a result of this monitoring campaign conducted by TDEC at the ETTP sites, analytical results indicate no apparent elevated levels of HAPs metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis. Background levels, collected near Norris Lake were slightly lower than samples on the ETTP. This would be expected when comparing an industrialized area to a more remotely located residential area. Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

It should also be noted that there are other incinerator facilities in the vicinity of the Oak Ridge Reservation (ORR). The possibility exists that these operations, along with the Tennessee Valley Authority (TVA) Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR. Operations at the Toxic Substance Control Act (TSCA) Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results from the ETTP or the ORR in general.

This project will continue to monitor for potential effects on the ORR at ETTP in order to provide independent monitoring to assure protection of human health and the environment.

Introduction

In 1997, concerns were raised by members of the public regarding potential health effects due to possible concentrations of Hazardous Air Pollutants (HAPs) in the ambient air on and around the Oak Ridge Reservation (ORR). In response to these concerns, the Tennessee Department of Environment and Conservation's (TDEC's), Department of Energy Oversight Division (DOE-O), Waste Management (WM) program developed an ambient air monitoring program for the ORR in order to determine what effects, if any, Department of Energy (DOE) operations were having on the ambient air on and around the reservation with regard to HAPs. This program was designed to provide an independent verification of monitoring results as reported by the DOE. Background data was collected at a site located near Norris Lake. This data was used in a comparative manner as a baseline for the area surrounding the ORR. Nickel and Uranium as a metal were added in 1999 to the list of metals of concern. Future Decontamination and Decommissioning (D&D) activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.



ETTP

Monitoring for this project was conducted at Stations K-2 (Blair Rd opposite the TSCA Incinerator - 1), Perimeter Air Monitor Station 42 (next to Poplar Creek) and Perimeter Air Monitor Station 35 (Gallaher Rd Bridge area). See Figure 1. These sites were also utilized for the 1999 and 1998 campaigns.

Methods and Materials

The monitoring sites selected were chosen based upon windroses data that indicated the sites were in the prevailing wind flow patterns for the region surrounding the ORR. The windflow during the day is a southwest to northeast pattern while during the night; the flow pattern is reversed. The placement then of TDEC's monitors allowed for sampling that would be representative of a 24-hour windflow pattern at the ORR.

The project was conducted as closely as possible to the currently established 2000 sampling project schedule. The monitors were located at each site for approximately one month. Filter samples were collected on a weekly basis and mailed to the State Laboratory in Nashville for analysis

Materials required for this project included:

1. Hi-Volume sampler
2. Trailer
3. Extension cords
4. 4x4 vehicle
5. Filters
6. Calibration kit
7. Flow chart
8. Level
9. Project data form

Results and Discussion

Background Results

A site was located in Norris, Tennessee, near Norris Lake, in a residential area. This site was monitored during the periods of 4/7-5/21, and 6/23-7/14 1999. The results are shown in Table 1.

Table 1. Background/Norris

Metal of Concern	1999 Sample result $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	Undetected	0.0023 [1]
Beryllium	Undetected	0.004 [1]
Cadmium	Undetected	0.0056 [1]
Total Chromium	< 0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	Undetected	1.5 [2]
Nickel	Undetected	0.042[1]
Uranium	Undetected	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

Results from ETTP

HAPs metals were monitored at the K-2 station during the time periods of 2/17-3/23, 4/5-5/17, and 11/14-12/31 2000. The results are shown in Table 2.

Table 2. HAPs K2 Sampling Results

Metal of Concern	2000 Results $\mu g/m^3$	1999 Results $\mu g/m^3$	1998 Results $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	ND	< 0.01	ND	0.0023 [1]
Beryllium	ND	< 0.001	ND	0.004 [1]
Cadmium	ND	< 0.001	ND – 0.0004	0.0056 [1]
Total Chromium	< 0.001	< 0.0013	0.0007 – 0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0034	0.0026	0.006 – 0.002	1.5 [2]
Nickel	< 0.001	< 0.001	No sampling	0.042[1]
Uranium	ND	< 0.01	No sampling	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

The monitor was co-located with DOE Perimeter Air Monitor (PAM) Station K42 – TSCAI. HAPs metals were monitored at K-42 during the time periods of 1/27-2/17, 3/23-4/4, 7/13-9/13, and 10/12-11/14 2000. The results are shown in Table 3.

Table 3. HAPs K42 Sampling Results

Metal of Concern	2000 Results μg/m^3	1999 Results μg/m^3	1998 Results μg/m^3	Guideline Concentration μg/m^3
Arsenic	ND	< 0.01	ND – 0.03	0.0023 [1]
Beryllium	ND	< 0.001	ND - 0.0002	0.004 [1]
Cadmium	ND	< 0.001	ND – 0.0001	0.0056 [1]
Total Chromium	< 0.001	< 0.0013	0.0009 – 0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0028	0.0026	ND- 0.05	1.5 [2]
Nickel	< 0.001	< 0.001	No sampling	0.042[1]
Uranium	ND	< 0.01	No sampling	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

The monitor was co-located with DOE Perimeter Air Monitor (PAM) Station 35 – TSCA2. HAPs metals were monitored at K-35 during the time periods of 1/1-1/27, 5/17-7/13, and 9/13-10/12 2000. The results are shown in Table 4.

Table 4. HAPs K35 Sampling Results

Metal of Concern	2000 Results μg/m^3	1999 Results μg/m^3	1998 Results μg/m^3	Guideline Concentration μg/m^3
Arsenic	ND	< 0.01	ND	0.0023 [1]
Beryllium	ND	< 0.001	ND	0.004 [1]
Cadmium	ND	< 0.001	ND	0.0056 [1]
Total Chromium	<0.001	< 0.005	0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0044	< 0.0015	ND-0.001	1.5 [2]
Nickel	< 0.001	< 0.001	No sampling	0.042[1]
Uranium	ND	< 0.01	No sampling	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

Levels of Total Chromium were compared to the Risk Specific Dose levels for Hexavalent Chromium at the following monitoring locations: K2, K35, and K42.

As Hexavalent Chromium is a fractional constituent of Total Chromium, it is highly unlikely that these levels of Total Chromium would translate into elevated levels of Hexavalent Chromium. These results are consistent with previous sampling efforts. For those monitoring locations at ETTP, observed levels of Total Chromium could possibly be attributed to the ongoing decommissioning and decontamination activities related to reindustrialization at the ETTP site.

Based upon the analytical data generated at these monitoring sites, it would appear that there has been no significant change in levels of any metals of concern in the ambient air on and around these sampling points at the ETTP. Background levels, collected near Norris Lake were slightly lower than samples on the ETTP. This would be expected when comparing an industrialized area to a more remotely located residential area.

This project has been re-authorized to continue into 2001. Sampling sites will remain as they have for the year 2000. Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2000 was not available. However, analytical results from the 1998 and 1999 HAPs monitoring program were compared with the 1999 ASER, indicating comparable levels of HAPs in the ambient air in and around the ORR.

Conclusion

As a result of the 2000 monitoring campaign conducted by TDEC at the ETTP sites, analytical results indicate no apparent elevated levels of HAPs metals of concerns. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

It should also be noted that there are other incinerator facilities in the vicinity of the ORR. The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR. Operations at the TSCA Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results from the ETTP or the ORR in general.

References

Draft New York State Air Guide-1, Guidelines for the Control of Toxic Ambient Air Contaminants, Appendix B of Air Guide-1, Ambient Air Quality Impact Screening Analyses, 1994 Edition.

Boiler and Industrial Furnace Regulations - 40 CFR Part 266 Appendix V.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, TN. *Health, Safety and Security Plan*, 1998 and 1999.

Operations Manual for GMW Model2000H Total Suspended Particulate Sampling System, 1998 Graseby GMW Variable Resistance Calibration Kit # G2835.

TDEC/DOE-O Procedure number: SOP-ES&H-004 Air Monitoring/Air Sampling

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AIR QUALITY MONITORING

Environmental Radiation Ambient Monitoring System (ERAMS) Air Program

Principal Author: James L. Dunlap

Abstract

The Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring System (ERAMS) is designed to monitor potential pathways for significant population exposures from routine and/or accidental releases of radioactivity from major sources (EPA, 1988). This program provides for radiochemical analysis of air samples from five monitoring stations located on the Oak Ridge Reservation (ORR). In this effort, samples are collected twice weekly at each monitoring station by personnel from the Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) to be analyzed at the EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. Results are provided to TDEC and published in a quarterly EPA report, *Environmental Radiation Data* (available on the Internet). While not all of the data for 2000 has been processed, gross beta results were very similar for each ERAMS monitoring station. These results followed trends previously observed in TDEC's Perimeter and Fugitive Air Monitoring Programs. Currently available ERAMS data, along with results from associated TDEC's air monitoring programs, were not indicative of a significant impact on local air quality attributable to the Department of Energy (DOE) activities on the ORR.

Introduction

In the past, because of the Department of Energy's (DOE) activities on the Oak Ridge Reservation (ORR), air emissions have been believed to be a potential cause of illnesses affecting area residents. While these emissions have substantially decreased over the years with the decommissioning of various processes, concerns have remained that air emissions from current activities may pose a threat to public health and the surrounding environment. As a consequence of the above, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) has implemented three air monitoring programs to assess the impact of ORR air emissions on the surrounding environment and the effectiveness of DOE controls and monitoring systems. TDEC's Perimeter and Fugitive Air Monitoring Programs, described in associated reports, focus on monitoring of exit pathways, non-point sources of emissions, and sites of special interest (e.g., remedial sites). TDEC's participation in the Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring Systems (ERAMS) supplements the other programs and provides verification of the State and DOE monitoring, via independent third party analysis.

EPA's ERAMS is comprised of a national network of monitoring stations that regularly collect samples of air, water, and milk for radiochemical analysis. Historically, this network has been used to track environmental releases of radioactivity from nuclear weapons tests and nuclear accidents. In response to TDEC's requests and an initiative to incorporate site specific

monitoring into the ERAMS program, EPA agreed to locate five air-monitoring stations on the ORR in December of 1994. These stations began operation in 1996.

Methods and Materials

In the Oak Ridge ERAMS effort, EPA provides radiochemical analysis of air samples collected by TDEC's staff at the five monitoring stations depicted in Figure 1.

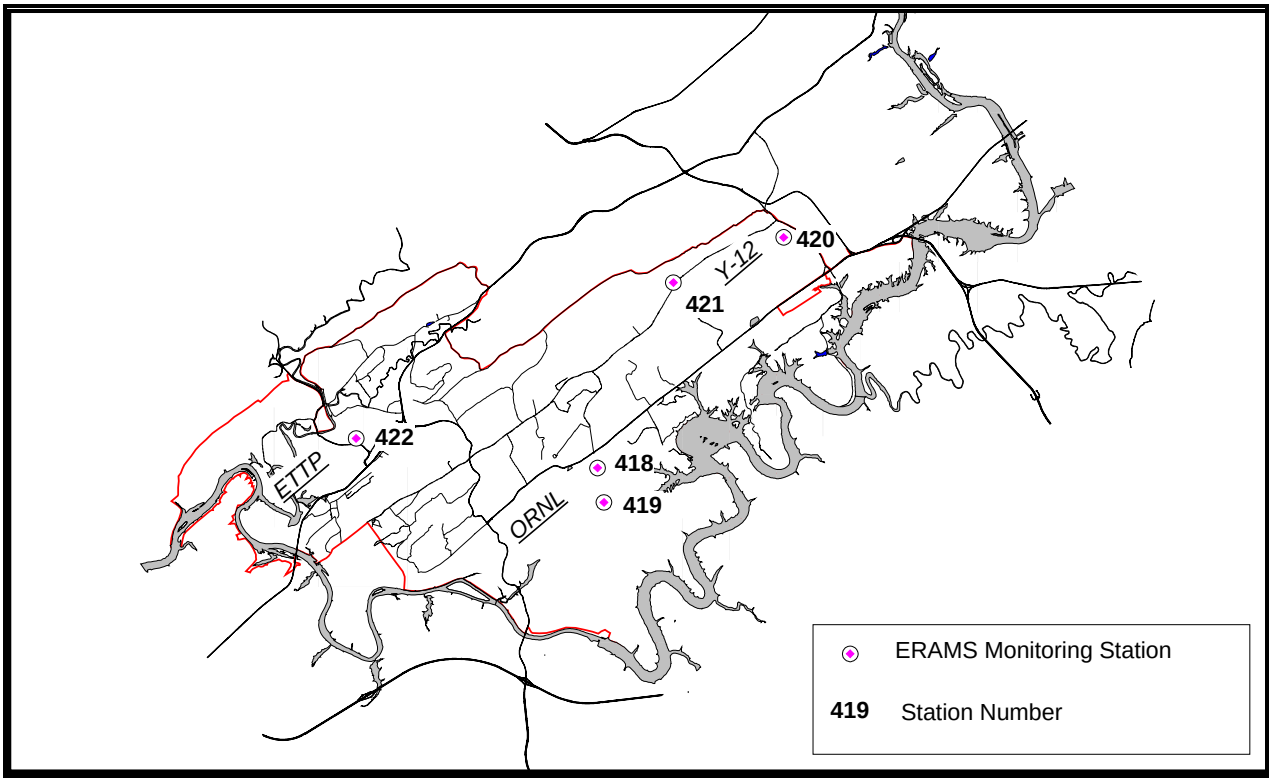


Figure 1. Approximate Locations of Air Stations Monitored in Association with EPA's Environmental Radiation Ambient Monitoring System (ERAMS) on the Oak Ridge Reservation

The ERAMS air monitors use synthetic fiber filters, ten centimeters in diameter, to collect airborne particulates moving through the units. The monitors are operated continuously and TDEC's staff change filters twice weekly. Airflow through each unit is recorded before and after the filter change. As prescribed in *Environmental Radiation Ambient Monitoring System (ERAMS) Manual* (EPA, 1988), field estimates of the quantity of radioactivity on each filter are made by the staff using a portable Geiger-Mueller radiation detector.

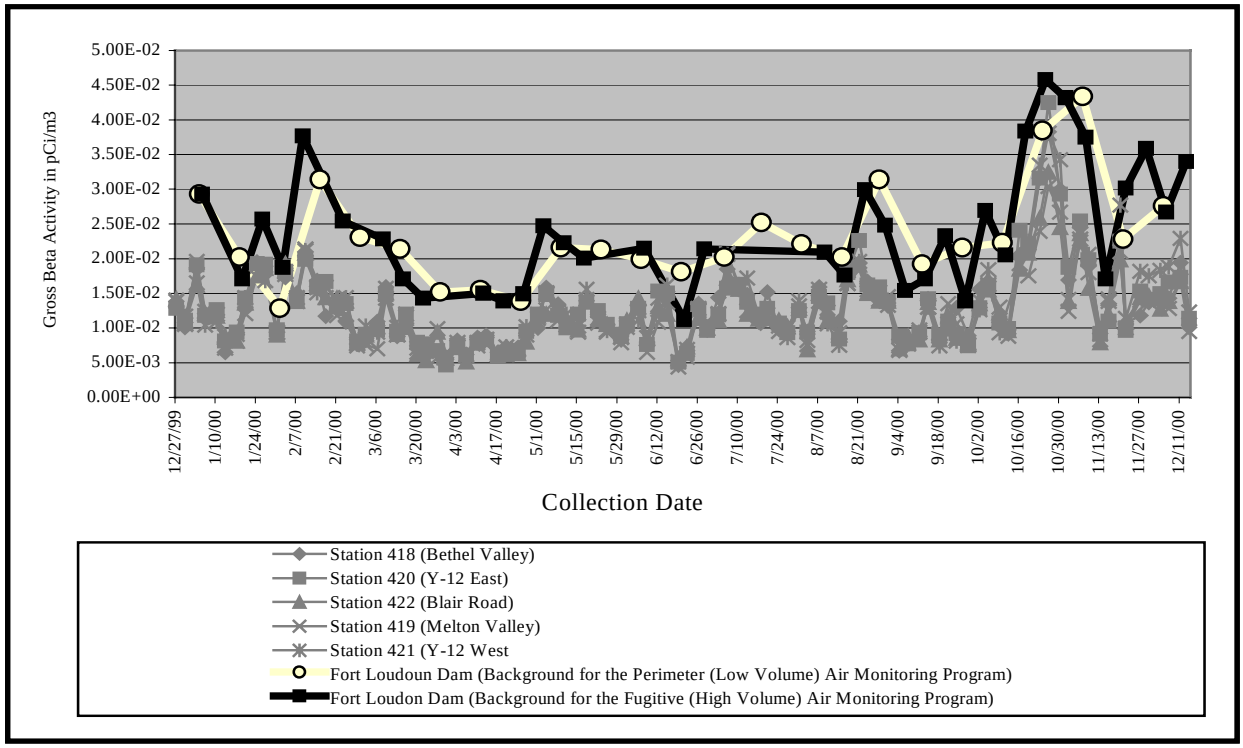
Radiochemical analysis is performed on the filters at EPA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama. Analytical parameters (Table 1) include: gross beta on each of the twice weekly samples; gamma spectrometry on samples that exhibit a gross beta activity greater than 1 pCi/m^3; and plutonium-238, plutonium-239, plutonium-240, uranium-234, uranium-235, and uranium-238 semiannually on composite samples. Results are provided to the TDEC and published by EPA in a quarterly report titled *Environmental Radiation Data*. This publication is currently available on the Internet (http://www.epa.gov/narel/erams.html).

Table 1: EPA Analysis of Air Samples Taken in Association with the Environmental Radiation Ambient Monitoring System

ANALYSIS	FREQUENCY
Gross Beta	Each of twice weekly samples
Gamma Scan	Samples showing greater than 1 pCi/m^3 of gross beta
Plutonium-238, Plutonium-239, Plutonium-240, Uranium-234, Uranium-235, Uranium-238	Semiannually on composite air particulate filters

Results and Discussion

The gross beta results for each ERAMS monitoring station followed the same general trends noted in the TDEC's Perimeter and Fugitive Air Monitoring Programs. Figure 2 illustrates the correlation between the trends noted in the ERAMS results for 2000 and those observed in background samples taken at Fort Loudoun Dam in Loudon County by the low volume air monitor used in the Perimeter Air Program) and the high volume air monitor used in the Fugitive Air Program.



