DOE F 1325.8
(4/93)

United States Government **Department of Energy**
Oak Ridge Operations Office

memorandum

DATE: February 18, 2003

REPLY TO ATTN OF: EM-91:Rice

SUBJECT: **ENVIRONMENTAL ASSESSMENT ON THE PROPOSED CHANGES TO THE SANITARY BIOSOLIDS LAND APPLICATION PROGRAM ON THE OAK RIDGE RESERVATION**

TO: L. Dennis Boggs, Chief Operating Officer, EM-90

The subject Environmental Assessment (EA) dated January 2003 has been reviewed in accordance with our responsibilities under Department of Energy (DOE) Order 451.1B, paragraph 5a(9). Based upon this review, recommendations made by your staff and after consultation with the Office of Chief Counsel and the National Environmental Policy Act (NEPA) Compliance Officer, I have determined that within the meaning of NEPA, the proposed action is not a major Federal action significantly affecting the quality of the human environment. Therefore, the preparation of an Environmental Impact Statement is not required. The basis for this determination is explained in the attached Finding of No Significant Impact (FONSI) and the supporting final EA.

Please note that your office is responsible for providing public notice of the availability of the EA and FONSI in accordance with 40 CFR 1506.6(b), 10 CFR 1021.322, and DOE Order 451.1B, paragraph 5c (5).

If you need further assistance or have any questions or comments, please contact David R. Allen, Oak Ridge Operations NEPA Compliance Officer at 576-0411.

Gerald G. Boyd
Manager

Attachments

cc w/attachments:
C. Borgstrom, EH-42, FORS (5 copies with 1 CD-ROM)
H. Erbes, EM-32, CLVRLF
G. McRae, Bechtel Jacobs Company LLC
D. Allen, SE-32, ORO (2 copies)
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DOE/EA-1356

Environmental Assessment
Proposed Changes to the
Sanitary Biosolids Land Application Program
on the Oak Ridge Reservation
Oak Ridge, Tennessee

February 2003

U.S. Department of Energy

Oak Ridge Operations

ACRONYMS AND ABBREVIATIONS

ac	acres
ALARA	as low as reasonably achievable
AMSA	American Metropolitan Sewer Association
CEQ	Council on Environmental Quality
CSF	cancer slope factor
DOE	U.S. Department of Energy
EA	environmental assessment
EFPC	East Fork Poplar Creek
EPA	U.S. Environmental Protection Agency
EPS	Effluent Polishing System (West End Treatment Facility)
FONSI	Finding of No Significant Impact
g	gram
ha	hectares
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IDP	Industrial Discharge Permit
IRIS	Integrated Risk Information System
kg	kilogram
l	liter
LET	linear energy transfer
LOAEL	Lowest Observed Adverse Effect Level
mg	milligram
mrem/yr	millirem per year
MSL	mean sea level
NEPA	National Environmental Policy Act
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation

PCB	polychlorinated biphenyl
POTW	Publicly Owned Treatment Works
PPE	Personnel Protective Equipment
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity computer model
RfC	reference concentration
RfD	reference dose
ROI	Region of Influence
SHPO	State Historic Preservation Office
TDEC	Tennessee Department of Environment and Conservation
TWRA	Tennessee Wildlife Resources Agency
USFWS	U.S. Fish and Wildlife Service
WETF	West End Treatment Facility
WSMS	Westinghouse Safety Management Systems

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) proposes to raise the biosolids land application radionuclide loading limits from the current, self-imposed 4 mrem/yr lifetime loading to the Tennessee Department of Environment and Conservation (TDEC)-approved level of 10 mrem/yr. The planning level increase is necessary for industrial development within the Oak Ridge community. In addition, DOE proposes to allow the discharge of treated wastewaters from the West End Treatment Facility (WETF) to the Y-12 Plant and City of Oak Ridge sanitary sewer systems, resulting in an operational cost savings of approximately $133,000 per year.

The Oak Ridge Reservation (ORR) Biosolids Land Application Program has been in operation since 1983, utilizing 6 application sites on a total of 133 ha (329 acres) and has been awarded a number of awards from regulators for excellence in biosolids management, most recently in 1999 by EPA Region IV, the program's permitting authority. WETF is a process wastewater treatment facility located at the Y-12 Plant that treats low levels of contaminated wastewater for discharge directly through a National Pollutant Discharge Elimination System (NPDES) permitted outfall to East Fork Poplar Creek (EFPC).

Residual Radioactivity (RESRAD) modeling was performed for the proposed 10 mrem/yr planning level increase. Risk factors were calculated for each nuclide. All nuclides were within the acceptable EPA and DOE risk of 1×10^{-4} for a resident living on the land application site, drinking the water, etc. These calculated risks represent a "worst-case" scenario because the existing land application sites are physically isolated and access to the public is restricted during biosolids land application operations.

To obtain a forecast of what the actual application soil radionuclide concentrations would be at the end of site life, a predictive model was prepared. The results demonstrated that 47.1% of the proposed 10 mrem/yr planning level would be achieved for the most heavily loaded site, the Rogers Site. This corresponds to an approximate 4.71 mrem/yr for the cumulative exposure received on-site by a resident. Human health risk assessments were also performed using actual radioactive loading levels and land application operational parameters to simulate what the true exposure scenarios to a worker or a transient would be. The risk factors (4×10^{-7} for a worker and 1×10^{-7} for a transient) were well below the acceptability value of 10^{-4} and the maximum calculated dose received would be 0.143 and 0.016 mrem/yr for a worker and transient, respectively, representing little to no measurable increases in dose or risk for the proposed planning level increase.

The addition of the WETF effluents into the sewer system also produces a negligible impact on both the risk and dose factors on the ORR land application sites and City of Oak Ridge NPDES discharge point. A total of 7.56 kg of uranium from WETF operations would be land applied on an annual basis on land application sites. This amount correlates to a 0.04 g/kg increase in the total uranium levels for the city biosolids and 0.002 mg/kg or 0.7 pCi/g increase in application site soils over the life of the most heavily loaded application site. Consequently, this increase in total uranium only represents 0.0014% of the proposed 10 mrem/yr planning level, which is negligible.

A human health risk assessment was also performed for the proposed WETF sanitary sewer discharge limits and was compared to actual discharge analytical data for the existing WETF NPDES Outfall. The assessment was extremely conservative assuming no removal of WETF contaminants at the city wastewater treatment plant and no dilution with EFPC. Even using this conservative scenario, the calculated risk (4.59×10^{-9}) of discharging treated WETF effluents to the sanitary sewer system was well below the acceptable risk value of 10^{-4}.

Minimal impacts to biota, natural resources, and humans would be expected under the proposed action based on the evaluation of socioeconomic and environmental factors. Combined chemical and radiological impacts to human health would be minimal and within or below DOE and EPA target ranges, as previously discussed. Transportation risk would also be very low.

The no action alternative would impact the City of Oak Ridge's ability to sustain future industrial growth due to the lack of radionuclide capacity within the sewer system. This could force the city to alter and even discontinue existing government and commercial radionuclide discharges to the sanitary sewer system, limit industrial growth to remaining radionuclide capacity or leave the existing ORR land application sites altogether in favor of free distribution of the biosolids material to the public. This could directly impact the city's acceptance of the ORNL biosolids and could result in the management of sanitary ORNL biosolids as low level radioactive waste because of the lack of other viable sanitary waste options for the material. This change would result in an operational cost increase of $67,000 per year for DOE Oak Ridge Operations. Future commercial and DOE sanitary wastewater projects could also be affected by the city's limited radionuclide capacity; however, direct socioeconomic impacts are impossible to forecast. The projected cost savings of $133,000 per year for WETF operations would also not be realized.

GLOSSARY

GLOSSARY

Adsorption	Adhesion of molecules of gas, liquid, or dissolved solids to a surface.
Anaerobic	A life or process that occurs in, or is not destroyed by, the absence of oxygen.
Aeration	A process that promotes biological degradation of organic water. The process may be passive (as when waste is exposed to air) or active (as when a mixing or bubbling device introduces the air).
Agronomic Rate	The annual application rate which is based upon the total amount of nitrogen needed to grow a specific type of vegetation.
Biosolids	Solid particles that are physically separated and treated during the sanitary wastewater treatment process
Buffer zones	An area designated to separate certain features, such as streams, lakes, or roads, from impacts from sludge application. The width of buffer zones for sludge application is determined by the Tennessee Department of Environment and Conservation.
Class A	Biosolids that do not possess pathogenic organisms and meet all designated EPA standards for free release without the use of a permit
Class B	Biosolids that possess a minimal level of pathogens that are destroyed within the first few hours after application. The land application of these materials require a permit and adherence to specific site restrictions via EPA.
Demographics	Statistics relating to the dynamic balance of a population, especially with regard to density, distribution, and capacity for expansion or decline.
Desiccation	Drying out; plants or insects or microorganisms may dry out to the extent that they die.

Heavy metals	Metallic elements with high atomic weights, for example, mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.
Herbaceous	Plants having little or no woody tissue and persisting usually for a single growing season.
Hydrogeology	The geology of groundwater, with particular emphasis on the chemistry and movement of water.
Hydrology	The science dealing with the properties, distribution, and circulation of water.
Influent	Water, wastewater, or other liquid flowing into a treatment plant.
Inorganic chemicals	Chemical substances of mineral origin, not of basically carbon structure.
Natural areas	Areas on the Oak Ridge Reservation that have been established to protect state or federally listed rare species and species under status review for federal listing that occur on the Oak Ridge Reservation. The Natural Areas consist of a core area (actual location of the plants) and a buffer area for habitat protection.
Organic chemicals	Substances containing mainly carbon, hydrogen, and oxygen.
Pathogens	Microorganisms that can cause disease in other organisms or in humans, animals, and plants. They may be bacteria, viruses, or parasites and are found in sewage.
Potable water	Water that is safe for drinking and cooking.
POTW	Publicly owned treatment works: a waste treatment works, usually owned by a unit of local government and designed to treat domestic wastewaters.

Radionuclide	Radioactive element, characterized according to its atomic mass and atomic number, that can be man-made or naturally occurring. They can have a long life as soil or water pollutants.
Reference areas	Areas on the Oak Ridge Reservation that are representative of the vegetational communities of the southern Appalachian region or that possess unique biotic features. These areas are important as sources of baseline information for long-term observations and monitoring. They are set aside for the exclusive use of nonmanipulative environmental research.
Sewage sludge	Sludge (i.e., biosolids) produced at a POTW, the disposal of which is regulated under the Clean Water Act.
Transient	Passing through or by a place with only a brief stay.
Waters of the state	Any and all waters, public or private, on or beneath the surface of the ground, which are contained within, flow through, or border upon Tennessee or any portion thereof except those bodies of water confined to and retained within the limits of private property in single ownership which do not combine or effect a junction with natural surface or underground waters.

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) proposes to increase approved radionuclide land loading limits for the Oak Ridge Reservation (ORR) Biosolids Land Application Sites from a cumulative dose of 4 mrem/yr to 10 mrem/yr and to add treated, effluent discharges from the Y-12 West End Treatment Facility (WETF) into the Y-12 and City of Oak Ridge Sanitary Sewer Systems. If potentially significant environmental impacts are found to be associated with the increase from 4 mrem/yr to 10 mrem/yr and addition of the treated WETF discharges into the sewer system, an environmental impact statement will be prepared; if not, DOE will issue a Finding of No Significant Impact (FONSI) and proceed with the proposed action.

Public involvement is important to the NEPA process. Prior to preparation of this EA, public input was requested and a DOE Informational Session will be forthcoming. Informational handouts, a computerized presentation, and resource personnel will be available to explain the biosolids land application program and potential program changes. On February 15, 2001, DOE published a Notice to Prepare an EA. This notice included names of individuals to contact with comments or requests for copies of the EA. Two presentations were made to the Site Specific Advisory Board Waste Management Committee with a tour of the biosolids land application sites and WETF conducted on June 18, 2001 to discuss the proposed action. The public comment period occurred from October 1 to November 21, 2002. A total of 67 comments were received. Original comments received and comment responses are attached to this document.

1.1 PURPOSE AND NEED FOR AGENCY ACTION

DOE and the City of Oak Ridge have jointly sponsored the ORR Biosolids Land Application Program since 1984. This program allows for the beneficial re-use of treated, biosolids (i.e., sewage sludge) on open hayfields and reforestation plots on EPA-permitted land application sites. Since 1999, the City of Oak Ridge began accepting ORNL biosolids in the existing land application program. In addition, multiple industrial sources with the potential to discharge radionuclides exist, resulting in an extremely limited capacity for future industrial growth within the boundaries of Oak Ridge.

The specific impacts upon human health and the environment will be assessed in this National Environmental Policy Act (NEPA) document as part of the decision-making process to determine if the 10 mrem/yr planning level increase for the Oak Ridge Reservation Biosolids Land Application Sites and the addition of treated WETF effluents to the sewer system should be implemented.

The proposed action would allow the future expansion of additional industrial users to the City of Oak Ridge Sewer System and implement a more effective method of managing treated wastewater from WETF than the current method, which is the discharge of treated wastewaters through the existing Y-12 National Pollutant Discharge Elimination System (NPDES) point, at a higher sampling and materials treatment cost.

This action is driven by (1) the need for expanded radionuclide capacity on active ORR land application sites such as not to impact industrial growth within the City of Oak Ridge, (2) the need to assist the City of Oak Ridge in economic development and (3) the need to reduce the cost of current wastewater effluent discharges at WETF.

DOE Oak Ridge Operations (ORO) has established self-imposed, dose-based (4 mrem/yr) radionuclide limits for ORR application site soils and city biosolids to maximize the beneficial nutrient qualities of the material while effectively managing the trace radionuclides contained within the material. These limits were developed to prevent any future remedial activities involving biosolids amended soils. Presently, the City of Oak Ridge has reached the maximum level of radionuclides that can be issued to industrial dischargers within the city sewer system and needs the existing planning level of 4 mrem/yr to be raised to 10 mrem/yr.

Because of limited capacity for future industrial growth within the City of Oak Ridge Sewer System, the city consulted for short and long-term solutions to this problem. The short term solution was determined to minimize the acceptance of any additional dischargers to the city sewer system that may contain radionuclides within their effluent discharges. The long-term solution involved increasing land application site loading criteria from a cumulative dose-based on 4 mrem/yr to one based on 10 mrem/yr, for a maximally exposed individual. The concurrence letter from TDEC is available in ***Appendix A***.

This would allow the city to allocate radionuclide planning levels for future dischargers based upon operational need while not impeding future commercial growth within the City of Oak Ridge or affecting day to day operations. It should be noted that the existing and proposed radionuclide planning levels reflect the conceptual, worst-case exposure scenario that a person residing on the actual application site, eating food and drinking water exposed to the radionuclides that have been land-applied with the city biosolids. In reality, the existing sites are isolated from members of the public and access is controlled through ORR security because of the application site proximity to the Y-12 Plant. The proposed 10 mrem/yr planning level is extremely conservative considering that established Nuclear Regulatory Commission (NRC) radionuclide clean-up criteria is 25 mrem/yr. When compared to other exposures received by members of the general public on a day to day basis, the proposed planning level is also very conservative.

The planning level increase is required to allow future industrial growth for both government and commercial industries while minimizing impacts upon existing City of Oak Ridge wastewater treatment and biosolids beneficial re-use operations.

1.2 BACKGROUND

The current biosolids land application sites are located on the ORR in Oak Ridge, Tennessee (***Figure 1.1***).

1.2.1 Oak Ridge Reservation Biosolids Land Application Sites

The City of Oak Ridge, Tennessee, owns and operates a publicly owned treatment works (POTW) that receives wastewater from a variety of industrial, commercial, and residential generators in the Anderson/Roane County area. One of the chief contributors, with approximately 20% of the POTW's total influent (DOE 1996), is the U.S. Department of Energy (DOE) Y-12 Plant. All industrial generators are required by Oak Ridge City Ordinance Number 9-91 to obtain an industrial discharge permit (IDP) from the city, which prescribes discharge limits and monitoring/reporting requirements.

Under a land-license agreement (DOE 2000) with DOE, the City of Oak Ridge has been applying municipal biosolids as a beneficial soil amendment on the ORR since 1983 (DOE 1996). To date, no spills or traffic accidents have occurred since the program began.

The City of Oak Ridge Biosolids Land Application Program has been recognized for excellence in beneficial re-use and program management by the Tennessee/Kentucky Water Environment Association (WEA) in 1997 and EPA, Region IV in 1999. The existing land application sites have had no known historical operations or projects conducted on them prior to being approved for biosolids application. The sites are not adjacent to existing structures, houses, landmarks, recreational areas and are somewhat isolated from the public except for coordinated turkey and deer hunts and security personnel.

In October 1996 the ORR Biosolids Land Application Program prepared an EA (DOE 1996) that evaluated total site capacity, the addition of ORNL and ETTP sanitary wastewater treatment plant biosolids and the establishment of application site soil and biosolids radionuclide planning levels based upon a 4 mrem/yr cumulative dose modeling scenario. Upon completion of the EA, a Finding of No Significant Impact (FONSI) was issued in November 1996.

Municipal biosolids are not considered a Resource Conservation and Recovery Act (RCRA) waste but are regulated under the provisions of 40 *Code of Federal Regulations* (CFR) Part 503 of the Clean Water Act (CWA). EPA establishes standards for biosolids use and disposal, including risk-based, metal-loading criteria for the receiving soil, as specified in 40 CFR Part 503. Non-radiological program requirements are imposed by the State of Tennessee via the city's NPDES permit (TDEC 1998), State Land Application Approval (LAA), EPA permit #TNL024155 (EPA 1997) and EPA regulations listed in 40 CFR Part 503 (EPA 1993). The characteristics of the city biosolids are described in ***Appendix B***, ***Tables B.1*** through ***B.4*** show the concentrations of inorganic chemicals, heavy metals, organic chemicals, and radionuclides. Biosolids land application site profiles are also discussed in ***Appendix B Tables B.5*** through ***B.10***. Although Oak Ridge biosolids contains trace amounts of inorganic nutrients, heavy metals and radionuclides, as do most municipal biosolids, levels are well within prescribed limits as mandated by the Tennessee Department of Environment and Conservation (TDEC), EPA and DOE.

Biosolids recycling and land application, which are the terms EPA uses for biosolids applied to land for its beneficial properties (58 *FR* 9321 Standards for the Use or Disposal of Biosolids; Final Rule 1993), consists of distributing liquid, solid, or composted biosolids on or just below the soil surface where it is employed as a fertilizer or soil conditioner. For example, beneficial uses may include improving tree growth for hardwood reforestation, increasing organic matter and enhancing soil tilth for hay production or growth of native species, or helping to restore disturbed areas by providing nutrients for new seedlings.

Land application as currently practiced by the City of Oak Ridge currently involves spraying liquid biosolids (2 to 3% solids) under pressure from a tanker, resulting in a thin layer of biosolids on the soil surface and vegetation. The City of Oak Ridge currently trucks 2 to 6 loads/day (40 to 120 loads/month) of biosolids in the city-owned 20,400-L (5,400-gal) tanker truck to the active land application sites. On the ORR, the biosolids are transferred to a 5,300-L (1,400-gal) field vehicle for surface spray application (DOE 1996). In addition to the high-pressure surface spray, biosolids can also be applied by the same application vehicle using spray nozzles at the rear of the vehicle.

In the Summer of 2001, the City of Oak Ridge implemented a new de-watering and thermal treatment system that increased the solids content and sterilize the biosolids hauled and dispersed at the ORR land application sites, resulting in a more manageable, safer material. This material is applied using manure spreading equipment in a calibrated dispersion pattern. This minimizes the potential for over-application and results in an operational cost savings by reducing the transportation costs to land apply biosolids from 36 to 2 or 3 trips. Biosolids have been applied to TDEC-approved, EPA-permitted sites at a calculated agronomic (i.e., nitrogen) rate. This rate is based directly upon past amounts of application, the amount of nitrogen within the biosolids material being applied and what are the specific vegetative nitrogen growth requirements. The rate is calculated annually, and changes as the nitrogen levels and the total amount of biosolids are applied throughout each calendar year. Each site also has a cumulative lifetime loading limit of 50 tons/acre (dry wt.) that has been approved by TDEC and DOE (DOE 1996).

Figure 1.1. Oak Ridge Biosolids Land Application Sites

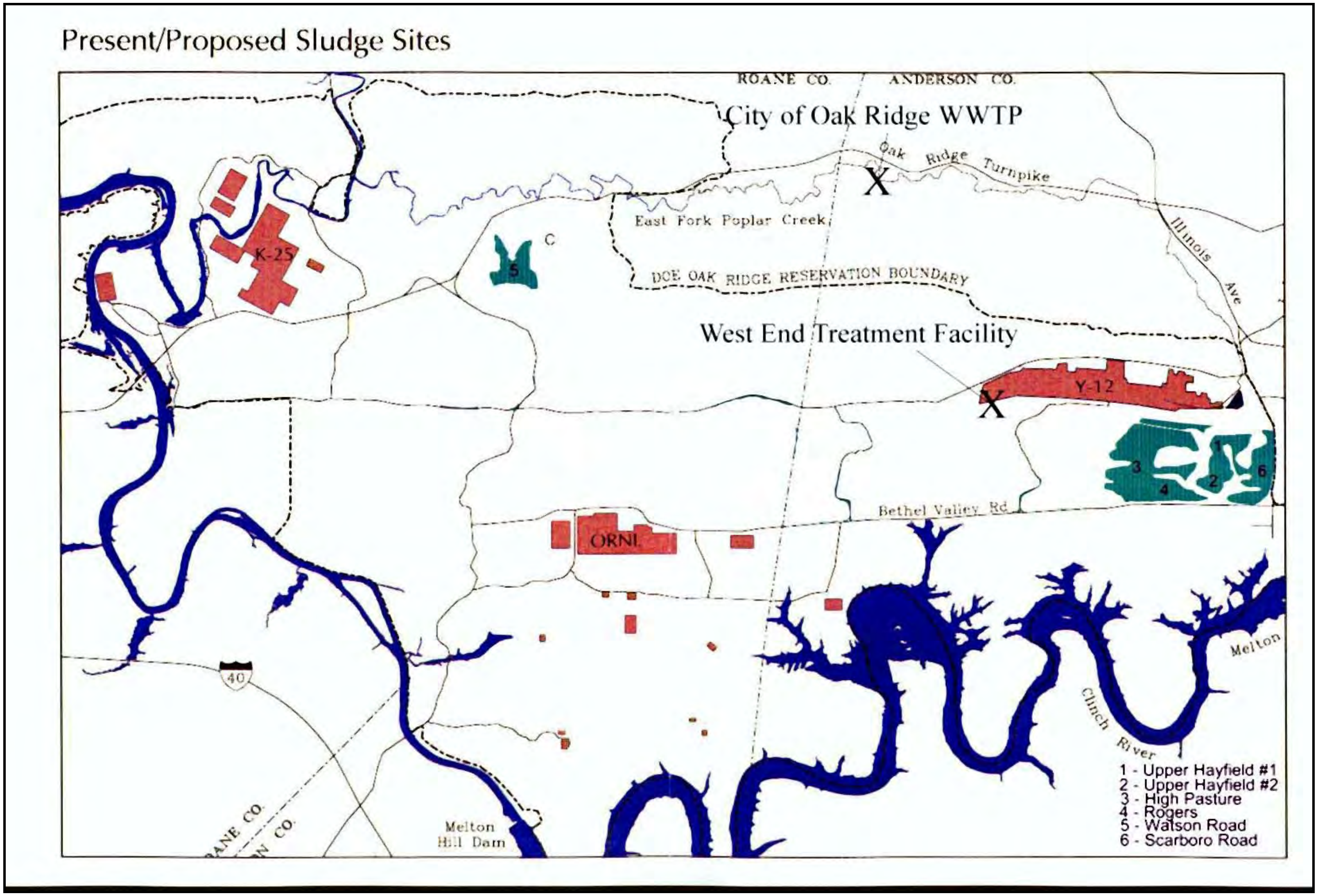


Table 1.1. Oak Ridge Reservation Biosolids Land Application Sites

Site Name	Status	Acres (Ac)	Hectares (ha)
Upper Hayfield #1	Active	30	12.15
Upper Hayfield #2	Active	27	10.93
High Pasture	Active	46	18.62
Watson Road	Active	117	47.37
Scarboro Road	Active	77	31.17
Rogers	Active	32	12.96
McCoy	Inactive	23	9.31
Cottonwoods	Inactive	17	6.88
Site #8	Inactive	12	4.85

There are six active land application sites totaling 133 ha (329 acres) on the ORR (***Table 1.1*** and ***Figure 1.1***). Three previously utilized sites totaling 21 ha (52 acres) are currently inactive (***Table 1.1***). Any actions by DOE to manage biosolids must comply with federal and state laws and DOE regulations (see ***Section 6.0***).

Biosolids typically contains both natural and human-made radionuclides. In 1995, the American Metropolitan Sewer Association (AMSA) conducted a radionuclide survey (AMSA 1995) of biosolids produced at over 100 POTWs located in heavily populated areas of the U.S. All POTWs exhibited some level of radioactivity, some had levels of particular concern. This concern prompted a nationwide survey of over 300 POTWs by the EPA and Nuclear Regulatory Commission (NRC) for the purposes of formulating baseline radioactivity data associated with biosolids products. The results of this survey will be made available to the public in future months.

Because there are currently no applicable federal biosolids radioactivity standards, the state, the City of Oak Ridge and DOE established conservative biosolids land application site soil planning levels for 23 specific radionuclides based upon a 4 mrem/yr, 365-day per year homesteader (i.e. living on site) utilizing 9 pathways of exposure in the previously approved EA. Residual Radioactivity (RESRAD) modeling of the previously-approved EA summarizes the methodology for establishing dose-based radionuclide planning levels for the land application program. In addition, the City of Oak Ridge operates an on-site gamma spectrometer system that analyzes the biosolids radionuclide content land applied each day.

This system has established action levels that prevent the land application of biosolids in excess of acceptable radionuclide levels. The city also contracts with ORNL to perform independent radionuclide analyses as a cross-check to ensure compliance with the established 4 mrem/yr criteria. Since many of the 23 radionuclides are not present in the City of Oak Ridge biosolids, analytical action levels are only established for known, key radionuclides to prevent the inadvertent application of biosolids confirmed to contain elevated levels of radionuclides. To date, only one action level has been triggered, resulting in a closer examination of the material but not important enough to halt application operations.

Since 1999, the City of Oak Ridge began accepting ORNL biosolids in the existing land application program. In addition, multiple industrial sources with the potential to discharge radionuclides exist, resulting in a extremely limited capacity for future industrial growth within the boundaries of Oak Ridge. In response, the City of Oak Ridge petitioned the TDEC-Division of Radiological Health to approve an increase in radionuclide land application loading criteria from that based on 4 mrem/yr to 10 mrem/yr. In June 1999, TDEC responded with a letter (***Appendix A***) concurring with the increase. The specific impacts upon human health and the environment will be assessed in this National Environmental Policy Act (NEPA) document as part of the decision-making process to determine if the 10 mrem/yr planning level for the Oak Ridge Reservation Biosolids Land Application Sites and the addition of treated WETF effluents to the sewer system should be implemented.

It should be noted that the existing and proposed radionuclide planning levels reflect the conceptual, worst-case exposure scenario that a person residing on the actual application site, eating food and drinking water exposed to the radionuclides that have been land-applied with the city biosolids. In reality, the existing sites are isolated from members of the public and access is controlled through ORR security because of the application site proximity to the Y-12 Plant. The City of Oak Ridge issues permit limits to industrial users based upon effluent discharge limits to East Fork Poplar Creek (EFPC) and ORR biosolids land application contaminant restrictions listed in existing permits and agreements with EPA, TDEC and DOE (***Section 6.0***). Industrial discharge limits are developed using these restrictions, the contaminant removal efficiency of the POTW and the needs of the industrial user petitioning to discharge to the city sanitary sewer system. At a minimum, the acceptance of contaminants prior to treatment at the POTW must not cause the POTW to exceed contaminant limitations on the effluent discharge to EFPC or on the ORR Biosolids Land Application Sites. Put simply, the limits for acceptance must not exceed the end point (e.g., ORR application sites) contaminant limits.

Specific contaminant limits are developed by assessing the needs of all industrial users in the City of Oak Ridge Pre-treatment Program. A worst-case scenario is used in developing the corresponding limit such that all permittees discharge at their maximum contaminant levels at one point in time. Although this scenario is extremely conservative and unlikely to occur in day to day operations of a POTW, this is the accepted method of contaminant limit development within EPA and TDEC.

Sanitary sewer discharge limits are issued to industrial users directly from the City of Oak Ridge. Larger industrial users, such as the Y-12 Plant, have users connected to their portion of the sewer system which require management by the permit holder to ensure that discharge limits are not exceeded. For example, the Y-12 Plant may have a number of building drains and other sanitary effluents that could enter the Y-12 sewer system. The BWXT Sanitary Sewer Coordinator would develop limits for each of the "internal users" based upon the Y-12 Plant IDP contaminant limits issued to them by the city. Limits to internal users are based upon available capacity, room for growth and process need within the Y-12 Sewer System. The addition of treated WETF effluents to the system are no exception and will be managed by BWXT as with any other internal user of the Y-12 sewer system.

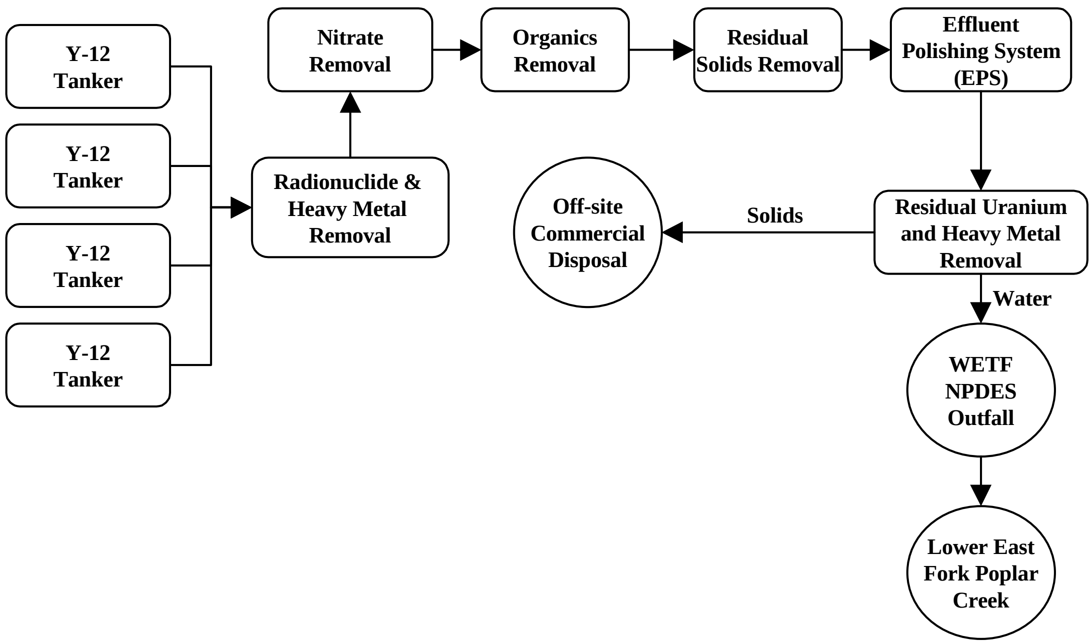
1.2.2 West End Treatment Facility

In May 2000, a sanitary sewer assessment (WSMS 2000) was conducted that assessed the feasibility and analyzed the regulatory impacts of allowing treated wastewaters from WETF to be directly discharged into the Y-12 Sewer System thereby reaching the City of Oak Ridge Sewer System and ultimately, the ORR Biosolids Land Application Sites. The study recommended sanitary sewer discharges as a viable, cost savings alternative to the current method of treating all of the wastewaters at EPS and discharging effluents through the WETF NPDES Outfall to East Fork Poplar Creek (EFPC).

WETF receives batch wastewater from a number of generators throughout the Y-12 Plant Site, as well as other approved DOE-ORR generators. The characteristics of these wastewaters vary greatly in constituent and concentration levels. Existing WETF operations consist of head-end treatment (heavy metal and radionuclide removal), bio-denitrification (nitrate removal), bio-oxidation (organic compound removal), Effluent Polishing System (EPS) and a number of other tanks used for storage of solids and wastewaters. WETF has had a number of process modifications within the physical configuration of the wastewater treatment processes increasing the removal of contaminants such as heavy metals, radionuclides, and organic compounds.

As a result, one process, the Effluent Polishing System (EPS) may not be required to used to treat wastewaters that have very low contaminant levels. Process changes, accelerated tank clean-out efforts and the prohibition on the acceptance of listed hazardous wastes have resulted in more cost-effective ways to manage treated wastewaters at WETF. ***Figure 1.2*** provides a simplified diagram of the current operational configuration of WETF.

Figure 1.2. Current WETF Operational Configuration



Prior to 1994, head-end treatment was not available and EPS was primarily utilized to remove heavy metals and radionuclides. Since 1994, head-end treatment has been extremely effective in removing the majority of heavy metals and radionuclides contained within wastewater treatment batches processed at WETF. Due to higher operating costs at EPS, increased heavy metal and radionuclide removal efficiency of head-end treatment, accelerated tank clean-out operations and prohibition of all listed RCRA wastes by Bechtel Jacobs Company and DOE-EM at WETF, discharges to the sanitary sewer system without treatment at EPS were evaluated and recommended as a viable option in the sewer assessment (WSMS 2000).

Because wastewaters are processed through WETF as batches, each 500,000-gallon batch has its own unique characteristics that, depending upon heavy metal and radionuclide concentrations, may or may not require treatment through EPS.

Some batches of wastewater generated have very low levels of contaminants that could meet Y-12 Sanitary Sewer System discharge criteria with a slight modification to the existing Y-12 Industrial Discharge Permit (IDP) for nickel and uranium. Based upon estimates performed as a part of the sewer assessment (WSMS 2000), a cost savings of approximately $133,000 per year could be realized by utilizing the Y-12 sanitary sewer system in conjunction with minimizing the use of EPS (50%) to treat only those batches of wastewater that would require additional treatment to meet established discharge criteria.

Although it is understood that the City of Oak Ridge cannot impose a uranium limit on discharges from the Y-12 Plant, the city has indicated that it reserves the right to refuse any discharges to the Oak Ridge Sewer System that may be considered problematic with their operations. In discussions held with the city during the time of the sanitary sewer study, a proposed limit of 3,785 total grams of uranium which corresponds to a 2 mg/l at a flow rate of 5 gpm for each 500,000 gallon tank had been discussed. This limit was developed such that treated wastewaters discharged to the Y-12 and City of Oak Ridge sanitary sewer systems would not impact the city's ability to treat wastewaters and beneficially re-use the biosolids produced at the city POTW. The limit is also feasible for WETF operations such that an entire 500,000-gallon tank of treated wastewater can be discharged in a reasonable amount of time (e.g., 70 days at the proposed uranium limit). The environmental impacts for the proposed radionuclide planning levels will be evaluated in this NEPA analysis.

1.3 SCOPE OF THE ANALYSIS

This Environmental Assessment (EA) evaluates the impacts of (1) increasing radionuclide loading planning levels for ORR Biosolids Land Application Sites from those previously modeled at 4 mrem/yr to newly modeled planning levels assuming a 10 mrem/yr dose rate; (2) the addition of the Y-12 Plant West End Treatment Facility (WETF) into the Y-12 and City of Oak Ridge Sewer Systems; and (3) no action.

The proposed action of converting from a liquid, Class B (i.e., biologically active) to a solid, Class A (i.e., non-biologically active) biosolids material is not addressed in this document, because it has been previously assessed in a previous EA (DOE 1996) and re-visited in a technical memorandum (H. Rice to D. Allen 2000) and found to not have significant impacts upon the ORR.

This EA conforms to the requirements of the Council on Environmental Quality (CEQ) regulations (40 *CFR* Parts 1500-1508) implementing the National Environmental Policy Act of 1969 (NEPA) and DOE NEPA Implementing Procedures (10 *CFR* 1021).