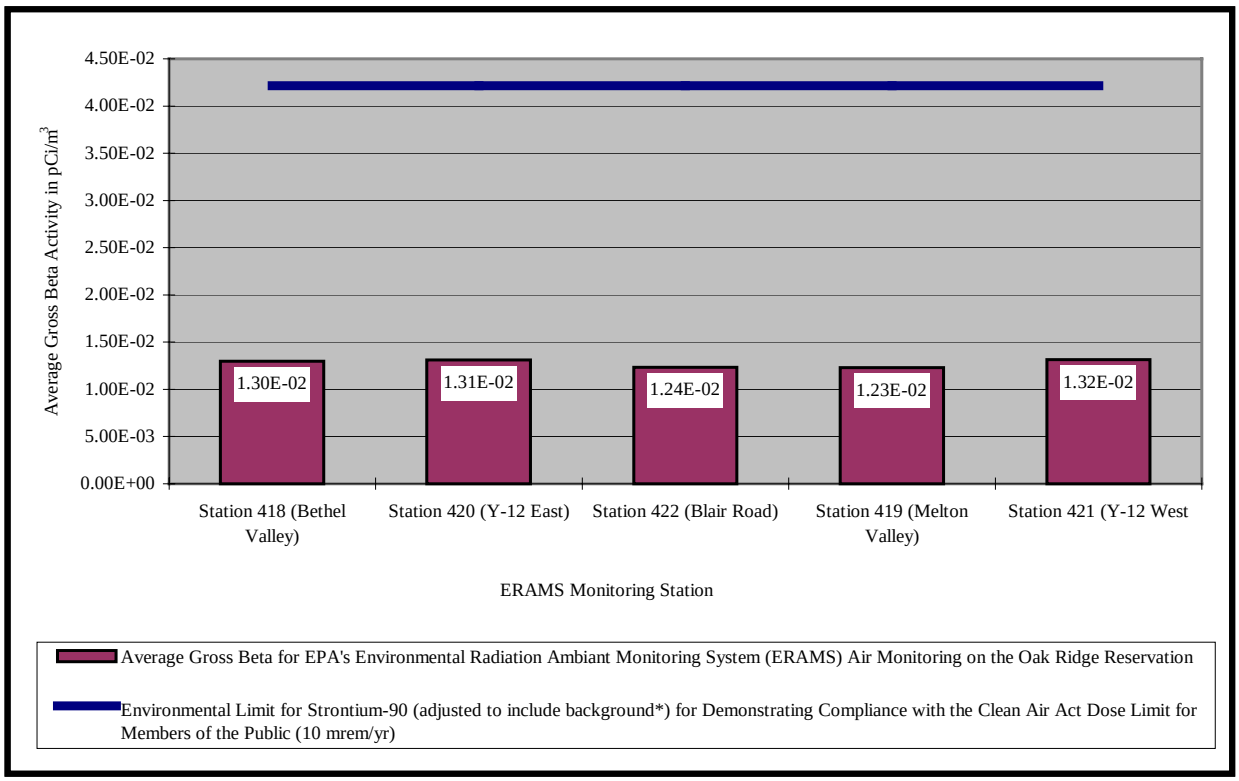
Note: Typical background values for gross beta range from 0.005 - 0.1 pCi/m^3 (ORISE, 1993)

Figure 2. Trends in the Year 2000 Gross Beta Results from Air Samples Taken on the Oak Ridge Reservation in Association with EPA's Environmental Radiation Ambient Monitoring System and the Division's Perimeter (Low Volume) Air Monitoring Program*

The 2000 average gross beta results for the stations in the ERAMS program were all relatively close (0.0123 to 0.0131 pCi/m^3), given the fluctuations noted above. As in the past, the results were also consistently lower than those calculated for the TDEC's Perimeter and Fugitive Air

*This chart is intended to illustrate the similarity in trends noted in the gross beta activity for samples associated with the ERAMS program and the Division's Perimeter Air Monitoring Program (not convey specific results).

Monitoring Programs. This bias is believed to be an artifact of the different types of sample collection systems (e.g., filters, pumps, etc.) used by the programs. Figure 3 provides the 2000, average results for each station monitored under the ERAMS Program. The environmental level for strontium-90 used to demonstrate compliance with the Clean Air Act radiation dose limit for members of the public (10 mrem/yr) is provided for comparison. This level applies to the dose above background; therefore, the standard provided in the figure has been adjusted to include the average gross beta background measurement for the TDEC's Perimeter Air Monitoring Program.



*The standards provide by the Clean Air Act apply to the dose above background; therefore, the standard provided for reference in this figure has been adjusted to include the background measurements taken from the Division's Perimeter Monitoring Program during the same period

Figure 3. Year 2000 Average Results for Gross Beta Analysis of Air Samples Taken on the Oak Ridge Reservation in Association with EPA's Environmental Radiation Ambient Monitoring System

Results of isotopic analysis performed semiannually by NAREL on composite samples have yet to be received by TDEC and none of the gross beta results exceeded the screening level of 1 pCi/m^3 that would have required analysis by gamma spectrometry under ERAMS protocol.

Conclusion

The gross beta results for each of the five ERAMS monitoring stations followed the same general trends observed in TDEC's Perimeter and Fugitive Air Monitoring Programs. Data currently available for these programs has not been indicative of a significant impact to local air quality attributable to DOE operations on the ORR.

References

EPA. 1988. *Environmental Radiation Ambient Monitoring System (ERAMS) Manual*. EPA 520/5-84-007, 008, 009. May 1988.

EPA. 1994. *Environmental Radiation Data Report 80*. EPA-402-R-97-004. February 1997. National Council on Radiation Protection and Measurements (NCRP). 1985. *Environmental Radiation Measurements.* NCRP Report No. 50. August 1, 1985.

Oak Ridge Institute for Science and Education (ORISE). 1993. *Environmental Air Sampling.* Hand Out from Applied Health Physics Course (PWF: jb, June 8, 1993).

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan*.

Tennessee Department of Environment and Conservation, *Department of Energy Oversight Division. Health, Safety, and Security Plan.* May 2000.

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AIR QUALITY MONITORING

Fugitive Radiological Air Emissions Monitoring

Principal Author: Gary Riner

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) use a portable high volume air sampler to monitor radiological fugitive air emission at sites of interest on the Oak Ridge Reservation (ORR). A second high volume monitor has been placed at Fort Loudoun Dam in Loudon County to provide background data for comparison. During 2000, the portable unit was placed near the K-33 Process Building at the East Tennessee Technology Park (ETTP). This facility is currently undergoing cleanup activities in association with DOE's reindustrialization effort. For the year 2000, results obtained from the K-33 site were consistent with data obtained from the background monitoring station.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) with the cooperation of the Department of Energy (DOE) and its contractors, conduct monitoring for fugitive radiological air emissions on and in the vicinity of the Oak Ridge Reservation (ORR). This program uses a portable high volume air monitor to supplement air sampling performed at fixed locations. In addition to mobility, the high volume monitor provides greater measurement sensitivity and resolution than can be achieved with the low volume monitors used in TDEC's Perimeter Air Monitoring Program. Monitoring performed in the Fugitive Air Program focuses on nonpoint sources of air emissions and sites of special interest.

Methods and Materials

TDEC use two high volume air samplers in the program. One of these units is mobile, allowing it to be moved to different areas of interest. The second unit is located at Fort Loudoun Dam in Loudon County to collect background information. Both high volume air samplers use 8x10 glass fiber filters to collect suspended particulate matter as air is pulled through the units. The filters are collected weekly by TDEC staff and shipped by certified mail to the State's Radiochemical Laboratory in Nashville, Tennessee, for analysis. Analysis includes gross alpha, gross beta, and gamma spectrometry on each of the weekly samples. Additional analysis is performed where merited.

Monitoring in this program is directed toward locations where there is a potential for the release of fugitive/diffuse emissions as a consequence of remedial or waste management activities. Results from the portable sampler are compared to background data collected by the high volume monitor placed at Fort Loudoun Dam. Results are also compared to environmental standards used to demonstrate compliance with the Clean Air Act (CAA). Last year (2000), the portable monitor was stationed near the K-33 Process Building at the ETTP. This facility is currently undergoing cleanup activities in association with DOE's reindustrialization effort.

Results and Discussion

Given the variability in the levels of naturally occurring radionuclides and uncertainties of radiochemical analysis at environmental levels, results from monitoring performed at the K-33 facility in 2000 were not significantly different from the background measurements taken at Fort Loudoun Dam. A comparison of these results for gross alpha and gross beta is provided in Figures 1 and 2.

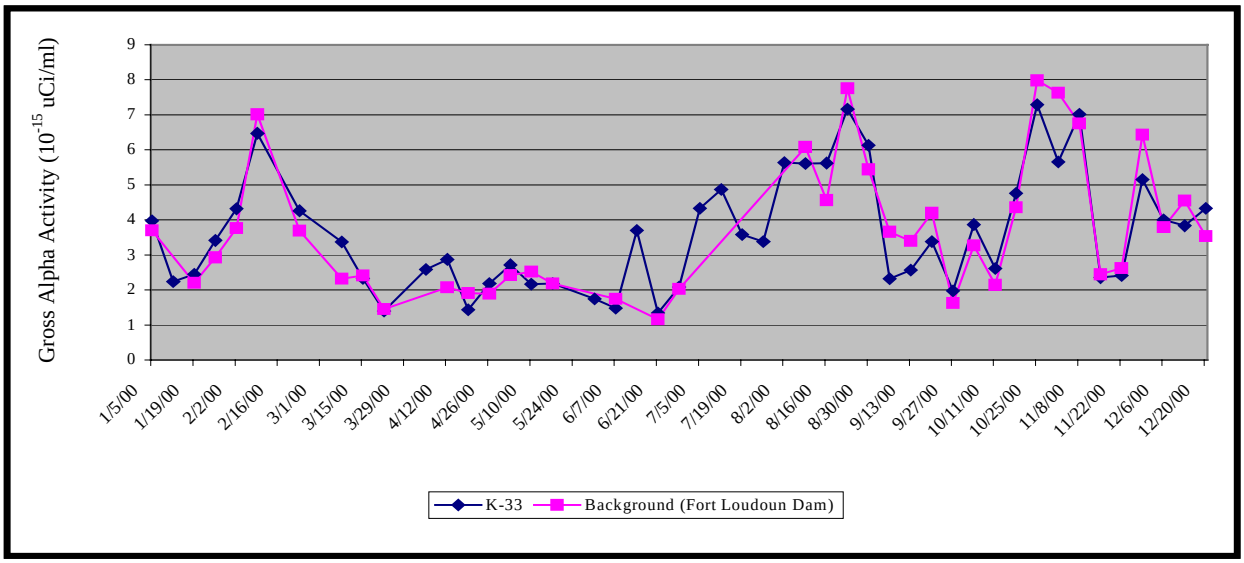


Figure 1: Gross Alpha Activities reported for Year 2000 Monitoring performed at the K-33 Process Building and the Background Station at Fort Loudoun Dam

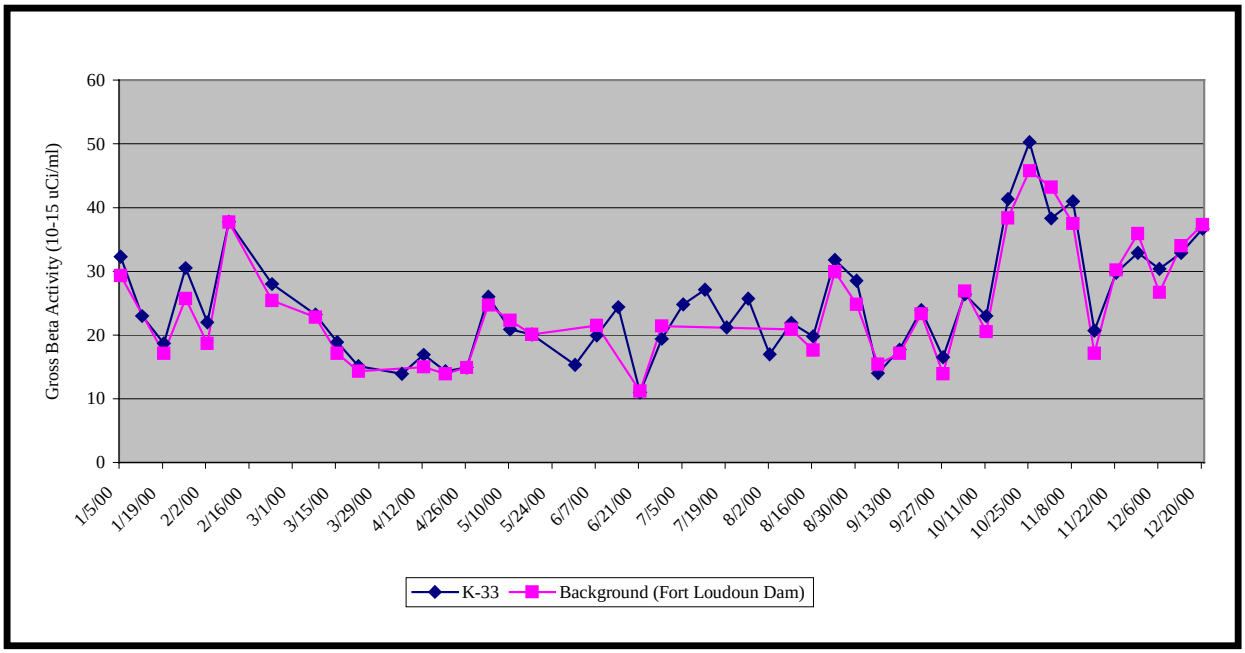
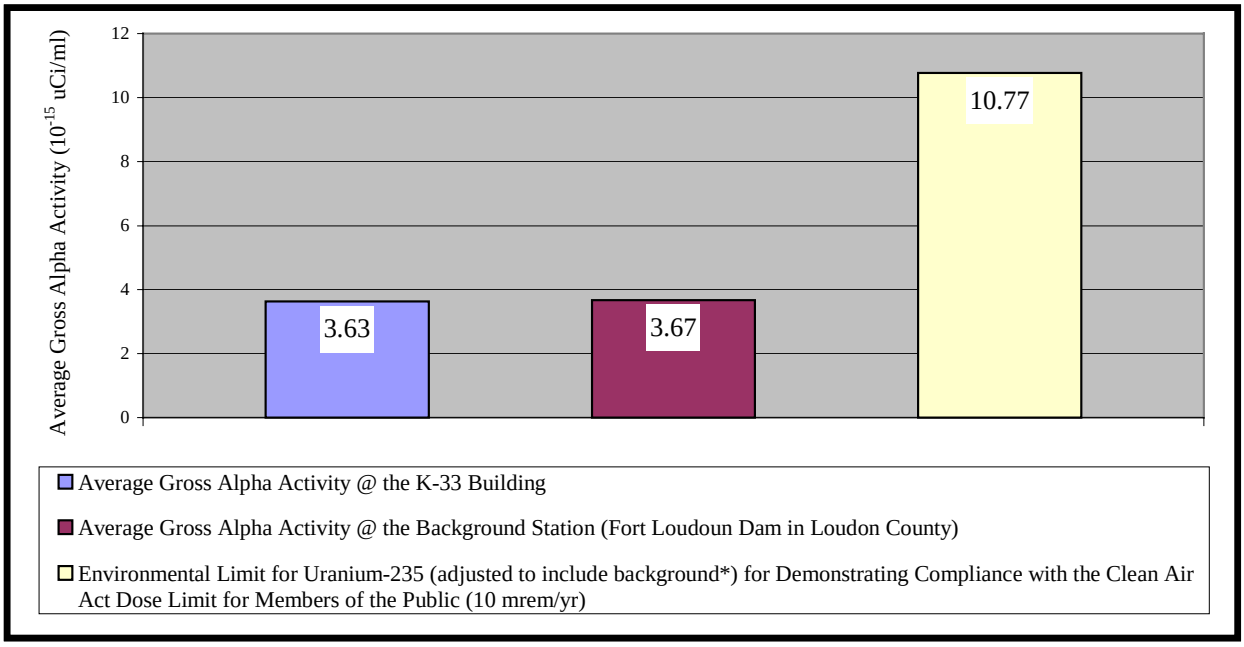


Figure 2: Gross Beta Activities reported for Year 2000 Monitoring performed at the K-33 Process Building and the Background Station at Fort Loudoun Dam

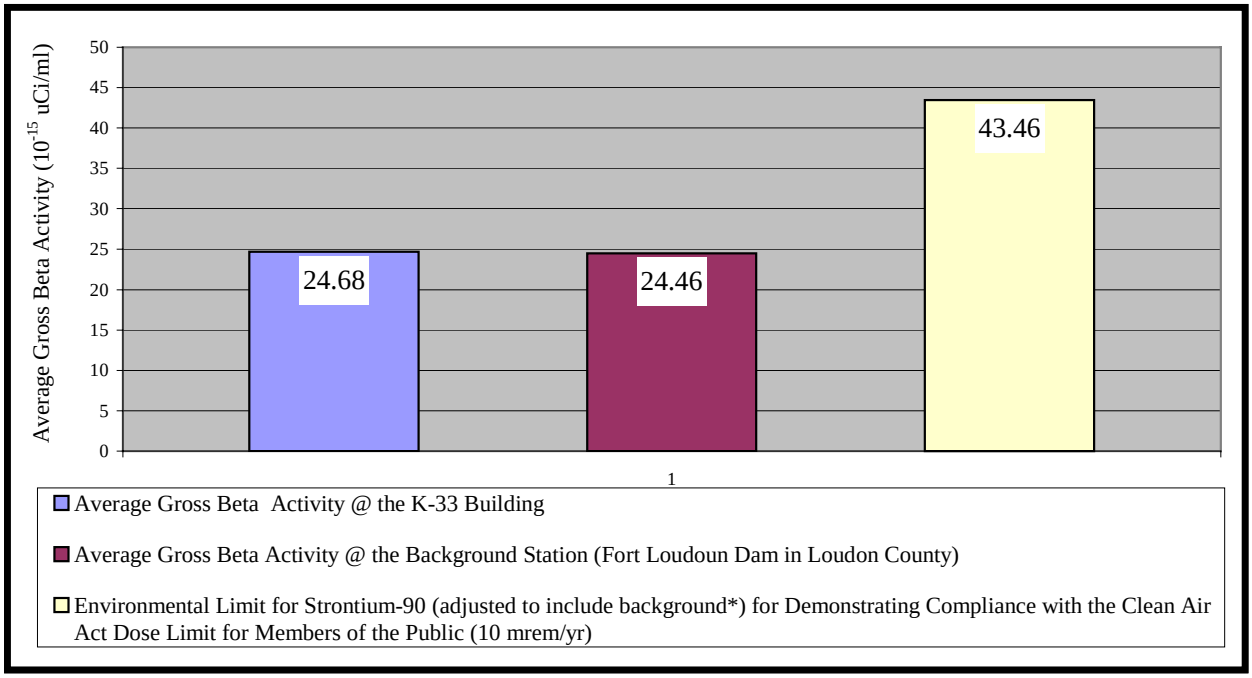
The CAA specifies that exposures to the public from radioactive materials released to the air from DOE facilities shall not cause members of the public to receive an effective dose equivalent greater than 10 mrem in a year. Compliance with this standard is generally determined for point source emissions that employ air dispersion models to predict the dose at off-site locations. However, the CAA also provides environmental concentrations for radionuclides that can be used to demonstrate compliance with the 10 mrem/yr limit. The TDEC staff uses these standards to evaluate the predictions derived from the air dispersion models and assess fugitive emissions. Due to the radiation hazard for the numerous radionuclide isotopes differs significantly, specific analysis for the CAA requires isotopes determined to be of concern at each facility. Consequently, the standards provided by the CAA do not include limits for gross alpha and beta activities. Nevertheless, the more economical gross measurements, when treated as surrogates for the more hazardous isotopes, can provide an effective screening mechanism to determine if further evaluation is warranted. To this end, staff compare the gross measurements obtained in TDEC's air sampling programs to some of the more restrictive standards provided by the CAA.

The average gross alpha and beta activities for TDEC's fugitive air monitoring at the K-33 Process Building and the Fort Loudoun background station are provided in Figures 3 and 4. The CAA standards provided for reference are those of uranium-235 (primarily an alpha emitter) and strontium-90 (a beta emitter). Since the environmental standards provided by the CAA apply to the dose above background, the standards provided for reference in these figures have been adjusted to include the background measurement.



*The standards provided by the Clean Air Act apply to the dose above background; therefore, the standards provided for reference in this figure have been adjusted to include the background measurements taken from the Division's perimeter monitoring program during the same period.

Figure 3: Average Gross Alpha measured at the K-33 Process Building during 2000 compared to Background Measurements and the Concentration Level for Uranium-235 to Demonstrate Compliance with the Clean Air Act Dose Limit for Members of the Public



*The standards provided by the Clean Air Act apply to the dose above background; therefore, the standards provided for reference in this figure have been adjusted to include the background measurements taken from the Division's perimeter monitoring program during the same period.

Figure 4: Average Gross Beta Measured at the K-33 Process Building during 2000 compared to Background Measurements and the Concentration Level for Strontium-90 to Demonstrate Compliance with the Clean Air Act Dose Limit for Members of the Public

Conclusion

During 2000, measurements of fugitive emissions taken near the K-33 Process Building by TDEC were not indicative of airborne radionuclides (attributable to DOE activities) at levels significantly above background.

References

National Council on Radiation Protection and Measurements (NCRP). 1985. *Environmental Radiation Measurements.* NCRP report No. 50. August 1, 1985.

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. *Health, Safety, and Security Plan*. May 2000.

AIR QUALITY MONITORING

Oak Ridge Reservation Low Volume (Perimeter) Ambient Air Monitoring Program

Principal Author: James L. Dunlap

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division, (DOE-O) in cooperation with the Department of Energy (DOE) and its contractors, conduct a perimeter air-monitoring program on the Oak Ridge Reservation (ORR) using low volume air samplers. This program in conjunction with associated air monitoring programs is intended to provide information relative to the impact of DOE activities on the local environment and public health, the identification and characterization of unplanned air releases, and verification of DOE monitoring data. The monitoring equipment used in the program is owned by DOE and maintained by DOE contractors. Analysis is performed at the State Radiochemistry Laboratory.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) with the cooperation of the Department of Energy (DOE), provides radiochemical analysis of air samples taken from twelve low volume air monitors located on and in the vicinity of the Oak Ridge Reservation (ORR). The monitors used to collect the samples are owned by DOE and maintained by DOE contractors. Data derived from the program, along with information generated by the other TDEC air monitoring programs, is used to (1) assess the impact of DOE activities on the public health and environment, (2) identify and characterize unplanned releases, (3) establish trends in air quality, and (4) verify data generated by DOE and its contractors.

Methods and Materials

The twelve air monitors used in the program are owned by DOE and DOE contractors are responsible for their maintenance and calibration. Nine of the units are a component of DOE's ORR perimeter air monitoring system. The remaining three monitors were previously used by the Y-12 facility in their perimeter air monitoring program. All the monitors use forty-seven millimeter borosilicate glass fiber filters to collect particulate as air is pulled through the units. The ORR perimeter monitors employ a pump and flow controller to maintain airflow through the filters at approximately two standard cubic feet per minute. The Y-12 monitors use a pump and rotometer, which provides an average flow rate of approximately three and one-half cubic feet per minute. The filters are collected from the monitors biweekly and sent by certified mail to the State's Radiochemical Laboratory in Nashville, Tennessee, for analysis. Analysis includes gross alpha and gross beta on the biweekly samples. Gamma spectrometry is performed on any samples that exhibit elevated gross results and annually on composite samples.

The twelve air monitoring stations used in the program are listed in Table 1. Eleven of these stations are located around the perimeter of the ORR and Y-12 facility. The twelfth site is a background station located near Fort Loudoun Dam in Loudon County. Figure 1 depicts the approximate locations of the perimeter air monitoring stations.

Table 1: Perimeter Air Monitoring Stations

Station	Location	County
4	Y-12 Perimeter near portal 2	Anderson
5	Y-12 Perimeter near Building 9212	Anderson
8	Y-12 Perimeter west end near portal 17	Anderson
35	East Tennessee Technology Park	Roane
37	Bear Creek at Y-12 / Pine Ridge	Roane
38	Westwood Community	Roane
39	Cesium Fields at Oak Ridge National Laboratory	Roane
40	Y-12 East	Anderson
42	East Tennessee Technology Park off Blair Road	Roane
46	Scarboro Community	Anderson
48	Deer Check Station on Bethel Valley Road	Anderson
52	Fort Loudoun Dam (Background Station)	Loudon

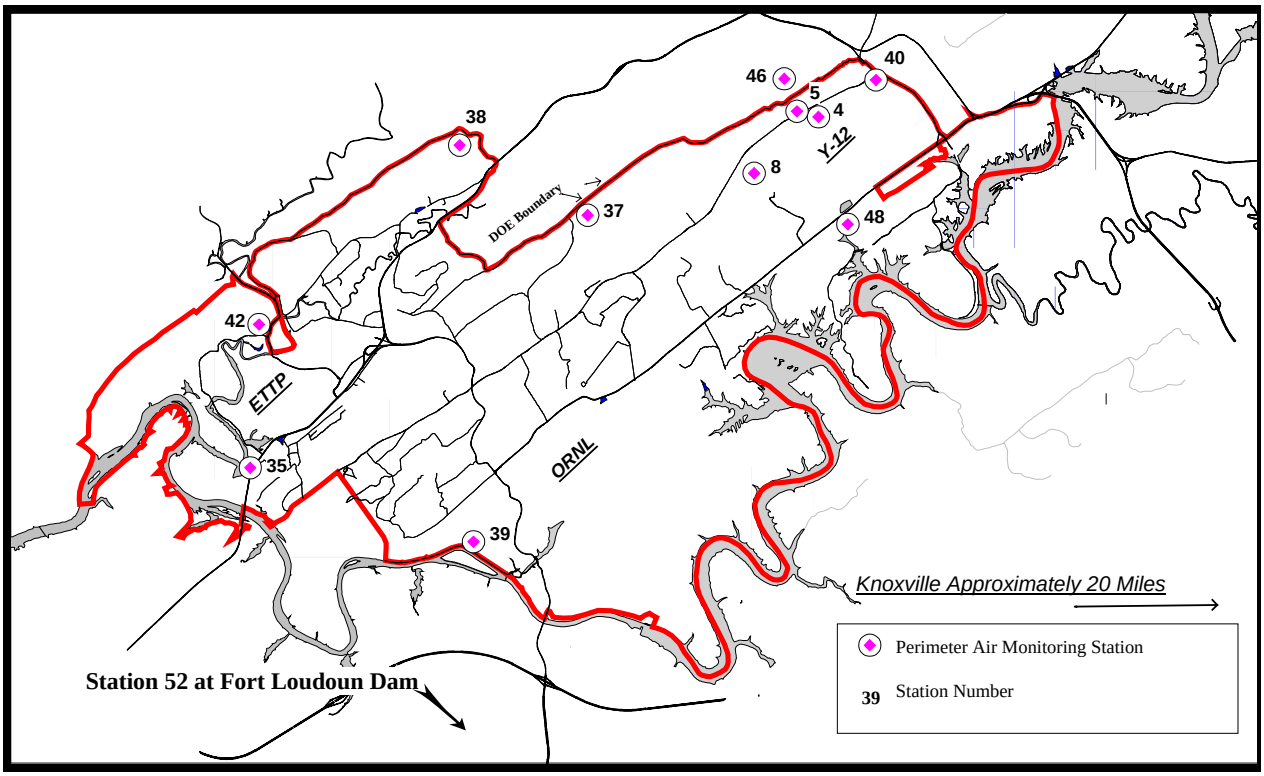


Figure 1: Approximate Location of Oak Ridge Reservation and Y-12 Perimeter Air Monitoring Stations

Results and Discussion

Results reported for the perimeter air monitoring stations were near or below those reported for the background station. Similar trends in the activities for gross alpha and gross beta were observed for each monitoring station. Figures 2 and 3 illustrate the correlation between fluctuations in the gross alpha and beta results at the perimeter stations and the background location at Fort Loudoun Dam. These fluctuations, to a large degree, can be attributed to natural phenomena or changing environmental conditions, which increase or decrease the amount of particulate deposited on the sampling filters. For example, concentrations of potassium-40 and radionuclides in the uranium and thorium decay series may increase because soils in which they

naturally occur have been dispersed in the air as a consequence of dry conditions, heavy winds, and/or local anthropogenic activities (e.g., construction). Conversely, rain and snow can remove materials suspended in the air reducing the concentration of contaminants deposited on the air filters. Concentrations of cosmogenic radionuclides (e.g., beryllium-7) are also highly variable, fluctuating in response to sunspot activity and the degree of mixing between the stratosphere, where they are produced, and the troposphere, where TDEC samples (ORISE, 1993).

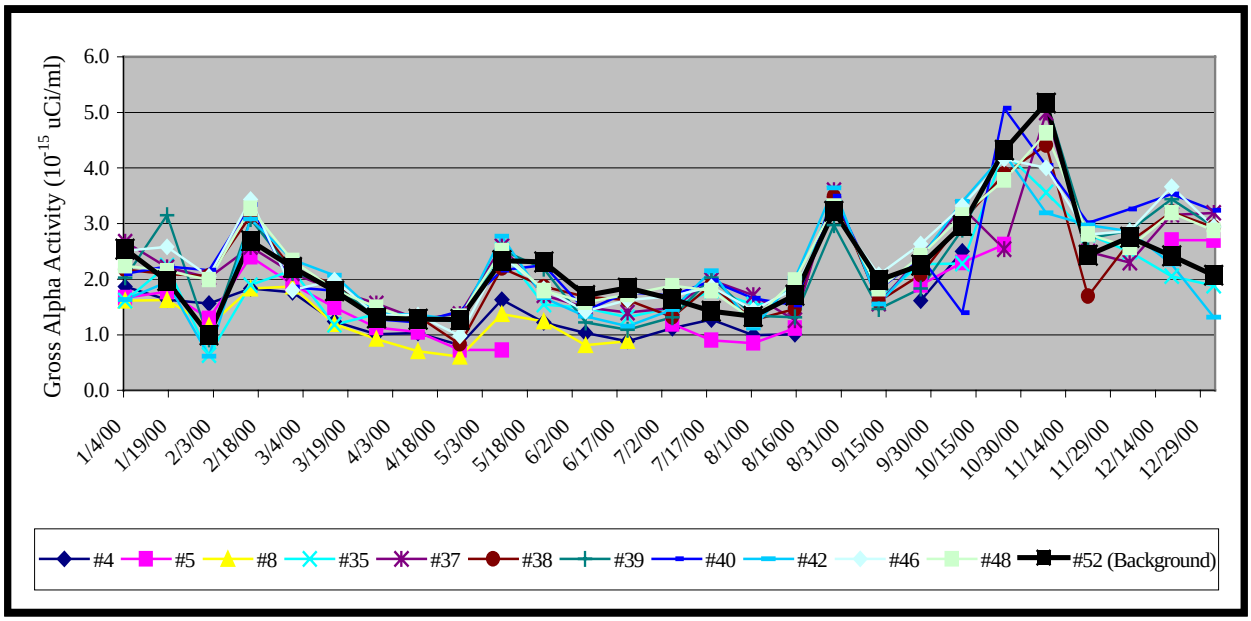


Figure 2: Gross Alpha Results from Tennessee Department of Environment and Conservation Low Volume Air Monitoring for the Year 2000

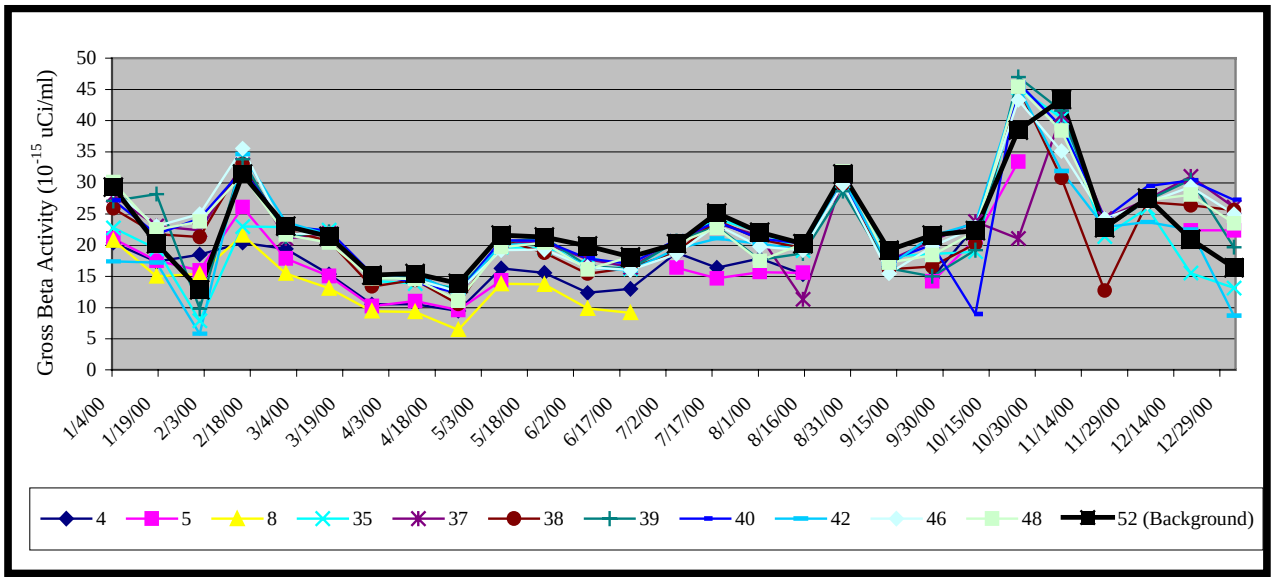
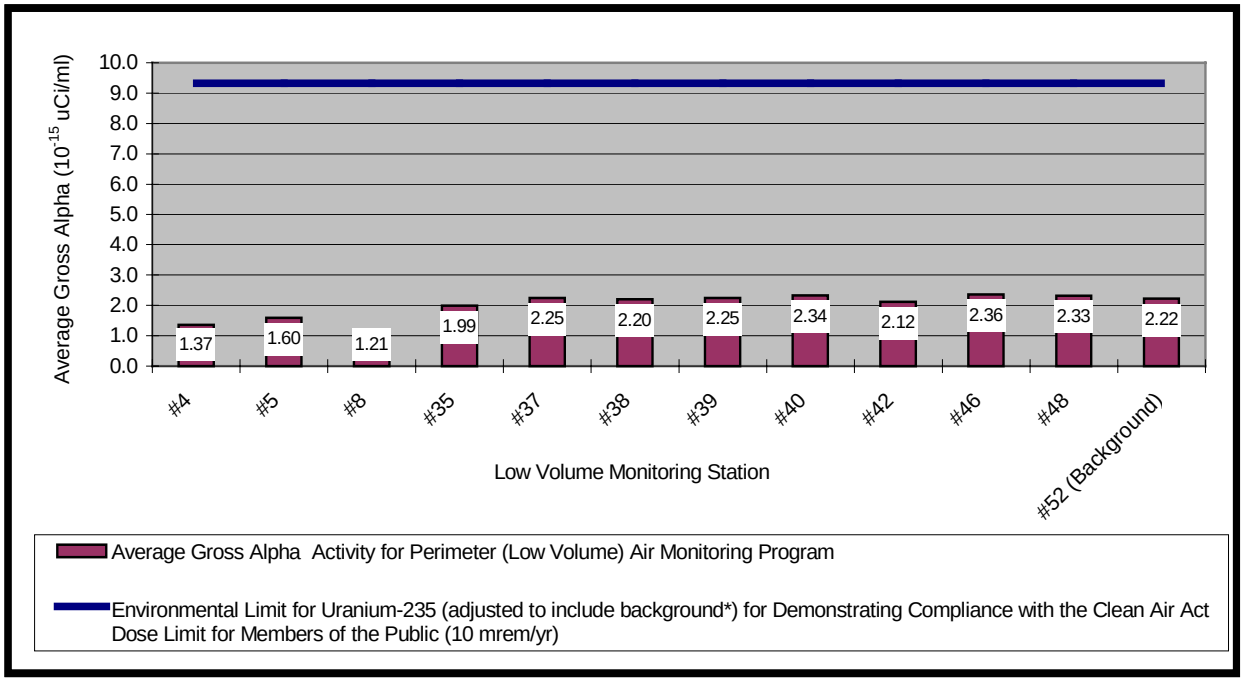


Figure 3: Gross Beta Results from Tennessee Department of Environment and Conservation Low Volume Air Monitoring for the Year 2000

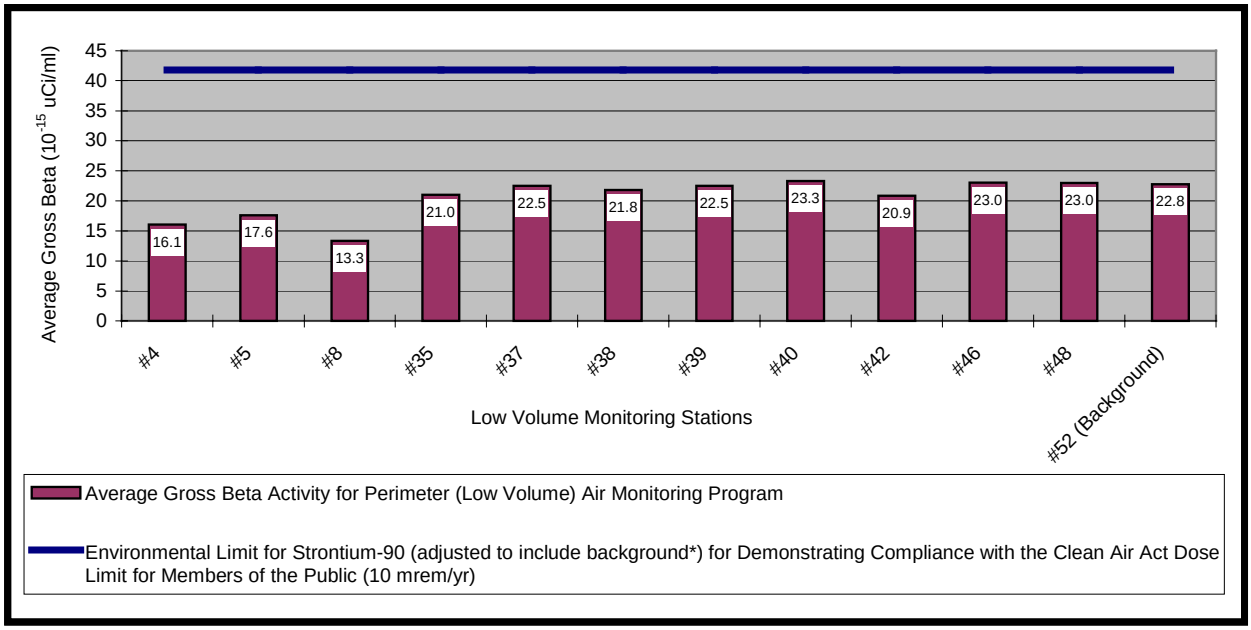
Due to the variations in the concentrations of naturally occurring radionuclides that are collected by the air monitoring systems, the simplest method of assessing the impact of ORR air emissions on the local environment is to compare results from the perimeter monitoring stations to those of the background station located at Fort Loudoun Dam (Station 52). As can be seen in Figures 4 and 5, the average activities calculated for the perimeter air stations for gross alpha and gross beta were all relatively consistent with the background values.

The Clean Air Act (CAA) specifies that exposures to the public from radioactive materials released to the atmosphere from DOE facilities shall not cause members of the public to receive, in a year, an effective dose equivalent greater than 10 mrem. Data from TDEC's air monitoring is compared to ambient air concentrations provided in the CAA for demonstrating compliance with the 10 mrem/yr limit. While the CAA environmental standards do not include limits for gross alpha and beta, these measurements provide an effective tool to assess if further investigation merited. Figures 4 and 5 show the average activity for gross alpha and beta measured during the year 2000 at the low volume air stations. The CAA environmental standards (adjusted to include background radiation) for uranium-235 (primarily an alpha emitter) and strontium-90 (a beta emitter) are provides for comparison. These isotopes have some of the more restrictive standards prescribed by the CAA. It should be understood that it is very unlikely that these isotopes would be responsible for a major proportion of the gross activity reported for the samples.