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

4 to 10 mrem/yr Radionuclide Loading Planning level Increase

DOE proposes to raise the biosolids land application loading limits for radionuclides from the current, self-imposed planning levels based upon 4 mrem/yr, 365-day homesteader (i.e., constant site occupancy) to 10 mrem/yr, 365-day homesteader. For consistency and the purposes of assessing specific impacts, the same assumptions and pathways utilized in the previous RESRAD modeling will be used in determining biosolids and application site soil planning levels. Land application planning levels for known radionuclides in the city sewer system (e.g., Uranium, Cobalt-60, Cesium-137) and others that were not previously modeled but have the possibility of demonstrating detectable levels (e.g., Strontium-90 and Europium-154) have been developed using a maximum reference dose of 10 mrem/yr and resulting planning levels are available in additional technical support documentation (Performance Technology Group 2001) that will be made available for review at the DOE Public Reading Room. Strontium-90 and Europium-154 have recently been identified in ORNL biosolids and have been included in the updated RESRAD modeling for 10 mrem/yr planning levels. Radionuclides (Plutonium-238, Neptunium-237, etc.) that have not shown detectable levels having established biosolids and site soil planning levels will remain at the 4 mrem/yr levels because the need to raise the respective levels does not exist. ***Table D.3.*** of the 10 mrem/yr RESRAD modeling (***Appendix D***) summarizes the applicable calculated dose-based planning levels. The planning level of each radionuclide listed in the RESRAD modeling corresponds to a 10 mrem/year cumulative dose planning level to the maximally exposed individual.

West End Treatment Facility Effluents

DOE also proposes the addition of the Y-12 Plant West End Treatment Facility (WETF) treated effluent discharges into the Y-12 and City of Oak Ridge sewer systems. This alternative is viable because of the removal of listed hazardous wastes (i.e., Non-RCRA coding) after treatment and the extensive tank clean out effort conducted in recent years at WETF. In addition, by adding equipment modifications such as the neutralization reaction tank thereby increasing the removal efficiency of heavy metals, nitrates and organic compounds, residual contaminant levels are very low and may not require the level of treatment provided by the Effluent Polishing System (EPS).

Since contaminant levels are very low, DOE proposes to provide a controlled, monitored discharge to the Y-12 Sanitary Sewer System for WETF wastewaters that have undergone treatment and can demonstrate compliance with proposed monthly sewer system discharge criteria (***Table B.12 in Appendix B***) as established by BWXT and the City of Oak Ridge. Because both the City of Oak Ridge and WETF wastewater treatment plants discharge to the same tributary, East Fork Poplar Creek (EFPC), but at different points in the stream, the flow of effluent is the same whether they were discharged directly from WETF or the City of Oak Ridge POTW. It is assumed that because heavy metals and radionuclides typically weigh more than other contaminants found in WETF wastewaters, these materials would settle in the biosolids treatment process at the city POTW and be land applied on the ORR land application sites. *A very small portion of the total uranium (i.e., maximum 7.56 kg per year) that would have been shipped off site as WETF process residuals to a commercial disposal facility would be land applied on the ORR application sites.* The specific impacts of this increase are discussed in ***Section 4.1***.

Based upon assumptions utilized in the WETF Sanitary Sewer Assessment (WSMS 2000), it would take approximately 70 days to discharge a 500,000-gallon tank at 5 gpm, 24 hours per day, 7 days per week.

Figure 2.1 displays the proposed flow diagram for WETF discharges to the Y-12 Sanitary Sewer System and NPDES outfall. Each batch of treated 500,000 gallon WETF effluent will be collected in Tank F-8, sampled and analyzed for a total of 165 pollutants to include heavy metals, radionuclides, organic compounds, pesticides and PCBs prior to discharge to the sewer system.

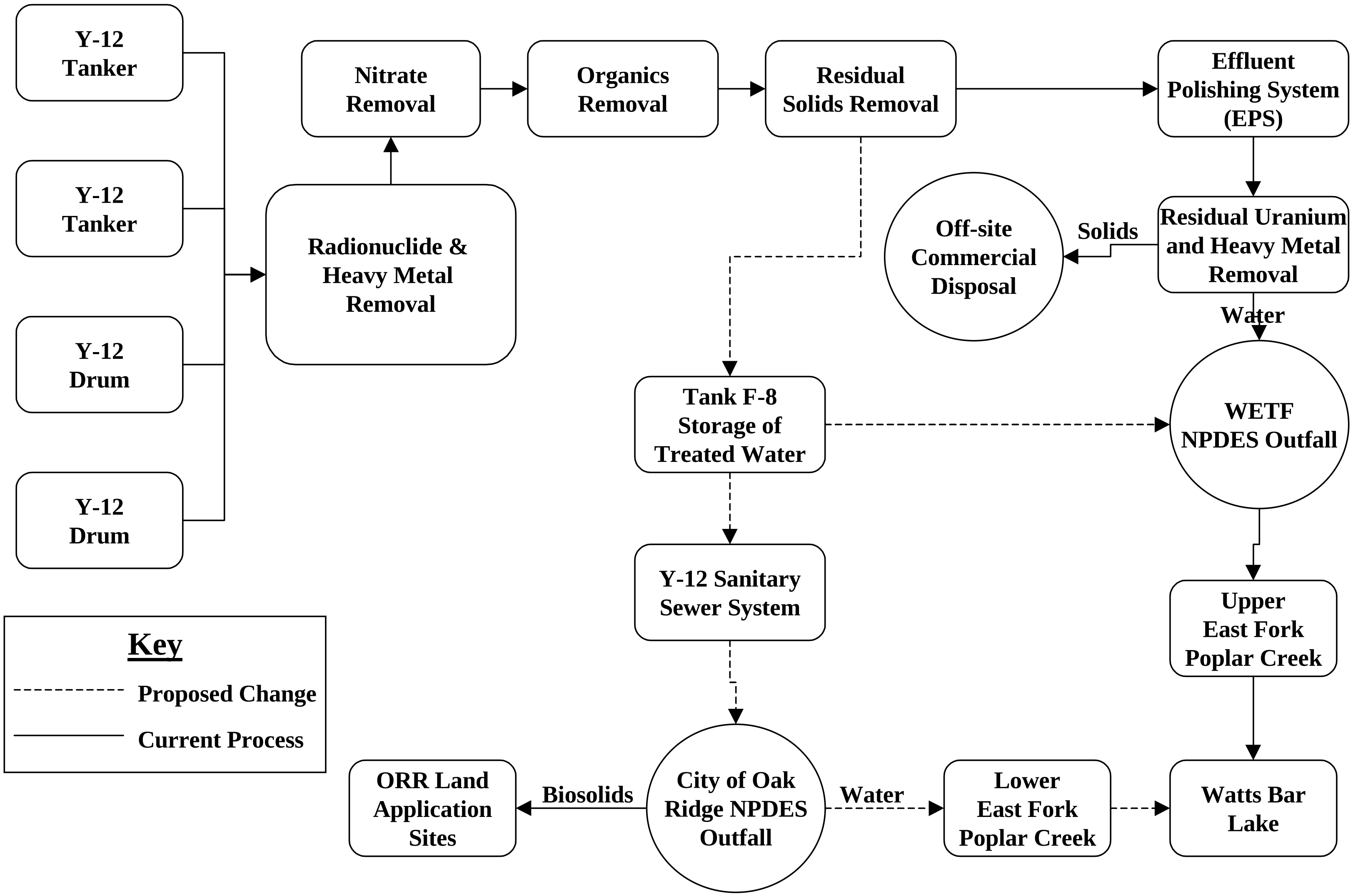
After analytical results have been received, the BWXT Sanitary Sewer Compliance Coordinator will be contacted requesting approval to discharge the analyzed WETF effluent to the sewer system, provided all contaminant parameters (***See Appendix B, Table B.12***) are met. The BWXT sewer coordinator will issue approval to discharge at a specific rate for a finite period of time. In times of unforeseen emergency or other circumstances that may be warranted, the discharges to the sewer system will be immediately halted upon notification by BWXT compliance personnel.

Batches can remain in storage until discharges are allowed to resume or can be pumped directly to the existing NPDES discharge point, provided compliance can be demonstrated with NPDES discharge criteria.

Batches that fail any established sanitary sewer discharge criteria will receive additional treatment through the appropriate operable unit at WETF, for example, if elevated nitrates are found in the treated wastewater stored in Tank F-8, the water will be pumped to the biodenitrification units to destroy the residual nitrate compounds. Wastewaters that receive further treatment will be re-sampled and analyzed to determine compliance with established sanitary sewer criteria prior to discharge.

A suitable, existing discharge point to the sanitary sewer system is located within 100 feet of the proposed WETF treated water holding tank F-8. To accommodate the discharge of treated WETF wastewaters to the Y-12 Sanitary Sewer System, a small amount (less than 100 feet) of underground sewer piping and new manhole cover will need to be installed before discharges can commence.

Figure 2.1. Proposed Sanitary Sewer Discharges from the West End Treatment Facility to the Sanitary Sewer System



2.2 PROPOSED ALTERNATIVES

2.2.1 Raising the ORR Biosolids Land Application radionuclide planning levels from 4 mrem/yr to 10 mrem/yr and not allowing the addition of WETF effluents into the sanitary sewer system

This alternative would allow raising the current ORR land application planning levels from 4 mrem/yr to 10 mrem/yr, but without the addition of WETF effluents into the Y-12 and City of Oak Ridge sanitary sewer systems. Normal land application activities would continue at all active sites. The City of Oak Ridge would recalculate available radionuclide capacities based upon the 10 mrem/yr modeled planning levels and would revise radionuclide acceptance levels for the POTW. The absence of WETF effluents in the sewer system would result in a slightly higher POTW contaminant capacity for nickel and uranium. As new commercial industries that have needs with regards to radionuclide discharge to the sewer system are identified, the City of Oak Ridge would assess potential maximum discharges and issue radionuclide limits based upon "worst-case" modeling scenarios and available capacity, as previously discussed. Biosolids land application site soils would continue to be closely monitored, as performed in the current scope of POTW operations.

WETF would continue to operate under its present configuration which would include treatment through EPS and discharge of effluents through the NPDES outfall to EFPC. The estimated cost savings of $133,000 projected in the sanitary sewer assessment (WSMS 2000) would not be realized. BWXT would not need to revise the existing Y-12 Plant Industrial Discharge Permit (IDP) to accommodate WETF effluents for total uranium and nickel. This would result in a maximum reduction of 41 g per day (1,260 g per month) for total uranium and 1.2 g per day (38 g per month) for nickel for 4 months of the entire 12 month calendar year.

2.2.2 No Action

The no-action alternative provides an environmental baseline with which impacts of the proposed action and alternatives can be compared. Under the no-action alternative, ORR biosolids land application radionuclide loading limits would remain at a 4 mrem/yr dose and WETF effluents would not be allowed to be discharged into the sanitary sewer system.

Because of the limited radionuclide capacity available for new industrial growth, any one or a combination of the following actions could be utilized:

1. Industries currently discharging even minimal amounts of radionuclides to the sanitary sewer system could be severely restricted or denied to allow for some radionuclide capacity;

2. Industries currently discharging could discharge radionuclide at permitted levels allowing no room for future industrial growth; and

3. The city could leave the ORR land application sites in favor of freely distributing the treated biosolids material to public outlets consistent with EPA regulations.

Also, present and future DOE sanitary wastewaters and biosolids bearing any level of radionuclides requiring treatment in all likelihood, would not be accepted at the city POTW, forcing DOE to explore other more costly treatment alternatives for their sanitary wastewaters. The acceptance and treatment of ORNL biosolids could also be discontinued, since there are no other sanitary sludge disposal options remaining, ORNL biosolids would be managed as low-level radioactive waste, resulting in an additional cost of approximately $67,000 per year (Arp 2001) for DOE. Future DOE projects could also be impacted by not accepting biosolids or wastewaters originating from the ETTP site. The amount and type of contaminants from industries currently at the ETTP site and future industries could be limited to treatment capacity of the on-site wastewater treatment plant, which at the present, is somewhat limited. This could have an impact upon new industries locating at the ETTP site and the potential presence of radionuclides in their respective effluents.

WETF would continue to operate under its present configuration, which would include treatment through EPS and discharge of effluents through the NPDES outfall to EFPC. An estimated cost savings of $133,000 projected in the Sanitary Sewer Assessment (WSMS 2000) would not be realized. BWXT would not need to revise the existing Y-12 Plant IDP to accommodate WETF effluents for total uranium and nickel. This would result in a maximum reduction of 41 g per day (1,260 g per month) for total uranium and 1.2 g per day (38 g per month) for nickel for 4 months of the entire 12 month calendar year.

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

Characteristics of the City of Oak Ridge Biosolids, ORR land application sites and WETF wastewaters are available in ***Appendix B*** of this document.

3.1 REGIONAL DEMOGRAPHY/SOCIOECONOMICS

The first step in providing background for demographic and socioeconomic impact analysis is to define a region of influence for the proposed and alternative actions. All activity related to the alternatives would take place either within the City of Oak Ridge or on the ORR, both of which are located within Anderson and Roane Counties, Tennessee. Knox county is also included because of the substantial financial contribution from the local economy. Although the site of the proposed activities represents a small portion of the entire two-county area, the actions taking place could have repercussions for the entire 3 county area. Therefore, it was assumed that Anderson, Roane and Knox Counties were the appropriate definition for the region of influence (ROI) (see ***Appendix C***).

Oak Ridge is located in the east central section of Tennessee, ~32 km (20 miles) west of Knoxville, Tennessee. Oak Ridge includes portions of both Anderson and Roane Counties. The following socioeconomic and demographic data is based upon the most recently available data from the U. S. Department of Commerce Bureau of Economic Analysis. ***Appendix C*** consists of four tables. ***Table C.1*** provides an economic profile for Anderson, Roane and Knox counties for 1996-1998, describing personal income, population, per capita incomes, earnings by category, etc. ***Table C.2*** summarizes the distribution of employment by industry and is inclusive of both full and part-time employment. ***Tables C.3*** and ***C.4*** provide summary statistics of economic data for Anderson, Roane and Knox counties.

Key data from ***Tables C.1*** through ***C.4*** shows that from 1996 to 2000, the population of Anderson County decreased 0.7%, Roane County increased 0.8% while that of Knox County demonstrated the greatest increase of 1.4%. Per capita personal income rose 10.9% for both Anderson and Roane Counties from 1996 to 1999 while Knox County increased to 14.4% for the same time period.. The employment figures for both full and part-time workers reflected a decline for Anderson (0.4%) and Roane (10.3%) Counties while Knox County displayed an increase of 5.2% during the reference period.

Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, signed by President Clinton in February 1994, requires each Federal Agency to formulate a strategy for addressing environmental issues in human health- and environment- related programs, policies, planning and public participation processes, enforcement, and rulemakings. The White House memorandum accompanying the Executive Order directs Federal agencies to "Analyze the environmental effects...of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA." Pursuant to the Executive Order, environmental justice analyses identify and address any disproportionately high and adverse human health or environmental effects on minority or low-income populations from the proposed actions included in this EA. Adverse health effects may include bodily impairment, infirmity, illness or death. Adverse environmental effects include socioeconomic effects, when those impacts are interrelated to impacts on the natural or physical environment.

Environmental justice guidance defines "minority" as individual(s) who are members or the following population groups: American Indian or Alaskan Native, Asian or Pacific Islander, Black or Hispanic. Minority populations are identified when either the minority population in the affected area is substantially greater than the minority population percentage in the general population in the surrounding area or other appropriate unit of geographical analysis. Low-income populations are identified using statistical poverty thresholds from the Bureau of Census (defined in 1990 as 1989 income less than $12,674 for a family of four). Minority population and income data at the census tract level are only available from the decennial census. The most recent data available is from 1990.

Biosolids Land Application Program operations are conducted on the ORR near the Y-12 Plant and in remote locations near the newly developed Parcel ED-1 industrial park. The only minority community located in close proximity to active application operations is the Scarboro Community.

The Scarboro Community is located within 2 miles of the active ORR land application sites. The community is located in east Oak Ridge and is bounded to the west by East Fork Ridge and to the east by Pine Ridge. It is a small urban community of approximately 650 individuals that is located approximately 457 m (1,500 ft) northwest of the Y-12 Plant along the ORR boundary. The community occupies an area of approximately 101 ha (250 acres).

Land in the Scarboro Community was cleared and divided into lots ranging in size from approximately 0.1 to 0.2 ha (0.25 to 0.5 acre). The Scarboro Community Center Park and various churches and small businesses are also located in the Scarboro Community.

3.2 LAND USE

The ORR consists of 13,912 ha (34,424 acres) of federally-owned land, most of which is within the corporate limits of the city of Oak Ridge in Anderson and Roane Counties. The predominant land uses on the ORR are environmental research, forest management, industry, agriculture, and wildlife management. Future land uses for the ORR include research facilities, environmental research areas, environmental partnership area, waste management facilities, future initiatives, transportation improvements, education and recreation, and land transfers/lease areas (ORNL, November 2000). Approximately 70% of the ORR is forested. The three major DOE industrial and research facilities occupy approximately the following land areas: the East Tennessee Technology Park (ETTP) Site, 293 ha (725 acres); the Y-12 National Security Complex (Y-12) , 332 ha (820 acres); and ORNL, 467 ha (1153 acres). The Oak Ridge National Environmental Research Park consists of approximately 20,000 acres and includes natural and reference areas and environmental research sites. Agricultural lands consist mainly of hay fields that are harvested under commercial contracts.

Major public transportation routes within the ORR include State Highways 95, 58, and 327. Highways 58 and 95 carry inter-city traffic to the east, west, and south of Oak Ridge, and Route 327 provides local access to nearby communities north of the ORR.

3.3 ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL RESOURCES

The ORR has a long history of habitation that began an estimated 10,000 years ago with the first occupation by Native Americans. Most recently, four distinct communities (Elza, Scarboro, Robertsville, and Wheat), with a total of ~1,000 families, existed within the area acquired by the federal government for the Manhattan Project. Forty-six archaeological sites have been identified on the ORR. Seven DOE-owned structures are listed on the National Register of Historic Places; five of these are on the ORR. Additional potential listings include any buildings or structures related to the Manhattan Project. Thirty-one cemeteries are also present on the ORR.

3.4 GEOLOGY AND SOILS

3.4.1 General Geologic Setting

The ORR lies within the Valley and Ridge Physiographic Province. The Valley and Ridge Province is characterized by steep-sided parallel ridges with broad intervening valleys, generally oriented in a northeast-southwest direction. The ORR lies ~16 km (10 miles) southeast of the Cumberland Mountains and ~113 km (70 miles) northwest of the Blue Ridge Mountains. Elevations on the ORR range from ~230 m (750 ft) above mean sea level (MSL) along the Clinch River to ~385 m (1260 ft) MSL along the highest ridge tops. The Valley and Ridge Province is part of the southern Appalachian fold and thrust belt. The bedrock stratigraphy of the ORR ranges in age from Lower Cambrian to Upper Ordovician and consists primarily of rock units of the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Group.

3.4.2 Site-Specific Geology

Upper Hayfield #1, Upper Hayfield #2, High Pasture, Rogers and Scarboro Road have all had thorough hydrogeolgical evaluations and were found to be suitable for the land application of biosolids by TDEC-Division of Solids Waste (TDEC, 1983). Watson Road underwent a full hydrogeological evaluation and was found to be suitable for the land application of biosolids by TDEC-Division of Wastewater (TDEC, 1989). Upper Hayfield #1, Upper Hayfield #2, High Pasture, Rogers and Scarboro Road land application sites are located on the southeast side of Chestnut Ridge. The land surface there is hilly with moderate to steep slopes and total relief of up to 200 feet. Chestnut Ridge is strongly dissected with long, deep drain ways which trend both east-west and north-south.

The direction of surface drainage is quite variable over these sites; however, all the sites drain first into Bethel Valley and subsequently into the Melton Hill Reservoir of the Clinch River about 1 mile to the southeast. The drainage pattern of the area is generally rectangular. Several sinks or depressions occur on these application sites. The application sites referenced predominantly overlie the Knox with just their southeast portions underlain by Chickamauga.

The Cambrian-Ordovician-aged Knox Group is composed primarily of thick-bedded siliceous or cherty dolomite and interbedded dolomitic limestone. These rocks are generally fine to medium-grained and thinly to massively bedded. Chert occurs in the Knox as irregular beds, lenses and nodules.

This group generally underlies broad ridges with fairly gentle slopes to the southeast. Thickness of the Knox Group ranges from 900 m (2469 ft) to 1000 m (2743 ft) (Butz 1984).

Knox dolomite gives rise to dissolution or karst features and sinkholes are common. The Knox Group weathers to form deep residual clay soils, commonly more than 100 feet in thickness. Knox soils resist erosion because of the abundant chert on the surface. The Knox weathers to form generally thick, orange to reddish brown, silty, residual clays with varying amounts of chert fragments and blocks. These soils are mostly Fullerton associations.

The Ordovician-aged Chickamauga Group dominantly comprises limestones sequences with calcareous shales and siltstones. Limestones are generally gray to blue-gray and argillaceous or shaly. Thickness of the Chickamauga can reach 670 m (2208 ft) (Butz 1984). Some beds of relatively "pure" limestone may occur within the Chickamauga in addition to interbedded calcareous shales of varying thickness. Chert occurs sparsely in the Chickamauga limestone. The surfaces of valleys underlain by this group are irregular, with the more silty and cherty layers underlying low ridges and hills. Sinkholes do occur, but are not as numerous nor as large as those found within the Knox Group. Chickamauga soils are thinner than those derived from the Knox and may be brown to reddish-brown to yellowish in color. The soils may contain limestone "float," particularly in horizons close to the soil-bedrock interface. The Chickamauga soils here are mostly Collegedale and Sequoia associations, but some areas may have Leadvale and Armuchee soil.

Strata in the area generally dip southeastward at about 25 to 35 degrees, although dips may vary considerably in some areas due to small local structures, faults, etc. The Copper Creek fault occurs just southeast of the application sites, its trace extending along the upper northwest side of Haw Ridge whereby the Cambrian Rome formation is thrust over the Ordovician Chickamauga limestone. Intense jointing has occurred in the subject area as attested to by the previously mentioned sinkholes and the strongly dissected land surface, the joints being probably related to the Copper Creek fault. No structures are located on these land application sites.

Groundwater moves mainly within a system of solution enlarged joints in the carbonate bedrock. Groundwater movement is probably generally southeastward toward the Clinch River, but locally such flow may be either to the northeast or southwest to the deep drainages which cut through Haw Ridge and the Copper Creek fault.

Sinks in the area may provide a substantial recharge system for the groundwater reservoir, although some of the sinks appear to be "filling in" with colluvial sediments wherein percolation would be greatly retarded. One spring occurs just to the northwest of the western most application site, High Pasture, however, this spring is up-gradient from the proposed site and is not affected by land application operations.

3.5 WATER QUALITY

Surface water is drained from the ORR by a network of small streams that are tributaries of the Clinch River. Generally, the tributaries of the Clinch River conform to the physiography of the Valley and Ridge Province by paralleling the Clinch for a long distance before crossing a ridge gap to unite with it. The net effect is a trellis pattern that can be seen on a map such as the topographic map of the Oak Ridge area. Each of the three DOE facilities, the ETTP, Y-12, and ORNL, affects a different subbasin of the Clinch River. Drainage from Y-12 enters both Bear Creek and EFPC; ORNL drains into White Oak Creek and several tributaries of the Clinch River; and ETTP drains predominantly into Poplar Creek and Mitchell Branch (DOE 1996). Surface water quality on the ORR is influenced by the geochemistry and soil-water interactions of the subbasins. Water quality is also affected by wastewater discharges and by groundwater transport of contaminants from land disposal of waste. All effluent discharged from ORR facilities to receiving streams must meet various chemical limits that are specified in the NPDES permits for each site (DOE 1996).

The water quality of EFPC is also heavily influenced by activities at Y-12. Discharges from Y-12 at the headwaters and from the Oak Ridge POTW near the middle of the stream's length constitute a large percentage of the stream's mean annual flow. The stream also receives urban and agricultural runoff. Water and sediment in EFPC contain metals, organic chemicals, and radionuclides from past operations at Y-12. These include ammonia, copper, mercury, nitrogen, petroleum-based oils and greases, perchloroethylene, PCBs, and residual chlorine. Recent actions taken at Y-12 to reduce the input of contaminants to EFPC have shown positive results in water quality improvement (DOE 1996). Although treated WETF effluents are currently discharged directly to EFPC, they represent less than 1% of the total flow to the stream and are not considered an important discharge, with regards to flow, to the creek.

The ORR Biosolids Land Application Sites have a number of small tributaries and streams that exist in wooded areas and boundaries of the active sites. These tributaries are protected by a 500 foot buffer zone that prohibits the land application of biosolids material. Surface water monitoring around current biosolids application sites has shown no noticeable degradation of water quality (DOE 1996).

Surface water sampling from Braden Branch above and below the closed McCoy site showed some nitrate enrichment in the stream from the application site (DOE 1996). Analyses for trace metals showed no important elevations, and the highest concentrations of regulated metals were still an order of magnitude or more below drinking water standards (DOE 1996). This sampling was performed following heavy rain showers in January 1988; the McCoy site was closed in September 1986 (DOE 1996).

Stream sampling of Bear Creek, performed during an intense storm event on May 1, 1990, below an active application site (Chestnut Ridge) showed minimal increases in the concentrations of measured parameters (organics, heavy metals, and fecal coliform bacteria). The data suggested that runoff from the application site had minimal ecological or human health effects. Subsequent sampling indicated that effects to the water quality of Bear Creek from the runoff during the storm event were largely restricted to a short-term increase in nutrient loading, biological oxygen demand, and fecal coliform bacteria (DOE 1996). The active land application sites are mostly open hayfields with dense vegetation that were originally selected because of the absence of streams and large ponds. There are no major streams that are adjacent or run through the existing land application sites.

Groundwater occurs on the ORR as localized perched water; as transient, shallow, subsurface stormflow in the unsaturated zone; and as unconfined water tables in the saturated zone. Groundwater quality on the ORR generally is good, with nearly all discharges currently meeting drinking water standards. Nevertheless, groundwater is not used as a source of potable water on the ORR. Because groundwater may provide a pathway for transport of contaminants from past disposal activities on the ORR, monitoring is being performed in greater than 1,400 groundwater monitoring wells to evaluate any current impacts to this resource. Typically, groundwater contamination is most likely to occur from activities in areas of shallow groundwater or in karst areas (DOE 1996).

3.6 FLOODPLAINS AND WETLANDS

Science Applications International Corporation (SAIC) conducted a wetlands survey in the summer and fall of 1996 on a total of approximately 426 ac (172 ha) on nine separate active and inactive biosolids land application sites on the ORR (SAIC, 1996). Six of the sites are actively used in DOE biosolids land application and cover a combined 329 ac (133 ha). The three remaining sites, which cover 52 acres, were used for biosolids application in the past, and are currently inactive. These inactive sites may be used again in the future.

The purpose of the survey was to determine the presence or absence of wetlands at any of the active or inactive biosolids application sites, and to mark wetlands in the field so that biosolids applicators would not inadvertently disperse biosolids into a wetland. The approximate boundaries of each wetland area were marked with surveyors ribbon.

Thirteen wetlands were identified at seven of the biosolids land application sites. All wetlands are of human origin and are associated with old farm ponds at the sites. Twelve of these wetlands are on active sites and one is on an inactive site (McCoy). Discussions with scientists associated with the biosolids land appliers indicated the applicators were already aware of the existence of these ponds. It is a general policy of the biosolids application program to maintain a wide buffer zone (i.e., 500 ft) around these ponds and to avoid these sites when applying biosolids.

Table 3.1. ORR Biosolids Land Application Site Designated Wetlands

Application Site	Wetland Type	Wetland Size (acres)
Rogers	Pond	0.9
High Pasture	Pond	0.3
Scarboro	Pond	0.4
	Pond	0.2
	Pond	0.07
	Pond	0.07
	Pond	0.1
	Pond	0.7
Watson Road	None	-
Upper Hayfield #1	Pond	0.7
	Pond	0.3
Upper Hayfield #2	Pond	0.05
	Pond	0.7

3.7 CLIMATE AND AIR QUALITY

The Oak Ridge area has a temperate, continental climate. Summers are warm and humid; winters are typically cool. Spring and fall are transitional seasons, normally warm and sunny. Severe weather (e.g., tornadoes or high winds, severe thunderstorms with damaging lightning, extreme temperatures, or heavy precipitation) is rare. Average annual precipitation is ~140 cm (55 in.). The Oak Ridge area has one of the lowest average wind speeds in the United States. Local terrain is the dominant influence on daily wind patterns and contributes to the low average wind speed. Prevailing wind directions are either southwesterly daytime winds or northeasterly nighttime winds. The Oak Ridge area is an attainment area (i.e., within permissible limits) with respect to National Ambient Air Quality Standards for all criteria pollutants (sulfur dioxide, particulate matter, nitrogen dioxide, carbon monoxide, ozone, and lead) (DOE 1996).

3.8 ECOLOGICAL RESOURCES

Terrestrial habitats on the ORR include hardwood forest, pine forest, mixed hardwood/pine forest, pine plantations, open grass/agricultural fields, and industrial areas. Approximately 70% of the ORR is in natural or planted forest. Because of their unique protected status by association with the ORR facilities, several areas of these habitats and associated wildlife have received limited human disturbance since 1942. The ORR was designated as a unit of the Southern Appalachian Biosphere Reserve within the United Nations' Man and the Biosphere Program. The ORR has also been established as a Wildlife Management Area under a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA) and includes the 20,000-acre Oak Ridge National Environmental Research Park and several state Natural Areas.

Wildlife on the ORR benefit not only from the quality of the habitats available but also from the interspersion (diversity) of the habitats. A diversity of habitats often makes it easier for an individual animal to provide for its needs in a given area of land. However, some species require large unbroken tracts of a single habitat. Many of the wildlife species, such as the white-tailed deer (*Odocoileus virginianus*), are ubiquitous and can be found in almost any habitat, although they may show a preference for a certain type. Other species, such as the yellow-breasted chat (*Icteria virens*), are to be found only in a specific type of habitat.

Game animals range from the gray squirrel (*Sciurus carolinensis*) to turkey (*Meleagris gallopavo*) and white-tailed deer. Public deer and turkey hunts on the ORR are managed by the TWRA. These are the only hunting activities allowed on the ORR.

Aquatic habitats on the ORR include small streams, Bear Creek, EFPC, the Clinch River, and several scattered ponds. Several species of fish, reptiles, and amphibians are found in these areas. Muskrat (*Ondatra zibethica*) and beaver (*Castor canadensis*) are found close to aquatic areas. The muskrat prefers open terrain where aquatic vegetation and dense growths of riparian grasses, sedges, and rushes exist, and beavers are found in locations where there are trees for food and for building dams and lodges. Mink (*Mustela vison*) and raccoon (*Procyon lotor*) are found in aquatic habitats but range into forest and field areas. Large mammals visit aquatic areas to drink.

Ecological studies and monitoring of EFPC have shown population trends and distributions similar to those found in Bear Creek. Densities of fish populations and benthic communities are lower and not as diverse as they should be in a stream of this size. Species richness, diversity, density, biomass, and production are lowest immediately below Y-12, and generally increase with distance downstream. Monitoring is showing that recovery is occurring in the lower reaches of EFPC and should continue (DOE 1996). Detailed information on the aquatic habitats of these two creeks can be found in the *East Fork Poplar Creek-Sewer Line Beltway Remedial Investigation Report* (DOE 1994a).

Five of six of the ORR Biosolids Land Application Sites are open grassland areas devoid of caves, streams and large bodies of water. The remaining application site is a mature forested area. Boundaries of the application sites are dominated by mature hardwood tree species that provide suitable habitat for a wide variety of plant and animal species. Four of the six application sites (Upper Hayfield 1 and 2, Scarboro Road and High Pasture) do not provide habitat for listed plant species. Watson Road and Roger's site have the possibility to provide listed plant habitat for shade tolerant species.

3.8.1 Threatened and Endangered Species

A Threatened and Endangered Species Survey was conducted by TN & Associates, Inc., of the biosolids application areas on the ORR in the spring and summer of 1997 (TN & Associates, 1997). The objective of the study was to survey six active and one inactive biosolids application sites in search of federally and state-listed threatened and endangered plant species and vertebrate habitat.

The plant and animal surveys were conducted by grouping the listed species known to occur on the ORR (or for which there is habitat) according to their environmental requirements (e.g., water and light availability). Potential listed habitat on the biosolids application sites was categorized according to physical gradients, the resulting intersection of potential habitat and protected species guided the surveys. Plant species were actively searched in the early spring and late summer growing seasons. The most recent survey of protected terrestrial vertebrates on the ORR (Mitchell et al. 1996) was used as the primary reference for vertebrate habitat identification. In addition a current species sightings list for Anderson and Roane counties was also obtained from TDEC, Division of Natural Heritage. The listed species survey did not include any active trapping or mist netting for vertebrates.

Plants

Four of the sites (High Pasture, Upper Hayfield # l and # 2, and Scarboro) are hayfields that are mowed each fall. These fields do not provide potential habitat for listed plant species. One site, Rogers, is planted with a diverse array of shrubs, trees and grasses which provide abundant wildlife food and habitat, but do not contain known listed habitats. Rocky limestone bluffs were encountered adjacent to application site boundaries at Rogers. These sites were surveyed for listed species, but none were sighted. About half of the Watson Road site is a dead pine plantation undergoing secondary succession. The remainder of the site also contains a natural forest and a riparian zone which do provide potential listed habitat. These areas were surveyed throughout the growing season for listed species, but none were identified.

Several sites adjacent to application areas are noteworthy because they are relatively undisturbed and/or are not commonly encountered on ORR:

- the mature upland hardwood stand at Watson Road,
- the mature forest on the west side of Upper Hayfield #1, and
- the west facing slope on Scarboro Road site.

However, these areas are outside of the application site boundaries.

Vertebrates

The ORR Biosolids Land Application Sites provide suitable habitat for 11 species of listed vertebrate animals listed in ***Table 3.2***.

Table 3.2 ORR Biosolids Land Application Sites Vertebrate Listed Species

Common Name	Scientific Name	Federal or State Status
Mammals		
Gray bat	*Myotis grisescens*	Federal Endangered
Indiana bat	*Myotis sodalis*	Federal Endangered
Eastern wood rat	*Neotoma floridana*	State In Need of Management
Meadow jumping mouse	*Zapus hudsonius*	State In Need of Management
Reptiles		
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	State In Need of Management
Birds		
Northern harrier	*Circus cyaneus*	State In Need of Management
Vesper sparrow	*Pooecetes gramineus*	State In Need of Management
Yellow-bellied sapsucker	*Sphyrapicus varius*	State In Need of Management
Common barn owl	*Tyto alba*	State In Need of Management
Bachman's sparrow	*Aimophila aestivalis*	Possible Federal Listing
Bewick's wren	*Thryomanes bewickii*	Possible Federal Listing

Aquatic species were not considered in this EA because federal regulations prohibit application of biosolids in areas or under conditions that would allow the material to enter a wetland or other waters of the United States.

The ORR Biosolids Land Application Sites provide suitable habitat for state and federally listed vertebrate species, including four species of mammals (Gray bat - *Myotis grisescens*, Indiana bat - *Myotis sodalis*, Eastern wood rat - *Neotoma floridana* and Meadow jumping mouse - *Zapus hudsonius*), one reptile species (Eastern slender glass lizard - *Ophisaurus attenuatus longicaudus*) and six bird species (Northern harrier - *Circus cyaneus*, Vesper sparrow - *Pooecetes gramineus*, Yellow-bellied sapsucker - *Sphyrapicus varius*, Common barn owl - *Tyto alba*, Bachman's sparrow - *Aimophila aestivalis* and Bewick's wren - *Thryomanes bewickii*). Most of these species would be likely to use these areas as habitats as a result of the clearing or open field nature of the sites. Thus, maintaining the sites as hayfields with biosolids applications would favor the potential use of the application sites by these species. None of these species consume earthworms as a high proportion of their diet, thus further minimizing any potential for heavy metal or radionuclide exposure.

Of the mammal species, the federally-listed endangered Gray and Indiana bats could potentially occur on or near the application sites. The Gray bat would be favored by the number of caves in the vicinity of the Clinch River. Gray bat caves have also been commonly found in areas with a mixture of forest and fields. The Indiana bat nests in specific caves and mining locations in Kentucky and Missouri; however, the ORR Biosolids Sites could provide suitable foraging habitat. The Indiana bat prefers foraging near streams and rests under the bark of exfoliating (loose) or dead trees. Thus, although there are no caves actually within the application areas, these sites could offer potentially suitable foraging habitat for both bat species. The state-listed Meadow jumping mouse could occur in any of the open grassy areas present at all the application sites except Watson road, however, it would be most likely to be found in the vicinity of the ponds that occur at several of the sites. The state-listed Eastern wood rat could occur in the wooded rock outcrop areas that appear at the Rogers, Upper Hayfield #2 and Scarboro Road sites.

The application sites offer a potentially suitable habitat for only one reptile or amphibian species, the state-listed Eastern slender glass lizard. This species prefers cutover woodlands and grassy fields.

The application sites offer potentially suitable habitats to six state-listed bird species: the Yellow-bellied sapsucker, Northern harrier, Vesper sparrow, Common barn owl, Bachman's sparrow, and Bewick's wren. All of these species require either a combination of forest and clearings or open, weedy fields or grasslands. Most of the Vesper sparrows sighted in Tennessee have been transients and not nesting birds. The species that potentially would be most affected by the biosolids application program are the Grasshopper sparrow and Bachman's sparrow.

These sparrows make their nests out of plant fibers and grasses placed on the ground. The breeding season for both species is from May to July. Mitchell *et al.* (1996) reported a population of grasshopper sparrow in hayfields in the Freels Bend area of the ORR near the Clinch River. The Freels Bend area is near the ORR applications sites located along Scarboro Road and Bethel Valley Road, and there is definite potential that this species could be nesting in the application sites.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

A "graded" approach was used as the basis for analysis of impacts of the proposed action and alternatives. That is, certain aspects of the action have a greater potential for causing adverse environmental impacts; therefore, they are discussed in greater detail in this EA than those aspects with little potential for impact.

4.1 PROPOSED ACTION (4 to 10 mrem/yr Radionuclide Planning Level Increase and WETF Effluent)

4.1.1 Regional Demography/Socioeconomics

The proposed action would not result in a major net change in employment because no additional personnel would be required to operate the existing land application program or be impacted from a reduction in operations associated with EPS at WETF. There would be investment in the construction of a newly fabricated man-hole at the proposed point of discharge from WETF Tank F-8 to the Y-12 Sewer System and the installation of a water meter and properly calibrated pump. These costs are expected to be less than $5,000. This investment would be so small relative to the total level of economic activity in the region of influence that the direct impact would be unimportant and no indirect employment would be generated by the expenditure. The action would result in an operational cost savings of approximately $133,000 due to a reduction in sample monitoring frequency at the WETF NPDES outfall and additional materials (e.g., sulfuric acid, sodium hydroxide, polymers, etc.) required in the operation of EPS. Because operations personnel can be utilized elsewhere within Y-12 Waste Treatment Operations, it would not be expected that not operating EPS would reduce area employment.

The long term implications of this proposed action could result in a positive net change in employment in the City of Oak Ridge commercial sector. Because it is impossible to predict future commercial growth requiring radionuclide discharges to the city sewer system, future financial projections cannot be made. If a commercial discharger does locate in the City of Oak Ridge due in whole or part to the availability of radionuclide discharge capacity to the sewer system, a net positive socioeconomic impact (when compared with other reasonable alternatives) would result from the proposed 10 mrem/yr radionuclide planning levels for the Oak Ridge land application sites.

Environmental Justice

Executive Order 12898 requires federal agencies to achieve environmental justice "to the greatest extent practicable" by identifying and addressing "disproportionately high and adverse human health or environmental effects of its ... activities on minority populations and low-income populations..."

Environmental justice impacts occur if the proposed activities result in disproportionately high and adverse human and environmental effects to minority or low-income populations. Disproportionately high and adverse human health effects are identified by assessing these three factors:

1. Whether the adverse health effects, which may be measured in risks or rates, are significant or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.

2. Whether health effects occur in a minority population or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

3. Whether the risk or rate of exposure to a minority population or low-income population to an environmental hazard is significant and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.

As demonstrated in ***Section 5.1***, ***Cumulative Impacts by Resource Area***, there are no measurable dose or risk impacts to any on or off-site receptors resulting from the proposed actions. All biosolids application sites are on federal land (the ORR), and sites were originally selected, based on physical criteria such as topography, soil type, and surface features (e.g., avoiding wetlands and floodplains) conducive to the land application of biosolids.

4.1.2 Land Use

Implementation of the proposed action would create no major, long-term negative impacts to land uses and would enhance the hardwood forest management use of several of the application sites (DOE 1996). Long-term land use restrictions would be avoided by following lifetime biosolids loading limits, contaminant loading limits, and management controls detailed in the Program Plan (Duratek Federal Services 2000).

4.1.3 Archaeological, Cultural, and Historical Resources

In compliance with Section 106 of the National Historic Preservation Act, DOE consulted with the State Historic Preservation Officer (SHPO) regarding impacts of the original biosolids land application operation in the previous EA (DOE 1996). The response from the SHPO concurred with the DOE determination that the project would have no effect on properties included or eligible for inclusion on the National Register of Historic Places. Because there are no new application sites, only a modification to the radionuclide soil limits in the proposed action and there are no newly identified archaeological areas on the active sites, further consultation is not necessary as no adverse impacts are expected upon ORR archaeological, cultural and historical resources.

4.1.4 Geology and Soils

The land application of city biosolids having increased radionuclide levels will not have any direct impact upon the existing geology of the ORR sites due to the fact that the material is organic by composition and is easily incorporated into the site soils. Adsorption of chemical and radiological contaminants, onto soil particles is the major means for immobilizing these contaminants, generally in the upper 15 cm (6 in.) of the soil surface. Transport of contaminants from the land application of biosolids to groundwater is extremely unlikely unless channels or fissures exist in the soil matrix. For this reason, biosolids application is prohibited in areas with rock outcrops, sinkholes, or other geologic features that could act as channels to groundwater. Buffer zones of 15 m (50 ft) around these features aid in preventing contaminants from entering groundwater sources.

The only measurable impact of the proposed actions would be an incremental increase in the radionuclide loading levels that the application site soils may experience over the life of program operations as described below. Inorganic compounds, heavy metals and other trace parameters in ORR Biosolids Land Application Site soils were evaluated and found to have no significant impact in a previous EA (DOE EA/1042, 1996)

Dose-based radionuclide planning levels for biosolids were developed for use by the city of Oak Ridge for the land application program using the RESRAD computer code (DOE 1996) and very conservative risk assumptions [i.e., residential farmer and pica (soil-eating) child receptors]; this methodology is accepted by TDEC and DOE.

The updated RESRAD modeling (***Appendix D***) for this EA explains how dose-based radionuclide planning levels were calculated to be protective of human health at a maximum dose of 10 mrem/year to the most exposed individual, assuming biosolids application at a rate of 5 tons/acre/year for up to 10 years (equaling 50 tons/acre lifetime loading). The modeling also explains that the assumption of a farm family moving onto the biosolids application site immediately following the final application is overly conservative because of application site restrictions that would prohibit such action.

Raising biosolids radionuclide application site loading planning levels to 10 mrem/yr and discharging treated, WETF effluents into the Y-12 and City of Oak Ridge sewer systems would not result in any impacts to the area's geology because of the program's operating limitations regarding geologic features such as sinkholes (e.g., 50 foot buffer zone). The soils, however, would experience incremental loading of radionuclides as demonstrated in RESRAD modeling (***Appendix D***) associated with the proposed planning level increase to 10 mrem/yr. ***Table 4.1*** lists the risk factors associated with the proposed 10 mrem/yr increase for known radionuclides that are tracked in the current monitoring program.

Table 4.1. Risk Factors Associated with Proposed Increase from 4 to 10 mrem/yr Dose Rate

Radionuclide	4 mrem/yr Risk Factor	10 mrem/yr Risk Factor
Cobalt-60	9×10^{-5}	2×10^{-4}
Cesium-137	7×10^{-6}	2×10^{-5}
Uranium-235	6×10^{-5}	2×10^{-4}
Uranium-238	6×10^{-6}	3×10^{-5}

Source: Appendix D, Stetar, July 2001.

It should be noted that the RESRAD modeling based upon 10 mrem/yr is a worst-case scenario and the resulting risk factors calculated in ***Table 4.1*** are used as boundaries for an on-site resident, which does not currently or is anticipated to exist in the future of the application sites. That said, it is envisioned that the resulting application soil radionuclide concentrations will be substantially lower than the modeled 10 mrem/yr boundary planning levels.

To determine approximate soil radionuclide concentrations at the end of application site life, predictive modeling (***Appendix E***) calculating the average radionuclide levels observed in city biosolids from 1996 to 2000, the remaining land application site life and soil radionuclide concentrations to date, was performed. The results were divided by existing (4 mrem/yr) radionuclide limit, added together with other radionuclide "fractions" and multiplied by 100 to predictive the percentage of the 4 mrem/yr planning level. The percentage loading at the end of each site life was averaged to obtain overall expected radionuclide soil loading percentage. This percentage was then multiplied by the proposed 10 mrem/yr planning level in an effort to demonstrate what dose could be present under normal operating conditions in comparison to the maximum proposed planning level of 10 mrem/yr. A summary of the results is available in ***Table 4.2***. The results demonstrated that the average application site would be loaded to approximately 47.1% of the 4 mrem/yr planning level, resulting in an estimated 1.88 mrem/yr dose at the end of the site life. Using the same 47.1% scaling factor for the proposed 10 mrem/yr planning level would result in a 4.71 mrem/yr dose at the end of the site life if the proposed planning level increase occurred. This would account for the addition of treated WETF effluents and future industrial growth. Therefore, the probability of land application sites attaining the proposed 10 mrem/yr radionuclide soil loading levels are remote, given the existing controls on the ORR Biosolids Land Application Program.

Table 4.2. Predictive Modeling Application Site Lifetime Soil Radionuclide Levels

Land Application Site	Projected % of Soil Radionuclide Planning levels (4 mrem/yr)
Upper Hayfield #1	40.9%
Upper Hayfield #2	39.3%
High Pasture	49.2%
Rogers Site	56.8%
Watson Road	51.3%
Scarboro Road	45.3%
Land Application Site Average	47.1%

The proposed WETF sewer discharge limit of 1,260 grams per month would be included in the limit increase to 10 mrem/yr. Assuming 100% of the uranium discharged to the sewer system would be land applied on the biosolids land application sites, a maximum of 7.56 kg of uranium from WETF would be applied during each year the city operates on the ORR.

On the smallest application site, Upper Hayfield #2, using an average remaining site life of 7 years, this would correspond to a cumulative increase of 0.002 mg/kg of total uranium in the site's soil (***Appendix F***). The resulting calculated radiological risk (Legin 2001) for ORR application site soils is 1×10^{-7}. This risk is based upon an actual soil concentration of approximately 2 pCi/g for total uranium. The lifetime soil loading of 0.002 mg/kg converts to 0.7 pCi/g which represents 35% of the calculated risk factor of 10^{-7}, again, well below the DOE and EPA acceptable risk limit of 10^{-4}.

Because of the city's rigorous monitoring and program action levels (City of Oak Ridge 1999) established to prevent the inadvertent land application of biosolids containing elevated levels of radionuclides, biosolids levels would not exceed benchmarks protective of human health and the environment as established by RESRAD modeling. It should also be noted that radionuclide levels for known radionuclides within the city sewer system are well below the proposed level of 10 mrem/yr and the existing 4 mrem/yr dose planning levels for biosolids (***See Appendix B, Table B.4***) and receiving site soils (***See Appendix B, Table B.11***).

The future use of the land for agriculture would not only be allowable but would be enhanced by the biosolids application.

4.1.5 Water Quality

Application Site Surface and Groundwater

A key geological concern associated with land application of biosolids includes the potential impacts to groundwater. Concentration limits established in the 40 CFR 503 regulations were based upon extensive fate, transport and exposure modeling. The Technical Support Document for Land Application of Sewage Sludge (EPA 1992) modeled 14 exposure pathways including migration of metals from the application site to groundwater. The results of this study indicate that metals applied within the regulatory limits have a minimum impact on groundwater due to the strong retention of metals species in the upper few centimeters of a clay rich soil column. Radionuclides of concern in this assessment are metal species as well; consequently, migration of radionuclides through the soil column and the vadose zone will tend to be retarded through sorption in the upper few centimeters of clay rich soil. This retention and retardation of radionuclides will result in minimal impact to the underlying groundwater over time. Because the city produces a Class A sterilized biosolids material, there is no threat of pathogenic contamination for underlying groundwater.

Nitrogen compounds are also not a threat to ORR application site groundwater due to the fact that the application rate is calculated such that it meets the growth requirements for the vegetation on the specific site, resulting in no excess nitrogen available for transport to the groundwater.

Pathogenic, chemical and radiological contaminants in biosolids applied to land may be transported by surface runoff to receiving waters such as streams, ponds, or wetlands. Potential adverse effects from exposure to these contaminants could occur in aquatic organisms in the surface water or in humans or animals drinking the water or consuming food organisms living in the water. Nitrogen or other nutrients in the biosolids could also have potential adverse effects on surface water quality should these nutrients reach excessive levels in the surface water. Most of the application sites on the ORR have a heavy herbaceous cover; reduction of runoff has been related directly to the density of vegetative cover on the site (DOE 1996). In addition, the city will be applying a solid, Class A biosolids material that is free of pathogens or sterilized. The physical state of the biosolids material will be such that when the biosolids material is applied, it will mostly likely remain at the point of application until incorporation into the site soil. The use of buffer zones, heavy vegetative cover and the application of a solid Class A material will substantially reduce any threat to surface waters on or near active land application sites.

Because land application rates are calculated on the nitrogen growth requirements of the vegetation physically located on each individual site, excess nitrogen will not be available for runoff to surface waters or percolation to the groundwater table. Studies (ORNL 1990, 1997) specifically conducted on radiological and heavy metal contaminants land applied on the ORR using city biosolids found that these contaminants remain in the upper 15 centimeters of the receiving site soils and would represent a minimal threat to surface and ground waters. Residual pathogenic organisms contained in the biosolids would be destroyed and will not represent a threat to surface or ground waters. Organic compounds are utilized as a food source by the microbiological organisms in the biological wastewater treatment process and are sometimes found in very low concentrations in biosolids as demonstrated in ***Appendix B, Table B.3***. Organic compounds resulting from the land application of city biosolids (***See Appendix B, Table B.11***) have not been found to accumulate in active land application sites and would not pose a threat to surface and ground waters given the use of existing program management practices.

The ORR Biosolids Land Application Sites have a number of small tributaries and streams that exist in wooded areas and boundaries of the active sites.

These tributaries are protected by a 500 foot buffer zone that prohibits the land application of biosolids material. Surface water monitoring around current biosolids application sites has shown no noticeable degradation of water quality. Surface water sampling from Braden Branch above and below the closed McCoy site showed some nitrate enrichment in the stream from the application site (DOE 1996). Analyses for trace metals showed no important elevations, and the highest concentrations of regulated metals were still an order of magnitude or more below drinking water standards (DOE 1996). This sampling was performed following heavy rain showers in January 1988; the McCoy site was closed in September 1986 (DOE 1996).

Stream sampling of Bear Creek, performed during an intense storm event on May 1, 1990, below an active application site (Chestnut Ridge) showed minimal increases in the concentrations of measured parameters (organics, heavy metals, and fecal coliform bacteria). The data suggested that runoff from the application site had minimal ecological or human health effects. Subsequent sampling indicated that effects to the water quality of Bear Creek from the runoff during the storm event were largely restricted to a short-term increase in nutrient loading, biological oxygen demand, and fecal coliform bacteria (DOE 1996). The active land application sites are mostly open hayfields with dense vegetation that were originally selected because of the absence of streams and large ponds. There are no major streams that are adjacent or run through the existing land application sites.

Although some biosolids land application areas are located near small surface water bodies (***See Table 3.1***), no adverse impacts would be expected if the proposed action is implemented. Prior to TDEC approval, a detailed hydrogeological evaluation of each site was completed. This evaluation established the technical suitability of the sites and any need for surface water and/or groundwater monitoring. In addition, EPA land application requirements state that biosolids shall not be applied to a site that is 10 m (33 ft) or less from surface waters. As a practice, the City of Oak Ridge has maintained a buffer of 150 m (500 ft) around waters of the State on sites where biosolids have been or are currently being applied. It is anticipated that since buffer zones have already been established around designated wetlands, the practice of not applying biosolids within 500 feet continue, regardless of biosolids classification (i.e., Class A or B). Biosolids management practices (*40 CFR 503.14*) also restrict biosolids application during precipitation events or when the ground is frozen or flooded, thereby minimizing the likelihood of runoff. These practices would continue as biosolids are applied on existing ORR sites.

None of the biosolids application sites are located in wetlands. Although some wetlands (old farm ponds) were found at several of the application sites (***Table 3.1***), biosolids application guidelines are sufficiently stringent and clear that biosolids appliers would not unwittingly apply biosolids into one of these wetlands. Boundaries of these wetlands are marked with wetland boundary flagging so that biosolids appliers would recognize wetland boundaries in the field and avoid inadvertent application of liquid or solid biosolids into wetlands.

None of the active land application sites are located within the 100-year flood plain; furthermore, 40 CFR 503 regulations prohibit the land application of biosolids within any area designated as a flood plain. Because 40 CFR 503 standards and Tennessee guidelines for biosolids prohibit application in areas or under conditions that would allow biosolids to enter a wetland or other waters of the United States, no biosolids are or would be applied in 100-year floodplains or wetlands.

City of Oak Ridge POTW Discharge to EFPC

Heavy metal and radionuclides contaminants typically partition (i.e., separate) to the biosolids or solid phase that is land-applied, as opposed to the water phase that exits the City of Oak Ridge NPDES discharge point to lower EFPC (City of Oak Ridge NPDES Permit, 2001). This is based upon historical data collected since the program began in 1984 and the fact that most metals and long-lived radionuclides have a higher density and typically weigh more than water. As a conservative measure to simulate worst case environmental impacts from the proposed action, predictive modeling, RESRAD modeling and risk assessment scenarios assume 100% of the radionuclides and heavy metals would partition to the solids phase and thus, be land applied on the ORR. Therefore, it is anticipated that the NPDES discharge point at the City of Oak Ridge will not be impacted as a result of the increase in the radionuclide levels associated with 10 mrem/yr for the ORR biosolids land application sites. Currently, the City of Oak Ridge only has specific NPDES permit limits for (1) heavy metal (mercury) and (5) toxic organic compounds (carbon tetrachloride, chloroform, tetrachloroethylene, trichloroethylene and methylene chloride). Radionuclide monitoring for treated discharges through the City of Oak Ridge NPDES discharge point is neither required by TDEC or EPA.

West End Treatment Facility Effluents

The human health risk assessment (***Appendix H***) was specifically prepared for WETF contaminants and concluded that the combined chemical and radiological risks of discharging treated wastewaters from WETF into the Y-12 and City of Oak Ridge sewer systems are negligible and are well below the EPA target range for excess lifetime cancer risk. A summary of the assessment results is available in ***Table 4.3***. When compared to risk factors calculated using the existing NPDES discharge limits for WETF, there was no incremental increase in risk. In fact, the risk for discharges to the sewer system substantially drop due to additional treatment provided by the City of Oak Ridge WWTP, the low amount of contaminants for the proposed daily discharge from WETF and the large amount of water that the treated discharges would mix with prior to treatment and discharge through the City of Oak Ridge NPDES discharge point. The risk assessment used extremely conservative assumptions such as 100% of all WETF contaminants were discharged at the proposed maximum levels, traveled through the sewer system and partitioned with the water phase, as opposed to the biosolids phase which is what typically occurs in day to day operations. In addition, the risk assessment simulates a child wading and drinking the treated water as it exits through the respective NPDES discharge points at WETF and the City of Oak Ridge en route to lower EFPC.

Table 4.3. WETF Parameter Concentrations and Associated Risks

Parameter	Monthly WETF Limit (g)	Daily WETF Concentration to Y-12 Sewer System (mg/l)[1]	Daily Oak Ridge NPDES Concentration to EFPC (mg/l)[2]	Associated Risk at City of Oak Ridge Point of Discharge (Including WETF) to EFPC
Arsenic	**8.5**	**0.0111**	**0.00002**	**3.48×10^{-14}**
Benzene	**8.5**	**0.0111**	**0.00002**	**2.91×10^{-10}**
Methylene Chloride	**23**	**0.0301**	**0.00004**	**3.51×10^{-11}**
Uranium-235[3]	**11.3**	**0.0148**	**0.00002**	**4.04×10^{-9}**
Uranium-238	**1248.7**	**1.6364**	**0.00233**	**1.99×10^{-10}**
			Total Chemical and Radiological Risk	**4.59×10^{-9}**

[1]Assumes 28 days per month for discharge at 7,200 gallons per day

[2]Assumes low flow per day in the Y-12 sewer system of 450,000 gallons and 4.6 mgd for City of Oak Ridge Sewer System

[3]Assumes U-235 is at normal enrichment of 0.91%

East Fork Poplar Creek

Both the City of Oak Ridge and WETF NPDES discharge points are physically located on EFPC. The WETF discharge point is located at upper EFPC, whereas the City of Oak Ridge discharge point is located at lower EFPC (***See Figure 1.1***). Discharges from WETF represent a maximum of 1,000,000 gallons, annually. Because discharges from WETF to EFPC represents less than 1% of the total estimated average creek flow of 3.5 mgd, augmenting the discharge route of the WETF wastewater to the sanitary sewer system will not produce a measurable impact upon the flow of EFPC.

Table 4.3 lists projected WETF parameter concentrations at the point of discharge to the Y-12 sewer system, and the resulting concentration of these parameters at the City of Oak Ridge NPDES discharge point. Resulting risk analysis numbers per contaminant at the city point of discharge to lower EFPC were calculated and well within the acceptable EPA and DOE target risk limit of 10^{-4}. Note that not all of the proposed contaminants have risk factors due to the fact that EPA has not developed cancer risk criteria for these parameters.

4.1.6 Floodplains and Wetlands

Biosolids regulations (40 *CFR* 503), Tennessee guidelines, and site selection criteria (DOE 1996) prohibit land application of biosolids in areas designated as wetlands and in areas designated as 100-year floodplains. During the hydrogeologic evaluation of the land application sites (DOE 1996), flood plain areas were identified. Biosolids application in floodplains and wetlands is and would continue to be prohibited so that no impacts would occur.

Thirteen wetlands were identified at seven of the biosolids land application sites (***Table 3.1***). All wetlands are of human origin and are associated with old farm ponds at the sites. Twelve of these wetlands are on active sites and one is on an inactive site (McCoy). None of the biosolids application sites visited were in wetlands. Although some wetlands (old farm ponds) were found at several of the application sites, biosolids application guidelines are sufficiently stringent and clear that biosolids appliers would not unwittingly spray biosolids into one of these wetlands. Boundaries of these wetlands have been marked with wetland boundary flagging so that biosolids appliers would recognize wetland boundaries in the field and avoid inadvertent application of liquid or solid biosolids into wetlands. EPA requires a 10-m (33-ft) distance from surface water for biosolids application to prevent runoff into streams or lakes.

However, in practice, the application of biosolids by the city on the ORR has been restricted from waters of the state by buffer zones (i.e., 500 ft) determined by TDEC.

4.1.7 Climate and Air Quality

No air quality impacts have been identified for the proposed action. Minor odor problems have been reported from a few past biosolids application sites located immediately adjacent to public access highways. Because of the remoteness of most of the ORR biosolids application sites, no odor problems to the public would be expected. The method of biosolids application is via a standard manure spreader for dried Class A biosolids, air quality degradation by pathogens is not a problem. An air dispersion model (***Appendix I***) was performed for to simulate the on-site exposure of a person standing on a biosolids application site inhaling fugitive radioactive particulates downwind during application. Results are listed in ***Table 5.1***.

Table 4.4. Air Dispersion Modeling Results to an On-Site Individual

Radionuclide	Air Activity (pCi/m^3)	Dose (mrem/yr)
Cobalt-60	8.33×10^{-8}	1.12×10^{-8}
Cesium-137	3.23×10^{-8}	7.21×10^{-10}
Uranium-235	6.23×10^{-9}	5.35×10^{-7}
Uranium-238	7.24×10^{-7}	8.33×10^{-5}

Source: Appendix I, Legin, 2001.

The maximum exposure of an individual breathing the biosolids as they are land-applied 260 operational days per year, 8 hours each day is 0.00008 mrem/yr. This level is considered to be negligible. As emissions travel off-site, the concentration of radionuclides drops substantially, resulting in an even lower exposure to an off-site individual.

4.1.8 Ecological Resources

The proposed action would not be expected to result in any adverse impacts to biota. Effects to most wildlife, especially in the short term, would be limited to physical disturbance from the application vehicle. This low ground-pressure vehicle currently follows the same general route within each application site during biosolids application.

This localizes direct physical disturbance to a certain degree, creating wide grassed paths (most application sites are grass fields) as opposed to bare-dirt roads through the application sites. Because of the more open nature of the vehicular paths and the slow speed of the vehicle during application, direct mortality of wildlife during biosolids application is and would continue to be unlikely.

It should be noted that most of these studies involved the use of municipal biosolids application in the reclamation of lands surface-mined for coal, where acidic soil conditions often enhance the mobilization of existing and any added heavy metals. Biosolids applications on mine lands generally have not had an adverse effect on the health of domestic or wild animals (DOE 1996). Although the uptake of radionuclides in plant and animal tissue directly resulting from the land application of biosolids is not know, it is known that the majority of the radionuclides are retained in the upper 15 cm of application site soils (ORNL 1990, 1997). Given the extremely low concentration of radionuclides in application site soils (***See Appendix B, Table B.11***) and the predictive modeling results (***See Table 4.2***), approximately 47.1% of the proposed 10 mrem/yr radionuclide soil planning level would be attained at the end of application site life. Therefore, toxic effects to ecological receptors would not be expected from the proposed action of increasing site radionuclide planning levels to 10 mrem/yr. Because contaminants contained in WETF effluents discharged to the sewer system will ultimately be land applied on the ORR, and are included in the proposed 10 mrem/yr radionuclide and EPA cumulative heavy metal limits for the existing application sites, no additional impacts to ecological receptors is expected. Because the city biosolids material is sterilized (i.e., free of biological pathogens) and land applied in a solid form, the potential for runoff is substantially reduced resulting in a more stable, pathogen free material. In addition, the dried biosolids material does not readily dissolve in water and trace contaminants such as heavy metals, radionuclides and inorganic compounds (e.g., nitrates) are affixed to the biosolids particulates slowly being released over time. This results in trace contaminants that are not readily leachable to surface or ground waters, further reducing any impacts to ecological receptors and waters of the U.S.

4.1.8.1 Threatened and endangered species

Impacts to any state or federally listed species from the proposed modification to the biosolids application program would be avoided or limited by adherence to biosolids application regulations (40 CFR 503). The protected natural areas established by the Oak Ridge National Environmental Research Park exclude the application of biosolids.

No listed plant species were found on any of the biosolids application sites (TN & Associates, 1997). Four of the sites (High Pasture, Upper Hayfield #1 And #2, and Scarboro) are hayfields that are mowed annually. These fields do not provide potential habitat for listed plant species. One site, Rogers, is planted with a diverse array of shrubs, trees, and grasses which provide abundant wildlife and food habitat, but do not contain listed plant habitat. Rocky limestone bluffs encountered adjacent to Rogers application site boundaries was surveyed for listed species, but none were sighted. Approximately half of the Watson Road site is a dead pine plantation undergoing secondary succession or replanting. This site also contains a natural forest and a riparian zone which were surveyed for listed species, but none were identified.

There are two possible explanations as to why no listed plant species were observed in the application areas. First, listed species are more commonly found in undisturbed areas. Most of the application acreage was probably in field or pasture prior to acquisition by the federal government, so the land has been disturbed from its native state for over 50 years (TN & Associates 1997). Second, operation of the biosolids program for the past 17 years has increased soil nutrient concentrations (mostly nitrogen and phosphorus). These nutrients are used more efficiently by fast-growing invasive or weedy species and, over time, the weedy species would out compete native and listed species. Biosolids can eliminate existing, native vegetation (TN & Associates 1997). However, biosolids application also produces desirable effects in agriculture and tree plantations. These sites experience an immediate growth response in both understory and overstory species and a long-term improvement in productivity of the site (TN & Associates 1997).

Biosolids application can have either favorable or detrimental effects on vertebrate habitat, depending on the species. Application requires that vehicular access be maintained. For five of the six study areas this means that the areas are mowed on an annual basis to prevent the development of woody plant species. Mowing maintains the areas in pastureland or hayfield condition, dominated by grassy plant species such as fescue and orchard grass.

Vehicular traffic required to spread biosolids can potentially impact vertebrate habitats. Nests established in the grassy areas where biosolids is applied, would be subject to disturbance by traffic and biosolids application. Application also occurs in the wooded margins around the edges of the grassy areas and also in the abandoned pine plantation areas. Thus, bird nests established in the lower branches of trees and on the ground in these areas could be affected.

Application of biosolids can result in increased heavy metal concentrations in the soils. There is evidence that earthworms can bio-accumulate heavy metals from soils. Thus, animals such as some shrew species and the woodcock (TN & Associates), which consume earthworms as a very high proportion of their diet, are subject to a higher level of exposure. The management program of the ORR application sites, however, strictly adheres to the heavy metal loading limits established by 40 CFR Part 503, thus minimizing the possibility of heavy metal accumulation.

The ORR Biosolids Land Application Sites provide suitable habitat for four species of mammals (Gray bat - *Myotis grisescens*, Indiana bat - *Myotis sodalis*, Eastern wood rat - *Neotoma floridana* and Meadow jumping mouse - *Zapus hudsonius*), one reptile species (Eastern slender glass lizard - *Ophisaurus attenuatus longicaudus*) and six bird species (Northern harrier - *Circus cyaneus*, Vesper sparrow - *Pooecetes gramineus,* Yellow-bellied sapsucker - *Sphyrapicus varius*, Common barn owl - *Tyto alba,* Bachman's sparrow - *Aimophila aestivalis* and Bewick's wren - *Thryomanes bewickii*). These species would use these areas as habitat as a result of the open-field nature of these sites. Therefore, maintaining the sites as hayfields with biosolids application would favor the potential use of these sites by these species.

At the request of the U.S. Fish and Wildlife Service, a Biological Assessment (BA) was performed (***Appendix J***) to evaluate the specific impacts of the proposed actions in this EA upon the federally-endangered Gray and Indiana bats. The results of the BA were that neither of these species would be expected to be impacted, if present, due to restrictions regarding the application of biosolids within 500 feet of a U.S. Waterway, the extremely low levels of radionuclides found in application site soils and plant tissues (***See Appendix J, Tables J.3. and J.4.***) that have been observed through program monitoring and the low occurrence of potential roosting habitat (e.g., caves, exfoliating trees, etc.) on the active application sites. Specifically, the BA found that the proposed action would be unlikely to adversely impact the Gray bat for the following reasons:

- the absence of caves from the ORR application sites, reducing the likelihood of roosting habitat;
- the absence of large water bodies present on the application sites, reducing the likelihood of foraging habitat;
- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Gray bat is present; and

- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils and vegetation, reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the Gray bat.

Also, the BA found that the proposed action would be unlikely to adversely impact the Indiana bat for the following reasons:

- the rarity of the Indiana bat species on the ORR;
- the absence of streams present on the application sites, reducing the likelihood of foraging habitat;
- the absence or rarity of exfoliating tree stands that are present or serve as the borders to application sites, reducing the likelihood of roosting habitat;
- the non-disturbance of existing tree stands by the current operations (e.g., lack of tree removal operations), reducing the likelihood of roosting disturbance if the Indiana bat is present;
- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Indiana bat is present; and
- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils (***Appendix J, Table J.3.***) and vegetation (***Appendix J, Table J.4.***), reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the Indiana bat.

The state-listed meadow jumping mouse prefers open grassy areas in close proximity to ponds. These ponds are actively avoided in the biosolids application program, and strict adherence to the current guidelines (i.e., 500 foot buffer zones around waters of the state) should be sufficient to protect this species if present.

The state-listed eastern wood rat could occur in the wooded rock outcrop areas that appear at the Rogers, Upper Hayfield #2 and Scarboro Road sites. Self-imposed application program practices prohibit the land application of biosolids within 50 of a rock-outcroppings or sinkholes. It is anticipated that this practice will continue and should provide adequate protection if this species occurs.

Because the state-listed eastern slender glass lizard prefers cutover woodlands and grassy fields, continued mowing as performed in the application program will favor this species. It spends much of its life underground and may not be affected by the vehicular traffic required during application operations.

All six of the state-listed birds that could occur on the ORR Biosolids Land Application Sites prefer either a combination of forest and clearings or open, weedy fields or grasslands. The impact on these species are minimized by avoiding mowing operations in August to allow completion of the second nesting cycle of the breeding season. Mowing of the fields in the current program occurs in later Winter and late Fall. The effect of the actual biosolids application on the nesting success of these species is unknown but would not be expected to be important because of the extremely low levels of contaminants present in the biosolids be applied.

4.1.9 Potential Radiological Impacts

4 to 10 mrem/yr Radionuclide Increase

As described in ***Section 2.1.2***, there are no federal standards for radiological content of biosolids and land application areas. Wastewater discharges from the Y-12 Plant to the city sewer system are conducted in accordance with *DOE Order 5400.5, Radiation Protection of Public and The Environment*. Wastewater discharges from State-licensed facilities are conducted in accordance with NRC, TDEC-Division of Radiological Health and City of Oak Ridge IDP radionuclide concentration release limits.

Under an agreement with DOE, the City of Oak Ridge, and TDEC, the radionuclide levels in the biosolids and land application areas are monitored, and self-imposed, 4 mrem/yr dose-based standards were developed and approved by DOE (DOE 1996) in November 1996. Additionally, workers currently exposed to the biosolids during treatment or application are monitored by the use of Thermoluminescent Dosimeters (TLDs) by an independent party for radiation exposure. To date, no measurable doses have been reported in the history of the program (City of Oak Ridge, 2001).

Workers could be exposed to radionuclides in biosolids by incidental ingestion and inhalation of particulates during handling of biosolids both during treatment and during land application operations.

The human health risk analysis (***Appendix G***) concludes that the combined chemical and radiological risks to employees exposed to biosolids during the land application process are minimal (i.e., 4×10^{-7}) and are within DOE and EPA acceptable risk criteria (10^{-4}) for excess lifetime cancer risk. TLD monitoring of city POTW employees has shown no detectable exposure to radionuclides (DOE 1996).

Transients could be exposed to the biosolids-amended soils. The combined chemical and radiological risks to transients exposed to soil are also minimal (1×10^{-7}) and within the DOE and EPA acceptable risk criteria for excess lifetime cancer risk (10^{-4}). Noncarcinogenic risks were estimated to be <1, for both the worker and the trespasser, indicating that no adverse effects would be expected from exposure to biosolids or biosolids amended soils.

In addition, during the entire operation of the program, no adverse health effects have been noted. The truck/field vehicle driver wears a dosimeter, and no important exposure has been measured. Health physics surveys of former biosolids land application sites found non-detectable levels of radionuclide activity on trees, ground cover, or site soil, nor was there evidence of removable contamination (i.e., no alpha or beta-gamma was detected on personnel or vehicles) (DOE 1996).

Impacts to human health while directly inhabiting the application sites (i.e., resident farmer) from radiological constituents due to the increase from 4 to 10 mrem/yr dose rate show a small incremental increase but remain within acceptable DOE and EPA acceptable risk criteria of 10^{-4}. Moreover, the predictive modeling (***Appendix E***) suggests that application site soils will attain only 47.1% of the proposed 10 mrem/yr planning levels demonstrating that the likelihood of application sites attaining the radionuclide levels in the proposed action are unlikely.