*The standards provide by the Clean Air Act applies to the dose above background: therefore, the standard provided for reference in the figure has been adjusted to include the background measurements.

Figure 4: Average Gross Alpha Results from Tennessee Department of Environment and Conservation Analysis of Low Volume Air Samples taken in the Year 2000



*The standards provide by the Clean Air Act applies to the dose above background: therefore, the standards provided for reference in the figure has been adjusted to include the background measurement.

Figure 5: Average Gross Beta Results from Tennessee Department of Environment and Conservation Analysis of Low Volume Air Samples taken in the Year 2000

Beryllium-7, potassium-40, lead-214, and bismuth-214 were reported in the results of gamma spectrometry (Table 2). Each of these radionuclides is found naturally in the environment and none of the results was considered significantly higher than the background values reported, given the variability in the levels of these radionuclides and uncertainty associated with measuring radionuclide concentrations at environmental levels.

Table 2: Results from Tennessee Department of Environment and Conservation Annual Gamma Spectrometry Analysis of Low Volume Air Samples taken in the Year 2000 (10^{-15} µCi/ml)

Station #	Lead-214		Bismuth-214		Beryllium-7		Potassium-40	
	Result	Error	Result	Error	Result	Error	Result	Error
4	ND		ND		ND		ND	
5	ND		ND		ND		ND	
8	ND		ND		ND		ND	
35	0.96	0.10	1.15	0.12	113.80	8.70	ND	
37	1.59	0.14	2.49	0.17	148.00	11.00	ND	
38	1.16	0.11	0.98	0.12	ND		ND	
39	0.88	0.13	1.11	0.12	141.20	9.50	2.20	0.55
40	1.31	0.12	1.30	0.13	166.40	9.20	2.33	0.59
42	1.05	0.11	0.83	0.10	ND		ND	
46	ND		0.25	0.07	175.00	13.00	2.95	0.63
48	ND		0.36	0.10	144.10	9.80	ND	
52 Background	0.66	0.10	0.71	0.11	153.00	11.00	ND	
ND = None Detected								

Conclusion

Environmental concentrations of radionuclides in the atmosphere tend to vary from location to location and seasonally in response to natural and anthropogenic influences. In this regard, results of radiochemical analysis of samples taken at ORR perimeter air monitoring stations appear to follow similar trends as the background station located near Fort Loudoun Dam. Concentrations of these radionuclides reported for the perimeter air stations, also, seem consistent with data reported for the background stations, given the natural variability associated with concentrations of radionuclides in the environment.

References

National Council on Radiation Protection and Measurements (NCRP). 1985. *Environmental Radiation Measurements.* NCRP report No. 50. August 1, 1985.

Oak Ridge Institute for Science and Education (ORISE). 1993. *Environmental Air Sampling.* Hand Out from Applied Health Physics Course (PWF:jb, June 8, 1993).

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. *Health, Safety, and Security Plan.* May 2000.

AIR QUALITY MONITORING

Hazardous Air Pollutants Metals Monitoring on Y-12 and ORNL (X-10)

Principal Author: Randy Meyer

Abstract

The Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight Division's (DOE-O) Hazardous Air Pollutant (HAPs) Monitoring Program was expanded in 1999 to include ORNL (X-10) and Y-12.

This program at East Tennessee Technology Park (ETTP) was designed to provide continued independent monitoring at the Oak Ridge Reservation (ORR) and to verify the Department of Energy (DOE) reported monitoring results. Monitoring was conducted for Arsenic, Beryllium, Cadmium, Total Chromium, Lead, Nickel and Uranium as a metal. In order to ensure conservative values, detection limits were utilized when averaging results below the detection limits of the laboratory analysis except for Background Data.

As a result of this monitoring campaign conducted by TDEC at the ORR sites, analytical results indicate no apparent elevated levels of HAPs metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis. Background levels, collected near Norris Lake were slightly lower than samples on the ORR. This would be expected when comparing an industrialized area to a more remotely located residential area.

It should also be noted that there are other incinerator facilities in the vicinity of the ORR. The possibility exists that these operations, along with the Tennessee Valley Authority (TVA) Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR.

This project will continue to monitor for potential effects on the ORR in order to provide independent monitoring to assure protection of human health and the environment.

Introduction

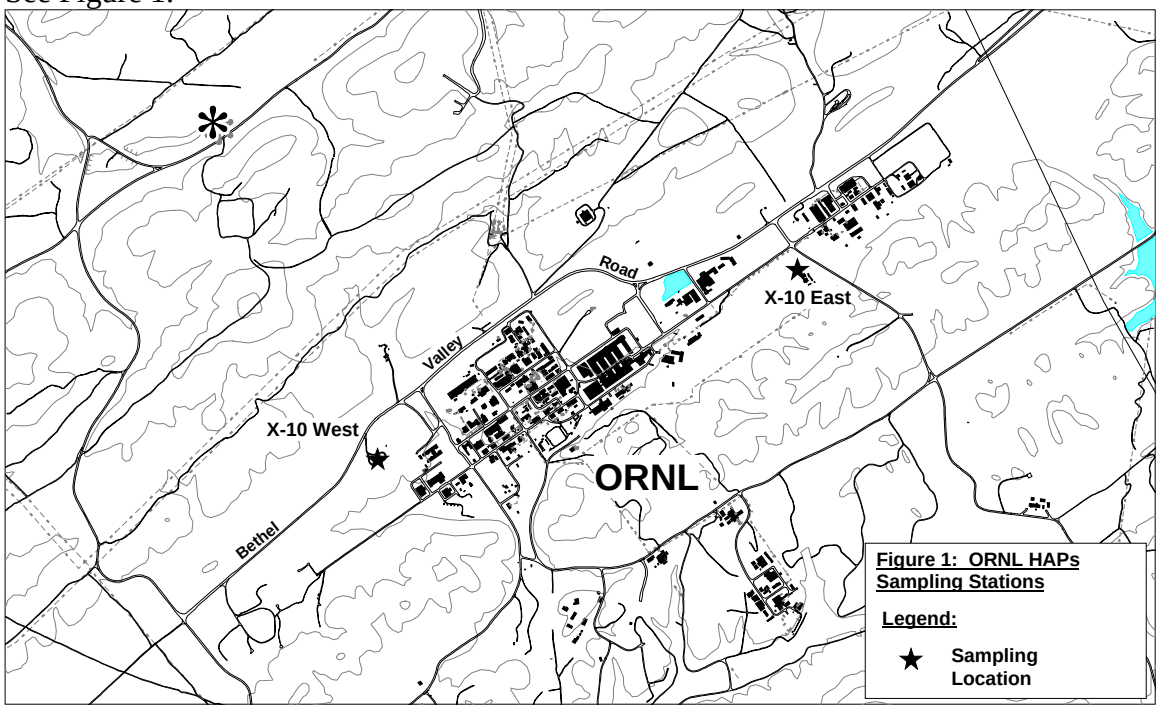
In 1999, the Tennessee Department of Environment and Conservation's (TDEC's), Department of Energy Oversight Division (DOE-O) Hazardous Air Pollutant's (HAPs) Monitoring Program was expanded to include Oak Ridge National Laboratory (ORNL) (X-10) and Y-12.

This program at East Tennessee Technology Park (ETTP) was designed to monitor concentrations of HAPs in the ambient air on and around the Oak Ridge Reservation (ORR), and to provide an independent verification of monitoring results as reported by the DOE. Background data was collected at a site located near Norris Lake. This data was used in a comparative manner as a baseline for the area surrounding the ORR. In 1999 Nickel and Uranium as a metal were added to the list of metals of concern.

Each monitoring site was co-located with ORR meteorological towers, perimeter air monitoring stations or an Environmental Radiation Ambient Monitoring Systems (ERAMS) monitoring station.

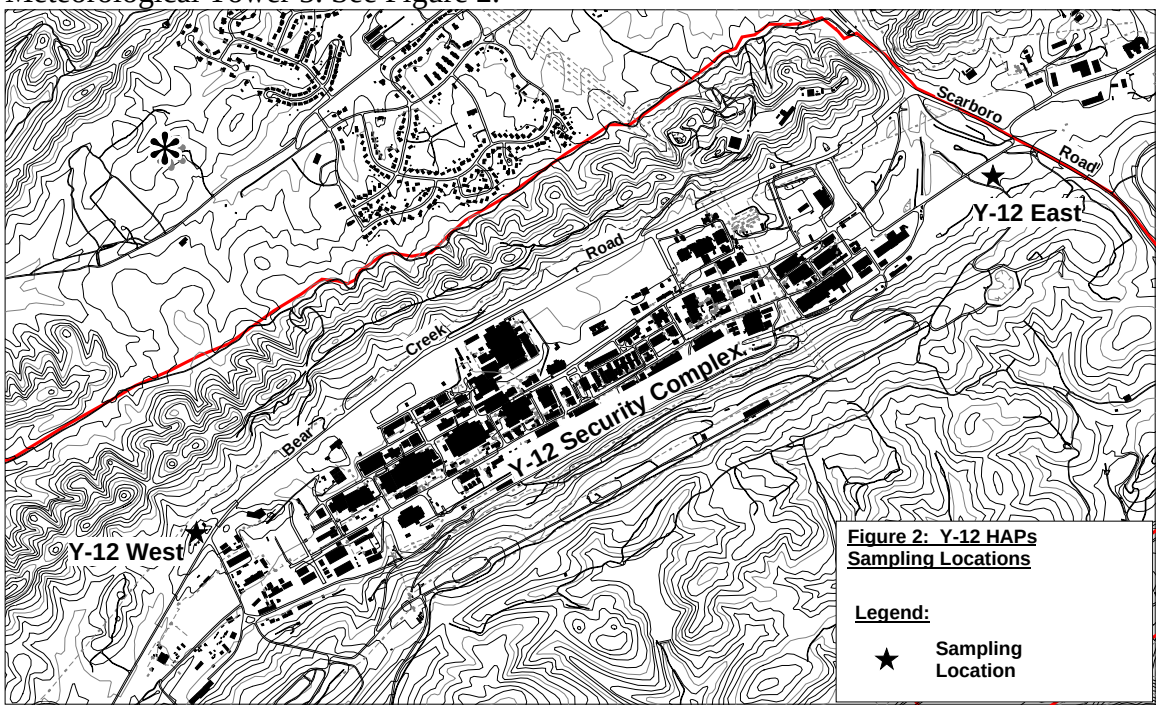
ORNL

Monitoring at ORNL was conducted at stations located at both the east and west ends of this facility. The western site is co-located at the Perimeter Air Monitor (PAM) 3 off Bethel Valley Road. The monitor at the east-end of ORNL is co-located with Meteorological Tower 3. See Figure 1.



Y12

Monitoring at Y-12 was conducted at stations located at both the east and west ends of this facility. The site at the west-end of Y-12 is co-located with Meteorological Tower 6 on Bear Creek Valley Road. The monitoring site at the east-end of Y-12 is co-located with Meteorological Tower 5. See Figure 2.



Methods and Materials

The monitoring sites selected were chosen based upon windroses data that indicated the sites were in the prevailing wind flow patterns for the region surrounding the ORR. The windflow during the day is a southwest to northeast pattern while during the night; the flow pattern is reversed. The placement then of TDEC's monitors allowed for sampling that would be representative of a 24-hour windflow pattern at the ORR. The project was conducted as closely as possible to the currently established 2000 sampling project schedule. The monitors were located at each site for approximately one month. Filter samples were collected on a weekly basis and mailed to the State Laboratory in Nashville for analysis

Materials required for this project included:

1. Hi-Volume sampler
2. Trailer
3. Extension cords
4. 4x4 vehicle
5. Filters
6. Calibration kit
7. Flow chart
8. Level
9. Project data form

Results and Discussion

Background Results

A site was located in Norris, Tennessee, near Norris Lake, in a residential area. This site was monitored during the periods of 4/7-5/21, and 6/23-7/14 1999. The results are shown in Table 1.

Table 1. Background/Norris

Metal of Concern	1999 Sample result $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	Undetected	0.0023 [1]
Beryllium	Undetected	0.004 [1]
Cadmium	Undetected	0.0056 [1]
Total Chromium	< 0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	Undetected	1.5 [2]
Nickel	Undetected	0.042[1]
Uranium	Undetected	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

Results from X10 (ORNL)

HAPs metals were monitored at station X10W through the periods of 1/1-1/27, 3/27-5/11, 7/6-8/10, 9/7-10/19, and 12/27-12/31 2000. The results are shown in Table 2.

Table 2. HAPs X10W Sampling Results

Metal of Concern	2000 Results $\mu g/m^3$	1999 Results $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	ND	< 0.01	0.0023[1]
Beryllium	ND	<0.001	0.004[1]
Cadmium	ND	< 0.001	0.0056[1]
Total Chromium	< 0.001	0.0016	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0042	0.0056	1.5[2]
Nickel	< 0.001	<0.0011	0.042[1]
Uranium	ND	< 0.01	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

HAPs metals were monitored at station X10E through the periods 1/27-3/27, 5/11-7/6, 8/10-9/7, and 10/19-12/27 2000. The results are shown in Table 3.

Table 3. HAPs X10E Sampling Results

Metal of Concern	2000 Results $\mu g/m^3$	1999 Results $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	ND	< 0.01	0.0023[1]
Beryllium	ND	< 0.001	0.004[1]
Cadmium	ND	< 0.001	0.0056[1]
Total Chromium	< 0.0006	< 0.0008	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0034	0.0031	1.5[2]
Nickel	< 0.001	0.001	0.042[1]
Uranium	ND	< 0.01	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

Results from Y12

HAPs metals were monitored at stationY12E through the periods 1/27-4/13, 6/1-7/6, 8/10-9/21, and 10/19-11/14 2000. The results are shown in Table 4.

Table 4. HAPs Y12E Sampling Results

Metal of Concern	2000 Results $\mu g/m^3$	1999 Results $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	ND	< 0.01	0.0023[1]
Beryllium	ND	< 0.001	0.004[1]
Cadmium	ND	< 0.001	0.0056[1]
Total Chromium	< 0.001	0.0005	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.0035	0.0066	1.5[2]
Nickel	< 0.001	< 0.001	0.0042[1]
Uranium	ND	< 0.01	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

HAPs metals were monitored at station Y12W through the periods 4/13-6/1, 7/6-8/10, 9/21-10/19 and 11/14-12/31 2000. The results are shown in Table 5.

Table 5. HAPs Y12W Sampling Results

Metal of Concern	2000 Results $\mu g/m^3$	1999 Results $\mu g/m^3$	Guideline Concentration $\mu g/m^3$
Arsenic	ND	< 0.01	0.0023[1]
Beryllium	ND	< 0.001	0.004[1]
Cadmium	ND	< 0.001	0.0056[1]
Total Chromium	< 0.001	0.001	0.00083[1] Cr VI 1000.0[1] Cr lll
Lead	0.003	0.004	1.5[2]
Nickel	< 0.001	< 0.001	0.042[1]
Uranium	ND	< 0.01	0.015[3]

[1]40 CFR Part 266 Appendices; IV, Reference Air Concentrations, V, Risk Specific Doses
[2]National Ambient Air Quality Standards (NAAQS) for Lead
[3]Derived Concentration Guide 100 mrem inhalation dose. DOE Order 5400.5

Levels of Total Chromium were compared to the Risk Specific Dose levels for Hexavalent Chromium at the following monitoring locations: Y-12E, Y-12W, X10W and X10E. As Hexavalent Chromium is a constituent of Total Chromium, it is highly unlikely that these levels of Total Chromium would translate into elevated levels of Hexavalent Chromium. These results are consistent with prior sampling efforts and demonstrate no elevation of Total Chromium in the ambient air.

Based upon the analytical data generated at these monitoring sites, it would appear that there has been no significant change in levels of any metals of concern in the ambient air on and around these sampling points at the ORR. Background levels, collected near Norris Lake were slightly lower than samples on the ORR. This would be expected when comparing an industrialized area to a more remotely located residential area.

This project has been re-authorized to continue into 2001. Sampling sites will remain as they have for the year 2000. Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2000 was not available. However, analytical results from the 2000, and 1999 HAPs monitoring program were compared with the 1999 ASER, indicating comparable levels of HAPs in the ambient air in and around the ORR.

Conclusion

As a result of the 2000 monitoring campaign conducted by TDEC at the ORR sites, analytical results indicate no apparent elevated levels of HAPs metals of concerns. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

It should also be noted that there are other incinerator facilities in the vicinity of the ORR. The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR.

References

Draft New York State Air Guide-1, Guidelines for the Control of Toxic Ambient Air Contaminants, Appendix B of Air Guide-1, Ambient Air Quality Impact Screening Analyses, 1994 Edition.

Boiler and Industrial Furnace Regulations - 40 CFR Part 266 Appendix V.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, TN. *Health, Safety and Security Plan*, 1998 and 1999.

Operations Manual for GMW Model2000H Total Suspended Particulate Sampling System, 1998 Graseby GMW Variable Resistance Calibration Kit # G2835.

TDEC/DOE-O Procedure number: SOP-ES&H-004 Air Monitoring/Air Sampling.

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RADIOLOGICAL MONITORING

Ambient Gamma Radiation Monitoring of the Uranium Hexafluoride (UF_6) Cylinder Yards at the ETTP

Principal Author: John Platt

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) in cooperation with the Department of Energy (DOE) and the Bechtel Jacobs Company (BJC) is conducting a radiation dose rate survey of East Tennessee Technology Park's (ETTP) Uranium Hexafluoride (UF_6) Cylinder Storage Yards. Dose rate measurements are taken at the boundary fence lines using Landauer® Luxel® optically stimulated luminescence dosimeters (OSL's). Monitoring of ambient gamma levels at the UF_6 cylinder storage yards began in April 1999, and has continued to date. The data gathered will be used to determine if areas monitored have exceeded state and/or federal regulatory limits for exposure to members of the public. This data will also be used to determine if environmental concerns are warranted and what, if any, remediation actions are necessary before this property is free released and/or prior to occupation by companies during the planned reindustrialization of the ETTP site. In this study period from January 2000 to January 2001, dose rates in excess of the 100-mrem/yr State/Federal exposure limit were observed at all five of the monitored cylinder yards. Starting in the last quarter of 2000 an additional project was begun that involved obtaining specific location telemetry of each OSL by the use of a hand held GPS instrument. This data will be incorporated into the MapInfo computer program along with its corresponding OSL radiological data. When complete, the user will have the ability to locate an individual monitoring point and view its radiological history.

Introduction

During the development and operation of the gaseous diffusion uranium enrichment process, containers, support equipment, and support facilities were designed, constructed, and used to store, transport, and process the depleted UF_6. After a significant inventory was produced, outdoor storage facilities (i.e., cylinder yards) evolved. Today, the Bechtel Jacobs Company operates the six East Tennessee Technology Park (ETTP) UF_6 cylinder storage yards for the Department of Energy (DOE). They are used for the temporary and long-term storage of UF_6 cylinders. The goal of the Tennessee Department of Environment and Conservation's (TDEC), Department of Energy Oversight Division (DOE-O) UF_6 cylinder yard dose assessment program is to evaluate that the public is protected from radiation doses emitted from the cylinder yards. This is especially important since DOE's mission is the continual transformation of ETTP into a commercial industrial park.