The proposed 10 mrem/yr planning level is extremely conservative considering that established Nuclear Regulatory Commission (NRC) radionuclide clean-up criteria is 25 mrem/yr. When compared to other exposures received by members of the general public on a day to day basis, the proposed planning level is also very conservative. ***Table 4.4*** provides a list of typical exposures to members of the general public in comparison to the proposed application site planning level.

Table 4.5. Typical Exposures Received by Members of The General Public in Comparison with Proposed 10 mrem/yr Dose Rate for ORR Land Application Sites

Activity	Dose (mrem/yr)
Gastrointestinal Series (Upper and Lower)	1,400
CT Scan (Head and Body)	1,100
Radon in Average Household in the U.S.	200
Living in Tennessee	40
Cosmic Radioactivity	31
Natural Radioactivity in the Body	39
Mammogram	30
Smoking Cigarettes (1 pack/day)	15-20
Consumer products (e.g., radon in drinking water)	11
Chest X-Ray	10
Proposed Maximum ORR Land Application Site Soil Planning levels	10
Using natural gas in the home	9
Living near Oak Ridge Reservation	8
Building materials (concrete)	3
Living near a nuclear power station	1
Air Travel (every 2,000 miles)	1

Source: Annual Site Environmental Report 1999

West End Treatment Facility Effluents

A maximum of 7.56 kg of total uranium from WETF operations would be land-applied on the ORR each year, resulting in an increase of 0.04 g/kg in the biosolids and a cumulative level of 0.002 mg/kg for application site soils, respectively. This results in a risk factor of 10^{-7} for the uranium applied on the application sites. As demonstrated in ***Table 4.3***, the cumulative risk of discharging treated effluents from WETF to the Y-12 and City of Oak Ridge sanitary sewer systems is extremely low and well below the DOE and EPA acceptable risk criteria of 10^{-4}. The radionuclide loading levels described above are extremely conservative and truly represent a worst case scenario from a boundary modeling perspective as described in the 10 mrem/yr RESRAD modeling (***Appendix D***).

Appendix K provides a technical memo stating that there is no measurable calculated dose received from a person standing next to the discharge pipe carrying WETF effluent to the Y-12 sewer system. Moreover, incremental exposures to a worker in the sewer system carrying treated WETF effluent would also not be measurable. In the event of a problem, discharges would be immediately halted for emergency repair operations.

4.1.10 Transportation

In a previous EA (DOE 1996) which addressed expansion of the biosolids land application program to include biosolids from ORNL and ETTP, total accidents and casualties (injuries and fatalities) were estimated for transportation of biosolids from ORNL and ETTP to the Oak Ridge POTW and from the Oak Ridge POTW to the application sites. It concluded that total potential accidents or casualties in 10 years of biosolids application would be < 1. The highway accident rates for transportation of biosolids for the City of Oak Ridge solid Class A program would be 2 in 100,000 trips or events. The highway casualty rate for transportation of the City of Oak Ridge Class A Biosolids Program is 1 in 100,000 trips per month. Because the biosolids material is free of pathogens, there is no potential for the spread of contamination during an accident. This is further substantiated by the fact that the total number of trips to and from the application sites has been drastically reduced because of the city's conversion from liquid (~40 trips per month) to solid (~4 trips per month) biosolids application.

It should be noted that since the beginning of the biosolids land application operation in 1983, there has not been a transportation-related spill. In the event of a spill, there is a spill response plan (Duratek Federal Services, 2000) that includes the initiation of proper spill response measures and the notification of essential oversight personnel.

4.1.11 Human Health and Safety

Human health issues of concern are chemical contamination from the biosolids, particularly buildup of heavy metals in the soil, and the survival of residual pathogens (viruses, bacteria, parasites, and some fungi) in the biosolids and soil. These potential health impacts are summarized here.

Heavy metal concentrations in the biosolids are well below the ceiling concentration limits established by EPA (see ***Appendix B, Table B.2***). Because of the historically conservative chemical loading limits of the land application program, chemical contaminants in the receiving soil have remained well below levels of concern for human health effects. As explained in the human health risk assessment for the biosolids land application sites (***Appendix G***), the hazard index (HI) for toxic (i.e., noncarcinogenic) effects from heavy metals is <1, which is within acceptable limits. For cancer effects, risks to the employee applying the biosolids and risks to a transient on the application site are also below the DOE and EPA acceptable value.

Studies indicate that under EPA-approved biosolids application practices, pathogens are not a health risk (DOE 1996). These organisms will not present a problem because they will be destroyed in the city's Class A biosolids treatment process. As a result, City of Oak Ridge biosolids will not contain residual pathogens, reducing any potential pathogenic threat to workers, transients or application operators.

Activities associated with the transportation of the biosolids would comply with DOE notices and regulations on employee health and safety and the spill response plan (Duratek Federal Services 2000), developed specifically for the transport of biosolids from the Oak Ridge POTW to the land application sites.

There are no major occupational health and safety concerns associated with the operations of the truck transporting the biosolids and the field vehicle applying the material. In the event of a spill, the driver is instructed to follow procedures outlined in the spill response plan.

Because there is only one employee operating the truck and the field vehicle, the occupational and health risks (radiological and nonradiological) would be the same as that for the maximally exposed individual (***Appendix G***). The public would not be exposed to the biosolids unless there is an accident involving the transport vehicle in a populated area, which, to date, has never occurred, in the event of which the spill response plan would be implemented. Thus, the radiological and nonradiological impacts to workers and the public would be below limits established by DOE and NRC.

4.1.12 Accidents

Accidents involving the management or transfer of city biosolids at the POTW or on the ORR application sites may occur but are very unlikely. The physical state of the biosolids produced at the city POTW is a dry, pelletized material that is easily managed during transfer from vehicle to vehicle or vehicle to storage areas. The material is Class A and does not pose a pathogenic (i.e., biological) threat. Heavy metal levels must meet EPA land application criteria prior to application and is therefore not a threat to humans or the environment. The trace amounts of radionuclides contained within the biosolids would produce a maximum exposure of 0.14 mrem/yr (***See Table 5.2***) with an associated risk of 4×10^{-7} to a worker, which are below acceptable EPA and DOE limitations. In addition, POTW workers wear dosimeters that are administered by a third party to measure doses received by biosolids at the city POTW. To date, no detectable levels of radiation have been observed for any POTW operations personnel.

Transients (i.e., members of the public) would receive a considerably lower dose of 0.02 mrem/yr with an associated risk of 1×10^{-7}, which is also well below acceptable EPA and DOE limitations.

4.2 ALTERNATIVE 1 (4 to 10 mrem/yr radionuclide planning level increase without WETF Effluent)

This proposed action has essentially the same environmental impacts as assessed in ***Section 4.1*** but would result in the following changes due to the absence of WETF effluents in the Y-12 and City of Oak Ridge sewer systems:

- The estimated annual cost savings of $133,000 associated with minimizing EPS operations and NPDES sampling and analysis would not be realized for WETF operations;

- 7.56 kg of total uranium from WETF operations would not be land applied on the ORR;

- Impacts of any additional pipe installation would not occur and

- Application site soils would not receive an incremental total uranium loading increase of 0.0020 mg/kg for the life of each site from maximum radionuclide discharge levels involving WETF operations. This loading increase corresponds to 0.0014%, or a negligible portion of the proposed 10 mrem/yr planning level.

4.3 ALTERNATIVE 2 (No Action)

This alternative, which is the continuation of the current biosolids application program using 4 mrem/yr radionuclide soil loading planning levels as assessed in a previous EA (DOE 1996) and discharge of wastewaters generated at WETF to upper EFPC, would involve the current costs and environmental impacts of operating the WETF NPDES outfall and treatment costs incurred by using EPS to treat low level contaminant batches of wastewater as described in ***Section 1.2***.

Impacts to water quality would not be important due to the fact that the city would produce a sterilized, solid biosolids material that physically ties up available nutrients and trace contaminants such as heavy metals, radionuclides and inorganic compounds such as nitrates. Because the physical form of the biosolids is in a solid form, the material will remain at the location where it is dispersed after application. The existing program prohibits the application of biosolids material within 500 feet of a wetland or U.S. waterway. Although this practice is not required for Class A biosolids products, it is anticipated that this practice will continue and is protective of established wetlands and other waters of the U.S. or state that are physically located on or near biosolids land application sites.

Impacts to archaeological/cultural/historical resources, climate and air quality or transportation would not be expected for this alternative and are not discussed further in this section.

Impacts to human health and safety would also not be expected for this alternative because of the rigorous EPA 40 CFR 503 Class A biosolids treatment standards that the City of Oak Ridge meets prior to land application. Strict limits on pathogenic organisms, heavy metals and vectors (e.g., flies, etc.) levels in Class A biosolids were established specifically using risk-based criteria to protect human health.

Because the City of Oak Ridge utilizes Class A biosolids standards, adverse impacts to human health would not be expected and are not discussed further in this section.

4.3.1 Socioeconomics

The no-action alternative would not generate employment or population changes that would induce socioeconomic impacts. Current biosolids land application practices would continue and could result in free distribution of the biosolids material to the community which could include home and garden horticultural and agricultural uses.

By not allowing the radionuclide loading limits for ORR biosolids application site soils to be raised from 4 mrem/yr to 10 mrem/yr, City of Oak Ridge industrial growth will be directly impacted. The maximum radionuclide loading planning level would remain at 4 mrem/yr resulting in a reduction in the total amount of radionuclides that would be land applied corresponding to the proposed net 6 mrem/yr dose increase to 10 mrem/yr. This will force the city to severely limit the amount of radionuclides entering the sewer system. Most industrial dischargers presently operate wastewater processes to reduce the total amount of heavy metals and radionuclides entering the sewer system. Additional restrictions on radionuclide discharges above currently authorized limits would require dischargers of radionuclides to install specialized radionuclide contaminant removal processes (e.g., demineralization units, ion exchange resins, etc.) that are very costly and may not entirely remove radionuclides to non-detectable levels.

The other option available to the city would be to directly refuse the radionuclide discharges of contributors altogether. This would be the case in the proposed discharge of treated WETF effluents and the acceptance of the ORNL biosolids in the existing land application program. Treated WETF effluents would not be allowed to enter the sewer system resulting in an unrealized cost savings of $133,000 per year. ORNL biosolids would also most likely be removed from the current beneficial re-use program to enable limited radionuclide capacity within the sewer system. This would result in an additional expenditure of $67,000 per year by DOE and would force ORNL to utilize low level waste disposal as the only other available course of action to dispose of their sanitary biosolids. This could have a direct impact upon the industrial growth and would not provide the City of Oak Ridge with sufficient capacity for future industrial growth that would require radionuclide discharges to the sewer system. In addition, future DOE projects that would require the treatment of sanitary wastewaters containing very low-levels of radionuclides would not be available to DOE-ORO because of the city's limited capacity for growth.

As stated in ***Section 3.1***, it is impossible to forecast the government and industrial need for radionuclide discharges to the City of Oak Ridge sewer system and therefore a projection of lost revenues cannot be accurately determined.

Land application of biosolids on the ORR by the City of Oak Ridge would cease when site loading limits (i.e., 50 tons/acre) are reached. At that time, other options for biosolids management by the city would be required, resulting in non-federal action(s) beyond the scope of this EA.

4.3.2 Geology and Soils

No impacts to the geology of the ORR would result from the no-action alternative; impacts are avoided by program-imposed operating limitations (e.g., no application within 50 feet of rock outcroppings and karst features, such as sinkholes). Until loading limits are reached, soils would continue to receive the monitored application and loading of heavy metals and radionuclides, along with the nutrient-loading and soil improvement benefits. Once loading limits were reached at all approved sites, land application of biosolids would cease on the ORR.

4.3.3 Ecological Resources

Continuation of the biosolids land application program at the current active sites would not be expected to result in adverse impacts to ecological resources of these sites. The application of site evaluation criteria for site approval and the use of sampling and analysis of biosolids, soil, and vegetation during site use limits the potential for adverse impacts to occur. Once the loading limits are reached, land application of biosolids would cease on the current ORR sites. The current biosolids land application program is not considered to impact any listed species. This is because the currently active sites were selected and approved with the avoidance of any impacts to these species in mind. Most of the active sites are grass and hay fields; few listed species prefer this type of habitat. Exceptions to this include the state-listed Vesper and Bachman's sparrow, which nests in large grass fields with infrequent mowing. Infrequent mowing (or burning), while necessary to maintain an area as grass or weedy grass habitat, could result in negative impacts both to nesting attempts by these sparrows. These impacts would occur only if mowing were performed during the reproductive seasons of these species (late April through June).

It should be noted that although these sites could provide suitable habitat, no threatened or endangered species or established habitats were noted during a survey conducted on the ORR biosolids land application sites in 1997 (TN & Associates 1997).

4.3.4 Radiological Impacts

Under the no-action alternative, the handling and application of biosolids using current practices would continue until the loading limits are reached, at which time biosolids application would cease on the ORR. As explained in the human health risk assessment (***Appendix G***), there would be no measurable risks to exposed workers or potential transients. Also, using the predictive modeling for all sites (***Table 4.2***), the most heavily loaded site when the 50 tons/acre nitrogen limit is attained, from a radiological perspective, would be the Rogers Site at 56.8% of the 4 mrem/yr dose planning level. The average lifetime radiological loading result for all sites is approximately 47.1% of the 4 mrem/yr dose planning level for a maximally exposed, resident farmer living on the ORR biosolids land application sites.

4.4 COMPARISON OF ALTERNATIVES

Table 4.5 summarizes and compares the proposed actions, alternatives and their projected impacts.

Table 4.6. Comparison of Alternatives

Action	Summary	Impacts
Proposed Action: Increase ORR biosolids land application site radionuclide loading from 4 to 10 mrem/yr dose-based planning levels and allow the discharge of treated WETF effluents into the Y-12 and City of Oak Ridge sewer systems.	- Minor increase in ORR site soil radionuclide loading levels, - Minor increase in risk factors for application sites; - Projected maximum radionuclide lifetime loading for ORR sites is 47.1% of proposed 10 mrem/yr planning level - Reduction in risk factors from WETF to sewer system (10^{-9}) over WETF to EFPC (10^{-7}) - Reduced operational costs for WETF - Negligible radionuclide increase in city biosolids and ORR site soils directly resulting from WETF discharges - Negligible impact upon EFPC - Allow City of Oak Ridge sufficient radionuclide discharge capacity for future industrial growth	Minimal increase (47.1% of proposed 10 mrem/yr planning level is expected) in health, environmental, and transportation risks over baseline; Worst-case risk factors are below the EPA and DOE accepted value of 10^{-4}
Alternative 1: Increase ORR biosolids land application site radionuclide loading from 4 to 10 mrem/yr dose-based planning levels.	- Minor increase in ORR site soil radionuclide loading levels, - Minor increase in risk factors for application sites; - Projected maximum radionuclide lifetime loading for ORR sites is 47.1% of proposed 10 mrem/yr planning level - Allow City of Oak Ridge sufficient radionuclide discharge capacity for future industrial growth - Negligible impact upon EFPC - Continued additional costs for WETF effluent discharges ($133,000 annually)	Minimal increase (47.1% of proposed 10 mrem/yr planning level is expected) in health, environmental, and transportation risks over baseline; Worst-case risk factors are below the EPA and DOE accepted value of 10^{-4}; 7.56 kg of total uranium will not be land applied from WETF Operations per year
Alternative 2 (No action): Continued biosolids application on the ORR until current loading limits reached; WETF effluents will continue to be treated and discharged to upper EFPC via NPDES discharge outfall #502	- Continued additional costs for WETF effluent discharges ($133,000 annually) - ORNL biosolids treatment at city POTW could be discontinued resulting in an additional operational cost of $67,000 annually - Future industrial growth requiring radionuclide discharges to the sanitary sewer system could be reduced, affecting both government and commercial projects within the City of Oak Ridge	No increase health, environmental and transportation risks; 7.56 kg of total uranium will not be land applied from WETF Operations per year; Impact future City of Oak Ridge industrial growth

5.0 POTENTIAL CUMULATIVE AND LONG-TERM IMPACTS

This section evaluates the impacts from the proposed action and alternatives in conjunction with other actions that could result in a cumulative impact to the environment. Cumulative impacts are defined as "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Impacts are considered on a cumulative basis because of individual minor direct and indirect effects of multiple actions that occur over the history of the site. Cumulative impacts are be considered over the "lifetime" of the impacts, rather than only the duration of the action.

Past and current impacts were evaluated in ***Section 4.0*** using Alternative 2 - No Action as a baseline for comparison against the proposed action (Increase soil radionuclide planning levels from 4 to 10 mrem/yr and allow the discharge of treated, WETF effluents into the Y-12 and City of Oak Ridge sewer systems) and Alternative 1 (Increase soil radionuclide planning levels from 4 to 10 mrem/yr but not allow discharge of WETF effluents into the sewer system). Other actions with similar potential effects to the proposed action could act synergistically or incrementally with the effects discussed in ***Section 4.0***, thereby increasing the potential adverse or beneficial impacts on a cumulative basis. The potential effects of implementing the Proposed Action or Alternative 1 are combined with potential impacts from other projects for consideration of cumulative impacts by resource area in this section. If a resource area would not be affected as a result of taking an action, it is assumed that there would be no cumulative impact potentially resulting from the action.

Identification of other actions that could result in cumulative impacts when combined with the proposed action is based on actions likely to have similar potential impacts within the same geographic area and over the same time frame. Because application sites utilized in the Biosolids Land Application Program were selected in presumably clean areas of the ORR that were physically isolated from other ORR plant operations, the active application sites are not located within the footprint of any other on-going projects at the time of this EA. Because the majority (i.e., five) of the sites are in the general vicinity of the Y-12 plant, it is possible that some of the environmental restoration projects and modernization of the Y-12 Plant could be considered in this cumulative impacts section. Local projects that could have cumulative impacts with the proposed action include a proposed connector highway from I-40 in Roane County to Oak Ridge.

5.1 Cumulative Impacts by Resource Area

Geology and Soils

The ORR covers 13,912 ha (34,424 acres). There are six active land application sites totaling 133 ha (329 acres) on the ORR (***Table 1.1*** and ***Figure 1.1***). Three previously utilized sites totaling 21 ha (52 acres) are currently inactive. The active sites represent approximately 1% of the total area of the ORR. The size of application sites ranges from 10.9 ha (27 acres) to 47.4 ha (117 acres).

The lifetime application site loading limits, ceiling concentrations for heavy metals and radionuclides and the comprehensive monitoring program are designed to prevent future land use restrictions and remedial actions from being placed on any sites used for land application of biosolids. The safety factor provided by the specific limits derived from the TDEC-approved, dose-based approach ensures protection of the environment.

Implementation of the proposed action and Alternative 1 would contribute to a slight increase in the radionuclide loading for ORR Biosolids Land Application Site soils. ***Appendix B, Tables B.5*** through ***B.11*** summarize cumulative loading of inorganics, heavy metals, organics, radionuclides, respectively, on active ORR biosolids application sites. Cumulative impacts involving biosolids land application for heavy metals, inorganic constituents and organic compounds have been previously evaluated (DOE 1996) and found to not be important and will not be further discussed in this section. These tables give an indication of how minimal the cumulative impacts would be. For example, city biosolids radionuclide concentrations are well below the dose-based planning levels in the proposed actions, and only represent a maximum of 20% of the proposed biosolids planning level for Cobalt-60. In addition, after 12 years of operation involving the land application of city biosolids, radionuclide concentrations within ORR soils are at an average of 8% of existing planning levels. Because the average remaining life of the ORR land application sites is estimated to be 7 years, it is expected that only approximately 47.1% of the proposed 10 mrem/yr soil planning levels will be realized. This is demonstrated by the predictive modeling results (***Appendix E***) listed in ***Table 4.2*** for the existing sites. Therefore, it can be concluded that the probability that ORR biosolids land application site soils will ever fully achieve radionuclide concentrations that correlate to the proposed level of 10 mrem/yr is extremely low and unlikely. In the unlikely event that ORR application sites ever achieve the proposed radionuclide planning levels, the associated risk to an on-site resident is still below the acceptable EPA and DOE risk value of 10^{-4}.

No soils will be removed or excavated from the active application sites in conjunction with Y-12 environmental restoration projects or the modernization of the Y-12 Plant. In addition there are no construction activities planned now or in future operations for these sites; therefore, no potential cumulative effects from the proposed action or Alternative 1 were identified.

Water Resources

Implementation of the proposed action or Alternative 1 would not contribute to the cumulative impact on the surface water and groundwater of the ORR or surrounding communities. Under the proposed action, treated WETF wastewaters would be discharged to the Y-12 and City of Oak Ridge sewer systems where they would receive additional treatment at the city POTW and then be discharged into lower EFPC. ***Appendix H, Table H.6.*** demonstrates that the total chemical and radiological risk from this discharge scenario would actually be less than that of Alternative 1 or 2, direct treatment by the WETF Effluent Polishing System (EPS) and discharge to upper EFPC. WETF discharges to upper EFPC represents less than 1% of the total average flow and is not expected to augment the physical flow of the creek.

There are no major streams, lakes or bodies of water found on the ORR Biosolids Land Application Sites. There are a few small ponds that have been marked and identified by wetlands flagging. These areas are protected by a 500 foot buffer zone that prohibits the application of biosolids. Because the physical state of the biosolids has been converted from liquid to solid and the material has been sterilized (i.e., no pathogens), the biosolids material being land-applied poses little to no threat for surface water runoff. Radionuclides are bound to the solid matrix of the biosolids and are not readily released when the material becomes wet and begins to incorporate into the site soils. For this same reason, groundwater will also not be impacted. The city is required to calculate the quantity of biosolids that can be applied on a given site based upon previous applications, what the growth requirements of the vegetation are required and the level of nitrogen found in the biosolids each year. Using this formula, biosolids application is limited for each site, protecting the ORR groundwater.

The proposed action and Alternative 1 would not contribute to surface water discharges that could occur from Y-12 environmental restoration actions or the Y-12 Plant Modernization Project. No groundwater withdrawals are planned as any part of the proposed action or Alternative 1. In addition, there should be no interaction between the proposed action, Alternative 1 and any environmental restoration actions involving groundwater recovery or discharge.

Negligble chemical or radiological impacts on groundwater or surface water are anticipated from the implementation of the proposed action or Alternative 1. Therefore, negligble cumulative impacts would be expected.

Ecological Resources

Implementation of the proposed action or Alternative 1 would have little effect on ecological resources (***Section 4.8.1***). No impacts to wetlands or threatened and endangered species were identified as a result of implementation of the proposed action and Alternative 1. The Y-12 Plant Modernization Project and Y-12 environmental restoration activities would also not impact wetlands and threatened and endangered species; therefore, ecological resources of the ORR should not be cumulatively impacted.

Cultural Resources

No prehistoric sites have been identified on the active ORR Biosolids Land Application sites. Therefore, the implementation of the proposed action or Alternative 1 would not contribute to cumulative effects on the archaeological resources of the ORR.

Air Quality

Because of the biosolids processing change at the city POTW, the physical state of the biosolids being land-applied went from liquid to solid. This change could result in the formation of dust particulates at the point of application. An air dispersion model (***Appendix I***) was formulated for the proposed action and Alternative 1 to simulate the on-site exposure of a person standing on a biosolids application site inhaling fugitive radioactive particulates downwind during application. Results are listed in ***Table 4.4***.

The maximum exposure of an individual breathing the biosolids as they are land-applied 260 operational days per year, 8 hours each day is 0.00008 mrem/yr. This corresponds to 0.01% of the total 0.7 mrem/yr off-site exposure (ASER 2000) received by an individual from cumulative operations conducted on the ORR or any concurrent projects in and around the application sites that have the potential to produce dust emissions. Thus, the proposed action or Alternative 1 would not be expected to adversely impact air quality in and around the ORR.

Socioeconomic

Environmental effects from the proposed action and Alternative 1 on the economy and community infrastructures of the ROI would be minimal. A total of $133,000 per year would not be realized for WETF operations due to the inability to discharge treated effluents to the sewer system and there is a strong possibility that the city will no longer accept ORNL biosolids in the existing land application program, resulting in an additional $67,000 per year for DOE. *This represents approximately 0.01% of Anderson County, 0.01% of Roane County, and 0.001% of Knox County 1999 personal income statistics (**Appendix C, Table C.1**), respectively.* Economic impacts could be more substantial if a commercial industry or government entity that required some level of radionuclide capacity, decided to relocate to the Oak Ridge Community and sewer capacity was not available. Because of the variety and size of industries, it is difficult to predict the economic impact upon the Oak Ridge Community due to the substantial number of unknown variables involved. It should be noted that if the proposed action or Alternative 1 were successfully implemented, it could contribute indirectly to sustained or increased numbers of well-paying jobs within the OR region over the long-term, particularly when considered in combination with other actions and initiatives, e.g., the Y-12 Plant Modernization Project, reindustrialization at ETTP and the development of a four-lane highway from I-40 in Roane County to Oak Ridge. However, at the present time, there are no industries that require sanitary sewer system radionuclide capacity, thus, there would be no cumulative impact or change to regional income, housing markets, or the demand for community services.

Environmental Justice

No potential effects to environmental justice were identified from the proposed action or Alternative 1 or for other projects with a potential to contribute to cumulative effects. Therefore, there would be no cumulative effects on environmental justice.

Transportation

Implementation of the proposed action would not result in appreciable changes to commuter traffic since the number of long-term employees operating the city program would not change. Negligible increases in traffic would arise from employment of temporary workers, such as for construction, but no change in the level-of-service on-site or on nearby roads is expected to be needed on that basis. Traffic to the SNS site would be accommodated by an access road already being constructed as part of the SNS facility. Increases in traffic could result from environmental restoration activities on ORR over the short term. These would only exceed traffic levels in past years if all of these activities occurred concurrently. Because access roads to the ORR Biosolids Land Application Sites are restricted from public use, there would be no cumulative change to demand for roadway access.

Land Use

The proposed action and Alternative 1 would not result in changes to land use because activities would occur on sites that have been in use since 1986 for biosolids land application activities. There would be no change in the total acreage. Although the sites have trace quantities of heavy metals and radionuclides that have been applied over the years of city operation, the levels of these contaminants are well within background levels observed from adjacent sites that have not received biosolids application.

Human Health and Safety

No operations included under the proposed action or Alternative 1 would increase chemical or radiological emission for the ORR Biosolids Land Application sites because operations would be the same or similar to the current operations. ***Table 5.1*** represents respective on-site exposures for individuals resulting from the proposed actions. Since the overall contribution of radionuclides from WETF is negligible (0.0014% life of each site), radiation doses receive on-site from each of the proposed actions are essentially the same.

Table 5.1. Cumulative On-Site Impacts from the Proposed Actions

Individual	Expected Dose (mrem/yr)
On-Site Resident	4.71
Worker	0.14
Transient	0.02

The generally very low levels have been confirmed by monitoring data showing no detection of radiation above background levels at any of the biosolids application sites surveyed (DOE 1996). Impacts to human health are evaluated in the land application site program risk assessment (***Appendix G***). Combined chemical and radiological risks to employees and transients are minimal and are below the acceptable DOE and EPA risk value (10^{-4}) for excess lifetime cancer risk and for nonradiological hazard. Cumulative human health impacts would be expected to be less than those described in the risk assessment for direct exposure to biosolids during or immediately after land application. TLD monitoring of employees has shown no important exposure to radionuclides (DOE 1996). As discussed in ***Sections 4.1.5*** and ***Table 4.3***, off-site impacts to EFPC from the proposed actions are negligible.

6.0 PERMIT AND REGULATORY REQUIREMENTS

EPA regulates municipal biosolids disposal under the Clean Water Act (40 *CFR* 503), with the Congressional mandate to reduce the potential environmental risks and maximize the beneficial use of biosolids (DOE 1996). In Tennessee, TDEC does not issue permits for land application practices but does approve each site that will be used for land application operations. Permits (EPA 1997) to land apply biosolids are issued directly from EPA, Region IV for POTWs located in Tennessee.

4 to 10 mrem/yr Dose Planning level Increase

Concurrence for raising the existing ORR biosolids land application site radionuclide planning levels from 4 to 10 mrem/yr has already been granted at the request of the City of Oak Ridge by the TDEC Division of Radiological Health. A copy of the approval letter is available in ***Appendix A***. Since EPA does not regulate radionuclides within biosolids materials, a revision to the existing EPA land application permit will not be necessary. No additional permits or approvals will be required for the proposed radionuclide loading increase beyond DOE-ORO approval.

It is the policy of DOE to keep radiation exposures as low as reasonably achievable (ALARA) below applicable dose limits. DOE notices and regulations specifically require the application of the ALARA process for radiation protection of workers and the public and the environment. DOE (1991) provides guidance on the procedures for applying the ALARA process for compliance with DOE 5400.5. The guidance states that both "...DOE Orders and regulations recognize that ALARA decisions require consideration of a broad range of technical and social considerations and recommend that the bases for ALARA judgments be documented." ALARA considerations are identified throughout the text of this analysis.

West End Treatment Facility Effluents

The TDEC Division of Radiological Health regulates discharges of radionuclides to POTWs by licensed nuclear material facilities under *State Regulation for Protection Against Radiation*. In Oak Ridge, sewer effluents are specifically regulated for each licensee by a license condition; the limits for the license conditions are set via consultations between the City of Oak Ridge POTW and the Division of Radiological Health. Generic effluent radiological release concentration limits are lower than those of the NRC.

DOE regulates its discharge of radionuclides to sewers in DOE Order 5400.5: "...the control of releases of liquid wastes to community sanitary sewer systems is designed to be generally consistent with requirements imposed by the Nuclear Regulatory Commission on its licensees..." (Chapter I, Sect. 7) (DOE 1996). DOE Order 5400.5 specifies concentration discharge limits for radionuclides. Regulation of source, special nuclear, and by-product material was reserved to the Atomic Energy Commission under the Atomic Energy Act of 1954, as amended. That regulatory authority passed to the Atomic Energy Commission successor agencies: NRC (and agreement states, including Tennessee, for privately-owned nuclear facilities) and DOE (for its government-owned nuclear facilities). DOE regulation currently applies to the radionuclides in treated WETF wastewaters being added to the City of Oak Ridge POTW. All discharges from WETF to the Y-12 and City of Oak Ridge Sanitary Sewer Systems will be conducted in accordance with DOE Order 5400.5 limitations and criteria. In addition, WETF discharges would be required to meet pretreatment standards and prescribed sanitary discharge limits as required of the Y-12 Plant in order to be compatible with the city's industrial pretreatment program.

Discharge of treated WETF effluents would require the Y-12 Plant to modify their existing industrial discharge permit (IDP) with the City of Oak Ridge to include the additional uranium and nickel levels contained in WETF effluents. The City of Oak Ridge would respond to the request with a modified IDP to include WETF discharges. Specific language regarding the type and number of samples to be taken for treated WETF effluents will be included in the Y-12 IDP.

After the Y-12 IDP has been modified and approved by the City of Oak Ridge, contaminant limits will be issued for WETF by BWXT. When all sampling and analysis has been conducted on treated wastewaters ready for discharge to the sanitary sewer system, results will be forwarded to the Y-12 BWXT Sanitary Sewer Compliance Coordinator for approval to discharge. After approval has been received, discharges to the sewer system will commence. WETF discharges may be interrupted by Y-12 for any number of reasons (i.e., flooding, water line breakage, etc.). If WETF discharges are requested to cease, the discharge pump will be turned off and the appropriate valving closed to ensure that effluent flow to the sewer system halts. Discharges will resume upon notification from the Y-12 BWXT Sanitary Sewer Compliance Coordinator. In extended periods of delay, discharge through the existing WETF NPDES Outfall #502 may proceed, provided all contaminant limitations can be met.

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APPENDIX A

TDEC DIVISION OF RADIOLOGICAL HEALTH APPROVAL LETTER

DIVISION OF RADIOLOGICAL HEALTH
L & C Annex, 3rd Floor
401 Church Street
Nashville, Tennessee 37243-1532
(615) 532-0364 phone
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internet: mmobley@mail.state.tn.us

November 3, 1999

Bruce Giles
Oak Ridge Waste Water Treatment Plant
200 Monterey
Oak Ridge, TN 37830

Dear Mr. Giles:

Pursuant to our meeting on October 6. 1999 this will acknowledge our concurrence in the use of 10 mrem/year as a planning level for determining acceptable sewer release criteria from facilities utilizing radioactive materials in the Oak Ridge area. This concurrence is predicated on the conservative analysis of the impact of sludge spreading, the analysis to date demonstrating much less impact from actual releases and the routine sampling of sludge just prior to spreading.

The Division of Radiological Health is very appreciative of the excellent working relationship we have jointly maintained through the years. We look forward to its continuation.

Sincerely,

Michael H. Mobley gtb

Michael H. Mobley
Director

APPENDIX B

ORR BIOSOLIDS LAND APPLICATION PROGRAM AND WETF CHARACTERIZATION DATA

B.1 CITY OF OAK RIDGE BIOSOLIDS CHARACTERISTICS

This section discusses the characterization of the biosolids from the city of Oak Ridge POTW, which are currently being land applied on the ORR. Biosolids characteristics discussed include constituent inorganic chemicals, heavy metals, organic chemicals, radionuclides, and pathogens as they relate to biosolids Classes A and B.

Inorganic Chemicals

Biosolids inorganic analytical parameters must be sampled annually, as stated in the NPDES (TDEC 1998) and EPA (EPA 1997) permits issued to the City of Oak Ridge. The city performs these analyses depending upon the EPA and TDEC required frequencies. ***Table B.1*** shows the minimum, mean, and maximum levels of each required analyte found in the city's biosolids from 1993 to 2000 (City of Oak Ridge 1994-2000).

Table B.1. Inorganic Parameters and Analytical levels in City of Oak Ridge Biosolids (1993-2000)

Analyte	Sampling frequency	1993 levels (mg/kg dry wt)	1994 levels (mg/kg dry wt)	1995 levels (mg/kg dry wt)	1996 levels (mg/kg dry wt)	1997 levels (mg/kg dry wt)	1998 levels (mg/kg dry wt)	1999 levels (mg/kg dry wt)	2000 levels (mg/kg dry wt)
		Max	Max	Max	Max	Max	Max	Max	Max
Ammonia-nitrogen[a]	3/Year	20300	30000	34,900	28672	43000	33000	41000	33000
Manganese	3/Year	1,260	1,710	1,540	1345	1900	1400	1100	880
Nitrate nitrogen	3/Year	8.5	269.0	144.0	250	220	920	1000	380
Nitrite Nitrogen[a]	3/Year	6.5	30.7	30.7	N/A	N/A	N/A	N/A	N/A
Organic nitrogen	3/Year	31,000	49,800	66,000	64400	48000	52000	62000	92000
pH	Daily	7.1	8.1	7.5	8	8	8.4	7.9	7.2
Potassium	3/Year	3,420	5,410	6,020	5510	7100	4600	6000	3500
Phosphorus	3/Year	25,400	36,800	36,800	31800	48000	32000	47000	35000
Total Kjeldahl Nitrogen[b]	3/Year	59,200	77,200	89,100	89100	120000	87000	97000	93000
Total Nitrogen[b]	3/Year	61,616	77,223	89,127	89127	120140	87190	98000	93300
Total solids %	Daily	2.0	3.3	3.3	3.9	3.6	3.2	3.2	3
Volatile solids (% of TS)	Daily	61%	62%	63%	63%	63%	64%	63%	64%

Source: City of Oak Ridge 1994, 1995, 1996, 1997, 1998, 1999 and 2000

[a] These parameters are required to be sampled annually by NPDES permit #TN0024155. Reporting of quantitative data is required, but limits are not specified.

[b] Total nitrogen represents the sum of total Kjeldahl and nitrate nitrogen.

Heavy Metals

Heavy metal sampling and analysis is based upon the total amount of biosolids produced within a calendar year. The City of Oak Ridge averages 400 dry tons per year which places their operation in the 290 to 1,500 tons per year EPA designation, requiring quarterly analysis for the (9) regulated metals listed in 40 CFR 503.13. With the exception of the Y-12 sewer mercury incident in 1995 that resulted in the inadvertent discharge of mercury producing city biosolids in excess of established 40 CFR 503 limits during video surveillance of the Y-12 sewer system, the concentrations of heavy metals have been well below the 40 *CFR* 503.13 ceiling concentration limits. ***Table B.2*** compares maximum concentration of each heavy metal in Oak Ridge POTW biosolids with the ceiling concentration limits for that metal. Although quarterly sampling and analysis is required for these metals, monthly analysis is performed by an EPA-certified, commercial laboratory. The additional monitoring is designed to help prevent an abnormally high concentration of a heavy metal from being applied on the ORR and to prevent total loading limits from being exceeded.

Organic Chemicals

The City of Oak Ridge's NPDES permit requires annual sampling of biosolids organic analytical parameters. Currently, the city performs these analyses, including other organic compounds not required to be tested such as benzene, toluene, etc. ***Table B.3*** summarizes the maximum levels of organics in the biosolids from 1993 to 2000. Most of the organic chemicals were undetected.

Radionuclides

Both the biosolids and the land application areas on the ORR are part of an ongoing radiological monitoring program (see ***Section 6.0*** for a summary of permit and regulatory requirements). Because of the various contributions of natural background radiation, atmospheric deposition, industrial operations, and medical facilities, all biosolids contain radioactive materials.

Bulk gamma emitters and selected radionuclides (e.g., cobalt-60, cesium-137, iodine-131) are monitored by the Oak Ridge POTW daily during application, analyzed quarterly using composite biosolids samples, and monitored on an as-needed basis in land application area soils. The City of Oak Ridge collects the soil samples and contracts with ORNL to analyze the samples for radionuclide content.

In 1984, there was a report of elevated levels of Cobalt-60 in the biosolids from the Oak Ridge POTW; however, no cleanup was necessary at the treatment plant because of the relatively low concentrations and short half lives (i.e., < 5 years) of the radionuclides (DOE 1996). It was determined that land-applied biosolids contained elevated levels of Cobalt-60 from a private manufacturing facility in Oak Ridge. Because of the relatively short half-life of Cobalt-60 (5.3 years), the levels were determined to be of minimal risk. However, as a precaution the land application site (McCoy) was closed, and an extensive sampling and monitoring program was developed to ensure that no biosolids with radioactivity in excess of prescribed action levels outlined in the Oak Ridge POTW Gamma Screening Protocol (City of Oak Ridge 1999) would be applied without additional sample screening by ORNL. Low-level radiation surveys were conducted at the McCoy site in September 1994, and active and retired biosolids application sites were also surveyed. Radiation above background levels was not detected (DOE 1996).

Table B.4 shows the average radiological characterization of the Oak Ridge biosolids from 1996 to 2000.

Major contributors to the radiological content of the City of Oak Ridge POTW biosolids include groundwater infiltration containing naturally-occurring radionuclides (Radium, Uranium, Potassium-40, Beryllium-7), medical facilities (Iodine-131, Technetium-99m), industrial facilities (Cobalt-60 and Cesium-137), ORNL biosolids (Strontium-90 and Cesium-137) and the Y-12 Plant (Uranium). As expected, the levels of naturally occurring radionuclides in the biosolids remain relatively constant. The contribution of radionuclides from industrial facilities (including the Y-12 Plant) has shown an overall reduction and remain well under established 4 mrem/yr RESRAD planning levels. For example, the uranium content of biosolids dropped from 1.57 pCi/g to non-detectable levels between 1996 and 2000, most likely due to sewer line rehabilitation projects on both the City of Oak Ridge and Y-12 sewer systems.

Pathogens

The pathogen reduction requirements for biosolids are divided into two categories: Class A and Class B. If the biosolids meet Class A, pathogen levels are reduced to levels below detection limits. If the biosolids meet Class B, the pathogen levels are reduced to levels that are unlikely to threaten public health and the environment when applied to land with specific use restrictions. The 40 CFR 503 site restrictions (e.g., no application in frozen or flooded areas, wetlands, threatened or endangered species or designated habitats, etc.) for application of Class B biosolids minimize the potential for human and domestic animal contact until environmental attenuation has further reduced the pathogen levels. Biosolids that are applied to home gardens or distributed to the public must meet Class A pathogen requirements. Biosolids that are applied in bulk form to agricultural land, forest, reclamation sites, or public sites must meet either Class A or Class B pathogen requirements.

The City of Oak Ridge POTW biosolids currently meet Class B standards and will meet Class A standards after their biosolids process modification in the Summer of 2001. Even though the City of Oak Ridge would meet Class A standards which would allow the biosolids material produced at the POTW to be freely distributed to the community, the City of Oak Ridge plans to continue to utilize the existing land application sites for the beneficial re-use of all of the material produced because of the long history of program operations and DOE cooperation.

Either liquid or solid biosolids that meets either Class A or Class B standards may be land applied on the ORR. The City of Oak Ridge POTW is currently producing and applying liquid Class B biosolids. However, the city will be producing only Class A biosolids material beginning in the Summer of 2001. Whether biosolids are applied in liquid or solid form, existing program limits for heavy metals, nitrogen and radionuclides are all calculated on a dry weight basis (i.e., 100% solids). For this reason, all analytical results, calculations for risk assessment and RESRAD modeling involving biosolids will be done on a dry weight basis and will cover both liquid or solid materials. Class B liquid may be applied only in areas evaluated by TDEC and permitted by EPA. Solid Class A biosolids may be land applied without permit restrictions per 40 CFR 503.

Table B.2. Concentrations of Heavy Metal Levels in City of Oak Ridge Biosolids (1993-2000) versus 40 CFR 503.13 Limits

Heavy Metal	40 CFR 503.13 Limits	1993 (mg/kg)		1994 (mg/kg)		1995 (mg/kg)		1996 (mg/kg)		1997 (mg/kg)		1998 (mg/kg)		1999 (mg/kg)		2000 (mg/kg)	
		Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Arsenic	75	5.9	25.1	4.2	9.1	9.03	9.12	6.71	12.8	2.5	7.5	2.4	4.3	2.7	4.7	2.1	3.8
Cadmium	85	10.4	15.1	9.4	17.8	8.3	11	9.92	19.4	3.6	5.2	3.1	4.8	3.4	3.8	3.1	4.5
Copper	840	460.1	544	450.6	490	476.5	543	361.7	520	430.8	570	479.2	700	484.4	570	510.8	620
Lead	4300	69.3	88.4	103.6	128	71.2	116	32.52	74	38	74.6	33.6	63	36.6	43	36.2	48
Mercury	57	9.12	16.2	7.59	9.45	57.6[a]	264[a]	2.16	8.2	12	20	11	16	10.6	19	6	11
Molybdenum	75	27.8	33.8	19.73	23.5	17.7	26.6	23	54	7	13	10.1	21	15.8	21	13.9	26
Nickel	420	40.2	51	37.6	45.6	35.8	61.5	26.23	39.7	28.2	42	33.5	100	25.5	47	63.1	100
Selenium	100	7.6	20.9	5.7	10.2	6.5	15.1	10.29	18.2	1.7	3.1	3.1	7	8.6	14	8.4	15
Zinc	7500	1698	2070	1700	1840	1641	1940	887	1610	1404	1910	1209	1600	1150	1400	1039	1600

Source: City of Oak Ridge 1994 - 2000

[a] Biosolids that exhibit mercury levels of 40 CFR 503.13 limits were disposed at a landfill under a special waste permit from TDEC

Table B.3. NPDES Organic Parameters and Concentrations of Organic Constituents in City of Oak Ridge Biosolids (1993-2000)

Analyte	Sampling frequency	1993 levels (mg/kg dry wt)	1994 levels (mg/kg dry wt)	1995 levels (mg/kg dry wt)	1996 levels (mg/kg dry wt)	1997 levels (mg/kg dry wt)	1998 levels (mg/kg dry wt)	1999 levels (mg/kg dry wt)	2000 levels (mg/kg dry wt)
		Max	Max	Max	Max	Max	Max	Max	Max
Aldrin	Annually	U	1.1	0.021	0.025	U	U	0.38	0.67
Chlordane	Annually	0.55	U	0.33	2.7	1.3	0.34	3.8	6.7
DDD	Annually	U	U	U	U	0.071	U	0.38	0.67
DDE	Annually	U	0.05	U	0.01	0.023	U	0.38	0.67
DDT	Annually	U	U	U	U	0.0071	U	0.38	0.67
Dieldrin	Annually	U	0.07	0.09	0.099	0.061	U	0.38	0.67
Heptachlor	Annually	U	U	U	U	U	U	0.38	0.67
Lindane (gamma-BHC)	Annually	U	U	.0075	U	U	U	0.38	0.67
PCBs	Annually	U	0.96	0.37	U	U	U	7.7	N/A
Toxaphene	Annually	U	U	U	U	U	U	7.7	13
Trichloroethene	Annually	U	U	U	U	U	U	0.038	0.17
Benzo(a)pyrene	Annually	U	U	U	U	1	U	13	11
Dimethylnitrosamine (n-nitroso-di-methylamine)	Annually	U	U	U	U	U	U	13	11
Hexachlorobenzene	Annually	U	U	U	U	U	U	13	11
Hexachlorobutadiene	Annually	U	U	U	U	U	U	13	11

Source: City of Oak Ridge 1994 through 2000

U = Undetected. Indicates that the compound was analyzed for but was not detected.

Table B.4. Concentrations of Radionuclide Levels in City of Oak Ridge Biosolids (1996-2000)

Radionuclide	4 mrem/yr Biosolids Planning level (pCi/g)	1996 (pCi/g)		1997 (pCi/g)		1998 (pCi/g)		1999 (pCi/g)		2000 (pCi/g)	
		Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Cobalt-60	10.7	0.46	7.05	0.51	8.96	0.52	1.17	0.51	0.8	0.48	0.81
Cesium-137	43.6	0.8	9.24	0.31	0.85	0.36	0.69	2.07	4.17	1.88	3.8
Iodine-131	N/A	35.7	103	21.6	86.2	9.46	32.6	8.52	44.8	5.7	40.1
Beryllium-7	N/A	2.72	5.05	1.7	6.15	1.3	2.69	1.08	1.89	0.72	1.09
Potassium-40	120	7.19	12.3	6.19	8.08	6.04	9.27	5.86	7.24	5.67	10.43
Radium-228	20.7	1.13	1.69	1.01	1.42	0.97	1.51	0.84	1.36	0.62	0.99
Uranium-235	157	0.75	1.85	0.35	0.71	0.33	0.83	0.36	0.73	N/D	N/D
Uranium-238	459.5	13.3	51	8	24.2	10.6	21.9	7.62	15.7	2.58	6.2

Source: City of Oak Ridge 1996 - 2000

Class B biosolids are well suited for land application on the ORR because the existing access restrictions are consistent with site restrictions for bulk biosolids land application. Class A biosolids have fewer restrictions regarding how and where it can be applied, but result in higher treatment costs to meet Class A standards.

B.2 OAK RIDGE RESERVATION LAND APPLICATION SITE CHARACTERISTICS

This section discusses the six ORR sites currently utilized for biosolids application by the City of Oak Ridge. Site profile sheets are available in ***Tables B.5*** through ***B.10*** that provide cumulative nitrogen, heavy metal and radionuclide loading levels as of December 31, 2000 as well as relevant NEPA characteristics such as threatened and endangered species, wetlands, etc.

Inorganic Chemicals

Biosolids land application site soils are required by TDEC to be analyzed for a number of inorganic parameters once every 3 years. Until recently, the City of Oak Ridge performed soil analyses annually to establish a thorough baseline of data.

Soil sampling frequency for land application sites is now performed every 2 years. ***Table B.11*** summarizes soil sample results collected during various times in the program history and compares them to data collected in reference areas that have not received biosolids application. Results are reported in the annual biosolids management report that is prepared February 19, annually.

Two limits are in effect for nitrogen loading on ORR land application sites, annual and lifetime loading limits. Annual limits are based upon EPA requirements to calculate the nitrogen (i.e., agronomic) loading limit. The annual nitrogen limit takes into account previous applications of biosolids, nitrogen compound levels analyzed in the biosolids and the vegetation nitrogen growth needs found on the application site. A calculation, known as plant available nitrogen (PAN) is performed to determine annual vegetation nitrogen needs. The calculation is as follows:

Plant Available Nitrogen = (MR)(Organic Nitrogen) + (VR)(Ammonia Nitrogen) + Nitrate Nitrogen

MR **-** mineralization rate, rate at which organic nitrogen is released as readily available nitrogen
VR **-** volatilization rate, rate at which ammonia nitrogen is released directly to atmosphere without being utilized by plants

This calculation is adjusted as new nitrogen analyses are performed as well as the total quantity of biosolids land applied within a calendar year are recorded. By using this methodology, all available nitrogen is utilized by plant to sustain growth on the application site in question, eliminating nitrogen as a groundwater contaminant threat.

ORR land application sites also have a maximum lifetime loading limit of 50 tons/acre (dry wt.) imposed by TDEC and DOE. TDEC issued the LAA in 1989 before the 503 regulations were promulgated in 1993. Because the State of Tennessee has not receive the authority to administer and regulate biosolids land application sites, EPA issues land application permits directly to POTW performing land application operations in Tennessee. However, the State of Tennessee must approve the use of new land application sites prior to the EPA permit process. The calculated average life remaining for all of the six active application sites is approximately 7 years.

Heavy Metals

EPA does not require soil sampling on sites that receive biosolids application; however, the city is required to track cumulative levels of the 9 heavy metals listed in 40 CFR 503.13, Table 2. Upon achieving 90% of the cumulative loading limit for any of the metals listed, formal notification to EPA is required. As of December 31, 2000 the maximum level reached for any metal on any site was 6% of the EPA limits, which was for mercury on the Rogers Site.

Organic Chemicals

The City of Oak Ridge's EPA land application permit does not require organic chemical analysis for site soils; however, organic compound analysis was performed on sites as a conservative measure. ***Table B.11*** summarizes the maximum levels of organics found in site soils in 1993. Most of the organic chemicals were undetected.

Radionuclides

There are no federal requirements to test land application site soils for radionuclides or federal limits on the radiological content of biosolids that are land-applied. Because of the various sources of natural background radiation and atmospheric deposition all soils contain some level of radioactive materials. The City of Oak Ridge collects the soil samples every 2 years and contracts with ORNL to analyze the samples for radionuclide content. Soil samples from adjacent areas that have not receive biosolids application are also collected and analyzed for comparative purposes in ***Table B.11***. All results are reported to EPA and TDEC in the Annual Biosolids Management Report submitted February 19, annually. Application site soil radionuclide results are very close and in some instances, less than results collected in non-applied areas.

Table B.5. Upper Hayfield #1 Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Upper Hayfield #1
Total Acres (ac):	30
Total Hectares (ha):	12.15
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	2 Ponds, 1 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.21	41	**0.5%**	Total Tons Allowed Lifetime:	1500
Cadmium	0.38	39	**1.0%**	Total Tons Applied to Date:	618
Chromium	6.84	-	**-**	Total Tons Remaining:	882
Copper	25.22	1500	**1.7%**	Total Tons per Acre Applied:	20.6
Lead	4.25	300	**1.4%**	Total Tons per Acre Remaining:	29.4
Mercury	0.62	17	**3.7%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.99	-	**-**		
Nickel	2.04	420	**0.5%**		
Selenium	0.33	100	**0.3%**		
Zinc	84.44	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.005	7.2	**0.001**	
Uranium-238	0.2	21.1	**0.009**	
Cesium-137	0.016	2	**0.008**	
Cobalt-60	0.017	0.49	**0.035**	
		Sum of Fractions (limit is 1):	**0.053**	

Table B.6. Upper Hayfield #2 Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Upper Hayfield #2
Total Acres (ac):	27
Total Hectares (ha):	10.93
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	2 Ponds, 0.75 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit
Arsenic	0.25	41	**0.6%**
Cadmium	0.44	39	**1.1%**
Chromium	7.59	-	**-**
Copper	28.76	1500	**1.9%**
Lead	4.42	300	**1.5%**
Mercury	0.71	17	**4.2%**
Molybdenum	0.48	-	**-**
Nickel	1.63	420	**0.4%**
Selenium	1.92	100	**1.9%**
Zinc	95.74	2800	**3.4%**

Nitrogen	
Total Tons Allowed Lifetime:	1350
Total Tons Applied to Date:	585
Total Tons Remaining:	765
Total Tons per Acre Applied:	21.6
Total Tons per Acre Remaining:	28.3

Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level
Uranium-235	0.005	7.2	**0.001**
Uranium-238	0.164	21.1	**0.008**
Cesium-137	0.018	2	**0.009**
Cobalt-60	0.016	0.49	**0.033**
		Sum of Fractions (limit is 1):	**0.051**

Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels

Table B.7. High Pasture Site Profile Information

General Site Environmental Information	
Land Application Site Name:	High Pasture
Total Acres (ac):	46
Total Hectares (ha):	18.62
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	1 Pond, 0.3 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.26	41	**0.6%**	Total Tons Allowed Lifetime:	2300
Cadmium	0.44	39	**1.1%**	Total Tons Applied to Date:	560
Chromium	6.45	-	**-**	Total Tons Remaining:	1740
Copper	24.21	1500	**1.6%**	Total Tons per Acre Applied:	12.2
Lead	3.55	300	**1.2%**	Total Tons per Acre Remaining:	37.8
Mercury	0.51	17	**3.0%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.44	-	**-**		
Nickel	1.35	420	**0.3%**		
Selenium	1.75	100	**1.8%**		
Zinc	79.81	2800	**2.9%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.003	7.2	**0**	
Uranium-238	0.081	21.1	**0.004**	
Cesium-137	0.011	2	**0.006**	
Cobalt-60	0.012	0.49	**0.024**	
		Sum of Fractions (limit is 1):	**0.034**	

Table B.8. Rogers Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Rogers Site
Total Acres (ac):	32
Total Hectares (ha):	12.96
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	1 Pond, 0.9 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.25	41	**0.6%**	Total Tons Allowed Lifetime:	1600
Cadmium	0.58	39	**1.5%**	Total Tons Applied to Date:	969
Chromium	18.02	-	**-**	Total Tons Remaining:	631
Copper	43.69	1500	**2.9%**	Total Tons per Acre Applied:	30.3
Lead	10.4	300	**3.5%**	Total Tons per Acre Remaining:	19.7
Mercury	1.1	17	**6.5%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	3.15	-	**-**		
Nickel	5.06	420	**1.2%**		
Selenium	0.44	100	**0.4%**		
Zinc	129.04	2800	**4.6%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.002	7.2	**0**	
Uranium-238	1.599	21.1	**0.076**	
Cesium-137	0.033	2	**0.016**	
Cobalt-60	0.116	0.49	**0.237**	
Sum of Fractions (limit is 1):			**0.329**	

Table B.9. Watson Road Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Watson Road
Total Acres (ac):	117
Total Hectares (ha):	47.37
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	None
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Hardwoods & Orchard grass
Vegetation Nitrogen Growth Requirement:	120.67 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.26	41	**0.6%**	Total Tons Allowed Lifetime:	5850
Cadmium	0.46	39	**1.2%**	Total Tons Applied to Date:	1100
Chromium	7.04	-	**-**	Total Tons Remaining:	4750
Copper	25.33	1500	**1.7%**	Total Tons per Acre Applied:	9.4
Lead	4.12	300	**1.4%**	Total Tons per Acre Remaining:	40.6
Mercury	0.5	17	**3.0%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.44	-	**-**		
Nickel	1.55	420	**0.4%**		
Selenium	1.94	100	**1.9%**		
Zinc	84.06	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.002	7.2	**0**	
Uranium-238	0.064	21.1	**0.003**	
Cesium-137	0.009	2	**0.004**	
Cobalt-60	0.007	0.49	**0.014**	
		Sum of Fractions (limit is 1):	**0.021**	

Table B.10. Scarboro Road Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Scarboro Road
Total Acres (ac):	77
Total Hectares (ha):	31.17
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	6 Ponds, 1.54 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.23	41	**0.6%**	Total Tons Allowed Lifetime:	3850
Cadmium	0.41	39	**1.1%**	Total Tons Applied to Date:	1157
Chromium	6.63	-	**-**	Total Tons Remaining:	2693
Copper	24.35	1500	**1.6%**	Total Tons per Acre Applied:	15
Lead	3.56	300	**1.2%**	Total Tons per Acre Remaining:	35
Mercury	0.62	17	**3.6%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.61	-	**-**		
Nickel	1.39	420	**0.3%**		
Selenium	1.72	100	**1.7%**		
Zinc	82.85	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.004	7.2	**0.001**	
Uranium-238	0.111	21.1	**0.005**	
Cesium-137	0.012	2	**0.006**	
Cobalt-60	0.009	0.49	**0.018**	
		Sum of Fractions (limit is 1):	**0.03**	

Table B.11. Biosolids Land Application Site Soil Analyses

Parameter	Upper Hayfield #1		Upper Hayfield #2		High Pasture		Rogers Site		Watson Road		Scarboro Road	
	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.
Inorganics (mg/kg unless otherwise noted)												
CEC (meq/100 g)	280	200	310	200	200	180	220	240	260	240	250	200
Manganese	510	1300	2600	1300	1200	260	790	1600	2000	1300	1400	1300
pH	4.3	5.3	5.7	5.3	5.9	5.7	6.8	5.7	6	8.5	8.1	5.3
Phosphorus	46	61	23	61	19	12	89	58	17	6	2.1	61
Potassium	330	370	520	370	280	260	1200	1100	760	900	590	370
Total Kjeldahl Nitrogen	430	470	520	470	300	350	100	100	290	220	83	470
Heavy Metals (mg/kg)												
Arsenic	2.2	2.7	2.2	2.7	1.7	1.5	N/A	N/A	0.057	2.1	2.5	2.7
Cadmium	0.61	0.48	0.69	0.48	0.52	0.32	0.74	0.56	0.11	0.49	0.71	0.48
Chromium	21	23	18	23	15	7.5	23	11	0.11	13	13	23
Copper	40	13	26	13	13	0.63	20	4.6	0.57	5.5	3.1	13
Lead	15	14	27	14	17	8.6	20	27	0.28	20	21	14
Nickel	4.8	5	5.8	5	5.3	3.2	6.3	6.4	0.57	11	3.6	5
Zinc	110	83	120	83	80	47	80	350	0.57	58	75	83
Organics* (mg/kg)												
Heptachlor Epoxide	U	U	U	U	4.9	U	U	U	U	U	U	U
Alpha-Chlordane	7.2	U	U	U	U	U	U	U	U	U	U	U
Gamma-Chlordane	6.9	U	4.9	U	U	U	U	U	U	U	U	U
Bis (2-Ethylhexyl) Pthalate	0.2	U	U	U	U	U	U	U	U	U	U	U
Radionuclides (pCi/g)												
Co-60	0.029	0.01	0.018	0.01	0.045	0.01	0.526	0.01	0	0.01	0.01	0.01
Cs-137	0.575	0.415	0.627	0.415	0.371	0.215	0.556	0.215	0.333	0.498	0.459	0.415
U-235	0.123	0.102	0.1	0.102	0.063	0.071	0.156	0.071	0.087	0.033	0.075	0.102
U-238	1.96	1.05	2.18	1.05	1.68	0.725	2.73	0.725	1.55	0.888	1.37	1.05

*Only parameters that had detectable levels were reported

U - Undetected, N/A- Not analyzed

B.3 WEST END TREATMENT FACILITY EFFLUENT CHARACTERISTICS

This section discusses the proposed sanitary sewer discharge limits and characterization of the WETF effluents. Effluent limits and characteristics discussed include constituent inorganic chemicals, heavy metals, organic chemicals, radionuclides, and pathogens as they relate to the sanitary sewer system.

Proposed Sanitary Sewer Discharge Limits

Appendix B, Table B.12 lists sanitary sewer discharge limits for WETF that were proposed in the sanitary sewer assessment (WSMS 2000). These limits are mass-based for each month, meaning the discharges up to total quantity of a specified parameter are allowed and cannot be exceeded. WETF effluent discharges will be controlled using metered pumps at pre-determined rates to ensure that a non-conformance does not occur. The final discharge rate will be determined using critical parameter limits after the treated wastewaters have been sampled and analyzed. Because discharge limits are mass-based, the discharge rate is inversely proportional to the concentration of contaminants. Put simply, the lower the concentration of residual contaminants in the wastewater, the higher the rate of discharge to the sewer system.

Table B.12. Proposed WETF Sanitary Sewer Monthly Discharge Limits

Parameter	Proposed WETF Discharge Mass Limit (g)	Existing Y-12 Plant Discharge Mass Limit (g)
Silver	42.5	85
Arsenic	8.5	17
Cadmium	2.8	5.6
Total Chromium	42.5	85
Copper	119.0	238.1
Iron	8,510	17010
Mercury	19.5	39.1
Nickel	85.1	170.1
Lead	41.7	83.3
Total Kjeldahl Nitrogen	38,300	76545
Total Suspended Solids	170,000	340200
Zinc	297.7	595.3
Cyanide	34.8	69.7
Oil and Grease	21,300	42525
Phenols	255.2	510.3
Benzene	8.5	17
Methylene Chloride	22.9	45.9
Trichloroethane	15.3	30.6
Toluene	8.5	17
Total Uranium*	1260	1200

*Not a limit, acceptance levels discussed with the City of Oak Ridge

Inorganic Chemicals

Inorganic compounds such as nitrates are typically found within WETF wastewater batches and are treated in the bio-denitrification units. These treatment units are 99.9% effective in reducing these residual inorganic compounds to extremely low or non-detectable levels. Excess mass calculations (i.e., remaining contaminant capacities in comparison with established limits, taking into account all dischargers within the Y-12 sewer system) for inorganic compounds in WETF wastewater batches are adequate and should not pose any discharge non-compliances or measurable regulatory impacts within the Y-12 or City of Oak Ridge sanitary sewer systems.

Heavy Metals

A variety of metals are present at varying times and levels within WETF operations. Heavy metals typically found in wastewater batches are cadmium, chromium, arsenic, lead, silver and nickel, among others. Based upon excess mass calculations for the Y-12 sewer system, an adjustment in the current permitted Y-12 nickel limits were discussed with the City of Oak Ridge. A proposed, increased concentration for the Y-12 BWXT IDP from 0.021 mg/l to 0.1 mg/l for nickel would accommodate the addition of the WETF discharges. The proposed limit for each 500,000-gallon WETF wastewater batch is 85 g. It is anticipated that other heavy metal limits (e.g., chromium, lead, etc.) currently in effect will adequately accommodate the WETF discharges into the Y-12 sewer system.

The City of Oak Ridge issues heavy metal limits based upon NPDES discharge criteria and loading limits imposed upon the Oak Ridge Reservation Biosolids Land Application Sites, as established in 40 CFR 503. EPA allows for land application sites to be loaded to 100% of each metal limit but to provide notification when 90% of any limit has been attained. Since WETF wastewater heavy metal levels, with the exception of nickel, can adequately meet Y-12 discharge criteria without a permit modification, only a minimal increase, 0.003% for nickel, in cumulative metal levels on land application sites is expected. 40 CFR 503.13 requires that the city meet biosolids heavy metal ceiling concentrations in Table 1 and land application site cumulative loading limits in Table 2. To date, the highest cumulative metal loading level is 6% which involves mercury at the Rogers Site.

Organic Chemicals

WETF 500,000 gallon wastewater batches that indicate the presence of excess organic compounds from initial characterization data performed after bio-denitrification will undergo treatment in the bio-oxidation units. These treatment units are 99.9% effective in reducing residual organic compounds to very low levels. If necessary, wastewater batches will also undergo carbon adsorption to remove any residual organic compounds to ensure compliance with the Y-12 IDP. Polychlorinated Biphenyls (PCBs) are prohibited at WETF and should not be present in effluent discharges to the Y-12 sewer system. Existing excess mass calculations (i.e., remaining contaminant capacities in comparison with established limits, taking into account all dischargers within the Y-12 sewer system) for organic compounds in WETF wastewater batches are adequate and should not pose any discharge non-compliances or measurable regulatory impacts within the Y-12 or City of Oak Ridge sanitary sewer systems. At the present time, there are no EPA organic compound limits for biosolids or land application site soils. Because organic compounds are removed in the treatment process at WETF, treated wastewaters are not expected to cause toxicity problems within the Y-12 or City of Oak Ridge sewer systems.

Radionuclides

In discussions held with the city during the WETF Sanitary Sewer Assessment, a proposed limit of 3,785 total grams of uranium was proposed for each 500,000 gallon tank. Based upon a 70 day, 3 month discharge period, this would result in a 1,260 g total uranium level per month acceptance level as stated in ***Table B.12***. Approval of this limit is contingent upon the outcome of this EA and the issuance of a FONSI by DOE.

The corresponding WETF uranium discharge limits will be 2 mg/l at 5 gpm or 3,785 total grams of uranium per 500,000-gallon tank. At the proposed discharge rate, a maximum of 1,260 total g of uranium would be discharged per month, requiring about 70 days to discharge the entire tanks contents. This increase in total uranium discharged to the city would result in an increase of 0.04 g/kg for total uranium in city biosolids that are land applied on ORR land application sites (See ***DOE EA-1356, Appendix F***).

DOE Order 5400.5 (DOE, 1993) also lists derived concentration guidelines (DCGs) for specific radionuclides that are discharged in effluents to public utilities and U.S. waterways. This Order requires that all radionuclides are identified and divided by their corresponding DCG limit to produce a "fraction" (e.g., 1 pCi/l / 10 pCi/l limit = 0.1). This fraction is added to other radionuclide fractions that may be present in the effluent and is multiplied by 100. This represents an overall percentage or a "Sum of Fractions" for radionuclides within a given discharge.

The sum of fractions methodology will be used in demonstrating compliance with the Order for WETF discharges. The sum of fractions limit, as listed in the Order, is 5. WETF discharges will not exceed a sum of 5 to ensure compliance with the Order. This will be accomplished using a spreadsheet developed for each WETF discharge. The radionuclides that will be included in the spreadsheet will be evaluated using generator wastewater characterization data prior to treatment at WETF and process sampling to determine appropriate compliance with DOE Order 5400.5.

Radionuclide modeling calculations have been performed that simulate a discharge from WETF at a sum of fractions of 5, combined with low flow rates and maximum radionuclide levels observed to be discharged from the Y-12 sewer system to the City of Oak Ridge from 1994 to 1998. In this worst-case scenario, the total sum of fractions at the point of discharge to the city was approximately 0.2, well below the limit of 5 as listed in the order.

Pathogens

WETF effluents do not contain pathogenic organisms.

APPENDIX C

SOCIOECONOMIC/DEMOGRAPHICS
FOR KNOX, ANDERSON AND ROANE COUNTIES

Table C.1 Regional Economic Profile for Anderson, Roane, and Knox County, 1996, 1997, 1998, and 1999

	Anderson County				Roane County				Knox County			
Category	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Place of residence profile												
Personal income (thousands of dollars)	1,621,606	1,678,020	1,736,953	1,787,925	971,908	991,789	1,049,133	1,086,569	8,868,421	9,252,833	9,843,409	10,294,349
Nonfarm personal income	1,622,955	1,679,192	1,737,567	1,788,653	975,009	994,285	1,052,249	1,089,703	8,870,322	9,253,329	9,845,047	10,296,262
Farm income	-1,349	-1,172	614	-728	-3,101	-2,496	-3,116	-3,134	-1,901	-496	-1,638	-1,913
Derivation of personal income												
Net earnings[1]	1,002,650	1,023,695	1,057,767	1,081,437	629,772	637,393	672,765	694,570	6,158,093	6,373,343	6,755,638	7,091,292
Transfer payments	285,878	296,730	305,539	318,340	217,870	224,925	234,276	244,430	1,243,518	1,289,535	1,320,342	1,367,967
Income maintenance[2]	26,496	26,488	26,860	27,458	18,705	18,720	18,716	19,512	111,917	110,350	110,687	112,297
Unemployment insurance benefit payments	4,277	4,562	3,879	3,880	3,242	3,949	3,530	3,037	15,269	15,858	16,837	16,556
Retirement and other	255,105	265,680	274,800	287,002	195,923	202,706	212,030	221,881	1,116,332	1,163,327	1,192,818	1,239,114
Dividends, interest, and rent	333,078	357,595	373,647	388,148	124,266	129,471	142,092	147,569	1,466,810	1,589,955	1,767,429	1,835,090
Population (number of persons)[3]	71,478	71,369	70,893	71,004	49,616	49,876	49,945	50,008	370,737	373,409	374,693	376,039
Per capita incomes (dollars)[4]												
Per capita personal income	22,687	23,512	24,501	25,181	19,589	19,885	21,006	21,728	23,921	24,779	26,271	27,376
Per capita net earnings	14,027	14,344	14,921	15,231	12,693	12,780	13,470	13,889	16,610	17,068	18,030	18,858
Per capita transfer payments	4,000	4,158	4,310	4,483	4,391	4,510	4,691	4,888	3,354	3,453	3,524	3,638
Per capita income maintenance	371	371	379	387	377	366	375	390	302	296	295	299

Table C.1 Regional Economic Profile for Anderson, Roane, and Knox County, 1996, 1997, 1998, and 1999

	Anderson County				Roane County				Knox County			
Category	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Per capita unemployment insurance benefits	60	64	55	55	65	79	71	61	41	42	45	44
Per capita retirement and other	3,569	3,723	3,876	4,042	3,949	4,064	4,245	4,437	3,011	3,115	3,183	3,295
Per capita dividends, interest, and rent	4,660	5,011	5,271	5,467	2,505	2,596	2,845	2,951	3,956	4,258	4,717	4,880
Place of work profile												
Earnings by place of work ($000)	1,511,624	1,570,985	1,581,175	1,633,066	888,965	790,129	799,844	805,101	6,862,502	7,219,661	7,718,983	8,035,735
Wage and salary disbursements	1,250,954	1,307,360	1,317,884	1,362,272	738,189	653,630	661,087	662,640	5,311,438	5,653,481	6,089,349	6,327,161
Other labor income	174,160	162,108	153,659	153,967	99,526	75,527	74,205	73,698	701,207	671,621	682,614	696,200
Proprietors' income	86,510	101,517	109,632	116,827	51,250	60,972	64,552	68,763	849,857	894,559	947,020	1,012,374
Nonfarm proprietors' income	88,407	103,206	110,810	118,131	54,686	63,819	68,047	72,285	853,458	896,749	950,491	1,016,161
Farm proprietors' income	-1,897	-1,689	-1,178	-1,304	-3,436	-2,847	-3,495	-3,522	-3,601	-2,190	-3,471	-3,787
Total full-time and part-time employment	48,315	48,109	47,715	48,137	28,043	25,753	25,528	25,154	252,955	257,256	261,798	266,145
Wage and salary jobs	41,295	40,747	40,192	40,460	23,836	21,301	20,996	20,539	213,318	216,283	219,695	223,069
Number of proprietors	7,020	7,362	7,523	7,677	4,207	4,452	4,532	4,615	39,637	40,973	42,103	43,076
Number of nonfarm proprietors[5]	6,481	6,815	6,969	7,121	3,577	3,822	3,893	3,975	38,249	39,587	40,698	41,668
Number of farm proprietors	539	547	554	556	630	630	639	640	1,388	1,386	1,405	1,408

Table C.1 Regional Economic Profile for Anderson, Roane, and Knox County, 1996, 1997, 1998, and 1999

Category	Anderson County				Roane County				Knox County			
	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999
Average earnings per job (dollars)	31,287	32,655	33,138	33,925	31,700	30,681	31,332	32,007	27,129	28,064	29,484	30,193
Average wage and salary disbursements	30,293	32,085	32,790	33,670	30,969	30,685	31,486	32,263	24,899	26,139	27,717	28,364
Average nonfarm proprietors' income	13,641	15,144	15,900	16,589	15,288	16,698	17,479	18,185	22,313	22,653	23,355	24,387

*Source: Regional Economic Information System, Bureau of Economic Analysis, Table CA30. This information was updated June 25, 2001.

Footnotes:

1. Total earnings less personal contributions for social insurance adjusted to place of residence.

2. Consists largely of supplemental security income payments, family assistance, general assistance payments, food stamp payments, and other assistance payments, including emergency assistance.

3. Census Bureau midyear population estimates. Estimates for 1990-99 reflect county population estimates available as of march 000 except for Prince George's and Montgomery, MD. A portion of Takoma Park, MD was annexed from Prince George's County, MD to Montgomery County, MD on March 1, 1997. The Census Bureau adjusted their population estimates to reflect this annexation back through 1990. The Prince George's MD and Montgomery, MD population estimates for 1990-1996 have been adjusted by BEA to be consistent with BEA income estimates, which do not reflect the annexation.