Materials and Methods

OSL's measure the dose from exposure to gamma radiation over time. TDEC's cylinder yard monitoring is performed using one type of OSL, Aluminum Oxide. They are obtained from Landauer®, Inc., Glenwood, Illinois. Aluminum Oxide dosimeters (minimum reporting value of 1 mrem) are generally placed in areas where exposures are expected to be significantly higher than background. The OSL's are collected by TDEC's staff and shipped to Landauer® for processing. To account for exposures that may be received in transit or storage, control

dosimeters are included in each shipment from the Landauer® Company. The control OSL's are stored at the TDEC's office and returned to Landauer® with the field deployed OSL's for processing. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the TDEC's office (761 Emory Valley Road, Oak Ridge, Tennessee), is subtracted from the exposure reported for the field deployed OSL's. Annually, the quarterly exposures (minus the exposure obtained from the control dosimeter) are summed for each location. The resultant annual dose is compared to the State/DOE primary dose limit for members of the public (100 mrem/yr exposure).

Discussion and Results

The Division's Ambient Gamma Radiation Monitoring program has determined that there is an elevated exposure potential to the public at all five of the monitored cylinder yards. At these yards, the total adjusted accumulated annual dose, as measured by OSL, has ranged from a low of below the minimum measurable quantity of 1 mrem at the K-1066-J yard to a high of 14156 mrem at the K-1066-E yard. Within this range, there are numerous elevated data points that are shown in tables 1-5. These results are compared with the State/DOE primary dose limit for members of the public (100 mrem/yr total exposure). The mapping and recording of dose rate data will ensure that workers/non-DOE workers under ETTP's reindustrialization plan and the public will be knowledgeable of and protected from the cylinder yard's radiation source.

The following ETTP cylinder yards under the OSL project are: K-1066-K, K-1066-E, K-1066-J, K-1066-B, and K-1066-L.

Current and future plans by ETTP to prepare cylinders for yard to yard movement and off-site shipment will necessitate "shuffling" cylinders between various yards. It is anticipated that the dose readings will change as these cylinders are sorted by size and content. K-1066-F yard is not being monitored due to the fact it does not have an outside perimeter fence that could be accessed by the public.

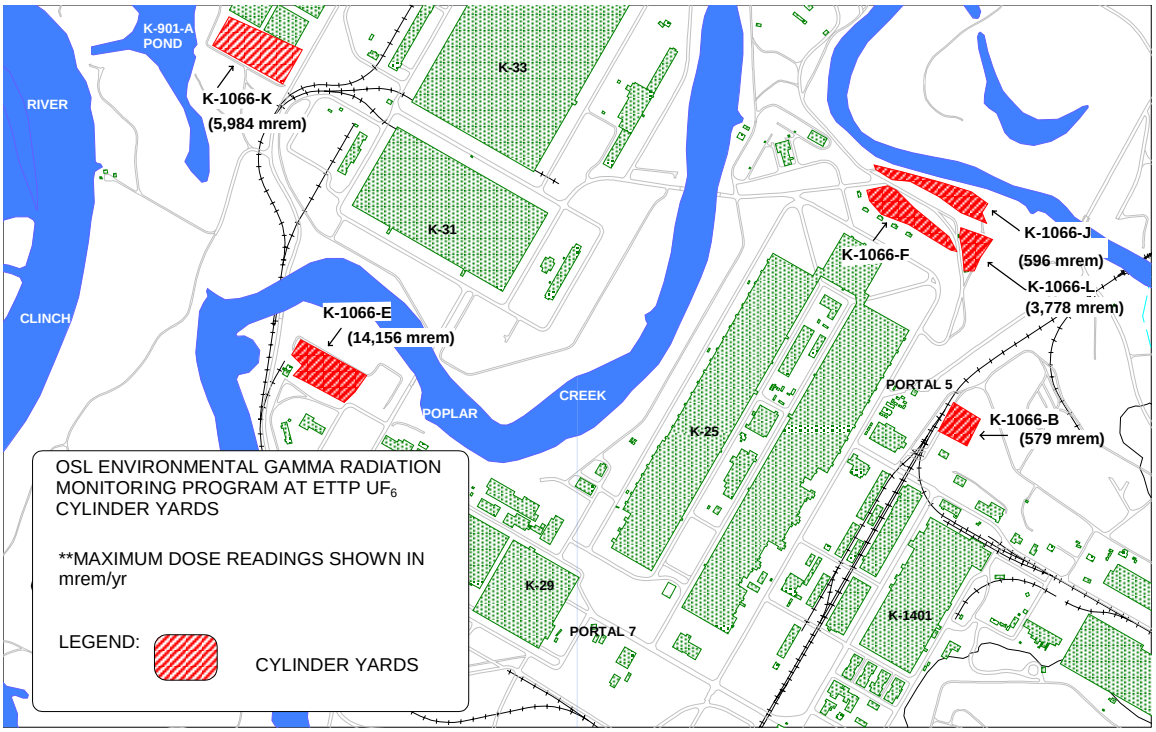

Figure 1: Map of ETTP showing location of cylinder yards.

Table 1: Results from OSL's deployed at ETTP UF_6 Cylinder Yards

K-1066-K Yard

OSL Number	**Period 1** (01/19/00 - 05/10/00) (113 Day Exposure) OSL Reading (mrem)	**Period 2** (05/10/00 - 08/17/00) (99 Day Exposure) OSL Reading (mrem)	**Period 3** (08/17/00) - (12/01/00) (105 Day Exposure) OSL Reading (mrem)	**Period 4** (12/01/00) - (01/12/01) (42 Day Exposure) OSL Reading (mrem)	Total Accumulated Dose Equivalent (359 days) mrem	Total Adjusted Dose to 365 days mrem
1	66	76	67	22	231	235
2	461	389	387	116	1353	1376
3	767	697	1263	467	3194	3247
4	915	1305	1684	568	4472	4547
5	746	1154	1443	473	3816	3880
6	891	1272	1403	528	4094	4162
7	595	573	637	212	2017	2051
8	1013	1040	904	371	3328	3384
9	837	1275	1398	465	3975	4041
10	395	325	402	125	1247	1268
11	232	208	228	68	736	748
12	700	775	482	153	2110	2145
13	1198	1777	940	595	4510	4585
14	*	*	1513	572	2085	2120
15	892	1365	1526	532	4315	4387
16	1125	1203	1365	433	4126	4195
17	484	498	560	188	1730	1759
18	1044	1321	1283	438	4086	4154
19	1573	1869	1736	708	5886	***5984***
20	248	223	270	442	1183	1203
21	93	97	104	51	345	351
22	407	374	495	184	1460	1484

* 14 not sent. Lost in field.

100 mrem/yr is the exposure limit to the public from all sources except medical and natural background. Background is subtracted.

Table 2: Results from OSL's deployed at ETTP UF_6 Cylinder Yards

K1066-E
Yard

OSL Number	**Period 1** (01/19/00 - 05/10/00) (113 Day Exposure) OSL Reading (mrem)	**Period 2** (05/10/00 - 08/17/00) (99 Day Exposure) OSL Reading (mrem)	**Period 3** (08/17/00) - (11/30/00) (104 Day Exposure) OSL Reading (mrem)	**Period 4** (11/30/00) - (01/12/01) (43 Day Exposure) OSL Reading (mrem)	Total Accumulated Dose Equivalent (359 days) mrem	Total Adjusted Dose to 365 days mrem
23	774	871	749	284	2678	2723
24	685	538	586	183	1992	2025
25	1645	1398	1524	611	5178	5264
26	3911	4547	4546	919	13923	***14156***
27	2076	1785	1467	739	6067	6168
28	2179	1878	1964	139	6160	6263
29	2436	723	596	435	4190	4260
30	1396	571	609	379	2955	3004
31	1443	262	259	339	2303	2341
32	104	164	240	145	653	664
33	152	116	95	38	401	408
34	1132	933	1091	380	3536	3595
35	230	213	179	68	690	702
36	434	388	420	149	1391	1414
37	445	422	459	159	1485	1510
38	648	445	510	177	1780	1810
39	993	394	369	155	1911	1943
OSLs hung on outer fence:						
76	104	125	98	34	361	367
77	310	315	278	103	1006	1023
78	145	179	142	54	520	529
79	558	486	477	196	1717	1746
80	610	567	459	93	1729	1758
81	545	312	211	109	1177	1197
82	375	218	*	105	698	710
83	178	112	114	79	483	491
84	141	103	99	61	404	411

* OSL lost by Landauer

100 mrem/yr is the exposure limit to the public from all sources except medical and natural background. Background is subtracted.

Table 3: Results from OSL's deployed at ETTP UF_6 Cylinder Yards

K1066-J
Yard

	Period 1 (01/21/00 - 05/01/00) (101 Day Exposure)	**Period 2** (05/01/00 - 08/18/00) (109 Day Exposure)	**Period 3** (08/18/00) - (11/30/00) (103 Day Exposure)	**Period 4** (11/30/00) - (01/10/01) (41 Day Exposure)	Total Accumulated Dose Equivalent (354 days)	Total Adjusted Dose to 365 days
OSL Number	OSL Reading (mrem)	OSL Reading (mrem)	OSL Reading (mrem)	OSL Reading (mrem)	mrem	mrem
40	M	M	3	1	4	4
41	M	M	M	M	M	M
42	M	M	1	M	1	1
43	M	M	3	M	3	3
44	M	3	9	6	18	19
45	M	6	8	5	19	20
46	M	10	16	10	36	37
47	6	29	27	18	80	82
48	15	56	49	30	150	155
49	58	211	202	107	578	***596***
50	64	154	148	99	465	479
51	5	47	40	183	275	284
52	1	13	12	242	268	276
53	M	4	5	2	11	11
54	M	M	4	M	4	4
55	M	4	1	2	7	7
OSLs hung on outer fence:						
85	M	M	M	M	M	M
86	M	M	M	M	M	M
87	M	M	1	M	1	1
88	M	5	6	6	17	18
89	M	6	9	3	18	19
90	M	18	16	8	42	43
91	5	25	21	9	60	62
92	3	17	18	7	45	46

Dose equivalents below the minimum reportable quantity are recorded as "M".
100 mrem/yr is the exposure limit to the public from all sources except medical and natural background.
Background is subtracted.

Table 4: Results from OSL's deployed at ETTP UF_6 Cylinder Yards

K1066-B
Yard

OSL Number	**Period 1** (02/01/00 - 05/18/00) (107 Day Exposure) OSL Reading (mrem)	**Period 2** (05/18/00 - 08/22/00) (96 Day Exposure) OSL Reading (mrem)	**Period 3** (08/22/00) - (11/06/00) (75 Day Exposure) OSL Reading (mrem)	**Period 4** (11/06/00) - (01/12/01) (67 Day Exposure) OSL Reading (mrem)	Total Accumulated Dose Equivalent (345 days) mrem	Total Adjusted Dose to 365 days mrem
56	16	22	11	7	56	59
57	56	52	38	24	170	180
58	163	184	108	92	547	***579***
59	58	76	46	37	217	230
60	31	38	23	20	112	118
61	48	52	30	25	155	164
62	31	38	25	24	118	125
63	14	23	14	9	60	63
64	9	*	5	7	21	22
65	6	9	7	3	25	26
66	3	8	6	4	21	22
67	4	9	4	2	19	20
OSLs hung on outer fence:						
93	11	12	10	8	41	43
94	25	28	22	17	92	97
95	45	40	24	22	131	139
96	41	37	24	21	123	130
97	6	8	6	2	22	23
98	2	1	3	M	6	6
99	M	2	5	M	7	7
100	3	2	5	M	10	11
101	2	M	1	1	4	4
102	22	33	17	12	84	89
103	M	1	2	M	3	3

* 64 missing.
Lost in field.
Dose equivalents below the minimum reportable quantity are recorded as "M".
100 mrem/yr is the exposure limit to the public from all sources except medical and natural background.
Background is subtracted.

Table 5: Results from OSL's deployed at ETTP UF_6 Cylinder Yards

K1066-L
Yard

OSL Number	**Period 1** (01/21/00 - 05/01/00) (101 Day Exposure) OSL Reading (mrem)	**Period 2** (05/01/00 - 08/18/00) (109 Day Exposure) OSL Reading (mrem)	**Period 3** (08/18/00) - (11/30/00) (103 Day Exposure) OSL Reading (mrem)	**Period 4** (11/30/00) - (01/10/01) (41 Day Exposure) OSL Reading (mrem)	Total Accumulated Dose Equivalent (354 days) mrem	Total Adjusted Dose to 365 days mrem
68	21	68	57	24	170	175
69	28	63	70	23	184	190
70	38	67	62	23	190	196
71	397	421	356	39	1213	1251
72	312	709	596	55	1672	1724
73	294	213	927	851	2285	2356
74	104	785	1630	605	3124	3221
75	612	1853	797	402	3664	***3778***

100 mrem/yr is the exposure limit to the public from all sources except medical and natural background. Background is subtracted.

Conclusion

The data are showing elevated readings at all five cylinder yards. These annual doses are in excess of the State/DOE primary dose limit for members of the public where the public has access. The yards may also produce ten or fifteen percent additional mrems in neutron as well as gamma doses. Neutron dosimetry is being gathered in another Division program that is just beginning to develop a database.

References

Tennessee Department of Environment and Conservation. Department of Energy Oversight Division. 1999. *Environmental Monitoring Plan January through December 1999.*

U.S. Department of Energy. Office of Nuclear, Science and Technology. 1999. *Programmatic Environmental Impact statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride.*

Bechtel Jacobs Company, LLC. 1998. *East Tennessee Technology Park UF_6 Cylinder Yards Final Safety Analysis Report.*

Tennessee Department of Environment and Conservation. Department of Energy Oversight Division. 2000. *Health, Safety and Security Plan.*

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RADIOLOGICAL MONITORING

Oak Ridge Reservation Facility Survey Program

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Abstract

Like other Department of Energy (DOE) sites across the nation, the Oak Ridge Reservation (ORR) released large quantities of radiological and chemical contamination into the environment during nearly five decades of nuclear weapons research and development. In response to this legacy, the Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) in 1994 developed a Facility Survey Program (FSP) to characterize the overall condition of facilities on the ORR. This characterization documents their physical condition, inventories of hazardous chemical and radioactive materials, process history, levels of contamination, and present-day potential for release of contaminants to the environment. Both active and inactive facilities are evaluated under varying conditions ranging from catastrophic (i.e. tornado) to normal everyday working situations. This broad-based assessment supports the objectives of Section 1.2.3 of the *Tennessee Oversight Agreement (TOA)*, which was designed to inform local citizens and governments of the historic and present-day character of all operations on the ORR. This information is also essential for local emergency planning purposes. Since 1994, TDEC's survey team has characterized 143 facilities and found that about thirty percent pose a relatively high potential for release of some contaminants to the environment. In many cases, this high potential for release relates to legacy contamination that migrated from facilities as their infrastructures degraded from decades of continual industrial use (e.g. leaking underground waste lines, substandard sumps and tanks, or ventilation ductwork). During 2000, the survey team evaluated 14 facilities and found that 4 of these buildings posed a high potential for environmental release. Two of these facilities were at Y-12 (Y-9204-3, Y-9213); one was at ORNL (X-3505); and one was at K-25 (K-1004-J). Since the inception of the program, corrective actions have removed four facilities from TDEC's list of "high" Potential Environmental Release facilities.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) in cooperation with the Department of Energy (DOE) and DOE contractors, conducts a Facility Survey Program (FSP) on the Oak Ridge Reservation (ORR). The program provides a comprehensive independent assessment of active and inactive facilities on the Reservation based on their: (1) present physical condition; (2) inventories of radiological materials and hazardous chemicals; (3) levels of contamination; and (4) operational history. The ultimate goal of the program is to fulfill the commitments agreed to by the State of Tennessee and DOE in Section 1.2.3 of the *Tennessee Oversight Agreement (TOA)* which states that *"Tennessee will pursue the initiatives in attachments A, C, E, F, and G. The general intent of these action items is to continue Tennessee's: (1) environmental monitoring, oversight and environmental restoration programs; (2) emergency preparedness programs; and (3) delivery of a better understanding to the local governments and the public of past and present operations at the ORR and potential impacts on the human health and/or environment by the ORR."* The

overall objective of the Facility Survey Program is to provide a detailed assessment of all potential hazards affecting or in any way associated with facilities on the ORR. To this end, the program evaluates facilities' potential for release of contaminants to the environment under varying environmental conditions ranging from catastrophic (i.e. tornado, earthquake) to normal everyday working situations. This information is also essential to proper emergency preparedness planning.

Methods, Materials, and Evaluating the Potential for Environmental Release (PER)

Survey program team members take a historical research approach to evaluating each facility. Prior to commencing fieldwork they examine historical and engineering documents, past contaminant release information, hazard-screening documents, drain databases, and radiological and chemical inventory data. They then perform a walk through of the facility with the facility manager to gather interview information, and to "ground truth" previously reviewed documents. During the walk through, calibrated radiation survey instruments are used to estimate radiation and dose levels. At the end of the document review and walk through process, information is entered into TDEC's PER database. This database helps the team to characterize conditions at each facility based on its physical condition and potential for release of contaminants to the environment.

The PER database is simply an index of 10 "categories" that relate directly to the contents and condition of the operational infrastructure within and around each facility (Table 1). Each category is assigned a score from 0 to 5 (5 is the greatest potential) for each of the 10 "categories" (Table 2). As facilities are scored, totaled, and compared with each other, a relative ranking emerges. Special circumstances, such as legacy releases and professional judgment also influence category scoring. Scores are not intended to reflect human health risk. Rather, their sole purpose is to characterize facilities based on the conditions in and around them. This information is used within TDEC for information, comparison, and review purposes only.

Notifications of TDEC's findings are sent to DOE in the form of the Facility Survey Report so that it has the opportunity to respond and formulate corrective actions. When TDEC receives written confirmation from DOE of corrective actions taken on a particular facility, the ranking for that facility is modified accordingly. The 10 "categories" to be scored and the "scoring criteria" are presented below (Tables 1 and 2). Table 3 provides preliminary results.

Table 1: Categories to be scored

1.	Sanitary lines, drains, and septic systems
2.	Process tanks, lines, and pumps
3.	Liquid Low-level Waste tanks, lines, sumps, and pumps
4.	Floor drains and sumps
5.	Transferable radiological contamination
6.	Transferable hazardous materials contamination
7.	Ventilation ducts and exit pathways to create outdoor air pollution
8.	Ventilation ducts and indoor air/building contamination threat
9.	Radiation exposure rates inside the facility escalated
10.	Radiation exposure rates outside the facility escalated

Table 2: Potential Environmental Release Scoring Guidelines

Score	Score is based on observations in the field and the historic and present-day threat of contaminant release to the environment/building and/or ecological receptors.
0	**No threat**: no quantities of radiological or hazardous substances present.
1	**Minimal threat**: minimal quantities present, possibility of an insignificant release, very small probability of significant release, modern maintained containment.
2	**Moderate threat**: significant quantities of radiological or hazardous subs. present, structures stable in the near to long term, structures have integrity but are not state-of-the-art, adequate maintenance.
3	**Moderate threat**: structures unstable, in disrepair, containment failure clearly dependent on time, integrity bad, maintenance lacking, containment exists for the short term only.
4	**Imminent threat**: considerable quantities of radiological or hazardous subs. present. Containment for any period of time is questionable, migration to environment has not started.
5	**Release**: radiological or hazardous substance containment definitely breached, environmental/interior pollution from structures detected, radiological and/or hazardous substances in inappropriate places like sumps/drains/floors, release in progress, or radiological exposure rates above Nuclear Regulatory Commission (NRC) guidance.
Note: A score of 0 or 1 designates a low Potential Environmental Release rank; a score of 2 or 3 designates a moderate rank; a score of 4 or 5 designates a high rank.	

Discussion and Results

The Facility Survey Program entered its seventh year in January 2000. As in previous years, inter-agency staff cooperation was excellent, which facilitated the flow of information related to corrective actions, changes in facility status or mission, decommissioning and decontamination activities, and onsite professional activities. During 2000, the survey program's Y-12 representative spent approximately one half of his time at the Y-12 field office. This presence greatly enhanced program activities at that site.

In accordance with past TDEC policy, an individual survey conducted on a facility at K-25 that is now re-industrialized might only address those portions of the facility that are leased. Consequently, some older reports may not include adjacent areas in the same facility or related facilities. These adjacent areas and related facilities may be contaminated and/or exhibit safety problems that are not reflected in the report. Therefore, when reviewing these reports, it is important to look for the phrase "leased area of the facility." This phrase indicates that the survey

report covers only the leased area of the facility, specifically, and is not intended to assess the entire facility or related facility problems (such as drain lines) that may exist outside of the leased area.

Since we are continually in the process of evaluating corrective action plans or actions taken to address its concerns on facilities, any current ranking may not reflect the most recent corrective actions. Since the inception of the Facility Survey Program, corrective actions have removed four facilities (X-3525, X-7823-A, X-7827, and K-1098-F) from TDEC's list of "high" Potential Environmental Release facilities.

In 2000, the team surveyed 14 facilities: Six at ORNL (#3532, #3027, #3505, #3541, #3030, #3118), Four at K-25 (#1008-C, #1004-J, #1001, #722), and Four at Y-12 (#9204-3, #9999-1, #9416-9, #9213). Four of these facilities were ranked as having a "high" Potential for Environmental Release; one at ORNL (#3505), two at Y-12 (#9204-3, #9213), and one at K-25 (#1004-J).

Table 3: Facility Survey Program Summary

		High PER Facilities	Removed High PER	Facilities Resurveyed
A. Facilities surveyed, 1994	15	9	0	0
B. Facilities surveyed, 1995	35	11	0	0
C. Facilities surveyed, 1996	34	9	0	0
D. Facilities surveyed, 1997	23	8	0	0
E. Facilities surveyed, 1998	8	2	1	2
F. Facilities surveyed, 1999	14	1	0	0
G. Facilities surveyed, 2000	14	4	3	0
H. Totals	**143**	**45**	**4**	**2**

Description of the 38 Highest Scoring Facilities (1994-00)

The total score of the 10 categories is not always the best indicator of conditions at a facility and its potential for environmental release. Rather, what appears to be the most accurate indicator is the number of categories for which a facility scores a four or five (Table 1). Of the 143 facilities scored since 1994, 42 stood out with one or more categories scoring four or greater (Table 4). The following high-scoring facilities are arranged in descending order of total numbers of fours and fives scored in the PER database.

Table 4: Potential for Environmental Release for 38 High Scoring Facilities

	1	2	3	4	5	6	7	8	9	10		
	DRAIN	TANKS	TANKS	SUMPS	TRANSF	TRANSF	VENT TO	VENT	INT. EXP.	O. EXP.	NUMBER	SURVEY
	LINES	LINES	LINES	DRAINS	RAD.	HAZ.	OUTSIDE	INSIDE	RAD.	RAD.	OF	YEAR
BUILDING	SANI.	PROC.	LLLW	FLOOR	CONT.	CONT.	AIR	SYSTEM	SURVEY	SURVEY	4 and 5's	
X3028	0	4	4	3	4	4	4	5	5	3	7	1997
X3505	0	4	4	4	5	4	5	4	3	2	7	2000
K1037-C	0	0	0	0	5	5	5	5	5	4	6	1998
K1025-A	0	0	0	4	4	4	4	3	4	4	6	1995
Y9204-3	3	5	2	3	4	5	4	4	2	1	5	2000
X3019B	2	2	5	3	2	3	4	4	4	4	5	1995
X7819	1	2	4.5	1	3	2	2	5	5	5	4	1994
X7700	4	0	0	3	5	4	2	2	3	5	4	1996
X7700C	4	4	0	4	2	1	2	0	0	4	4	1996
Y9201-4	2	5	0	2	2	4	5	5	2	1	4	1998
K1004-J	5	5	0	4	3	0	0	0	1	1	3	2000
Y9203	4	2	0	4	2	4	2	2	2	0.5	3	1995
X2545	0	3	5	0	4	2	3	0	0	4	3	1995
K1200C	1	3	0	1	3	5	2	4	3	4	3	1995
Y9769	1	1	0	4	4	2	1	2	4	2	3	1995
K1025B	0	0	0	2	5	2.5	3	2	4	5	3	1996
X3020	0	0	5	5	5	0	2	0	0	1	3	1997
X3108	0	0	5	5	5	0	2	2	2	2	3	1997
X3091	0	0	5	5	5	1	2	2	3	2	3	1997
Y9213	3	1	5	3	3	5	1	1	1	1	2	2000
Y9404-3	1	5	0	5	0	3	0	0	0	0	2	1994
X7720	0	0	0	0	4	0	0	0	0	4	2	1996
X3001	3	1	2	3	3	2	4	4	3	3	2	1995
Y9208	2	0	0	2	1	4	4	2	1	1	2	1995
K1200S	2	3	0	3	3	2	3	4	2.5	4	2	1995
X7701	4	3	0	4	2	0	2	0	0	3	2	1996
X7706	4	3	0	4	2	0	2	2	2	2	2	1996
X7707	4	0	0	4	2	3	2	2	0	0	2	1996
X3085	1	4	3	3	3	2	1	2	3	3	1	1994
X7602	0	2	0	2	4	2	1	3	2	1	1	1997
Y9620-2	0	4	0	1	0	2	2	2	0	0	1	1994
K1220N	0	2	0	0	3	2	2	4	2	3	1	1995
X3002	0	2	0	2	3	1	2	3	4	1	1	1996
Y9210	1	0	0	4	1	1	1	2	1	0	1	1995
Y9224	1	0	0	4	1	1	1	2	1	0	1	1995
Y9211	1	0	0	4	1	1	1	2	1	0	1	1995
Y9207	2	0	0	1	1	4	3	1	1	0	1	1995
X7055	0	0	0	4	0	1	1	1	0	0	1	1997
X7700B	0	0	0	0	3	0	2	0	0	4	1	1996
K1401L3	1	0	0	1	4	2	1	2	3	1	1	1997
Y9201-3	2	1	0	2	3	5	2	2	2	1	1	1999

At **Y-12** thirteen facilities had at least one category score of four or five: 9204-3, 9201-4, 9213, 9203, 9769, 9404-3, 9208, 9620-2, 9210, 9224, 9211, 9207, and 9201-3.

Facility Y-9204-3 (Beta 3) is one of the original isotope enrichment facilities at Y-12. It received two category scores of five, three category scores of four with a total score of 33. This 250,000sq. ft. facility is shut down and locked. The largest issues are leaking PCB contaminated mineral oil (Z-oil) throughout the building, and radiological contamination. Contamination occurs throughout the building, yet it has not been sampled above eight feet. The probability for contamination above eight feet is great. The building vents directly to the environment without HEPA filtration.

Facility Y-9201-4 (Alpha 4) is also one of the original Y-12 uranium enrichment buildings. It received three category scores of five, one category score of four with a total score of 28. Mercury, mercury vapor, lithium hydroxide, PCBs, asbestos, and lead/chromium based paint are the contaminants of concern in this facility. Mercury is found throughout the process system. The containment integrity of this system is low and has resulted in breaches that have deposited mercury in unwanted places throughout the building. Evidence suggests that open (non-filtered) exhaust fans have distributed mercury vapor from the interior of the building to the environment for decades. Lithium hydroxide, PCBs, asbestos insulation, and chipping/flaking lead-based paint are also found deposited throughout the building.

Facility Y-9213 (Criticality Experiment Facility) received two category scores of five with a total score of 24. This facility was built in 1951 and contains two underground neutralization tanks and an underground pit. The tanks and pit present a very high potential for radiological and chemical soil contamination. The areas around the tanks have not been sampled for contamination. The facility also exhibits extensive flaking of exterior lead-based paint.

Facility Y-9203 (Instrumentation, Characterization Department and Manufacturing Technology Development Center) has three category scores of four with a total score of 22.5. The primary problem in this facility is the drain system. Despite much work that has been done to reroute process drains from terminating in the storm sewer system, these drains now go to the sanitary sewer system. This termination still presents a potential pathway to the environment and the public.

Facility Y-9769 (Analytical Services Organization) has three category scores of four with a total score of 21. The primary hazards associated with this facility are related to the wide variety of toxic materials maintained in the laboratory and the building's drain destination. Exit drains go to the Oak Ridge Sewage Treatment Facility and therefore represent a pathway for contaminants to the city's effluent and/or sludge. Also, the sub-basement area is posted as a contamination area and confined space. This area has legacy contamination of natural uranium. Depending on the quantity of natural uranium, a significant source term for radium-226 and radon-222 exists. Failure of containment could cause a release to East Fork Poplar Creek or to the atmosphere.

Facility Y-9201-3 (Alpha 3) received one category score of five with a total score of 20. This facility is not receiving any maintenance on its exterior painted surface. Lead based paint is chipping and is being spread extensively around the building.

Facility Y-9404-3 (Z-oil pumphouse) at Y-12 has two category scores of five with a total score of 14. The primary hazard is PCB contaminated oil in sumps and pumps and old oil lines beneath the floor. PCBs are carcinogenic and have a high bioaccumulation factor. Without secondary containment very small leaks may allow PCBs to enter the food chain via fish and other wildlife.

Facility Y-9208 has two category scores of four with a total score of 17. Despite administrative controls that were implemented, the asbestos-bearing paint peeling from the outer walls still presents an airborne particulate problem if not mitigated with an engineering control.

Facility Y-9620-2 (Oil Filtration Facility) had one category score of four with a total score of 11. The primary concerns with this facility are PCB contaminated filter presses and transfer oil dryers that still contain PCB-laden Z-oil without secondary containment. PCB contaminated oil is also on the floor. A secondary concern is that the roof is not maintained and may not support a person's weight.

Facilities Y-9210, Y-9211, and Y-9224 (ORNL Biology) each had one category score of four with a total score of 11 for each facility. The concern regarding each of these facilities was the questionable terminal destinations of their exit drains, which in some cases historically went to the storm sewer system. Written confirmation from the DOE contractor has since shown the correct terminations and corrective actions taken on some of these drains, but there are still undefined and/or inappropriate drain terminations (i.e. lab drains that terminate at the sanitary sewer).

Facility Y-9207 (Biology Complex) received one category score of four with a total score of 13. In this facility the sinks in a radiological area drain directly to the Oak Ridge sewer system and thus represent a potential pathway for radiological materials to the city sewage and sludge.

At **ETTP** nine facilities had at least one category score of four or five: K-1037-C, K-1025A, K-1200-C, K-1025B, K-1098-F, K-1200-S, K-1004-J, K-1220-N, and K-1401L3.

Facility K-1037-C (Nickel Smelter House) received five category scores of five, one category score of four with a total score of 29. This is an old facility with numerous roof leaks and in general disrepair. The building is heavily contaminated, both radiologically and chemically. Large scrubber-type vessels located on the East End of the second floor of the barrier production area contain internal radioactive contamination. Discarded contaminated equipment is stored in the building. The facility is posted as a PCB hazard.

Facility K-1025-A (Radiological Source Control Building) received six category scores of four with a total score of 27. The entire building is a contamination zone with plugged floor drains. The building houses radiological sources, and there is evidence that water has been standing in the building. The integrity of the roof is suspect. Floor drains historically went into a French-drain system with an unknown termination point. Elevated radiological readings outside of the building suggest that drains exit into the yard and that contamination has moved into the environment.

Facility K-1200-C (Centrifuge Preparation Laboratory, Center Bay) at K-25 has one category score of five, two scores of four with a total score of 26. The primary hazard is PCB contamination. Inactive equipment in the facility contains PCBs and there is a designated PCB spill area associated with under-floor drain lines. Radiological contamination is another concern. Several Radiological Contamination Areas are posted in the facility. The interior ventilation ductwork and portions of the roof have not been surveyed for radiological contamination. These circumstances present a degree of uncertainty that is reflected in the score.

Facility K-1025-B (Drum Storage Warehouse) has one category score of four, two category scores of five with a total score of 23.5. The primary concern associated with this facility is radiological contamination. Radiological contamination has moved from within the building via the floor drain system and has contaminated the soil in front of the building. Since a radiological survey map was not available to TDEC, the magnitude of soil contamination is unknown. TDEC has not been notified of actions taken to address these issues.

Facility K-1200-S (Centrifuge Preparation Laboratory, South Bay) at K-25 has two category scores of four with a total score of 26.5. The high score is primarily attributable to the uncertainty of radiological contamination associated with the ventilation system. The interior ductwork and portions of the roof where air is exhausted have not been surveyed for contamination. The potential for airborne release there appears great. Equipment inside the facility contains uranium hexafluoride and other hazardous chemicals, and there are numerous radiologically contaminated storage areas. Confined space entry requirements prevented TDEC from performing a survey of the pits below the centrifuges. The greatest release potential for contaminants would be during decontamination and decommissioning activities.

Facility K-1004-J received two category scores of five, one category score of four with a total score of 19. This facility was constructed in 1948 and was originally used for uranium recovery from spent fuel solutions, and centrifuge research. It originally included a hot cell, reinforced concrete vaults, and a 750 gal. “hot” tank, a 5,500 gal. underground Low Level Liquid Waste tank, and a laboratory. The facility was ranked high in the PER database because of a poor state of knowledge concerning facility infrastructure. First, there is considerable uncertainty over the location and number of active storage vaults under the facility. It is also unknown whether any of these vaults contain radioactive materials or contamination. There is also considerable uncertainty over drainpipe connections and their contribution of radiological and chemical contaminants to general area contamination.

Facility K-1220-N (Centrifuge Plant Demonstration Facility, North) at K-25 has one category score of four with a total score of 18. The interior ductwork has not been surveyed for radiological contamination and the score reflects a high degree of uncertainty concerning the presence of radionuclides. Uranium residuals are present inside the centrifuge systems. After the centrifuge systems are removed and the criticality and security concerns are addressed, this facility is a candidate for reuse.

Facility K-1401L3 received one category score of four with a total score of 15. This ranking was given because of extensive radiological contamination, which encompasses the building and housed equipment. There are also suspect contaminated areas that have not been surveyed, such as the areas above 8 feet.

At **ORNL** twenty facilities had at least one category score of four or five: X-3028, X-3505, X-3019-B, X-7819, X-3001, X-7700, X-7700C, X-7701, X-7706, X-7707, X-7720, X-7700B, X-2545, X-3002, X-3020, X-3108, X-3091, X-3085, X-7602, and X-7055.

Facility X-3028 received two category scores of five, five category scores of four with a total score of 36. The primary issue with this facility was the relatively large source term of radiological contamination distributed throughout the building. It also shows extensive peeling and chipping of interior wall paint that is supposed to serve as containment for plutonium contamination. Ongoing corrective actions are occurring at this facility.

Facility X-3505 (Metal Recovery Facility) received five category scores of four, two category scores of five with a total score of 35. This is a highly contaminated degraded structure. It contains seven rooms, a bank of seven contaminated hot cells, a grouted contaminated canal, and contaminated dissolver pit in the dissolver room. The building is highly contaminated with a variety of radionuclides (U-238, Pu-239, Np-237, Am-241, Sr-90, Cs-137, and Tc-99), and chemicals. The roof of this building is very badly degraded and allows considerable inflow of water on every rain event. This facility is scheduled to be demolished by the end of the 2001 fiscal year.

Facility X-3019-B (High Level Radiation Analytical Laboratory) at ORNL has four category scores of four, one category score of five with a total score of 33. The primary concern with this facility is the very high levels of radiological contamination. The eight hot cells in this facility are "Very High Radiation Areas" and contain many different radionuclides from past operations. The in-cell steam pipes, the off-gas ventilation system, and the ventilation ductwork on the roof are also radiologically contaminated. Also, the Laboratory Off-Gas ductwork located above the hot cells contains perchlorates six times above the maximum recommended by the ORNL Perchloric Acid Committee Corrective. Perchlorates are shock sensitive and have the potential to react violently when disturbed. Signage identifying this hazard is posted, and the situation was recently upgraded from an "Off-normal" to an "Unusual Occurrence."

Facility X-7819 (Old Decontamination Facility) had three category scores of five, one category score of 4.5 with a total score of 30.5. TDEC conducted a complete re-survey of this facility in 1998 which had originally been surveyed in 1994. There were several significant concerns raised. The primary one was that legacy operations resulted in the migration of extensive radiological contamination from the facility to the environment. Leaking drain lines have generated soil contamination around the building as well as the surrounding drainage system. Several radionuclides are involved. Five shielded transfer tanks containing Cs-137 residue are associated with the structure. One tank is thought to be empty and the other four are estimated to contain between 50-700 Ci of residual Cs-137. The building contains contaminated equipment. New data, and notice of some corrective actions provided to TDEC in 1998, reduced the scores in two categories and the total score in TDEC's PER database from 35.5 to 30.5.

Facility X-3001 (Graphite Reactor) at ORNL has two category scores of four with a total score of 28. The primary concern with this facility is that there is considerable radiological contamination. The air exhaust shaft that vented the reactor pile is contaminated with cesium-137, strontium-90, and fission products. This is a source releasable to the outside environment if a fire or other event occurred in the ventilation system. Several corrective actions, such as the plugging of drains that went to the sewer system, were recently addressed at this facility.

Facilities X-7700, 7700C, 7701, 7706, 7707, 7720, and 7700B (Towers, scrapyard, above-ground storage areas, waste storage tank, reactor pool, heat exchanger bldg., battery house, civil defense bunker, below-ground outside source storage area) are all part of the Tower Shielding Complex. A survey of this group of facilities resulted in two category scores of five and 14 category scores of four. The primary issues at this complex of facilities are: soil contamination, uncovered activated and contaminated equipment and material, and drain lines that have direct connections to the environment. Ongoing corrective actions are being carried out at this facility.

Facility X-2545 (Coal Yard Runoff Collection Basins) at ORNL has one category score of five, two category scores of four with a total score of 21. Orphaned, 2- and 6-inch diameter, cast iron Low Level Liquid Waste (LLLW) lines run through the facility property, and a LLLW line box is posted as a radiation area. The area has been chained off and is overgrown with vegetation. Due to the radiological postings, the cast iron LLLW lines are assumed to be degraded and leaking to the environment. ORNL Environmental Restoration staff has been notified of these lines and their condition, but TDEC has not received written confirmation concerning corrective actions.

Facility X-3002 (HEPA Filter House for the Graphite Reactor) has one category score of four with a total score of 18. The primary hazards associated with this building are related to the high level of airborne and other radiological contamination in the roughing filter room, the HEPA filter bank, and the ventilation system. Several corrective actions that were recommended by TDEC were implemented at this facility.

Facility X-3020 (Radiological stack for bldg. 3019A-B) received three category scores of five with a total score of 18. All of the major concerns noted for this facility were related to legacy features that are not part of the present-day operational infrastructure, but are still present on the site. First, there is an antiquated, contaminated drain line that was part of the ORNL LLLW system. This line leaked and contributed to surface and subsurface contamination of the general area from the 1940's through the 1970's. It was capped in the late 1970's, but is possibly still contributing contamination. There is also a contaminated, above-grade, single-walled concrete sump box attached to the floor drain system. The need for a comprehensive stack inspection was noted in the 1997 Facility Survey Program Annual Report. An inspection was conducted in 1998 and found the stack to be in "sound condition."