4. Type of income divided by population yields a per capita measure for that type of income.

5. Excludes limited partners.

6. Cibola, NM was separated from Valencia in June 1981, but in these estimates Valencia includes Cibola through the end of 1981.

7. La Paz County, AZ was separated from Yuma County on January 1, 1983. The Yuma, AZ MSA contains the area that became La Paz County, AZ thorugh 1982 and excludes it beginning with 1983.

8. Estimates for 1979 forward reflect Alaska Census Areas as defined in the 1980 Decennial Census; those for prior years reflect Alaska Census Divisions as defined in the 1970 Decennial Census. Estimates from 1988 forward separate Aleutian Islands Census Area into Aleutians East Borough and Aleutians West Census Area. Estimates for 1991 forward separate Denali Borough from Yukon-Koyukuk Census Area and Lake and Peninsula Borough from Dillingham Census Area. Estimates from 1993 forward separate Skagway-Yakutat-Angoon Census Area into Skagway-Hoonah-Angoon Census Area and Yakutat Borough.

9. Shawano, WI and Menominee, WI are combined as Shawano (incl. Menominee), WI for the years prior to 1989.

10. Halifax, VA contains South Boston for all years.

(L) Less than $50,000 or less than 10 jobs, as appropriate, but the estimates for this item are included in the totals.

(N) Data not available for this year.

Table C.2 Distribution of employment by Industry (number of jobs) for Anderson, Roane, and Knox County, 1996, 1997, 1998, and 1999

	Anderson County				Roane County				Knox County			
Item	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Employment by place of work												
Total full-time and part-time employment	48,315	48,109	47,715	48,137	28,043	25,753	25,528	25,154	252,955	257,256	261,798	266,145
By type												
Wage and salary employment	41,295	40,747	40,192	40,460	23,836	21,301	20,996	20,539	213,318	216,283	219,695	223,069
Proprietors’ employment	7,020	7,362	7,523	7,677	4,207	4,452	4,532	4,615	39,637	40,973	42,103	43,076
Farm proprietors’ employment	539	547	554	556	630	630	639	640	1,388	1,386	1,405	1,408
Nonfarm proprietors’ employment 2/	6,481	6,815	6,969	7,121	3,577	3,822	3,893	3,975	38,249	39,587	40,698	41,668
By industry												
Farm employment	592	589	589	593	671	682	682	685	1,572	1,604	1,587	1,598
Nonfarm employment	47,723	47,520	47,126	47,544	27,372	25,071	24,846	24,469	251,383	255,652	260,211	264,547
Private employment	42,322	42,278	41,924	42,450	23,248	20,875	20,625	20,214	213,234	218,872	223,285	227,670
Ag. services, forestry, fishing, & other 3/	339	343	(D)	(D)	124	133	(D)	(D)	2,297	2,581	2,668	2,871
Mining	100	161	125	(D)	47	47	(D)	(D)	543	579	613	619
Construction	4,216	2,888	2,894	2,854	1,058	1,073	1,109	1,200	15,537	16,152	16,734	16,834
Manufacturing	11,044	12,459	12,188	11,942	6,618	2,219	2,511	2,534	24,562	24,936	23,828	22,989
Transportation and public utilities	1,849	1,487	1,235	1,220	646	2,424	2,159	2,061	12,255	12,412	13,281	13,587
Wholesale trade	647	821	1,005	1,115	453	434	431	417	16,114	16,228	16,288	16,049
Retail trade	647	821	1,005	1,115	(D)	(D)	(D)	3,709	49,108	50,167	50,837	52,064
Finance, insurance, and real estate	1,825	2,019	2,012	2,101	585	770	827	869	16,328	17,137	18,273	19,009
Services	(D)	(D)	15,230	15,994	(D)	(D)	9,864	9,254	76,490	78,680	80,763	83,648
Government and government enterprises	5,401	5,242	5,202	5,094	4,124	4,196	4,221	4,255	38,149	36,780	36,926	36,877

Table C.2 Distribution of employment by Industry (number of jobs) for Anderson, Roane, and Knox County, 1996, 1997, 1998, and 1999

	Anderson County				Roane County				Knox County			
Item	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**	**1996**	**1997**	**1998**	**1999**
Federal civilian	1,514	1,331	1,230	1,160	546	523	521	490	4,071	4,075	3,953	3,804
Military	314	304	283	274	217	212	199	192	1,694	1,711	1,588	1,552
State and local	3,573	3,607	3,689	3,660	3,361	3,461	3,501	3,573	32,384	30,994	31,385	31,521
State	433	427	424	426	1,304	1,380	1,376	1,428	16,431	16,237	15,985	16,240
Local	3,140	3,180	3,265	3,234	2,057	2,081	2,125	2,145	15,953	14,757	15,400	15,281

Source: Regional Economic Information System, Bureau of Economic Analysis, Table CA25, updated June 25, 2001.

Footnotes:

The estimate shown here constitutes the major portion of the true estimate.

(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.

(L) Less than 10 jobs, but the estimates for this item are included in the totals.

(N) Data not available for this year.

Table C.3 1997 Economic Summary Statistics for Anderson County, 1997 NAICS Basis

NAICS Code	Description	Establishments	Sales, receipts or shipments ($1,000)	Annual payroll ($1,000)	Paid employees
21	Mining (not published for counties)	N	N	N	N
22	Utilities (not published for counties)	N	N	N	N
23	Construction (not published for counties)	N	N	N	N
31-33	Manufacturing	107	1,336,167	327,963	8,559
42	Wholesale trade	51	105,874	9,941	342
44-45	Retail trade	331	700,918	60,835	3,923
48-49	Transportation & warehousing (not published for counties)	N	N	N	N
51	Information (total not published for counties)	N	N	N	N
52	Finance & insurance (not published for counties)	N	N	N	N
53	Real estate & rental & leasing	74	39,155	6,428	336
54	Professional, Scientific, & technical services	180	934,465	384,615	7,960
55	Management of companies & enterprises (not published for counties)	N	N	N	N
56	Administrative & support & waste management & remediation services	66	142,339	56,868	2,659
61	Educational services	10	1,603	407	32
62	Health care & social assistance	156	117,416	61,341	1,801
71	Arts, entertainment, & recreation	13	4,963	1,562	113
72	Accommodation & foodservices	129	71,576	19,935	2,384
81	Other services (except public administration)	104	26,891	9,353	530

N= Not available

Source: 1997 Economic Census, U.S. Census Bureau

Table C.4 1997 Economic Summary Statistics for Roane County, 1997 NAICS Basis

NAICS Code	Description	Establishments	Sales, receipts or shipments ($1,000)	Annual payroll ($1,000)	Paid employees
21	Mining (not published for counties)	N	N	N	N
22	Utilities (not published for counties)	N	N	N	N
23	Construction (not published for counties)	N	N	N	N
31-33	Manufacturing	42	255,975	47,064	2,075
42	Wholesale trade	22	139,844	10,192	345
44-45	Retail trade	176	308,939	25,948	1,832
48-49	Transportation & warehousing (not published for counties)	N	N	N	N
51	Information (total not published for counties)	N	N	N	N
52	Finance & insurance (not published for counties)	N	N	N	N
53	Real estate & rental & leasing	29	5,603	1,167	62
54	Professional, Scientific, & technical services	34	9,233	1,881	87
55	Management of companies & enterprises (not published for counties)	N	N	N	N
56	Administrative & support & waste management & remediation services	15	11,044	3,456	163
61	Educational services	1	D	D	(1-19)
62	Health care & social assistance	65	32,661	12,112	577
71	Arts, entertainment, & recreation	14	3,388	769	47
72	Accommodation & foodservices	60	27,196	7,641	1,083
81	Other services (except public administration)	40	10,330	2,893	149

D= Withheld to avoid disclosure; N= Not available

Source: 1997 Economic Census, U.S. Census Bureau

Table C.5. 1997 Economic Summary Statistics for Knox County, 1997 NAICS Basis

NAICS Code	Description	Establishments	Sales, receipts or shipments ($1,000)	Annual payroll ($1,000)	Paid employees
21	Mining (not published for counties)	N	N	N	N
22	Utilities (not published for counties)	N	N	N	N
23	Construction (not published for counties)	N	N	N	N
31-33	Manufacturing	493	3,245,519	550,328	20,782
42	Wholesale trade	950	7,507,703	449,392	12,580
44-45	Retail trade	1,946	5,029,692	478,927	28,344
48-49	Transportation & warehousing (not published for counties)	N	N	N	N
51	Information (total not published for counties)	N	N	N	N
52	Finance & insurance (not published for counties)	N	N	N	N
53	Real estate & rental & leasing	464	326,513	65,679	2,822
54	Professional, Scientific, & technical services	937	724,188	280,743	8,000
55	Management of companies & enterprises (not published for counties)	N	N	N	N
56	Administrative & support & waste management & remediation services	444	521,287	271,650	14,818
61	Educational services	43	11,854	4,350	243
62	Health care & social assistance	925	962,990	451,710	10,391
71	Arts, entertainment, & recreation	113	48,511	15,455	1,274
72	Accommodation & foodservices	769	550,896	157,553	17,252
81	Other services (except public administration)	669	241,146	76,097	4,539

N= Not available

Source: 1997 Economic Census, U.S. Census Bureau

Table C.6 Profile of General Demographic Characteristics: 2000 for Anderson, Roane, and Knox County						
	Anderson County		Roane County		Knox County	
Subject	Number	Percent	Number	Percent	Number	Percent
Total Population	71,330	100.0	51,910	100.0	382,032	100.0
Sex and Age						
Male	34,009	47.7	25,150	48.4	184,577	48.3
Female	37,321	52.3	26,760	51.6	197,455	51.7
Under 5 years	3,976	5.6	3,039	5.9	23,371	6.1
5 to 9 years	4,746	6.7	3,093	6.0	23,984	6.3
10 to 14 years	4,857	6.8	3,372	6.5	23,846	6.2
15 to 19 years	4,614	6.5	3,290	6.3	26,976	7.1
20 to 24 years	3,668	5.1	2,695	5.2	31,408	8.2
25 to 34 years	8,607	12.1	6,265	12.1	55,057	14.4
35 to 44 years	10,867	15.2	7,673	14.8	60,900	15.9
45 to 54 years	10,630	14.9	8,055	15.5	53,742	14.1
55 to 59 years	4,151	5.8	3,273	6.3	19,170	5.0
60 to 64 years	3,390	4.8	2,804	5.4	15,163	4.0
65 to 74 years	6,005	8.4	4,639	8.9	25,983	6.8
75 to 84 years	4,453	6.2	2,880	5.5	16,839	4.4
85 years and over	1,366	1.9	832	1.6	5,593	1.5
Median age (years)	39.9	(X)	40.7	(x)	36.0	(x)
18 years and over	54,795	76.8	40,315	77.7	296,939	77.7
Male	25,558	35.8	19,178	36.9	140,719	36.8
Female	29,237	41.0	21,137	40.7	156,220	40.9

Table C.6 Profile of General Demographic Characteristics: 2000 for Anderson, Roane, and Knox County						
	Anderson County		**Roane County**		**Knox County**	
Subject	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
21 years and over	52,384	73.4	38,547	74.3	276,704	72.4
62 years and over	13,808	19.4	9,929	19.1	57,274	15.0
65 years and over	11,824	16.6	8,351	16.1	48,415	12.7
Male	4,690	6.6	3,411	6.6	18,859	4.9
Female	7,134	10.0	4,940	9.5	29,556	7.7
Household By Type						
Total households	29,780	100.0	21,200	100.0	157,872	100.0
Family households (families)	20,513	68.9	15,242	71.9	100,726	63.8
With own children under 18 years	8,824	29.6	6,066	28.6	44,966	28.5
Married-couple family	16,024	53.8	12,367	58.3	78,571	49.8
With own children under 18 years	6,321	21.2	4,581	21.6	32,803	20.8
Female householder, no husband present	3,426	11.5	2,145	10.1	17,211	10.9
With own children under 18 years	1,950	6.5	1,121	5.3	9,846	6.2
Nonfamily households	9,267	31.1	5,958	28.1	57,146	36.2
Householder living alone	8,259	27.7	5,306	25.0	46,687	29.6
Householder 65 years and over	3,618	12.1	2,365	11.2	14,356	9.1
Households with individuals under 18 years	8,259	27.7	6,792	32.0	48,873	31.0
Households with individuals 65 years and over	9,662	32.4	5,903	27.8	34,497	21.9
Average household size	2.37	(x)	2.42	(x)	2.34	(x)
Average family size	2.88	(x)	2.87	(x)	2.92	(x)
Housing Occupancy						

Table C.6 Profile of General Demographic Characteristics: 2000 for Anderson, Roane, and Knox County						
	Anderson County		Roane County		Knox County	
Subject	Number	Percent	Number	Percent	Number	Percent
Total housing units	32,451	100.0	23,369	100.0	171,439	100.0
Occupied housing units	29,780	91.8	21,200	90.7	157,872	92.1
Vacant housing units	2,671	8.2	2,169	9.3	13,567	7.9
For seasonal, recreational, or occasional use	197	0.6	433	1.9	586	0.3
Homeowner vacancy rate (percent)	1.9	(x)	1.7	(x)	2.5	(x)
Rental vacancy rate (percent)	12.8	(x)	13.1	(x)	10.0	(x)
Housing Tenure						
Occupied housing units	29,780	100.0	21,200	100.0	157,872	100.0
Owner-occupied housing units	21,592	72.5	16,453	77.6	105,562	66.9
Renter-occupied housing units	8,188	27.5	4,747	22.4	52,310	33.1
Average household size of owner-occupied units	2.44	(x)	2.47	(x)	2.49	(x)
Average household size of renter-occupied units	2.17	(x)	2.21	(x)	2.03	(x)

(X) Not applicable

Source: U.S. Census Bureau, Census 2000.

APPENDIX D

EVALUATION OF A 10 MILLIREM PER YEAR BASIC RADIATION DOSE LIMIT FOR SETTING SOIL GUIDELINES AND SLUDGE LIMITS FOR RADIONUCLIDES

RESULTS OF RESRAD MODELING FOR RADIONUCLIDES IN LAND APPLICATION SITE SOILS

EVALUATION OF A 10 MILLIREM PER YEAR BASIC RADIATION DOSE LIMIT FOR SETTING SOIL GUIDELINES AND SLUDGE LIMITS FOR RADIONUCLIDES

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INTRODUCTION

The RESRAD 6.0 code—developed by the Environmental Assessment Division of Argonne National Laboratory—was used to develop concentration guidelines for radionuclides in soils on the land application sites located on the Department of Energy (DOE) Oak Ridge Reservation (ORR). These application sites are used for the disposal of municipal sludge from the City of Oak Ridge Publicly Owned Treatment Works (POTW). The RESRAD code has been used extensively for assessments of potential doses form residual radioactive contamination in soils for both Department of Energy (DOE) controlled and Nuclear Regulatory Commission (NRC) licensed sites. The code calculates doses to a hypothetical resident farmer who lives on the contaminated site and obtains significant portions of his food and water from the site. Version 6.0 of RESRAD allows both deterministic and probabilistic dose analysis and risk assessment.

A basic radiation dose limit of 10 mrem/year was used as the basis for the land-application site soil guidelines. The 10 mrem/year limit was chosen because it is the value currently used by the City of Oak Ridge to develop limits for radionuclides in the POTW sludges. The City previously used a 4 mrem/year limit, but found it necessary to increase the dose limit, and corresponding sludge limits, to allow for future industrial growth.

The City currently has sludge limits for uranium, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{154}Eu, ^{152}Eu, ^{54}Mn, ^{90}Sr, and ^{65}Zn. These limits are based on soil guidelines that were calculated using the RESRAD code with a basic radiation dose limit of 10 mrem/year (Stetar 2000). The soil guidelines are converted to sludge limits based on the expected dilution (i.e., mixing of sludge into soil following application) and the amount of loss to radioactive decay that will occur between the time of application and the time the site becomes available for unrestricted use. The City uses its sludge limits as a basis for determining the maximum quantities of the various radionuclide that can be discharged to the Oak Ridge sewer system each month. These total acceptable discharge quantities, called allowable loadings, are allocated among the radioactive materials dischargers on the basis of need. The allocations are accomplished through the City’s industrial pretreatment permitting program. It should be noted, that because some of the permitted industries discharge only occasionally and because those that do discharge more frequently rarely discharge the entire allocated quantity, the radionuclide levels in the Oak Ridge sludge are at concentrations well below the calculated acceptable limits for sludge.

However, because the original allowable loadings—calculated on the basis of a 4 mrem dose limit—had for the most part been completely allocated, the decision was made to update the program using a somewhat less conservative dose limit of 10 mrem/year. The soil guidelines and sludge limits calculated using the higher dose limit result in larger allowable loadings for the key radionuclides entering the Oak Ridge treatment plant. Therefore, the updated limits allow the program to expand to meet the needs of future growth. Although the allowable loadings have been increased, the City of Oak Ridge does not anticipate that the concentrations of radionuclides in its sludge will actually exceed the limits originally established using the 4 mrem dose limit. It is the City's intention to maintain the radionuclide levels in the land application site soils to levels that are as low as reasonably achievable (ALARA). Oak Ridge has established a daily radionuclide screening program for sludge. Furthermore, in depth analyses are performed on the sludge and land application site soils on a regular basis. If analyses indicate any significant increase in radionuclide levels, the City could modify its land application procedures (primarily loading rates) to ensure soil concentrations are kept at a minimum.

It should be noted that the 10 mrem/year dose limit used for setting sludge limits is one-tenth the dose limit established by the NRC for members of the public when exposed to radiation from NRC or State-licensed facilities. Furthermore, it is less that half the dose limit established by the NRC—Final Rule on Radiological Criteria for License Termination—for use in deriving radiological criteria for unrestricted use following decontamination and decommissioning of licensed facilities.

PURPOSE

Soil guidelines and sludge limits—based on a 4 mrem/year dose limit—were previously calculated for 23 radionuclides in *Environmental Assessment, Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation* (DOE 1996). These guidelines and limits are provided in ***Table D.1.***

For this work, seven of the radionuclides from ***Table D.1.*** (^{60}Co, ^{137}Cs, ^{152}Eu, ^{155}Eu, ^{234}U, ^{235}U, and ^{238}U) and five additional radionuclides, ^{54}Mn, ^{65}Zn, ^{90}Sr, ^{134}Cs, and ^{154}Eu, are addressed. These radionuclides were chosen either because they have been detected in the Oak Ridge sludge or are believed to have a high potential for discharge to the Oak Ridge POTW. For the radionuclides listed in ***Table D.1.*** that are not addressed here, the previous soil guidelines from DOE/EA-1042 will continue to apply.

For these 12 primary radionuclides of interest, the RESRAD 6.0 code was used to calculate soil guidelines on the basis of a 10 mrem/year basic radiation dose limit to ensure consistency with the City of Oak Ridge's sludge management program. RESRAD 6.0 was also used to estimate the potential risks to the hypothetical resident farmer who establishes residency immediately following the last application of sludge. The risks that were estimated are the risk of cancer incidence (both fatal and nonfatal). One goal of this work was to ensure that the risk estimates for the soil guidelines do not exceed 10^{-4} (1 in 10,000). This risk level is considered appropriate because it is the "risk target" used by the Environmental Protection Agency (EPA) to establish regulatory limits for carcinogens in land applied sludges. Radionuclides are not currently addressed in the EPA's sludge standards.

Because the exposure scenario used in this work (the resident farmer) is highly conservative, the risk estimates reported should be considered upper bounds. The risk estimates associated with more probable exposure scenarios are provided in the human health risk assessment performed as part of this EA. For the seven radionuclides addressed in the previous EA (DOE/EA-1042), a comparison is provided of the risks associated with the former soil guideline values (based on 4 mrem/year) and those calculated here.

In addition to the calculation of soil guidelines and sludge limits, a probabilistic assessment was performed using RESRAD 6.0, to estimate the uncertainties associated with the dose and risk estimates for the radionuclides of interest.

Calculation of Soil Guidelines

To calculate soil guidelines for the application sites, the RESRAD code was initially run with the input soil concentrations for each of the 12 radionuclides of interest set to 1 pCi/g and the basic radiation dose limit set to 10 mrem/year.

Table D.1. Soil Guidelines and sludge limits as reported in *Environmental Assessment, Proposed Changes to the Sanitary Sludge Land Application Program on the Oak Ridge Reservation,* DOE/EA-1042. Final. October 1996.[a]

Radionuclide	Soil Guideline ($pCi/g_{-dry\ wt.}$)	Sludge Limit (pCi/g_{-drywt}.)
^{227}Ac	0.56	12.2
^{241}Am	7.7	167
^{60}Co	0.49	10.7
^{137}Cs	2.0	43.6
^{152}Eu	1.1	24.0
^{155}Eu	1.0	21.8
^{152}Gd	19.6	427
^{3}H	520	11,324
^{40}K	5.5	120
^{237}Np	1.5	32.7
^{231}Pa	0.81	17.6
^{210}Pb	2.5	54.4
^{238}Pu	9.1	198
^{239}Pu	8.3	181
^{226}Ra	0.11	2.4
^{228}Ra	0.95	20.7
^{99}Tc	35.5	773
^{228}Th	0.66	14.4
^{229}Th	1.5	32.7
^{230}Th	14.8	322
^{233}U	30.2	658
^{234}U	31.0	675
^{235}U	7.2	157
^{238}U	21.1	459.5

[a] taken from Table 1, page D-43 of DOE/EA-1042 (DOE 1996).

The radionuclides of interest were identified based on previous monitoring of the Oak Ridge sludge and information contained in the pretreatment questionnaires submitted to the City of Oak Ridge by all potential dischargers of radioactive materials. Short-lived medical radionuclides, such as I-131, were not included because their short half-lives would preclude significant build up on the land application sites. For the soil guideline calculations, the depth of the contaminated zone parameter was set to 0.15 m, and the area of contaminated zone parameter was set to 200,000 m^2. Previous studies conducted on the ORR land application sites indicate that a significant portion of applied radionuclides remain within the top 0.15 m of soil (Smith 1997, Boston et al., 1990). Furthermore, 0.15 m is the plow-layer depth used by the EPA in development of standards for metals and other contaminants in land applied sludges. The contaminated zone area of 500,000 m^2 corresponds to field size of approximately 120 acres. The current application sites range in size from approximately 25 to 117 acres.

Adjustment of Soil Guidelines

Uncertainty analyses were performed on the initial soil guideline values. The purpose was to identify any radionuclides for which further refinement in the modeling was needed to ensure the final calculated soil guidelines are sufficiently conservative (i.e., that the risk estimates for each radionuclide do not exceed 10^{-4}). Using information provided in NUREG/CR-6676, *Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes* (Kamboj et al., 2000), the most sensitive parameters were identified for the radionuclides of interest (***Table D.2.***). The RESRAD code was used to perform the uncertainty analysis which consisted of a probabilistic assessment in which distributions (rather than point estimates) were used to represent the most sensitive parameters. For the parameters listed in ***Table D.2.*** the RESRAD default distributions were used and for the "area of contaminated zone" parameter a uniform distribution ranging from 40,470 m^2 to 607,050 m^2 was assumed. The contaminated area range represents potential application site sizes from 10 to 150 acres.

For those radionuclide for which the uncertainty analysis indicated maximum risks estimates greater than 10^{-4}, adjustments were made in the most critical model parameters, and the code was rerun to calculate a new soil guideline concentration. This process was repeated until a soil guideline value was obtained for which the maximum risk estimates did not exceed 10^{-4}.

The initial maximum risk estimates for ^{90}Sr and ^{65}Zn were on the order of 10^{-3}. The most critical parameters for these radionuclides were found to be the plant transfer factor for strontium and the plant transfer factor and distribution coefficient for zinc. For ^{90}Sr, a more conservative plant transfer factor of 0.95 was used in lieu of the RESRAD default of 0.3. The value selected represents the average of the transfer factors reported for clay/loam soils by the International Atomic Energy Agency (IAEA 1994). In the case of ^{65}Zn, the RESRAD default distribution coefficient of 0 was replaced with a more conservative value of 1800 cm^3/g, the average of the values for loam, clay, and organics, reported by the IAEA. The plant transfer factor for zinc was raised to 1.5 from the default of 0.4 based on the IAEA values (IAEA 1994).

Table D.2. Most Sensitive Parameters and Dominant Pathways for Radionuclides of Interest

Nuclide	Dominant Pathway	Most Sensitive Parameters			
^{54}Mn	external	SHF1	BRTF(1)	DROOT	DCACTC
^{60}Co	external	SHF1	DCACTC	BRTF(1)	BRTF(2)
^{65}Zn	external	SHF1	BRTF(1)	DCACTC	DROOT
^{90}Sr	plant	BRTF(1)	DROOT	DCACTC	BRTC(2)
^{134}Cs	external	SHF1	BRTF(1)	DCACTC	BRTF(2)
^{137}Cs	external	SHF1	BRTF(1)	DCACTC	BRTF(2)
^{152}Eu	external	SHF1	DCACTC		
^{154}Eu	external	SHF1	DCACTC		
^{155}Eu	external	SHF1	DCACTC		
^{234}U	plant	BRTF(1)	DROOT	DM	DCACTCU
^{235}U	external	SHF1	DCACTC	BRTF(1)	
^{238}U	ext & plant	SHF1	BRTF(1)	DROOT	DCACTC

SHF1=external gamma shielding factor; BRTF(1)=transfer factor for plants; BRTF(2)=transfer factor for meat; DROOT=depth of roots; DM=depth of soil mixing; DCACTC=distribution coefficient-contaminated zone.

Risk Estimates

Once the final soil guidelines were established, the RESRAD code was used to make estimates of the risk to the hypothetical resident farmer who moves onto the site immediately following the last application of sludge. RESRAD uses the EPA slope factors from the 1992 Health Effects Assessment Summary Tables (HEAST). However, for this assessment the RESRAD default coefficients for the radionuclides of interest and their progeny were replaced with the more recent risk coefficients found in Federal Guidance Report 13 (Eckerman 1999). The risk factors that were used are the morbidity risk coefficients for inhalation, ingestion, and external exposure. These coefficients estimate the risk to an average member of the U.S. population—per unit activity inhaled or ingested for internal exposures or per unit time-integrated activity concentration in soil for external exposures—of experiencing a radiogenic cancer as a result of intake of the radionuclide or external exposure to its emitted radiations.

For inhalation exposures, the absorption type for the particulate aerosols was assumed to be Type M (medium rate of absorption to the blood) for all radionuclides except ^{134}Cs and ^{137}Cs (Type F) and thorium (Type S). These selections are based on recommendations of the International Commission on Radiological Protection (ICRP 72) as cited in Eckerman 1999.

Probabilistic Evaluation of Dose and Risk

A probabilistic assessment was performed using the final soil guideline values as the initial soil concentrations to obtain estimates of the uncertainties associated with the dose and risk values calculated for the resident farmer. The assessment was performed as described above using distributions for the most sensitive parameters listed in ***Table D.2.*** and the area of contaminated zone.

Sludge Limits

The final soil guideline values were used to calculate sludge limits for each of the 12 radionuclides of interest based on the expected dilution (i.e., mixing of sludge into soil) and the amount of loss to radioactive decay during the land application period. For these calculations, residency is assumed to begin immediately following the last application of sludge. It is conservatively assumed that no radionuclides are lost via leaching or erosion during the land application period.

On a per acre basis, the total quantity of a key radionuclide that can be present on the land application site at the time residency begins is the soil guideline multiplied by the mass of the corresponding soil volume of 6.1 x 10^2 m^3 (assuming a 0.15 m mixing depth):

$$Q_a = C_{soil_a} \times m_{soil}$$

C_{soil_a} = Concentration limits for radionuclide "a" in soil, (pCi/g)

m_{soil} = Mass of soil per acre in top 15 cm (g)

Assuming a soil density of 1500 kg/m^3, the corresponding soil mass is 9.15 x 10^5 kg (9.15 x 10^8 g).

For a given radionuclide, the total activity that can be land applied annually on a per acre basis, assuming a constant input each year, without exceeding the corresponding soil guideline at year 20, can be calculated as follows:

$$I = \frac{Q_t \lambda}{(1 - e^{-\lambda t})}$$

I = Annual allowable input quantity (total activity) per acre (pCi/year)

Q_t = Quantity (total activity) per acre in top 15 cm at time, t (pCi)

λ = decay constant (years^{-1})

t = time (20 years)

The calculated annual allowable input quantity (total activity) can then be converted to a sludge limit by dividing the quantity by the mass of biosolids that are land applied on a per acre basis each year (4 dry tons/acre/year or 3.63 x 10^6 g assumed):

$$SL_a = \frac{I}{m_{sludge}}$$

SL_a = Sludge limit for radionuclide "a"

I = Annual allowable input quantity

m_{sludge} = Mass of sludge land applied annually (g)

RESULTS

The RESRAD calculated soil guidelines and corresponding sludge limits—based on a 10 mrem/year basic dose limit— for the 12 radionuclides of interest are presented in ***Table D.3.*** The ***Table D.3.*** values are single radionuclide guidelines and limits. When more than one radionuclide is present, a sum-of-the-ratios approach must be applied to demonstrate compliance with the single radionuclide soil guidelines and sludge limits. This approach ensures that the combined annual risk for all of the key radionuclides actually present does not exceed 10^{-4}.

Table D.3. RESRAD Calculated Soil Guidelines and Sludge Limits for Radionuclides of Interest.

Radionuclide	Soil Guideline[a] (pCi/g)	Sludge Limit ($pCi/g_{\text{-dry wt.}}$)
^{54}Mn	5.4	1100
^{60}Co	1.3	45
^{65}Zn	3.5[b]	900
^{90}Sr	3.2[c]	50
^{134}Cs	2.3	190
^{137}Cs	5.2	80
^{152}Eu	2.8	60
^{154}Eu	2.6	50
^{155}Eu	99	9600
Total U-Natural[d]	95 (46, 2, 47)[e]	1100
Total U-Depleted[d]	92 (77, 1, 14)[e]	1100
Total U-Enriched (1 to 3%)[d]	99 (16, 3, 79)[e]	1200

[a]Soil guidelines and sludge limits are calculated for single radionuclides (i.e., as if that were the only radionuclide present). For mixtures of radionuclides the sum-of-the-ratios must be calculated to determine compliance.

[b]Reduced from RESRAD calculated value of 39 pCi/g to ensure maximum risk estimate of 10^{-4}.

[c]A more conservative plant transfer factor of 0.95 was used for ^{90}S (RESRAD default = 0.3).

[d]The RESRAD calculated dose source ratios (mrem/year per pCi/g) for ^{238}U, ^{235}U, ^{234}U were used to calculate the total uranium values.

[e]Approximate activities of the individual uranium isotopes in the order ^{238}U, ^{235}U, and ^{234}U.

Risk Comparison

RESRAD 6.0 was used to estimate the risk of excess cancer associated with the radionuclides of interest at the calculated soil guidelines for the hypothetical resident farmer who establishes residency immediately following the last application of sludge. The risks associated with the previous soil guidelines (***Table D.1.***)—based on a 4 mrem/year dose limit—were also estimated for the radionuclides of interest and are presented in ***Table D.4.*** with the risk estimates for the final soil guidelines calculated for this work (based on 10 mrem).

Table D.4. Comparison of Previous Soil Guidelines and Corresponding Risks (based on 4 mrem/year) to Updated Values Based on 10 mrem/year				
Radionuclide	“4-mrem” Soil Guideline (pCi/g)	“10 mrem” Soil Guideline (pCi/g)	“4-mrem” Morbidity Risk	“10-mrem” Morbidity Risk
^{54}Mn	a	5.4	a	3 x 10^{-4}
^{60}Co	0.49	1.3	9 x 10^{-5}	2 x 10^{-4}
^{65}Zn	a	3.5	a	2 x 10^{-4}
^{90}Sr	a	3.2	a	1 x 10^{-4}
^{134}Cs	a	2.3	a	3 x 10^{-4}
^{137}Cs	2.0	5.2	7 x 10^{-6}	2 x 10^{-5}
^{152}Eu	1.1	2.8	9 x 10^{-5}	2 x 10^{-4}
^{154}Eu	a	2.6	a	2 x 10^{-4}
^{155}Eu	1.0	99	2 x 10^{-6}	2 x 10^{-4}
^{234}U	31	240	7 x 10^{-5}	8 x 10^{-5}
^{235}U	7.2	22	6 x 10^{-5}	2 x 10^{-4}
^{238}U	21	92	6 x 10^{-6}	3 x 10^{-5}

[a]This radionuclide was not addressed in the previous EA.

[b]Risk of experiencing a radiogenic cancer as a result of intake of the radionuclide or external exposure to its emitted radiations.

Uncertainty Analysis Results

The minimum, average, and maximum annual dose and risk estimates for the hypothetical resident farmer during the first year of residency (i.e., beginning immediately after the last application of sludge) are provided in ***Table D.5.*** It should be noted that the maximum values represent estimates in excess of the 95th percentile. For example, the maximum dose and risk estimates for ^{90}Sr are 41 mrem/year and 6 x 10^{-4}, respectively, but the 95th percentile values are 13 mrem/year and 2 x 10^{-4}.

The uncertainty analysis results indicate that the ***Table D.3.*** soil guidelines are adequately conservative for use in managing radionuclide levels on the land application sites.

Table D.5. Results of Uncertainty Analysis for Radionuclides of Interest at "10 mrem" Soil Guideline Concentrations.

Radionuclide	Statistic	Dose at time = 0	Risk at time = 0
^{54}Mn	min	1.3	2×10^{-4}
	max	12	4×10^{-4}
	avg.	6.5	2×10^{-4}
^{60}Co	min	0.70	1×10^{-4}
	max	12	3×10^{-4}
	avg.	6.7	2×10^{-4}
^{65}Zn	min	0.38	9×10^{-5}
	max	37	9×10^{-4}
	avg.	18	1×10^{-4}
^{134}Cs	min	5.1	1×10^{-4}
	max	14	3×10^{-4}
	avg.	7.3	1×10^{-4}
^{137}Cs	min	2.3	7×10^{-6}
	max	14	2×10^{-4}
	avg.	7.6	3×10^{-5}
^{90}Sr	min	0.19	6×10^{-6}
	max	41	6×10^{-4}
	avg.	3.7	6×10^{-5}
^{152}Eu	min	4.6	1×10^{-4a}
	max	11.7	3×10^{-4a}
	avg.	6.8	2×10^{-4a}
^{154}Eu	min	4.6	1×10^{-4}
	max	12	3×10^{-4}
	avg.	6.8	2×10^{-4}
^{155}Eu	min	4.6	1×10^{-4}
	max	12	3×10^{-4}
	avg.	6.8	2×10^{-4}
^{235}U	min	0.64	1×10^{-4}
	max	12	2×10^{-4}

Table D.5. Results of Uncertainty Analysis for Radionuclides of Interest at "10 mrem" Soil Guideline Concentrations *(Continued)*.

Radionuclide	Statistic	Dose at time = 0	Risk at time = 0
^{235}U (cont.)	avg.	6.5	1×10^{-4}
^{238}U	min	2.5	2×10^{-4}
	max	35	3×10^{-4}
	avg.	6.7	6×10^{-5}
^{234}U	min	0.75	2×10^{-5}
	max	16	1×10^{-4}
	avg.	7.1	3×10^{-5}

[a]Values are hand calculated because of an apparent error in the RESRAD results.

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APPENDIX E

PREDICTIVE MODELING FOR RADIONUCLIDE LOADING ON OAK RIDGE RESERVATION BIOSOLIDS LAND APPLICATION SITES

PREDICTIVE LIFETIME RADIONUCLIDE MODELING FOR THE OAK RIDGE RESERVATION BIOSOLIDS LAND APPLICATION SITES

MARCH 2001

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Knoxville, Tennessee 37930-1645

INTRODUCTION

The City of Oak Ridge owns and operates a Publicly Owned Treatment Works (POTW) at which wastewaters from a variety of residential and industrial users connected to the sanitary sewer system. Solids that settle and are created as a result of wastewater treatment are known as sludges or biosolids. These materials can be in a liquid or solid phase and can be applied to approved areas as a fertilizer soil-amendment due to it's nitrogen rich content. Biosolids are classified according to pathogenic organism (i.e., disease-causing) content. Class B contains very few pathogens that are typically destroyed within the first hour after surface application. Class B biosolids must have permitted areas and use established EPA management practices such as no application in wetlands or floodplains, minimization of contact with members of the general public for specific time periods after application, etc. to minimize negative consequences involving Class B biosolids. Class A biosolids have no pathogens and thus, do not require permits. Class A materials can be freely distributed without EPA management practices required for Class B materials.