Facilities X-3108 and 3091 (HEPA filter houses for buildings 3019A-B and Radiological Stack 3020) each received three category scores of five. 3108 received a total score of 23, and 3091 received a total score of 25. These two facilities are physically connected to the 3020 stack. And like the 3020 Stack situation described above, all major concerns noted with these facilities are related to their non-operational infrastructure. Associated with both facilities is a contaminated drain system that went to the LLLW system. This line leaked and contributed to surface and subsurface contamination of the general area from the 1940's through the 1970's. It was capped in the late 1970's, but is possibly still contributing to contamination. Both facilities also contain significant levels of radiological contamination, considerable contaminated aboveground ductwork, and contaminated lower-level HEPA filter pits. Both facilities are non-state-of-the-art structures that are adequately maintained.

Facility X-3085 (Oak Ridge Research Reactor Pumphouse) received one category score of four with a total score of 25. This score was based on the possibility for underground leakage of contaminated water from the 10,000 gallon decay tank and from the underground valve sump tank located in the front of the building. Two empty but internally contaminated, aboveground tanks are still tied to underground piping adjacent to the building. Several recommended corrective actions, such as the plugging of floor drains have been completed at this facility.

Facility X-7602 (Integrated Process Development Lab.) received one category score of four with a total score of 17. The primary concern with this building was the extensive transferable radiological contamination throughout the facility.

Facility X-7055 (Storage Bldg.) received one category score of four with a total score of seven. The only concern with this building was that it has a floor drain system that is connected directly to the outside yard. Even though the building has changed missions and several corrective actions have been implemented, it still contains hazardous materials.

Conclusion

The historic release of chemical and radiological materials from buildings and other facilities on DOE's ORR has led to elevated levels of contaminants in regional terrestrial and aquatic ecosystems. In an effort to better understand more about the sources of these contaminants, TDEC investigates the historic and present-day potential for release of contaminants from facilities through its Facility Survey Program. During its seven-year history the program has

examined 143 facilities and found that about thirty percent (42) pose a relatively high potential for release of some contaminant to the environment. In many cases, legacy contamination from degraded facility infrastructure, such as underground waste lines, or substandard sumps and tanks, or ventilation ductwork, will force high scores until antiquated facilities are fully remediated. This is particularly the case at ORNL where many facilities were connected to an aging low-level liquid waste line system. Inactive facilities that are no longer receiving adequate exterior maintenance due to a lack of funding are also contributing heavily to high scores. On many sites, peeling lead-based paint is extensive, and will only get worse as time passes if not remediated.

When facility concerns are noted by TDEC, they are relayed to DOE via the Facility Survey Report so that corrective actions can be formulated. To date, many corrective actions have occurred and four facilities have been removed from TDEC's list of high Potential Environmental Release facilities. Those concerns that have not been corrected to the extent that TDEC has reduced the Potential Environmental Release ranking to less than a "4" are reflected in this report. The rankings are changed when written documentation is received by TDEC from DOE. Also, since the evaluation of corrective actions is an ongoing, time-consuming process, present scores may in some cases not reflect the most recent completed corrective actions.

References

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 2000. *Health and Safety Plan.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1994-00. *Facility Survey Files.*

RADIOLOGICAL MONITORING

Real Time Ambient Gamma Monitoring of the Oak Ridge Reservation

Principal Author: Howard Crabtree

Abstract

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) use continuous exposure rate monitors to measure and record gamma radiation levels at various locations on the Oak Ridge Reservation (ORR). Data derived from this program, along with that generated by environmental dosimetry, is used to identify unplanned releases and assess the need and/or effectiveness of remedial activities. In the year 2000, two of the four instruments used in the program had to be returned to the manufacturer in Germany for maintenance and calibration. One of the two remaining monitors was deployed at Oak Ridge National Laboratory's 3513 Waste Holding Basin to measure gamma exposure rates before, during, and after the removal of contaminated sediments from this impoundment. The remaining gamma monitor was stationed at Fort Loudoun Dam in Loudon County to collect background information.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) in association with its Ambient Gamma Radiation Monitoring Program has deployed continuously recording exposure rate monitors at various locations on the Oak Ridge Reservation (ORR) since 1996. While the environmental dosimeters used in TDEC's Gamma Monitoring Program provide the cumulative dose over time, data do not indicate the specific time and magnitude of fluctuations in the dose rates. Consequently, a series of small releases cannot be distinguished from a single large release using the dosimeters alone. The continuous exposure rate monitors record gamma radiation levels at variable intervals over extended periods, providing an exposure rate profile that can be correlated with changing environmental and/or anthropogenic conditions. The instruments have primarily been used to monitor remedial activities and supplement the integrated dose rates provided by environmental dosimetry. In 2000, two of TDEC's exposure rate monitors had to be returned to the manufacturer for maintenance. The two remaining instruments were stationed at a background location and Oak Ridge National Laboratory's (ORNL) 3513 Waste Holding Basin, which is currently undergoing remediation.

Methods and Materials

The exposure rate monitors used by TDEC incorporate detection equipment, power supply, software, and associated instrumentation in a portable weather resistant case. The units can measure and record gamma exposure rates from 1 μR/hr to 1 R/hr at predetermined intervals (one minute to two hours) over relatively long periods of time (TDEC's monitors are programmed to take hourly measurements for the duration of the monitoring period). Data recorded by the monitors is downloaded to a computer using the associated transceiver and software.

Monitoring in the program focuses on the measurement of exposure rates under conditions where gamma emissions can be expected to fluctuate substantially and/or there is a potential for the unplanned release of gamma emitting radionuclides to the environment. In 2000, one of TDEC's monitors was placed at ORNL's 3513 Waste Holding Basin, which is undergoing remediation under CERCLA. Another monitor was placed at Fort Loudoun Dam in Loudon County to collect background information. TDEC's two remaining monitors had to be sent back to the manufacturer in Germany for maintenance and calibration.

Results and Discussion

Background gamma exposure rates vary over time due to a number of phenomena that alter the quantity of gamma emitting radionulides in the environment and/or the intensity of the radiation being released by these radionuclides. For example, the gamma exposure rate above soils saturated with water after a rain can be expected to be lower than that over dry soils because the moisture attenuates radiation released by terrestrial radionuclides. To better assess exposure rates measured on the Reservation and the influence that natural conditions have on these rates, staff placed one of the TDEC's continuous gamma monitors at Fort Loudoun Dam in Loudon County to collect background information. As can be noted in Figure 1, exposure rates measured at this background station from 03/24/99 to 12/27/00 ranged from 7 µR/hr to 17 µR/hr. The average exposure rate measured during this period was 8.8 µR/hr. As might be expected, the higher rates recorded were during the dryer seasons (summer & fall); the lower rates were reported during the wetter seasons (winter & spring).

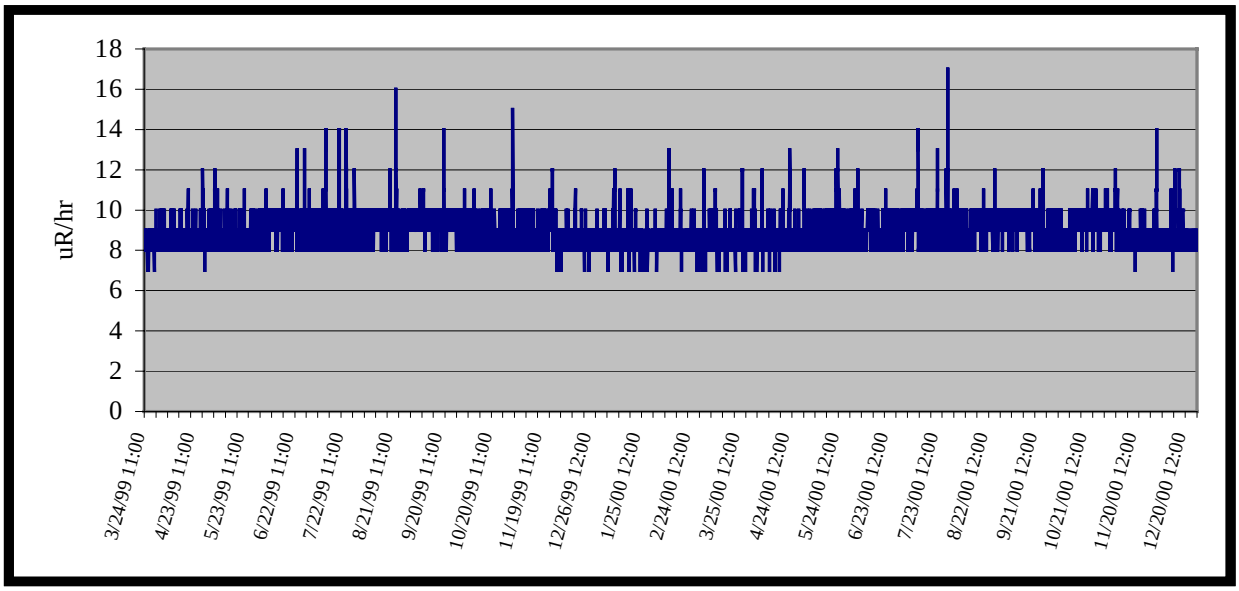

Figure 1: Results of Continuous Gamma Exposure Rate Monitoring at the Background Station located near Fort Loudoun Dam in Loudon County

The second continuous gamma monitor deployed in 2000 was located near Oak Ridge National Laboratory's 3513 Waste Holding Basin. From 1944 to 1976 this impoundment served as a settling pond for ORNL effluents prior to release to White Oak Creek. Consequently, sludges and sediments at the bottom of the basin accumulated significant amounts of radioactive materials. These wastes include an estimated 200 curies of cesium-137 (Bechtel, 1992): the radionuclide primarily responsible for elevated gamma emissions measured at the pond. A

CERCLA Record of Decision (signed September 24, 1997) provided for the removal and disposal of contaminated sludges/sediments in this pond and the adjacent 3524 Equalization Basin. In order to develop a baseline against which to measure the effectiveness of this action and supplement data obtained by environmental dosimetry, TDEC attached a gamma exposure rate monitor to a tree located approximately 28 feet from eastern edge of the impoundment in 1999.

From 01/11/99 to 12/27/00 the exposure rates at the basin ranged from 18 to 271 μR/hr and averaged 77.1 μR/hr. Figure 2 plots the exposure rates recorded at the 3513 Impoundment along with those reported for the background station at Fort Loudoun Dam. Significant fluctuations in the exposure rates measured at the basin are attributable to changes in the water level in the pond. In this regard, the water in the pond attenuates (shields) gamma radiation emitted by the radioactive wastes in the basin sludges/sediments. The increased water level during the wetter months and/or during storm events enhances this effect and provides shielding to previously exposed sediments at the basin perimeter, resulting in lower exposure rates. A significant increase in the exposure rates during August of 1999 is due to the lowering of the water level in the basin to repair a seep that had been observed in the berm that separates the basin from White Oak Creek. During the summer of 2000, sediments from the 3524 Equalization Basin were transferred to the 3513 Impoundment in preparation for final removal. During this effort, the water level in the 3513 Impoundment was maintained to reduce radiation emitted by the sediments and the potential for contaminants becoming airborne. In 2001, it is planned to remove and treat the sediments in the impoundment, after which they will be transported to the Nevada Test Site for disposal. The pond will then be filled and a vegetative cover placed over the site.

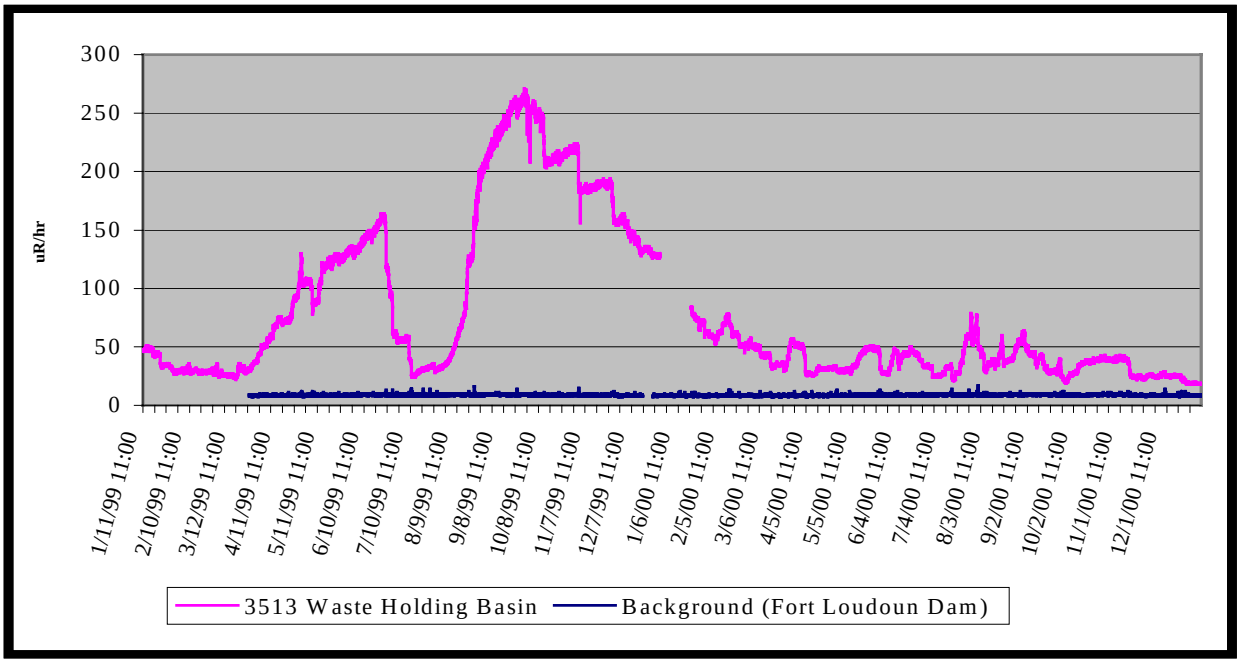

Figure 2: Results of Continuous Gamma Exposure Rate Monitoring at the 3513 Waste Holding Basin and Background Measurements taken at Fort Loudoun Dam in Loudon County.

The actual dose of radiation an individual receives is a function of the amount of time they are exposed to the emissions. Assuming the average rate measured at the 3513 Impoundment in 2000 (39.1 μR/hr) was constant, an individual standing at the monitoring location forty hours a week for a year would receive an external dose from gamma radiation of approximately 83 mrem, down from 246 mrem projected for 1999 (average exposure rate = 116 μR/hr). For comparison, DOE's dose limits for members of the public and radiation workers are 100 mrem/yr and 5000 mrem/yr respectively above contributions from natural background, medical applications, and the dose received from consumer products.

Conclusion

The use of continuous exposure rate monitors in conjunction with environmental dosimetery has proven to be a relatively economical and effective method of monitoring gamma radiation levels on the Reservation. While the environmental dosimetry provides an integrated dose level, the continuous exposure rate monitors are capable of recording an exposure rate profile that provides specific gamma radiation levels at relatively small intervals over extended periods of time. This capacity has proven valuable when trying to identify the source/duration of unplanned releases or correlate exposure rates with changing environmental conditions, such as those encountered during remedial activities.

In 1999 and 2000, the continuous gamma rate monitor placed at TDEC's background station exhibited fluctuations characteristic of the influence of natural phenomena. Lower exposure rates were recorded during the wetter seasons, when it is believed the higher moisture content of the soils and/or snow cover attenuated radiation emitted by terrestrial radionuclides. While fluctuations in gamma background measurements can be attributed to a number of variables, attenuation of terrestrial gamma emissions by moisture in the soil or snow appears to be a major factor in the exposure rates recorded.

The radiation shielding capacity of water was also evident in measurements taken at the 3513 Waste Holding Basin during 1999 and 2000. Water in the pond attenuates gamma radiation emitted by the radioactive contaminants in the basin sediments. When the water level is low, contaminated sediments at the basin perimeter are exposed resulting in higher exposure rates. As the water level rises, shielding is provided from radiation emitted by the previously exposed sediments and the exposure rates decrease. While relatively high exposure rates (compared to background) have been measured at the 3513 Impoundment, radiation levels should substantially decrease as the current remedial effort nears completion.

References

Bechtel. 1992. *Site Characterization Summary Report for Waste Area Grouping 1 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*. DOE/OR-1043/V1&D1. September, 1992.

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. *Health, Safety, and Security Plan*. May 2000.

U.S. Department of Energy (DOE). 2000. *The Surface Impoundment Operable Unit*. Fact Sheet. September 2000.

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RADIOLOGICAL MONITORING

Ambient Radiation Monitoring on the Oak Ridge Reservation using Environmental Dosimetry

Principal Author: Gary Riner

Abstract

The Tennessee Department of Environment and Conservation, (TDEC) Department of Energy Oversight Division (DOE-O) began monitoring ambient radiation levels on the Oak Ridge Reservation (ORR) in 1995. This program provides conservative estimates of the dose to members of the public from exposure to gamma/neutron radiation attributable to Department of Energy (DOE) activities and baseline values for measuring the need and effectiveness of remedial actions. In this effort, environmental dosimeters have been deployed at locations on and in the vicinity of the Reservation. Annual results are compared to background values and the State/DOE primary dose limit for members of the public. In 2000, results for various sites located in access controlled areas of the Reservation exceeded this primary dose limit. These sites are subject to remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Three monitoring locations considered accessible to the public also exhibited elevated dose levels. Two of these sites are adjacent to Poplar Creek, near uranium hexafluoride cylinder storage yards at the East Tennessee Technology Park (ETTP). The third location is on Bear Creak Road in the vicinity of a commercial facility. Given current conditions, it is not anticipated that a member of the public would spend the time necessary to accumulate more than a relatively small percentage of the primary dose limit at any of these locations.

Introduction

Radiation is emitted by various radionuclides that have been produced, stored, and disposed on the Oak Ridge Reservation (ORR). Associated contaminants are evident in ORR facilities and surrounding soils, sediments, and waters. In order to assess the risked posed by these contaminants, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) began monitoring ambient radiation levels on the ORR in 1995. This Program is intended to provide:

- conservative estimates of the potential dose/risk to members of the public from external exposure to radiation attributable to DOE activities/facilities on the ORR;
- baseline values used to assess the need/effectiveness of remedial actions;
- information necessary to establish trends in radiation emissions;
- and information relative to the unplanned release of radioactive contaminants on the ORR.

In this effort, optically stimulated luminescent dosimeters (OSLs) and neutron dosimeters are used to measure the radiation dose attributable to gamma and neutron radiation at selected monitoring stations located on and in the vicinity of the Reservation. Results are compared with background values and the State/DOE primary dose limit for members of the public (100 mrem/yr).

Methods and Materials

In 2000, TDEC used optically stimulated luminescent dosimeters (minimum reporting value of 1 mrem) to measure the dose attributable to gamma radiation at the monitoring locations in the program. Where merited dosimeters with the additional capability of measuring the dose from neutrons (minimum reporting value of 10 mrem) were deployed. Both types of dosimeters were obtained from Landauer, Inc., Glenwood, Illinois.

Each quarter, field deployed dosimeters were replaced with new dosimeters and the field deployed dosimeters are shipped to the Landauer Company for processing. To account for exposures that could have been received in transit or storage, control dosimeters were stored at TDEC's office and returned with the associated field deployed dosimeters to Landauer for processing. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the TDEC's office (761 Emory Valley Road, Oak Ridge, Tennessee), was subtracted from the exposure reported for the field deployed dosimeters. At the end of the year, the quarterly results were summed for each location and the resultant annual dose compared to background values and the State/DOE primary dose limit for members of the (100 mrem/yr total effective dose equivalent).

The monitoring stations in the program were chosen based on their accessibility to the public and/or proximity to known radiation sources. Figures 1 through 3 depict the sites monitored in 2000. Table 1 provides a brief description of each site, along with associated results.

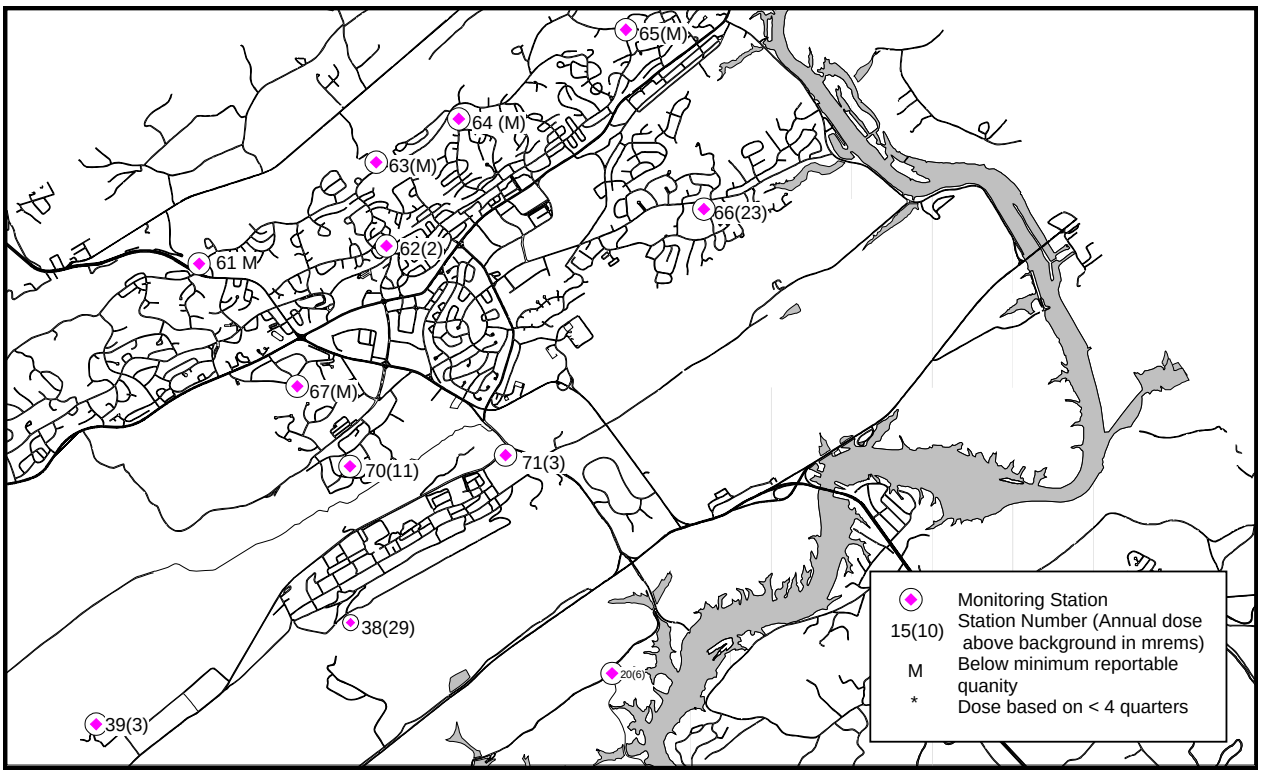

Figure 1: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the Y-12 Facility during the Year 2000

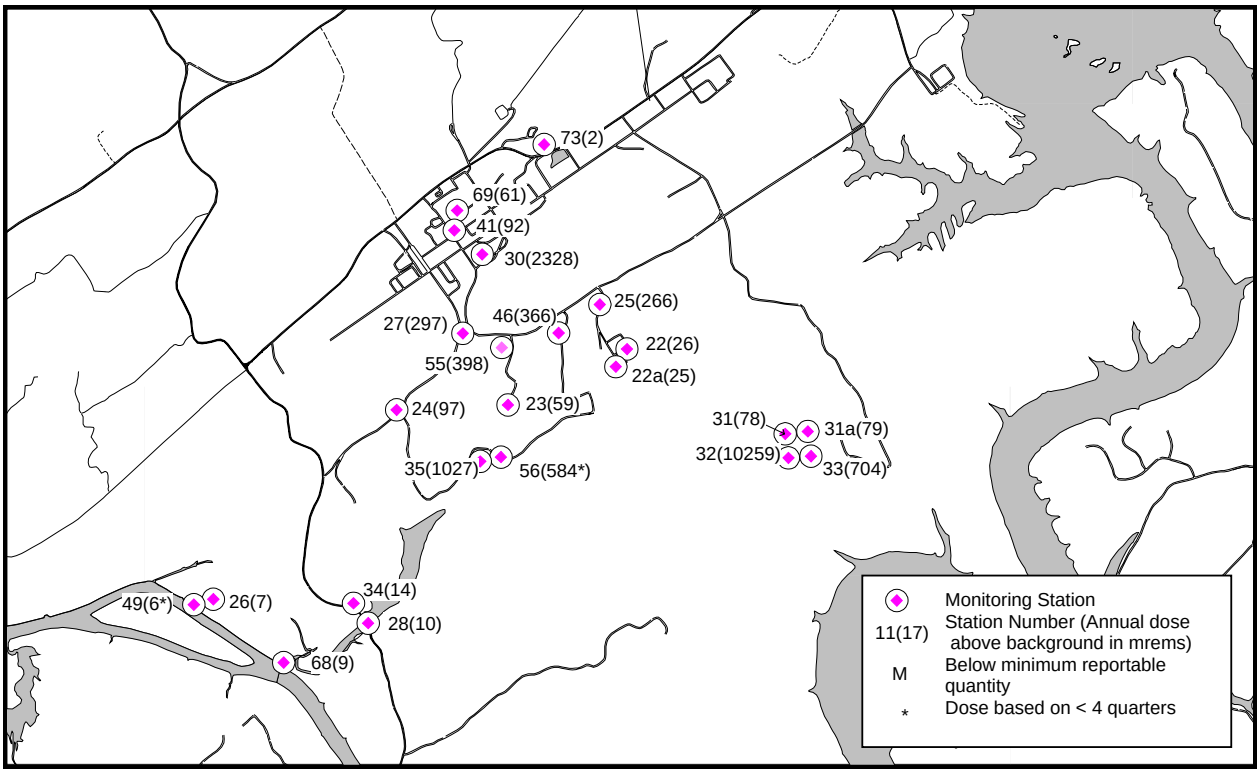

Figure 2: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the Oak Ridge National Laboratory during the Year 2000

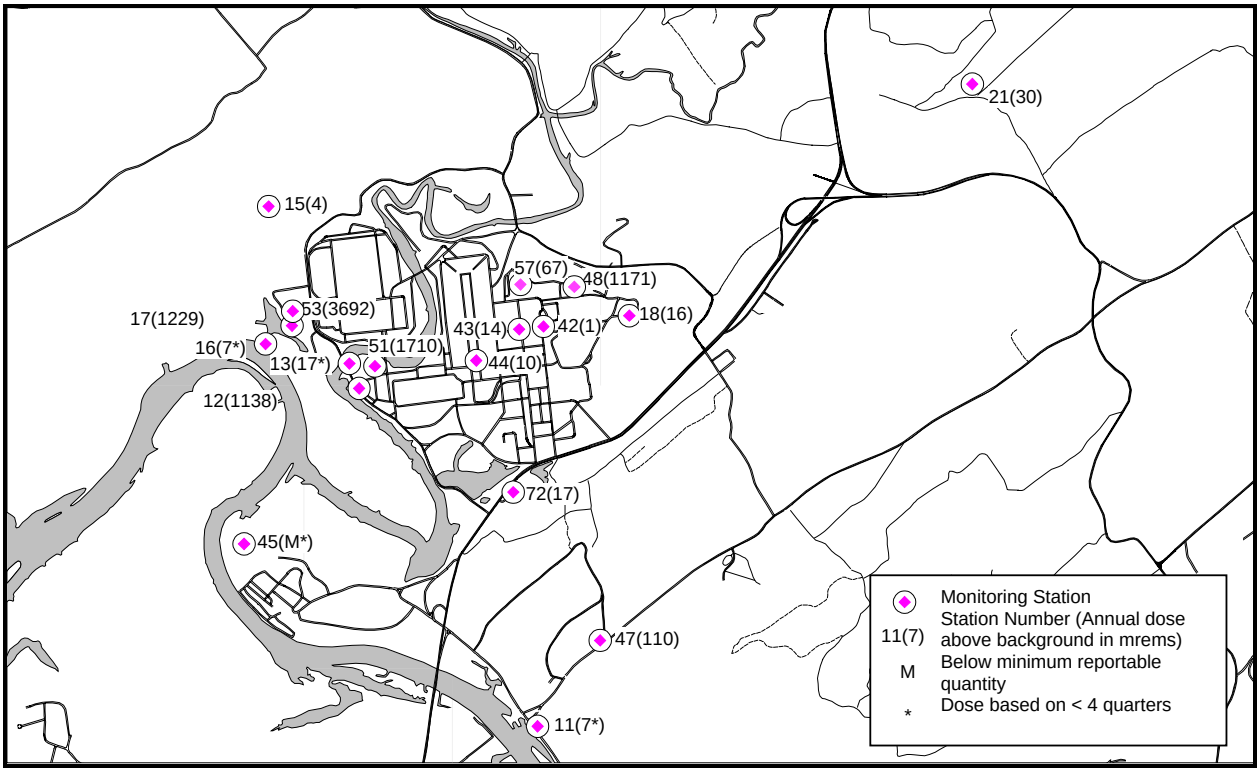

Figure 3: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the East Tennessee Technology Park during the Year 2000

Table 1: Year 2000 Results from Tennessee Department of Environment and Conservation Monitoring on the Oak Ridge Reservation using Environmental Dosimetry

Station Number	Location	Dose in mrems (M = Below minimum reportable quantity)				
		1/00 to 4/00	4/00 to 7/00	7/00 to 10/01	10/00 to 1/01	Total 2000
9.	Norris Dam air monitoring station	M	2	M	6	8
11.	ETTP Grassy Creek Embayment	M	LOST	M	7	7
12. Neutron	ETTP UF_6 Cylinder Storage Yard K-1066-E	Neutron 30 γ 270	Neutron M γ 276	Neutron M γ 327	Neutron M γ 235	1138
13.	ETTP at Poplar Creek near UF_6 Cylinder Storage Yard K-1066-E	17	Discontinued			17
15.	ETTP K-1070-A Burial Ground	M	1	M	3	4
16.	ETTP K-901 Pond	M	2	Lost	5	7
17. Neutron	ETTP K-1066-K UF_6 Cylinder Yard	Neutron M γ 316	Neutron M γ 288	Neutron M γ 367	Neutron M γ 258	1229
18.	ETTP TSCA on fence across from Tank Farm	1	5	3	7	16
20.	Freels Bend Entrance ORNL	M	3	M	3	6
21.	ETTP White Wing Scrap Yard	7	10	5	8	30
22.	ORNL High Flux Isotope Reactor	5	10	5	6	26
22a.	ORNL High Flux Isotope Reactor (duplicate)	5	7	8	5	25
23.	ORNL Solid Waste Storage Area 5	18	19	14	8	59
24.	ORNL Building X-7819	19	27	25	26	97
25.	ORNL Molten Salt Reactor Experiment	8	14	127	117	266
26.	ORNL Cesium Fields	3	2	M	2	7
27.	ORNL White Oak Creek Weir @ Lagoon Rd	66	81	85	65	297
28.	ORNL White Oak Dam	1	2	4	3	10
30.	ORNL X-3513 Impoundment	941	573	637	177	2328
31.	ORNL Cesium Forest boundary	19	19	21	19	78
31a.	ORNL Cesium Forest boundary (duplicate)	19	21	21	18	79
32.	ORNL Cesium Forest on tree	2891	1926	2860	2582	10259
33.	ORNL Cesium Forest Satellite Plot	180	122	218	184	704
34.	ORNL SWSA 6 on fence @ Highway 95	2	6	3	3	14
35.	ORNL convergence of White Oak Creek & Melton Branch.	252	262	305	208	1027
38.	Y-12 Uranium Oxide Storage Vaults	5	12	4	8	29
39.	Y-12 Back side of walk in pits	M	2	M	1	3
41.	ORNL North Tank Farm	23	27	28	14	92
42.	ETTP Building K-1401 East Side	M	1	M	M	1
43.	ETTP Building K-1401 West Side	1	6	4	3	14
44.	ETTP K-25 Building	M	5	2	3	10
45.	ETTP K-770 Scrap Yard	M	Lost	M	M	M
46.	ORNL Homogeneous Reactor Experiment Site	63	83	145	75	366

Table 1: Year 2000 Results from Tennessee Department of Environment and Conservation Monitoring on the Oak Ridge Reservation using Environmental Dosimetry (Continued)

Station Number	Location	Dose in mrems (M = Below minimum reportable quantity)				
		1/00 to 4/00	4/00 to 7/00	7/00 to 10/01	10/00 to 1/01	Total 2000
47.	Y-12 Bear Creek Road 2800 ft from Clinch River	22	34	31	23	110
48.	ETTP Building K-1420	266	259	340	306	1171
49.	Cesium Field near River	2	4	M	Discontinued	6
51. Neutron	North side of K-1066-E Cylinder Yard	Neutron 20 γ 484	Neutron M γ 465	Neutron M γ 493	Neutron M γ 248	1710
53. Neutron	South West corner of K-1066-K Cylinder Yard	Neutron 40 γ 945	Neutron M γ 887	Neutron 30 γ 1022	Neutron M γ 768	3692
53a. Neutron	South West corner of K-1066-K Cylinder Yard (duplicate)	Not deployed	Not deployed	Neutron M γ 1056	Neutron M γ 763	1819
55.	SWSA 5 True Waste Trench	105	113	107	73	398
56.	Old Hydrofracture Pond	1686	1326	392	208	3612
56a. Neutron	Old Hydrofracture Pond (duplicate)	Not deployed	Not deployed	Neutron M γ 379	Neutron M γ 205	584
57.	Cylinder yard K-1066-B	9	20	17	21	67
61	Temp. #14 Outer & Illinois Ave	M	M	M	M	M
62.	Temp. #15 East Pawley	M	M	M	2	2
63.	Temp. #16 Key Springs Road	M	M	M	M	M
64.	Temp. #17 Cedar Hill Greenway. #16 Key Springs Road	M	M	M	M	M
65.	Temp. #18 California Ave.	M	M	M	M	M
66.	Temp. #19 Emory Valley Greenway	3	8	11	1	23
67.	Temp. #20 West Vanderbilt	M	M	M	M	M
68.	White Oak Creek Coffer Dam	4	5	M	M	9
69.	ORNL Graphite Reactor	19	13	14	15	61
70.	Scarboro Perimeter Air Monitoring Station	2	6	M	3	11
71.	Y-12 East Perimeter Air Monitoring Station	M	1	M	2	3
72.	ETTP Visitors Center	2	6	2	7	17
73.	ORNL Visitors Center	M	2	M	M	2

M = Below minimum reportable quantity

Notes: The primary dose limit for members of the public specified in both DOE Orders and 10 CFR Part 20 (*Standards for Protection Against Radiation*) is 100 mrem total effective dose equivalent exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. Dose equivalent is the product of the absorbed dose in tissue and a quality factor. Total Effective Dose Equivalent means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). The deep dose equivalent refers to the dose equivalent in tissue at 1 cm deriving from external (penetrating) radiation.

To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the Division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the Division offices, is subtracted from the exposure reported above for the field deployed dosimeters.

Results and Discussion

In the past, TDEC has relied on the measurement of gamma radiation to estimate the radiation doses at the various monitoring stations. While gamma radiation is expected to be the major contributor to external exposures, an additional dose from neutrons was anticipated at sites near uranium hexafluoride cylinder storage yards located at the ETTP. To account for this dose, TDEC placed neutron dosimeters at monitoring stations near the storage yards. Results for 2000 from these dosimeters were erratic, but indicative of a measurable neutron flux at several of the locations. This flux is attributed to the interaction of alpha particles emitted by uranium reacting with the nuclei of fluorine ($\alpha + {}^{19}F \rightarrow {}^{22}Na + n$) and/or the spontaneous fission of uranium isotopes. The neutron doses measured were incorporated into the total doses reported in Table 1.

Monitoring locations and associated results can be roughly organized into three categories: (1) background location; (2) sites on/near the ORR which are, to some degree, accessible to the public; and (3) locations within access controlled areas.

Background Station

The total dose measured at the background station (Norris Dam Ambient Air Monitoring Station) was 8 mrem.

Stations Potentially Accessible to the Public

Of the sites monitored that are considered potentially accessible to the public, stations 12, 47, and 51 exceeded the 100 mrem/yr primary dose limit. In this regard, it should be understood that the annual exposure estimates generated by the program are conservative in nature and would require an individual to be at the location of the associated dosimeter twenty-four hours a day for a year to receive the dose reported.

Stations 12 (1138 mrem) and 51 (1710 mrem) are located on DOE property at the fence that separates the K-1066-E Uranium Hexafluoride Cylinder Storage Yard at ETTP from the Poplar Creek area. While the sites are adjacent to Poplar Creek and accessible by boat, it is not anticipated, given current conditions (e.g., security precautions), that an intruder on DOE property or a fisherman would spend the time necessary to accumulate a substantial dose at these locations. Nevertheless, TDEC considers the uranium hexafluoride cylinders to be a problem (particularly, in light of the reindustrialization/privatization efforts at ETTP) and has advocated their removal or stabilization.

Station 47 (110 mrem) is located within the Reservation boundary on Bear Creek Road across from a commercial facility regulated by TDEC's Division of Radiological Health.

Stations within Access Controlled Areas of the Reservation

Other sites monitored that reported results appreciably above background levels and/or the primary dose limit are located within access controlled areas of the Reservation. These sites are subject to remediation in accordance with provisions of the CERCLA and the Federal Facility Agreement (FFA) for the ORR. For the purposes of this report, areas within the perimeter fence at each facility have been treated as access controlled areas. As facilities within these boundaries

become more available to the public, this delineation becomes less distinct and elevated dose levels a more significant concern.

Conclusion

The monitoring of radiation using optically stimulated luminescent and neutron dosimeters has proven to be a relatively economic and effective method of estimating ambient gamma radiation levels on and in the vicinity of the ORR. Data generated by the program indicates various sites located in restricted areas of the Reservation exhibited annual doses in excess of the State/DOE primary dose limit for members of the public. These sites are subject to remediation in accordance with provisions specified in CERCLA and the FFA. Three locations considered potentially accessible to the public, also, exhibited elevated results. However, it is not anticipated, given current conditions, that a member of the public would spend the time necessary to accumulate more than a relatively small percentage of the primary dose limit at these locations.

References

Tennessee Department of Environment and Conservation. 1996. *Tennessee Oversight Agreement, Agreement between the Department of Energy and the State of Tennessee.*

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 1999. *Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Environmental Monitoring Plan*.

Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. *Health, Safety, and Security Plan*. May 2000.

U.S. Department of Energy, 1999. *1999 Remedial Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge Tennessee*. DOE/OR-1790&D1. February 1999.