Biosolids also contain trace quantities of contaminants such as heavy metals, organic compounds and radionuclides. Presently, only heavy metals have specific limits that must be maintained in order to land-apply biosolids. Organic compounds and radionuclides do not have regulatory limits established by the Tennessee Department of Environment and Conservation (TDEC) or U. S. EPA.

The city land-applies biosolids produced at their POTW on six (6) TDEC-approved, EPA-permitted application sites on the Oak Ridge Reservation (ORR). These sites account for a total of 133 ha (329 acres) on the ORR. At the present time, the city applies liquid Class B (i.e., low pathogen content) at approximately 2% solids (i.e., 98% water) via pressurized spray that extends 30 to 40 feet to the left of the application vehicle. In the Summer of 2001, the city will convert their biosolids management process to produce solid Class A (i.e., no pathogens) material at a 50 - 60% solids content.

Predictive Models

In 1996, DOE Oak Ridge Operations (DOE-ORO) completed an Environmental Assessment (EA) which established radionuclide limits for both biosolids and land application site soils. Because of limited radionuclide capacity, the City of Oak Ridge requested the dose-based radionuclide limits for application sites to be increased from 4 to 10 mrem/yr. In November 1999, TDEC Division of Radiological Health responded with a concurrence letter authorizing the increase. As a result, a new EA has been prepared by DOE that assesses all environmental impacts from the proposed increase.

Predictive models were developed for the sole purpose of aiding in the assessment of application site soils and the radionuclide levels each site would attain at the end of operational life. The results and assumptions used for the predictive models in this document reflect the following criteria:

- 50 tons/acre lifetime loading for each ORR land application site
- 15 centimeter soil mixing depth with land applied biosolids
- Existing (SAIC 1996) and proposed (Performance Technology Group 2001) radionuclide limits developed specifically for ORR land application sites
- Average radionuclide levels observed in the City of Oak Ridge Sewer System since 1988
- Calculated radionuclide loading levels for application site soils as of 12/31/00
- Uniform application of biosolids materials to each land application site

Summary of Results

The results of the predictive modeling for the ORR biosolids land application sites demonstrate that the Rogers Site would attain the greatest percentage of the existing and proposed application site radionuclide loading limits. The level attained is 56.8% of the existing 4 mrem/yr limit (DOE 1996) and 20.1% of the 10 mrem/yr limit proposed in the current EA (DOE 2001). Modeling results summaries are listed in ***Table E.1***.

Table E.1 ORR Biosolids Land Application Site Radionuclide Predictive Model Results

Land Application Site	Projected Total Sum of Radionuclide Fractions for Site Soil (4 mrem/yr)	Projected Total Sum of Radionuclide Fractions for Site Soil (10 mrem/yr)
Upper Hayfield #1	0.409	0.150
Upper Hayfield #2	0.393	0.145
High Pasture	0.492	0.182
Rogers Site	0.568	0.201
Watson Road	0.513	0.190
Scarboro Road	0.453	0.167

References

Environmental Assessment of The Proposed Changes to The Land Application of Sanitary Sludge on the Oak Ridge Reservation. Prepared by U.S. Department of Energy, Oak Ridge Operations Office, Waste Management and Technology Development Division. November 1996.

Environmental Assessment of The Proposed Changes to The Land Application of Sanitary Biosolids on the Oak Ridge Reservation. Prepared by U.S. Department of Energy, Oak Ridge Operations Office, Environmental Management. August 2001.

APPENDIX F

WEST END TREATMENT FACILITY

TOTAL URANIUM CALCULATIONS

Daily WETF Uranium Impacts upon City of Oak Ridge Biosolids

Average Dry Tons Produced Per Year City of Oak Ridge Biosolids		Land Application Days per Year		Dry Tons Biosolids Produced Per Day
400	/	265	=	115

Dry Tons Biosolids Produced Per Day		lbs per ton		lbs per kg		Dry kgs Biosolids Produced Per Day
1.5	x	2,000	/	2.2	=	1,372.2

Total grams U Per Month Discharged From WETF		Days per Month		Total grams U Discharged Per Day from WETF
1,260	/	31	=	40.6

Total grams U Discharged Per Day from WETF		**Dry kgs Biosolids Produced Per Day**		**Total grams Per kg Increase in City Biosolids From WETF**
40.6	/	**1,372.2**	=	0.030

Cumulative WE TF Uranium Impacts upon ORR Biosolids Land Application Sites

Total grams U Per Month Discharged From WETF		Months Per Year WETF Discharge		Total grams U Discharged Per Year from WETF		mg per g		Total mg U Discharged Per Year from WETF
1,260	x	6	=	7,560	x	1,000	=	7.56E+06

Dry Tons Biosolids Produced Per Day		lbs per ton		lbs per kg		Dry kgs Biosolids Produced Per Day
1.5	x	2,000	/	2.2	=	1,372.2

Dry kgs Biosolids Produced Per Day		Land Application Days per Year		Total kgs **Biosolids** Produced in 6 Months
1,372	x	133	=	182,504

Total mg U Discharged Per Year from WETF		**Total g Soil on the Smallest Land Application Site**		**Total mg/kg Increase** on **ORR Biosolids Site Per Year From WETF**		**Years -** Average **Remaining Life of Each Application Site**		**Total mg/kg Lifetime Increase on ORR Biosolids Site From WETF**
7.56E+06	/	**2.63E+10**	=	0.00029	x	**7**	=	**0.0020**

All results are calculated on a dry weight basis

Daily WETF Uranium Sanitary Sewer/NPDES Discharge Comparison

Maximum NPDES mg/l Total U Discharge Level		Gallons per hour Discharge Rate Through NPDES Point		Duration of Discharge in Hours Through NPDES Point		Liters Per. Gallon		mg Total U Discharged through NPDES Point Per Day		mg per kg		kg Total U Discharged through NPDES Point Per Day
0.048	x	1200	x	14.0	x	3.785	=	3,052.2	/	1.00E+06	=	0.003

Maximum Sanitary Sewer mg/l Total U Discharge Level		Gallons per hour Discharge Rate to Sanitary Sewer		Duration of Discharge in Hours to Sanitary Sewer		Liters Per Gallon		mg Total U Discharged to Sanitary Sewer Per Day		mg per kg		kg Total U Discharged to Sanitary Sewer Per Day
2.0	x	300	x	18.0	x	3.785	=	40,878.0	/	1.00E+06	=	0.041

Annual WETF Uranium Sanitary Sewer/NPDES Discharge Comparison

Maximum NPDES mg/l Total U Discharge Level		Total Gallons Discharged Through NPDES Point per Year		Liters Per Gallon		mg Total U Discharged through NPDES Point Per Year		mg per kg		kg Total U Discharged through NPDES Point Per Year
0.048	x	1.00E+06	x	3.785	=	181.680.0	/	1.00E+06	=	0.18

Maximum Sanitary Sewer mg/l Total U Discharge Level		Gallons per hour Discharge Rate to Sanitary Sewer		Liters Per Gallon		mg Total U Discharged to Sanitary Sewer Per Day		mg per kg		kg Total U Discharged to Sanitary Sewer Per Year
2.0	x	1.00E+06	x	3.785	=	7,570,000.0	/	1.00E+06	=	7.57

APPENDIX G

ORR BIOSOLIDS LAND APPLICATION SITES
HUMAN HEALTH RISK ASSESSMENT

ACRONYMS

COC	constituent of concern
CSF	cancer slope factor
DOE	U.S. Department of Energy
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
LET	linear energy transfer
LOAEL	Lowest Observed Adverse Effect Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No Observed Adverse Effect Level
NRC	National Research Council
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
POTW	Publicly Owned Treatment Works
RESRAD	Residual Radioactivity computer model
RfC	reference concentration
RfD	reference dose
TDEC	Tennessee Department of Environment and Conservation

1. HUMAN HEALTH RISK ASSESSMENT

1.1 INTRODUCTION

This appendix presents a human health risk assessment and is provided as a component of the environmental assessment (EA) for the U.S. Department of Energy (DOE) action to manage sewage sludge by land application on federal land. The ongoing land application operation, regulated by the state of Tennessee under U.S. Environmental Protection Agency (EPA) authority, is not part of the proposed action described in the EA. No human health risk evaluation exists for the ongoing operation; therefore, this risk evaluation of the ongoing sludge management practice is presented as an appendix to the EA.

Municipal sewage sludge is regulated by EPA under the authority of the Clean Water Act. EPA has delegated authority for local sludge management to the Tennessee Department of Environment and Conservation (TDEC), which has responsibility for compliance. However, the city of Oak Ridge must still comply with 40 *CFR* 503 regulations and report to the EPA Region IV annually.

The city of Oak Ridge has been applying sanitary sewage sludge to selected sites on the Oak Ridge Reservation (ORR) since 1983. The Oak Ridge Y-12 Plant is a standard industrial customer of the city of Oak Ridge. The Y-12 Plant is permitted to discharge sanitary sewage to the city, under the city's industrial pretreatment charter, with prescribed sanitary sewage discharge limits and restrictions similar to those of other industrial sewage generators located in the city. Final management of the treated sludge is by land application on federal land.

In addition to the Oak Ridge Y-12 Plant, which is a DOE facility that uses radioactive materials, there are several other state of Tennessee-licensed industrial facilities that also release radioactive materials into the Oak Ridge sanitary sewer system (e.g., American Ecology Recycle Center, Scientific Ecology Group, Manufacturing Sciences Corporation). With certain exceptions for patients of the local hospital, all facilities must meet the same acceptance criteria as other industrial users of the city's sewage treatment plant. In addition to radioactive materials, small quantities of inorganic compounds may also be released to the sewer.

Sanitary sewage sludge also contains high concentrations of human pathogens. Bacterial, viral, parasitic, and fungal pathogens in municipal sewage sludge have been identified as potential hazards to human health (WHO 1981; Kowal 1982,1985). EPA has evaluated the risk from exposure to pathogens in land-applied sludge separately (EPA 1988, 1989a) and determined that the risk of exposure to pathogens in sludge-amended soils is minimal.

During the treatment process, constituents may become concentrated in the sludge. The health effects of exposure to sludge containing low levels of radionuclides or chemicals need to be estimated in order to evaluate the safety of the current practice. Therefore, risks associated with exposure to low levels of radionuclides and chemicals in sanitary sewage sludge are addressed in this appendix.

This risk assessment has been performed in accordance with current risk assessment guidance provided by the EPA including: *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A)* (EPA 1989b), *Supplemental Guidance* (EPA 1991a), and *Exposure Factors Handbook* (EPA 1990).

The report organization is as follows. Section 1 provides an overview of the risk assessment process. Section 2, Identification of Constituents of Concern, describes the COCs that are evaluated in this risk assessment and their site-specific media concentrations. Section 3, Toxicity Assessment, describes the determination of toxicity or dose-response values for the COCs. Section 4, Exposure Assessment, identifies potential receptors and describes how potential exposure pathways were identified and exposure conditions were estimated. Section 5, Risk Characterization, combines the data generated in the Exposure Assessment with the data presented in the Toxicity Assessment to derive estimates of potential risk posed by COCs in sludge-amended soils. Section 6, Uncertainty Analysis, discusses the major sources of uncertainty associated with each step of the human health risk assessment process. Section 7 presents the Summary and Conclusions.

1.2 SITE-SPECIFIC RISK ASSESSMENT APPROACH

The purpose of this human health risk assessment is to evaluate the extent to which compounds present in the Publicly Owned Treatment Works (POTW) sewage sludge may potentially present a risk to human health, either during the application process or after blending with site soils. Quantitative estimates of potential carcinogenic and noncarcinogenic risks are made and presented for potential exposures associated with probable use of the land application site.

The predominant current and expected future land uses on the ORR are industry, forestry, environmental research, and agriculture. Nearly all workers are employed and located at the three major DOE industrial and research facilities [Oak Ridge National Laboratory (ORNL), Y-12 Plant, K-25 Site]; only a small percentage of work (environmental research, silviculture, and agriculture) is performed on the ORR outside of these facilities. Access is restricted on the entire ORR, including the three major facilities. All land application sites are within the ORR. The focus of this risk assessment is the evaluation of the potential risk to human health due to the presence of constituents in treated sewage sludge and ultimately in site soils at the land application sites. Because access is restricted at each of the locations, surface soils are not generally available for direct human contact by the general public.

Trained sludge workers would be present at the land application site during application of sewage sludge to soil. Exposure could occur during application; however, procedures are currently in place to limit exposure to workers during application. Theoretically, it is possible for a trespasser to have intermittent contact with the sludge-amended soils, although because of current access restrictions the potential for this exposure scenario to occur is limited. If it did occur, it is likely that it would be infrequent and that the exposure would be of short duration. Therefore, the only realistic potential exposure scenario for each of the land application sites is contact with sludge during the application process by a worker. However, to be conservative, it is assumed that a trespasser could contact constituents in soils. Both of these scenarios have been evaluated in the risk assessment.

There are no off-site residential receptors in the vicinity of the land application sites on the ORR; therefore, off-site impacts from land application of sludge have not been evaluated in this risk assessment.

Risk estimates for the two scenarios [on-site employee and trespasser (transient)] were made using default parameters provided by regulatory guidance to evaluate reasonable maximal exposure associated with land application sites.

1.3 RISK ASSESSMENT OVERVIEW

The risk assessment evaluates a single hypothetical land application site using the standard operating practices and receiving sanitary sludge that contains radionuclide and chemical concentrations that represent the measured sludge concentrations and soil concentrations at current land application sites. The approach and methodology used in this human health risk assessment are consistent with the guidance developed by the National Research Council (NRC). The NRC, established by the National Academy of Sciences to further scientific knowledge and to advise the federal government, developed the four-step paradigm for conducting health-based risk assessments (NRC 1983). This paradigm has been adopted by EPA as well as many other federal and state agencies. In accordance with the NRC recommendations, this risk assessment is organized into the following four steps:

1. Identification of Constituents of Concern (COCs)
2. Toxicity Assessment
3. Exposure Assessment
4. Risk Characterization

These four steps are described briefly below.

Identification of COCs. This step of the risk assessment process defines the COCs that are selected for more detailed evaluation in the remainder of the risk assessment. The data used to evaluate potential exposure are also presented in this section.

Toxicity Assessment. In the toxicity assessment, the relationship between the magnitude of exposure (dose) and the potential for occurrence of specific health effects (response) for each COC is evaluated. Both carcinogenic and noncarcinogenic effects are considered. The most current EPA-verified dose-response values are used when available.

Exposure Assessment. The objective of the exposure assessment is to evaluate the magnitude and frequency of potential exposure to COCs. Potentially exposed individuals, and the pathways by which they are potentially exposed, are identified based on the physical characteristics and uses of the site and surrounding area. The extent of a receptor's exposure is estimated by constructing “exposure scenarios” that describe the potential pathways of exposure to COCs and the activities and behaviors of individuals that might lead to contact with constituents in the environment.

Risk Characterization. In the risk characterization step, the results of the exposure assessment are combined with the results of the toxicity assessment to derive pathway-specific quantitative estimates of potential health risks. The estimates for each exposure pathway are then summed to give total risk estimates. Separate quantitative estimates of potential risk are derived for potentially carcinogenic effects and for noncarcinogenic effects.

2. IDENTIFICATION OF CONSTITUENTS OF CONCERN

Digested sludge that is to be applied to the land application areas is sampled and analyzed for organic, inorganic, heavy metal, and radionuclide compounds in an ongoing monitoring program based on state and federal requirements. Parameters such as pH, total percent solids, and percent volatile solids are monitored daily. Total gamma content is monitored each day that sludge is applied on the ORR, and quantitative radionuclide levels in sludge are measured weekly. Inorganic parameters such as nitrogen (ammonia, nitrate, nitrite, organic, and total nitrogen), potassium, phosphorus, and heavy metals are analyzed monthly. Organic compounds are analyzed in the digested sludge semiannually.

Many chemical and physical parameters monitor the efficacy of the sludge treatment system. For example, pH and total solids content allow treatment workers to judge whether the system is properly loaded or in danger of becoming too acid for effective microbial degradation. Similarly, measures of different forms of nitrogen monitor the degree to which the sludge is digested and the limits to which the resulting sludge can be spread on land and used as a fertilizer. These parameters are shown in ***Table G.1***. While measurable and vital to the operation of the treatment system, these analytes are nutrients for beneficial use and are not COCs to be addressed in this risk assessment.

During the biological digestion of sludge, microorganisms use the organic compounds present for growth, producing carbon dioxide or methane as a by-product. Therefore, with a properly working treatment system, most organic constituents would be reduced below detectable limits. For example, analyses for 1994 show that of the organic chemicals that were tested for in composite samples, aroclor-1254, chlordane, 4,4-DDE, and dieldrin were each reported at or slightly above detection in a single composite sample. Because, as a whole, the digestion process is working properly and reduces organic compounds below detectable limits, organic compounds are not considered to be of concern in this risk assessment.

Digested sludge was sampled monthly in 1993 and 1994 for heavy metals as required by 40 *CFR* 503 regulations for the land application of sludge. ***Table G.2.*** shows the maximum detected metal levels during 1993 and 1994 and compares them with the concentration limits in 40 *CFR* 503.13. In all samples, the heavy metals content of the sludge is below statutory limits. However, because some heavy metals can accumulate in the soil and bioaccumulate in biota, it is a conservative assumption for this risk assessment to consider these metals of potential concern.

The city of Oak Ridge sludge contains radionuclides that are generated from a variety of domestic and industrial sources. Although there are no applicable regulatory limits governing radionuclide levels in sewage sludge, composite sludge samples are monitored daily and analyzed weekly for radionuclides. The average yearly radionuclide levels from 1988 to 1993 are shown in ***Table G.3.*** Because of the conservative approach for this risk assessment, radionuclides with half-lives longer than 2 months (see ***Table G.3.*** for half-lives) were considered to be potential COCs because of their ability to accumulate.

Although some pathogens tend to concentrate in sludge during wastewater treatment, most are inactivated during anaerobic digestion (Sopper 1993). Inactivation varies by pathogen type, but, in general, the success of a treatment process to significantly reduce pathogens (as defined in 40 *CFR* 257) depends on its retention time and creating an environment particularly hostile to pathogenic organisms (EPA 1991b, 1991c, 1992b). For example, ova and cysts of parasites, which are more resistant to inactivation, may be reduced by only about 30-40% during anaerobic digestion (EPA 1991c); but poliovirus can be 98.8% inactivated (Bertucci et al. 1977) and bacteria typically reduced by 1-2 orders of magnitude (Pedersen 1981) [i.e., 5000 organisms reduced to 500 (1 order of magnitude) or even 50 (2 orders of magnitude)]. Application of sludge on plants and on the soil surface exposes remaining pathogens to desiccation and sunlight, further reducing the pathogens' survival rate.

Table G.1. Maximum concentrations of inorganic constituents in city of Oak Ridge POTW sewage sludge (1993-1994)

Inorganic parameter	Sampling frequency	Highest level detected in sludge in 1993 (mg/kg)	Highest level detected in sludge in 1994 (mg/kg)
Ammonia-nitrogen[a]	Monthly	60,000.00	30,000.00
Manganese	Monthly	1,260.0	1,710.0
Nitrate nitrogen[a]	Monthly	40.2	269.0
Nitrite nitrogen[a]	Monthly	8.8	30.7
Organic nitrogen	Monthly	40,000.0	49,800.0
pH	Daily	7.7	8.1
Potassium	Monthly	5,960.0	5410.0
Phosphorus	Monthly	36,200.0	36,800.0
Total Kjeldahl nitrogen[a]	Monthly	94,100.0	77,200.0
Total nitrogen[b]	Monthly	94,111.8	77,223.7
Total solids %	Daily	3.2%	3.3%
Volatile solids (% or TS)	Daily	63%	62%

Source: City of Oak Ridge 1994, 1995.

[a] These parameters are required to be sampled annually by National Pollutant Discharge Elimination System permit #TN0024155. Reporting of quantitative data is required, but limits are not specified.

[b] Total nitrogen represents the sum of total Kjeldahl and nitrate nitrogen.

Table G.2. Maximum concentrations of heavy metal constituents in city of Oak Ridge POTW sewage sludge (1993-1994) vs 40 *CFR* 503.13 ceiling concentration limits

Heavy metal	Mean concentration detected in sludge (mg/kg dry wt) 1996-2000	Maximum concentration detected in sludge (mg/kg dry wt) 1996-2000	40 *CFR* 503.13 Ceiling concentration limits (mg/kg dry wt)	Highest level detected as a percentage of regulatory ceiling
Arsenic	3.05	12.8	75	17%
Cadmium	4.23	19.4	85	22%
Chromium[a]	48.5	180	NA	NA
Copper	459.87	700	4300	16%
Lead	35.56	74	840	9%
Mercury	8.77	23	57	40%
Molybdenum	13.09	54	75	72%
Nickel	35.96	100	420	24%
Selenium	6.13	18.2	100	18%
Zinc	1157.77	1910	7500	26%

Source: City of Oak Ridge 1996-2000

[a] 40 *CFR* 503 limits for chromium have been excised by the EPA until further notice.

NA - Not Applicable

Table G.3. Historical radiological characterization of Oak Ridge sanitary sewage sludge (selected radionuclides)

		Average concentration, pCi/g dry weight						
Radionuclide	Half-life	1996	1997	1998	1999	2000	Mean	Maximum
Potassium-40	1.28×10^9 years	7.19	6.19	6.04	5.86	5.67	6.19	12.29
Cobalt-60	5.27 years	0.46	0.51	0.52	0.51	0.48	0.5	8.96
Cesium-137	30.2 years	0.8	0.31	0.36	2.07	1.88	1.08	9.24
Radium-228	5.8 years	1.13	1.01	0.97	0.84	0.62	0.91	1.69
Uranium-235	4.5×10^8 years	13.29	0.35	0.33	0.36	0.00	0.36	1.85
Uranium-238	4.5×10^9 years	0.75	8.0	10.58	7.62	2.58	8.41	50.95

Source: City of Oak Ridge

Reliable, EPA-approved risk assessment models are not available for quantifying human health risk from pathogens, but sludge application operator evidence and literature research show minimal risk from pathogens. Studies indicate that under EPA-approved sludge application practices, pathogens are not a health risk (Kowal 1982; EPA 1988, 1989a, 1991b, 1991c, 1992b; Sopper 1993). Land application of anaerobically digested sludges known to contain Salmonellae were found to present no apparent health risk to farm families when used in agricultural applications (Ottolenghi and Hamparian 1987). Cows grazed on anaerobically digested sludge-treated forage showed no bacterial, viral, or fungal infections in live animals or at necropsy, and incidence of intestinal parasites was the same in experimental and control cattle (Fitzgerald 1979). Land application of Chicago sludge on 6,000 ha resulted in no significant public health problems (Sedita et al. 1977) Reddy et al. (1985) also noted no significant health risk to humans or animals at sludge application rates of 2-10 metric tons/ha.

In summary, because of their potential to accumulate, heavy metals and radionuclides are potential COCs for evaluation of human health risk. Organics, inorganic nutrients, and pathogens are not considered COCs in this human health risk assessment.

3. TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to identify the types of adverse health effects a COC may cause and to define the relationship between the dose of a COC and the likelihood or magnitude of an adverse effect (response). Adverse effects are characterized by EPA as carcinogenic or "noncarcinogenic," (i.e., potential effects other than cancer). Dose-response relationships are defined by EPA for oral exposure and for exposure by inhalation. Combining the results of the dose-response assessment with information on the magnitude of potential human exposure provides an estimate, usually very conservative, of potential risk.

Section 3.1 describes EPA's approach for developing noncarcinogenic dose-response values. Section 3.2 describes the carcinogenic dose-response relationships developed by EPA. Section 3.3 presents a discussion of radiological dose-response values and Sect. 3.4 discusses chemicals for which no EPA toxicity values are available. Sources of the published dose-response values used in this risk assessment include EPA's Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/)

3.1 NONCARCINOGENIC DOSE-RESPONSE

Compounds with known or potential noncarcinogenic effects are assumed to have a dose below which no adverse effect occurs or, conversely, above which an adverse effect may be seen. This dose is the threshold dose. The threshold dose is called a No Observed Adverse Effect Level (NOAEL). The lowest dose at which an adverse effect occurs is called a Lowest Observed Adverse Effect Level (LOAEL). By applying uncertainty factors to the NOAEL or the LOAEL, References Doses (RfDs) for chronic exposures to chemicals with noncarcinogenic effects have been developed by EPA (1994a, 1994b). The uncertainty factors account for uncertainties associated with the dose-response relationship such as the effects of using an animal study to derive a human dose-response value, extrapolating from high to low doses, and evaluating sensitive subpopulations. Generally, a 10-fold factor is used to account for each of these uncertainties; thus, the total uncertainty factor can range from 10 to 10,000. In addition, an uncertainty factor or modifying factor of up to 10 can be used to account for "inadequacies in the database."

For chemicals with noncarcinogenic effects, an RfD provides reasonable certainty that no noncarcinogenic health effects are expected to occur even if daily exposures were to occur at the RfD level for a lifetime. RfDs and exposure doses are expressed in units of milligrams of chemical per kilogram body weight per day (mg/kg-day).

Table G.4. summarizes the dose-response information for the COCs with potential noncarcinogenic effects for the oral and inhalation routes of exposure. For each chemical, the dose-response value, and the reference for the dose-response value is presented. In addition, the target organ and critical effect upon which the dose-response value is based are also presented for each chemical.

In accordance with EPA National Center for Environmental Assessment policy, only chemicals with EPA-verifiable Reference Concentrations (RfCs) have been evaluated for noncarcinogenic effects following inhalation exposures. Dose-response values for the inhalation route of exposure are provided by the EPA as RfCs, expressed as milligrams of compound per cubic meter of air (mg/m^3). In order to use these dose-response values to calculate an average daily exposure dose, the RfCs are converted to RfDs, expressed as the corresponding inhaled dose in mg/kg-day. The conversion from RfC to RfD follows the formula cited in HEAST (EPA 1994b):

$$\text{RfC } (mg/m^3) \times (1/70 \text{ kg}) \times (20 \text{ } m^3/\text{day}) = \text{RfD (mg/kg-day)}.$$

Table G.4. Dose-response data for COCs with potential noncarcinogenic effects

Compound	CAS[a]	Inhalation RfD (mg/kg-day)	Reference (last verified)	Oral RfD (mg/kg-day)	Reference (last verified)	Target organ system
Arsenic	7440382	NA[b]	—	3.0E-4	IRIS (1/01)	Skin; keratosis
Cadmium	7440439	NA	—	5.0E-4	IRIS (1/01)	[c]
Chromium-VI	7440473	NA	—	5.0E-3	IRIS (1/01)	No adverse effects observed
Chromium-III	7440473	NA	—	1.5E+0	IRIS (1/01)	
Copper	7440508	NA	—	NA	IRIS (1/01)	Gastrointestinal
Lead	7439921	NA	—	NA	—	CNS[d]; blood
Mercury	7439976	8.57E-5	IRIS (1/01)	NA	—	Kidney effects
Molybdenum	7439987	NA	—	5.0E-3	IRIS (1/01)	Urine; joints; blood
Nickel	7440020	NA	—	2.0E-2	IRIS (1/01)	Decreased body and organ weight
Selenium	7782492	NA	—	5.0E-3	IRIS (1/01)	Whole body; selenosis
Zinc	7440666	NA	—	3.0E-1	IRIS (1/01)	Blood; anemia

[a] Chemical Abstracts Service Registry Number.

[b] NA = Not available; inhalation RfD is not listed in IRIS database or HEAST tables (EPA 1994b).

[c] The oral RfD for cadmium was derived by EPA using a pharmacokinetic model assuming 5% absorption from water and 2.5% absorption from food/soil.

[d] CNS = central nervous system.

3.2 CARCINOGENIC DOSE-RESPONSE

The underlying assumption of regulatory risk assessment for compounds with known or assumed potential carcinogenic effects is that no threshold dose exists. Thus, the characterization assumes that there is some finite level of risk associated with each nonzero dose. The EPA methodology is to extrapolate dose-response relationships observed at the relatively high doses used in animal studies to the low dose levels encountered by humans in environmental situations. The mathematical models assume no threshold and use both animal and human data to develop a potency estimate for a given compound. The potency estimate, called a cancer slope factor (CSF) is expressed in units of $(mg/kg\text{-}day)^{-1}$.

Table G.5. summarizes the oral and inhalation dose-response information developed by EPA for potentially carcinogenic COCs identified for this assessment. For each chemical, the CSF and its reference are provided.

3.3 RADIATION TOXICITY

The potential health effects associated with exposure to radionuclides at the land application sites are due to low-level ionizing alpha, beta, and gamma radiation emitted by the radionuclides in sanitary sewage sludge. The primary effects include an increase in the occurrence of cancer in irradiated individuals and possible genetic effects that may occur in future generations. The risk of serious genetic effects is much lower than the risk of cancer induction (EPA 1989b). Therefore, genetic effects are not the focus of this toxicity assessment, and radiological risks are evaluated only with respect to incremental cancer probabilities per EPA guidance (EPA 1989b).

The toxicity of the various radionuclides found in sludge is based on:

- the types and energies of radiation they emit;
- the biological importance of the organs/tissues being irradiated;
- the radiological sensitivity of the organs/tissues being irradiated; and
- for internal exposure only, metabolic behavior in the body and biological retention characteristics in the body.

Radiation-induced health effects for humans have been confirmed only at relatively high doses or high dose rates with large populations. Exposure to a high dose of radiation (e.g., a thousand times the average annual background dose rate) during a short period of time (a few hours) produces detrimental effects in all the organs and systems of the body. For low doses, health effects are presumed to occur but can only be estimated statistically. Risk estimates are strictly applicable to large populations, because the appearance of health effects after an exposure is a chance event. For purposes of radiological impact assessment, the health effects are measured by cancer incidence in the exposed population. However, risk estimates in the low-dose range are uncertain because of extrapolation from high doses and because of assumptions made on dose-effect relationships and the underlying mechanisms of carcinogenesis.

Table G.5. Dose-response data for COCs with potential carcinogenic effects

Compound	CAS[a]	Weight of evidence[b]	Oral slope factor (mg/kg-day)$^{-1}$	Reference (last verified)	Inhalation slope factor (mg/kg-day)$^{-1}$	Reference (last verified)
Arsenic	7440382	A	1.5E+0	IRIS (1/01)	1.51E+1	IRIS (1/01)
Cadmium	7440439	B1	NA[c]	—	6.3E+0	IRIS (1/01)
Chromium-VI	7440473	A	NA	—	4.2E+1	IRIS (1/01)
Copper	7440508	D	NA	—	NA	IRIS (1/01)
Lead	7439921	B2	NA	—	NA	IRIS (1/01)
Mercury	7439976	D	NA	—	NA	IRIS (1/01)
Molybdenum	7439987	—	NA	—	NA	IRIS (1/01)
Nickel	7440020	A	NA	—	NA	IRIS (1/01)
Selenium	7782492	D	NA	—	NA	IRIS (1/01)
Zinc	7440666	D	NA	—	NA	IRIS (1/01)

[a] Chemical Abstracts Service Registry Number.

[b] Weight of Evidence Classifications:

A = Human carcinogen (sufficient evidence of carcinogenicity in humans)

B1 = Probable human carcinogen (limited evidence of carcinogenicity in humans)

B2 = Probable human carcinogen (sufficient evidence of carcinogenicity in animals, with inadequate or lack of evidence of carcinogenicity in humans)

C = Possible human carcinogen (limited evidence of carcinogenicity in animals, and inadequate or lack of evidence of human data)

D = Not classifiable as to human carcinogenicity

[c] NA = Not available; chemical is not listed in IRIS database or HEAST tables as a carcinogen (EPA 1994b).

Radiation effects in the exposed population cannot be readily identified because radiogenic cancers are indistinguishable from those resulting from other factors. Studies of populations chronically exposed to low-level radiation, such as those residing in regions of elevated natural background, have not shown consistent evidence of an associated increase in the risk of cancer.

Alpha, beta, and gamma radiations are released during the radioactive decay process. Each type of radiation differs in its physical properties and in its ability to induce damage to biological tissue. The BEIR IV report (NRC 1988) addresses the risk from alpha radiations. Alpha particles are an internal exposure hazard rather than an external hazard because they are unable to penetrate the dead skin cell layer of the body to reach living tissue. Within the body alpha particles are the most effective of the three types of radiation in damaging cells because they have high linear energy transfer (LET), (i.e., their energy is completely absorbed by tissue within a short distance). High LET radiation is more damaging to cells than low LET radiation. The BEIR V report (NRC 1990) addresses the risk from low LET radiation such as gamma and beta particles. Beta particles are primarily an internal hazard; however, in cases of external skin exposure, energetic beta particles can penetrate living skin cells, representing an external hazard as well. Beta particles deposit less energy to small volumes of tissue than alpha particles and, therefore, induce much less damage than alpha particles. Gamma radiation is primarily an external hazard because it can penetrate tissue and reach internal organs without being taken into the body.

EPA has developed guidance for radiological risk assessment consistent with existing guidance for assessing chemical carcinogenic risks (CSFs per unit intake) (EPA 1989b). ***Table G.6.*** summarizes potency factors used in the calculation of potential risk from exposure to radionuclides.

3.4 CHEMICALS FOR WHICH EPA TOXICITY VALUES ARE NOT AVAILABLE

Because of the uncertainties in the relationship between exposure to lead and biological effects (dose-response), it is unclear whether the noncarcinogenic effects of lead exhibit a threshold response. Therefore, an RfD for lead is not available. Lead exposure health effects of most concern are impaired mental and physical development in young children.

Because most human health effects data are based on blood lead (Pb) concentration, EPA has developed a quantitative method for estimating detrimental environmental lead levels in children using an uptake biokinetic model. Several EPA regional and state models exist to address situations where adults are exposed. Because the interim soil cleanup level of 400 ppm for residential sites and 1000 ppm for industrial sites recommended by Office of Emergency and Remedial Response directive 9355.4-12 (EPA 1994c) is so much greater than the maximum measured concentration in sludge or soil, an evaluation of blood lead levels was not done in this assessment.

Table G.6. Radionuclide potency factors

Radionuclide	External radiation slope factor 1/year per pCi/g	Inhalation slope factor 1/pCi	Ingestion slope factor 1/pCi
Cobalt-60	9.8E-6	6.9E-11	1.9E-11
Cesium-137 + D	2.1E-6	1.9E-11	3.2E-11
Potassium-40	6.1E-7	7.5E-12	1.3E-11
Radium-228 + D	6.7E-6	2.7E-9	3.0E-10
Uranium-235 + D	2.7E-7	1.3E-8	4.7E-11
Uranium-238 + D	5.7E-8	1.2E-8	6.2E-11

Source: HEAST (EPA 1995).

4. EXPOSURE ASSESSMENT

4.1 IDENTIFICATION OF POTENTIAL RECEPTORS

Receptors considered for exposure to the sludge include an employee who would load the sludge and spread it on the application areas and a transient who would be incidentally exposed to the soil shortly after sludge application. Currently, an employee of the city of Oak Ridge POTW applies sludge to the designated soil areas on a daily basis and is considered as the maximally exposed individual. Although there is restricted access to the application areas on the ORR, a transient scenario was considered. Land use at the ORR is anticipated to remain industrial; therefore, a hypothetical receptor residing on an application site in the future was not considered in this assessment.

4.2 IDENTIFICATION OF EXPOSURE PATHWAYS

A complete exposure pathway consists of the following four elements: (1) a source and mechanism of contaminant release to the environment, (2) an environmental transport mechanism for the released contaminants, (3) a point of human contact with the contaminated medium, and (4) a route of entry for the contaminant into the human receptor at the exposure point. The sludge itself can be considered the exposure point without a release to any other medium. The soil, as the receiving medium, can also be an exposure point following sludge application. An integration of the source, its release, fate and transport mechanisms, exposure points, and exposure routes is evaluated for complete exposure pathways. If any of these elements is missing, the pathway is incomplete and will not be considered further in this risk evaluation.

For the city of Oak Ridge POTW sludge, the sludge itself is the source of the contamination. It can be released into the air during application procedures, and it is released into the soil as it is applied. Potential exposure routes to human receptors include inhalation of suspended sludge particles, incidental ingestion of sludge, and dermal contact when handling contaminated equipment or soil.

Because of uncertainties associated with the quantification of dermal exposure (EPA 1992a) and because dermal exposure is considered to be less than that by direct ingestion for the constituents included in this risk assessment, only inhalation and ingestion pathways and external radiation are considered quantitatively in this assessment. The city uses a gamma counting system to screen sludge each day that material is hauled to the ORR for application to ensure that external exposures are below the approved action limits. Therefore, external exposure to radionuclides in sludge is not evaluated for the worker. Because radionuclides can be concentrated in soil over time, external exposure to gamma radiation from the soil is included for evaluation of the trespasser.

4.3 MEDIA EXPOSURE CONCENTRATIONS

Radionuclide and chemical exposure point concentrations in sludge are shown in ***Table G.7.*** Maximum and average measured concentrations from sampling events in 1994 were used in the risk assessment. Mean and maximum radionuclide and chemical air concentrations (pCi/m^3 or mg/m^3) were conservatively estimated from the sludge concentration by:

$$C_{air} = PL * C_{soil} * CF$$

where

PL = Particulate loading (50 $\mu g/m^3$),
C_{soil} = Concentration of chemical or radionuclide in soil (mg/kg or pCi/g), and
CF = Conversion factor (1E-9 kg/µg or 1E-6 g/µg).

It is conservatively assumed that air particulates during application are equal to the National Ambient Air Quality Standard for the annual average respirable portion (PM_{10}) of suspended particulate matter of 50 $\mu g/m^3$. It is further assumed that 100% of the particulates have the same contaminant concentration as the soil value.

Table G.7. Exposure point concentrations in sludge and air

Constituent	Maximum sludge concentration	Maximum air concentration	Mean sludge concentration	Mean air concentration
Radionuclides				
	pCi/g	pCi/m^3	pCi/g	pCi/m^3
Cobalt-60	8.96	4.5E-04	0.50	2.5E-05
Cesium-137	9.24	4.6E-04	1.08	5.4E-05
Potassium-40	12.29	6.1E-04	6.19	3.1E-04
Radium-228	1.69	8.5E-05	0.91	4.6E-05
Uranium-235	1.85	9.3E-05	0.36	1.8E-05
Uranium-238	50.96	2.5E-03	8.41	4.2E-04
Chemicals				
	mg/kg	mg/m3	mg/kg	mg/m3
Arsenic	12.8	6.40E-07	3.05	1.53E-07
Cadmium	19.4	9.70E-07	4.23	2.12E-07
Chromium	180	9.00E-06	48.52	2.43E-06
Copper	700	3.50E-05	459.87	2.30E-05
Lead	74.6	3.73E-06	35.56	1.78E-06
Mercury	23	1.15E-06	8.77	4.39E-07
Molybdenum	54	2.70E-06	13.09	6.55E-07
Nickel	100	5.00E-06	35.96	1.80E-06
Selenium	18.2	9.10E-07	6.13	3.07E-07
Zinc	1910	9.55E-05	1155.77	5.79E-05

The 1994 measured maximum soil concentrations for radionuclides and chemicals and the estimated air concentrations are shown in ***Table G.8.*** The values shown represent the soil exposure point concentrations used in evaluating potential exposure of a trespasser to accumulated concentrations in soil.

4.4 ESTIMATION OF POTENTIAL EXPOSURE DOSES

Chemical intake estimates are based on EPA methodology presented in *Risk Assessment Guidance for Superfund* (EPA 1989b) and related guidance (EPA 1991a). Radiological dose estimates were calculated using Residual Radioactivity (computer model) (RESRAD) in accordance with DOE Order 5400.5. For the worker, intakes and radiological doses were calculated for incidental sludge ingestion and inhalation of sludge particulates. The average and the maximum exposure point concentrations were used to provide a range of potential exposure.

Incidental ingestion of soil and inhalation of soil particulates as well as direct irradiation from the application site were evaluated for the trespasser. Maximum measured soil concentrations from 1996-2000 were used.

The assumptions and calculations used to estimate chemical and radiological intakes for the receptors are shown in ***Tables G.9.*** and ***G.10.*** Exposure time, frequency, and duration determine the total time that a receptor is exposed to the contaminant source. Exposure time is the number of hours per day that a receptor is present at a specific exposure point. Exposure frequency is the number of days per year that the exposure occurs, and exposure duration is the total number of years over which exposure occurs.

Based on current activity patterns, an employee is expected to be exposed to sludge through pumping, loading, or application activities for no more than 4 hours of each work day. An employee is assumed to work with sludge 250 days/year for 25 years (EPA 1989b). Because the application areas on the ORR have restricted access, trespassers were conservatively assumed to have exposure once a month for 1 hour each time over a 10-year period. Rates for incidental soil ingestion and inhalation are conservative based on maximal levels recommended in EPA guidance (EPA 1991a).

The radiological dose for both the employee exposed to maximal and average concentrations of radionuclides in sludge is 0.143 mrem/year and 0.067 mrem/year, respectively, (see ***Table G.11.***) well below a 10 mrem/year threshold, or an order of magnitude reduction of the primary public dose limit of 100 mrem/year from all sources of radiation as described in DOE Order 5400.5, Chap. II.

Table G.8. Exposure point concentrations in soil and air

Constituent	Maximum soil concentration	Maximum air concentration
Radionuclides	**pCi/g**	**pCi/m^3**
Cobalt-60	0.64	3.2E-5
Cesium-137	0.71	3.6E-5
Potassium-40	ND	ND
Radium-228	ND	ND
Uranium-235	0.89	4.5E-05
Uranium-238	2.04	1.0E-04
Metals	**mg/kg**	**mg/m^3**
Arsenic	12.8	6.40E-07
Cadmium	19.4	9.70E-07
Chromium	180	9.00E-06
Copper	700	3.50E-05
Lead	74.6	3.73E-06
Mercury	23	1.15E-06
Molybdenum	54	2.70E-06
Nickel	100	5.00E-06
Selenium	18.2	9.10E-07
Zinc	1910	9.55E-05

Table G.9. Incidental sludge ingestion

Parameter (unit)	Value: Employee	Value: Transient	Reference
Sludge ingestion rate (mg/day)	50	50	EPA 1991a
Fraction ingested from contaminated source (unitless)	0.5	1.0	Conservative judgment
Exposure frequency (day/year)	250		EPA 1989b, based on days employee works on site per year
		12	Conservative judgment
Exposure duration (years)	25		EPA 1989b, based on 90th percentile for employees
		10	Conservative judgment
Body weight (kg)	70	70	EPA 1989b, EPA 1991a, combined mean of male and female body weights
Carcinogen averaging time (days)	25,550	25,550	EPA 1990, equivalent to 70-year lifetime exposure at 365 days/year
Noncarcinogen averaging time (days)	9,125	3,650	EPA 1991a, exposure duration × 365 days/year

Equation for ingestion of chemicals in soil and sludge (EPA 1989a):

$$Intake\ (mg/kg\text{-}d) = \frac{C_s \times IR_s \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:
- C_s = chemical soil concentration in soil (mg/kg),
- IR_s = soil ingestion rate (mg soil/day),
- CF = conversion factor (10^{-6} kg/mg),
- FI = fraction ingested from contaminated source (unitless),
- EF = exposure frequency (days/year),
- ED = exposure duration (year),
- BW = body weight (kg), and
- AT = averaging time (day).

Equation for ingestion of radionuclides in soil and sludge (Gilbert et al. 1989):

$$D_i = C_{soil,i} \times IR_s \times FI \times EF \times ED \times CF_m$$

where:
- D_i = intake from radionuclide i (pCi),
- $C_{soil,i}$ = soil concentration of radionuclide i (pCi/g),
- IR_s = soil ingestion rate (mg/day),
- FI = fraction ingested from the contaminated source (unitless),
- EF = exposure frequency (days/year),
- ED = exposure duration (year), and
- CF_m = conversion factor, 10^{-3} g/mg.

Table G.10. Inhalation of particulates

Parameters (unit)	Value		Reference
	Employee	Transient	
Inhalation rate of airborne particles (m^3/hour)	20	20	EPA 1991a; Inhalation rates based on combination of rates for light, moderate, and heavy activity for an 8-hour workday
Exposure time outdoors (hours/day)	4	1	Site-specific observation (based on current activity for employee). Professional judgment for transient.
Exposure frequency (days/year)	250	12	EPA 1989b, number of days employee works on site per year
Exposure duration (years)	25	10	EPA 1990, based on 90th percentile for employee; best judgment
Body weight (kg)	70	70	EPA 1989b
Carcinogen averaging time (days)	25,550	25,550	EPA 1990, equivalent to 70-year lifetime exposure at 365 days/year
Noncarcinogen averaging time (days)	9,125	3,650	EPA 1991a, exposure duration × 365 days/year

Equation for inhalation (chemicals) (EPA 1989a):

$$Intake\ (mg/kg\text{-}d) = \frac{C_{air} \times IR \times ET \times EF \times ED}{BW \times AT}$$

where: C_{air} = contaminant concentration in air (mg/m^3), derived from chemical concentration in soils,
IR = inhalation rate (m^3/hour),
ET = exposure time (hours/day),
EF = exposure frequency (days/year),
ED = exposure duration (year),
BW = body weight (kg), and
AT = averaging time (days).

Equation for inhalation of particulates (radionuclides) (Gilbert et al. 1989):

$$D_i = C_{air,i} \times IR \times EF \times FT \times CF_t$$

where: D_i = intake from radionuclide i (pCi),

$C_{air,i}$ = air concentration of radionuclide i (pCi/m^3) (based on soil concentration),

EF = exposure frequency (days/year) (e.g., 4 hours/day × 250 days/year × days/24-hours = 41.7 days/year),

ED = exposure duration (year),

IR = inhalation rate (m^3/hour), and

CF_t = conversion factor (24 hours/day).

5. RISK CHARACTERIZATION

5.1 METHODOLOGY

For the chemical assessment, risk is defined as the lifetime probability of cancer incidence for carcinogens and the estimate of exceeding toxic effect thresholds for noncarcinogens. For the radiological assessment, risk is defined as the lifetime probability of cancer morbidity and does not include genetic or noncarcinogenic effects.

EPA does not use a probabilistic approach to estimate the potential for noncarcinogenic health effects (EPA 1989b). The potential for noncarcinogenic adverse health effects is evaluated as the ratio of the daily intake for the exposure period over the RfD. This ratio is the hazard quotient (HQ). The RfD is a provisional estimate of the daily exposure to the human population, including sensitive subgroups (with uncertainty spanning perhaps an order of magnitude). The RfD is a reference dose below which appreciable risk of negative health effects during a lifetime for chronic exposure would not be expected to occur (EPA 1989b). Although EPA has derived RfDs for both chronic and subchronic exposure, only chronic exposure of over 7 years is considered in this health assessment.

The noncancer HQ assumes that there is a level of exposure (the RfD) below which it is unlikely for even sensitive populations to experience adverse noncarcinogenic health effects (EPA 1989b). The HQs for each chemical addressed in the intake and exposure pathway are summed to obtain the hazard index (HI), which allows assessment of the overall potential for noncarcinogenic health effects. An HI greater than one (HI>1) has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989b).

Cancer risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of pathway-specific exposure to carcinogenic contaminants. Results of the cancer risk estimates can be compared with the acceptable risk range of 10^{-6} to 10^{-4} (or 1 in 1,000,000 to 1 in 10,000) that is the goal of EPA outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The risk to an individual resulting from exposure to chemical or radiological carcinogens is expressed as the increased probability of a cancer occurring over the course of a lifetime. The increased cancer risk is calculated by estimating the daily intake of a chemical carcinogen averaged over a lifetime multiplied by a contaminant-specific CSF. Oral and inhalation pathway-specific CSFs have been derived for certain carcinogens; some carcinogens do not have a CSF available or are presently under review by EPA. All CSFs used in the chemical risk estimate calculations were obtained from EPA's IRIS (EPA 1994a) or HEAST (EPA 1994b). RESRAD (v.5.61) was used to calculate radiological risks (Yu et al. 1993); chemical risks were calculated following EPA guidance (EPA 1989b).

The CSF converts estimated daily intakes averaged over a lifetime of exposure directly to the incremental risk of an individual developing cancer (EPA 1989b). The carcinogenic risk estimate is generally an upper-bound estimate because the CSF is typically derived as the upper 95% confidence level of the probability of response based on experimental animal data (EPA 1989b). Thus, EPA is reasonably confident that the "true risk" will not exceed the risk estimate derived through use of the CSF and is likely to be less than that predicted using CSFs (EPA 1989b).

5.2 RISK AND HAZARD INDEX ESTIMATES

Table G.11. summarizes the carcinogenic risk from radionuclides in sludge and soil to the worker and trespasser. The risk to workers is estimated to be 4×10^{-7} and 2×10^{-7} for the maximum and mean sludge concentrations, respectively, which are below the EPA target range of 10^{-4} to 10^{-6}. The risk to transients from exposure to soil is estimated to be 1×10^{-7}, which is also below the EPA target range.

Table G.11. Summary of radiological exposure

Employee				**Transient**	
Dose (mrem/year)		**Cancer risk**		**Dose (mrem/year)**	**Cancer risk**
Mean	Maximum	Mean	Maximum		
0.0669	0.143	2E-7	4E-7	0.016	1E-7

Carcinogenic health effects from exposure to heavy metals are summarized in ***Table G.12.*** The estimated cancer risks for both the employee exposed to maximum concentrations in sludge and trespasser receptors exposed to soil are 6.33×10^{-6} and 1.67×10^{-7}, respectively, which are within the EPA target range.

Hazard quotients from exposure to heavy metals for both employees and transients are summarized in ***Table G.12.*** The HQ for both ingestion and particulate inhalation pathways is less than the threshold of one for both receptors. Exposure to noncarcinogenic contaminants in the sludge and soil is not likely to result in adverse health effects under the employee or trespasser scenarios.

Particulate inhalation and ingestion both contribute to the risk for both chemicals and radionuclides. Risks to employees could be reduced further by procedural controls during spraying of sludge (e.g., closing the truck window, wearing a mask). The major contributing pathway to risks to trespassers on the sludge application sites is external irradiation from exposure to cobalt-60 mixed into the soil. The likelihood of a trespasser on these sites is very low, so the risks in this analysis may be overstated. Additionally, because cobalt-60 has a relatively short half-life, the potential risks would decrease over time after application ceases.

Table G.12. Chemical Risk and Hazards

	Employee				Transient			
	HQ		Cancer risk		HQ		Cancer risk	
Pathway	CrIII	CrVI	CrIII	CrVI	CrIII	CrVI	CrIII	CrVI
Ingestion	1.73e-02	2.67e-02	3.67e-06	3.67e-06	2.07e-04	2.57e-04	8.45e-08	8.45e-08
Inhalation	5.14e-04	4.15e-01	2.12e-06	2.67e-06	4.55e-06	5.52e-03	6.29e-09	8.21e-08
Total	1.78e-02	4.42e-01	5.79e-06	6.33e-06	2.07e-04	5.79e-03	9.08e-08	1.67e-07

The model parameter with the most significant impact on risk values and potential health effects is the valence state of chromium. The valence state is not known, therefore, the carcinogenic risks and health effects are estimated for both valence states.

6. UNCERTAINTY ANALYSIS

The risks calculated in this assessment are single point estimates of risk rather than probabilistic estimates. Therefore, it is important to discuss uncertainties inherent in the risk assessment in order to place the risk estimates in proper perspective. Uncertainties can be associated with sampling data adequacy, selection of potential COCs, exposure assessment variables, and toxicity values.

The sludge is composited and analyzed at regular time intervals for the various chemical parameters. Changes in customer activities (e.g., an increase or decrease in nuclear medicine studies) can affect the character of the sludge. These changes in sludge composition could increase the uncertainty that a sample is representative of an “average” sludge. However, since the sampling is conducted frequently (daily scanning when sludge is being applied on the ORR, weekly sampling for radionuclides, monthly for heavy metals, semi-annually for organics) and the levels of detected analytes are relatively constant among samples, the uncertainty in sampling data adequacy is low.

Uncertainty is inherent in the selection of potential COCs for analysis and is associated with a number of factors. The identification of potential COCs for a human health evaluation relies on both data from the monitoring program and the application of a selection process. Considerable data on the sludge composition have been collected over the years under the city of Oak Ridge's monitoring program. The monitoring program is based on federal and state requirements for chemical components and on knowledge of its industrial customers for radiological components. The monitoring program is comprehensive, hence the uncertainty associated with the identification of potential COCs for analysis is low.

The variables used for the exposure assessment were extremely conservative and could lead to an overestimation of risk. Maximal and average values were used for the exposure point concentrations. The exposure intake assumptions were generally the EPA default values. Employee receptors were assumed to be directly underneath the spray of sludge during application, breathing at a rate indicative of heavy activity. Workers are typically in the vehicle and are taking precautions to avoid exposure. The conservative nature of the assessment results in an overestimation of potential risk.

Standard risk estimate factors were used to estimate the hazards associated with exposure to the potential COCs. There were several identifiable potential COCs for which there were no toxicity factors or slope factors, precluding their inclusion in quantitative risk estimates. Additionally, radiological contaminants with half-lives <2 months (beryllium-7 and iodine-131) were not selected for consideration in this assessment. The resulting risk estimates do not include the incremental chemical-specific risks from these potential COCs and, therefore, may underestimate risk, although the magnitude of this underestimation is not quantifiable.

Some of the procedures used and uncertainties inherent in the human health risk assessment process may tend to underestimate potential risk. However, assumptions built into this assessment tend to overestimate rather than underestimate potential risks, including conservative assumptions for exposure point concentrations and exposure scenarios.

7. SUMMARY AND CONCLUSIONS

The radiological dose (***Table G.11.***) that an employee might receive from exposure to sludge is very low and consistent with health physics monitoring of current POTW employees involved in sludge handling and application procedures. Monitoring of employees has shown no detectable exposure to radionuclides (Mobley 1993), and there is anecdotal information that the sludge workers are in good health.

Combined chemical and radiological risks to employees exposed to sludge during the land application process are minimal and are within the EPA target range for excess lifetime cancer risk. These estimates of risk to human health should not be taken to represent absolute risk; rather, they represent the most important sources of potential relative risk from handling sludge.

Noncarcinogenic risks were estimated to be <1, for both the worker and the trespasser, indicating that no adverse effects would be expected from exposure to sludge or sludge-amended soils.

Potential carcinogenic risk to receptors infrequently contacting soils to which sludges have been applied was within the EPA target risk range. The land application areas on the ORR currently have limited access, and it is assumed that sludges will be applied to meet statutory and/or risk-based limits. Future changes in land use or access restrictions would not result in significant risks to future receptors, assuming sludge application limits were followed.

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APPENDIX H

NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM HUMAN HEALTH RISK ASSESSMENT

Introduction

This Appendix presents a human health risk assessment in support of Proposed Action to direct Y-12 West End Treatment Facility (WETF) treated effluent to the Oak Ridge City sewer system. This alternative is discussed in Section 2.2.1 of the Environmental Assessment. Currently, the Y-12 WETF liquid wastes are treated in a Five-step process to

1 Remove heavy metals and radionuclides,
2 Remove nitrates,
3 Remove organic compounds, and
4 Remove solid particulates
5 Make final adjustments to the liquid at Effluent Polishing System (EPS).

After the Five step process is completed effluents are sampled and released into Upper East Fork Poplar Creek (UEFPC) through a permitted National Pollution Discharge Elimination System (NPDES) outfall. Due to improvements in the WETF system (i.e., addition of step 1), the need for EPS has been significantly reduced. The proposed action described in section 2.1.1 therefore, includes releasing treated WETF effluent into the Y-12 and City of Oak Ridge sewer systems after the Four step treatment process. Treated waters will be analyzed for 165 Priority Pollutants (40 CFR 136) to verify compositions meet proposed sewer release limits (See Environmental Assessment ***Appendix B, Table B.12***). Those batches not meeting sewer release limits or found to be otherwise unsuitable for release to the sewer will be sent to the EPS for further treatment and released to the NPDES outfall at UEFPC.

The purpose of this Appendix is to model the human health risk impact of changing the ultimate disposition of WETF effluents. Currently, treated effluent is released at the NPDES outfall into UEFPC. Under the proposed action, WETF treated effluent will be released to the Y-12 Sewer System, undergo further treatment with other municipal sewage and be released at the City's NPDES outfall at Lower East Fork Poplar Creek (LEFPC). This assessment conservatively models the relative risk to human health by 1) releasing treated WETF effluents at the NPDES outfall at UEFPC and 2) releasing the WETF effluents to the Oak Ridge city sewer system and releasing the treated effluents at the city's permitted outfall.

The risk assessment evaluates a hypothetical child exposed to creek water of UEFPC and LEFPC through wading. The approach and methodology used in this human health risk assessment are consistent with the guidance developed by the National Research Council (NRC). The NRC, established by the National Academy of Sciences to further scientific knowledge and to advise the federal government, developed the four-step paradigm for conducting health-based risk assessments (NRC 1983). This paradigm has been adopted by EPA as well as many other federal and state agencies. In accordance with the NRC recommendations, this risk assessment is organized into the following four steps: 1) Identification of Constituents of Concern (COCs), 2) Toxicity Assessment, 3) Exposure Assessment and 4) Risk Characterization

Identification of COCs

The COCs modeled in this study are listed in ***Table H.1.*** These comprise the metals, organic compounds, inorganic compounds, and radionuclides specified in the WETF NPDES permit and in the proposed list of constituents to be released from WETF into the city sewer system.

Table H.1. Concentrations of constituents used in risk assessment

Constituents	WETF NPDES Outfall Concentration Limits to UEFPC (mg/liter)	Maximum Detected Concentration at WETF Outfall to UEFPC (mg/liter)	Predicted Concentration at City of Oak Ridge NPDES Outfall (mg/liter)
METALS			
Arsenic	0.052	0.026	0.00002
Cadmium	0.15	0.2	0.00001
Chromium	1.0	0.03	0.00008
Copper	1.0	0.03	0.00022
Lead	0.20	0.8	0.00008
Mercury	0.20	0.1	0.00004
Nickel	3.98	2.85	0.00016
Silver	0.50	0.03	0.00008
Zinc	2.0	0.6	0.00056
ORGANIC COMPOUNDS			
Benzene	0.01	0.01	0.00002
Methylene Chloride	0.01	0.01	0.00004
Phenols	0.01	0.01	0.00048
Toluene	0.01	0.01	0.00002
TCE	0.01	0.01	0.00003
INORGANIC COMPOUNDS			
Cyanide	1.2	0.03	0.00007
RADIONUCLIDES			
Total Uranium	0.096	0.048	0.0035

Toxicity Assessment

The toxicity assessment identifies the relationship between the magnitude of exposure or dose and the potential for occurrence of specific health effects or responses for each COC. Both carcinogenic and noncarcinogenic effects are considered. Dose response values for chemicals are derived from the Integrated Risk Information System (IRIS). IRIS is an EPA maintained web-based electronic data base, containing the most recently updated information on human health effects resulting from exposure to various chemicals. Dose response values for uranium are taken from *Health Risks From Low-level Environmental Exposure to Radionuclides, Federal Guidance Report No. 13 Part I – Interim Version* (EPA 1998).

Non carcinogenic effects are evaluated using the EPA accepted Reference Dose (RfD) for ingestion and inhalation of specific chemicals. EPA has develop both chronic and subchronic RfDs. A chronic RfD is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound. Chronic RfDs are used to evaluate the potential non carcinogenic effects associated with exposure periods between 7 years (approximately 10 percent of a human lifetime) and a lifetime. As noted in the next section this assessment assumes an exposure duration of 9 years and, therefore, utilizes chronic RfDs.

Table H.2. summarizes the dose-response information for the COCs with potential non carcinogenic effects for the oral and inhalation routes of exposure reported in the IRIS data base. For each chemical, the dose-response value, and the reference for the dose-response value is presented. In addition, the target organ and critical effect upon which the dose-response value is based are also presented for each chemical.

The underlying assumption of a risk assessment for constituents with known or assumed potential carcinogenic effects is that no threshold dose exists; consequently, there is an underlying assumption that a finite level of risk is associated with any dose greater than zero. The EPA methodology is to extrapolate dose-response relationships observed at the relatively high doses used in animal studies to the low dose levels encountered by humans in environmental situations.

The mathematical models assume no threshold and use both animal and human data to develop a potency estimate for a given compound. The potency estimate, called a cancer slope factor (CSF), is expressed in units of $(mg/kg\text{-}day)^{-1}$ for chemical carcinogens. ***Table H.3.*** summarizes the oral and inhalation dose-response information reported in IRIS for potentially carcinogenic COCs identified for this assessment.

The EPA considers all radioactive elements to be cause both cancer and genetic mutation. The risk, however, of serious genetic effects is much lower than the risk of cancer (EPA 1989); therefore, this assessment considers the carcinogenic effects of radioactive constituents only. EPA developed slope factors for radionuclides are expressed as $(pCi)^{-1}$ for the ingestion and inhalation routes and in various forms for external exposure to ionizing radiation, including m^3/pCi-second for immersion, m^2/pCi-second for ground plan exposure, and kg/pCi-second for exposure to soils of a given activity of radioactive constituent.

Table H.2. Dose-response data for COCs with potential noncarcinogenic effects

Compound	CAS[a]	Inhalation RfD (mg/kg-day)	Oral RfD (mg/kg-day)	Target organ system
METALS				
Arsenic	7440382	NA[b]	3.0E-4[c]	Liver, Kidney, Skin
Cadmium	7440439	NA	5.0E-4	Resp. System, Kidneys, Prostate, blood
Chromium-VI	7440473	2.29 E-6	5.0E-3	Skin
Chromium-III	7440473	NA	1.5E+0	Skin
Copper	7440508	NA	NA	Gastrointestinal
Lead	7439921	NA	NA	CNS[d]; blood
Mercury	7439976	8.57 E-5	NA	Respiratory System, Kidneys, CNS,
Nickel	7440020	NA	2.0E-2	Lungs, CNS, Paranasal Sinus
Silver	7440224	NA	5.0E-3	Nasal Septum, Skin, Eyes
Zinc	7440666	NA	3.0E-1	Blood; anemia
ORGANIC COMPOUNDS				
Benzene	71432	NA	NA	Blood, CNS, Skin, Bone, Marrow
Methylene Chloride	75092	NA	6.0E-2	Skin, CVS[e], CNS
Phenol	108952	NA	6.0E-01	Liver, Kidney and Skin
Toluene	108883	1.14 E-01	2.0E-01	CNS, Liver, Kidneys
Trichloroethylene	79005	NA	NA	Respiratory System, heart, liver, CNS
INORGANIC COMPOUNDS				
Cyanide	57125	NA	2.0E-2	Liver, CVS, CNS, Kidneys, Skin

[a] Chemical Abstracts Service Registry Number.

[b] NA = Not available; inhalation RfD is not listed in EPA IRIS database 2/01.

[c] RfDs are from EPA IRIS database 2/01

[d] CNS = Central Nervous System.

[e]CVS = Cardiovascular System

Table H.3. Dose-response data for COCs with potential carcinogenic effects

Compound	CAS[a]	Weight of evidence[b]	Oral slope factor $(mg/kg\text{-}day)^{-1}$	Inhalation slope factor $(mg/kg\text{-}day)^{-1}$
METALS				
Arsenic	7440382	A	1.5E+0	1.51E+1
Cadmium	7440439	B1	NA[c]	6.3E+0
Chromium-VI	7440473	A	NA	4.2E+1
Copper	7440508	D	NA	NA
Lead	7439921	B2	NA	NA
Mercury	7439976	D	NA	NA
Nickel	7440020	A	NA	NA
Silver	7440224	D	NA	NA
Zinc	7440666	D	NA	NA
ORGANIC COMPOUNDS				NA
Benzene	71432	A	5.5E-2	NA
Methylene Chloride	75092	B2	7.5E-3	NA
Phenol	108952	D	NA	NA
Toluene	108883	D	NA	NA
Trichloroethylene	79005	NA	NA	NA
INORGANIC COMPOUNDS				
Cyanide	57125	D	NA	NA

[a]Chemical Abstracts Service Registry Number.

[b]Weight of Evidence Classifications:

A=Human carcinogen (sufficient evidence of carcinogenicity in humans)

B1=Probable human carcinogen (limited evidence of carcinogenicity in humans)

B2=Probable human carcinogen (sufficient evidence of carcinogenicity in animals, with inadequate or lack of evidence of carcinogenicity in humans)

C=Possible human carcinogen (limited evidence of carcinogenicity in animals, and inadequate or lack of evidence of human data)

D=Not classifiable as to human carcinogenicity

[c]NA = Not available

Table H.4. Dose-response data for Uranium carcinogenic effects

Compound	Weight of evidence	Oral Slope Factor $(pCi)^{-1}$	External Exposure Slope Factor $L(pCi\text{-}yr)^{-1}$
Uranium-235-D	A	4.7E-11	4.1E-16
Uranium-238-D	A	6.2E-11	8.3E-19

Exposure Assessment

Exposure is defined as the contact of a human with a chemical or physical agent (EPA 1988a). The magnitude of exposure is determined by measuring or estimating the amount of an agent available at the exchange boundaries (i.e., the lungs, gut, skin) during a specified time period. The exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure.

The purpose of developing this exposure model is to assess the change in potential risk to human health associated with releasing WETF effluents at the City's discharge point on LEFPC as opposed to releasing them at the Y-12 discharge point on UEFPC.

The hypothetical receptor considered for exposure to the WETF effluents is a child wading in the UEFPC and LEFPC below the WETF and the City's respective NPDES discharge points. Because access to the Y-12 site is restricted it is unlikely that a child could be exposed to waters on the reservation; however, much of the creek is outside the reservation boundaries. The concentration of constituents in the creek at offsite locations will be rapidly and significantly diminished through dilution as they migrate downstream from the WETF discharge point. In this assessment, however, it is conservatively assumed that there is no dilution at offsite locations (i.e., we are assuming exposure at the release point at Y-12). Risk is therefore estimated for the a child exposed to water containing concentrations defined for the WETF NPDES outfall limits (***Table H.1.***).

Similarly, estimated risks to a hypothetical child wading in LEFPC are based on the modeled outfall concentrations at the discharge point with no dilution from stream water. It is conservatively assumed that all (100%) the mass (metals, uranium, etc.) from WETF sewer discharge point is released to the City's outfall after being joined by Y-12's other sewer inputs and the city of Oak Ridge's input.

The chemical intake model is documented in ***Table H.5.*** All assumptions are based on EPA recommended values or highly conservative assumptions (e.g., 3 hour wading events, 36 event/year, 9 years of exposure). The dominant exposure routes are assumed to be 1) incidental ingestion of water containing metal, organic compounds, inorganic compounds, and uranium, 2) inhalation of volatile organic compounds, and 3) exposure to ionizing radiation from uranium. It is assumed that this is no reasonable inhalation exposure route for metals, including uranium, in the wading scenario since all metals other than mercury have vanishingly small vapor pressures. The vapor pressure of mercury is also orders of magnitude less than that for benzene ($\sim 10^{-3}$ torr) and at the dilute concentrations considered in this model (1-0.03 mg/liter) its partial pressure will approach zero.

Table H.5. Intake Models for a trespassing child wading in Upper East Fork Poplar Creek

Parameter (unit)	Values	Reference
Contact rate (milliliters/hour)	50	EPA (1988) Superfund Exposure Assessment Handbook
Inhalation rate ($meter^3$/hour)	1.9	EPA (1997) Exposure Factors Handbook. Rate for children involved in "heavy" activity.
Exposure Time (hours/event)	3	Conservative judgement
Exposure Frequency (events/year)	36	Conservative judgement based on a wading event occurring 3 days/week over the a 12 week period. The national average for swimming is 7 days/year (EPA 1988)
Exposure Duration (years)	9	National median time at one residence (EPA 1989) Exposure Factors Handbook
Body Weight (kilograms)	24.6	EPA (1997) Exposure Factors Handbook. This is a conservative minimum weight. Assuming 9 years of exposure from age 7 to 16 the range in body weight is 24.6 kg for a girl age 7 to 66.8 kg for a male age 16
Noncarcinogen Averaging Time (days)	3285	Exposure duration in days
Carcinogen Averaging Time (days)	25550	EPA (1989) Risk Assessment Guidance for Superfund: Volume 1, Part A
Volatilization Factor (liters/ $meter^3$)	0.5	EPA (1991) Risk Assessment Guidance for Superfund: Volume I, Part B

Equations for ingestion and inhalation of chemicals in water, respectively are:

$$Intake\ (mg/kg\text{-}day) = \frac{CW \times CR \times ET \times EF \times ED}{BW \times AT} \qquad Intake\ (mg/kg\text{-}day) = \frac{CW \times K \times IR \times ET \times EF \times ED}{BW \times AT}$$

Equation for ingestion of uranium in water:

$$Intake\ (pCi) = AW \times CR \times ET \times EF \times ED \times CF$$

where:
- CW = chemical concentration in water (milligram/liter),
- AW = activity of uranium in water (pCi/liter),
- CR = contact rate (liters/hour),
- IR = inhalation rate (cubic meters/hour)
- K = volatilization factor (liters/cubic meter)
- ET = exposure time (hours/event),
- EF = exposure frequency (events/year),
- ED = exposure duration (year),
- BW = body weight (kilogram), and
- AT = averaging time (day).

Risk Characterization.

In the risk characterization step, the results of the exposure assessment are combined with the results of the toxicity assessment to derive pathway-specific quantitative estimates of potential health risks. The estimates for each exposure pathway are then summed to give total risk estimates. Separate quantitative estimates of potential risk are derived for potentially carcinogenic effects and for noncarcinogenic effects.

The potential health effects for non carcinogens is modeled by the Hazard Quotient (HQ). The HQ is ratio of the modeled intake of the COC to the RfD. Intakes that exceed the RfD, or an HQ greater than one indicates the potential for an adverse human health. The combined potential health effects of the COCs is estimated by the Hazard Index (HI), the simple sum of HQs for all COCs. An HI greater than one is defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989).

Cancer risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of pathway-specific exposure to carcinogenic COCs. Results of the cancer risk estimates can be compared with the acceptable risk range of 10^{-6} to 10^{-4} that is the goal of EPA outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300).

The risk to an individual resulting from exposure to chemical or radiological carcinogens is expressed as the increased probability of a cancer occurring over the course of a lifetime. The increased cancer risk is calculated by estimating the daily intake of a chemical carcinogen averaged over a lifetime multiplied by a contaminant-specific CSF. Oral and inhalation pathway-specific CSFs have been derived for certain carcinogens; some carcinogens do not have a CSF available or are presently under review by EPA. All CSFs used in the chemical risk estimate calculations were obtained from IRIS.

The CSF converts estimated daily intakes averaged over a lifetime of exposure directly to the incremental risk of an individual developing cancer (EPA 1989). The carcinogenic risk estimate is generally an upper-bound estimate because the CSF is typically derived as the upper 95% confidence level of the probability of response based on experimental animal data (EPA 1989). Thus, EPA is reasonably confident that the “true risk” will not exceed the risk estimate derived through use of the CSF and is likely to be less than that predicted using CSFs (EPA 1989).

Table H.6. summarizes the modeled health effects of a child wading in UPEFC at the WETF Outfall as compared to the same child wading at the city’s LEFPC outfall. The risk to the a child wading at either outfall is less the EPA target range of 10^{-4} to 10^{-6} for acceptable risks levels.

The estimated carcinogenic risk at the WETF outfall is 8.2 x 10^{-7}, if it is assumed the NPDES outfall releases at it's permitted limits and is 5.6 x 10^{-7} if the risk is modeled on the maximum concentration measured at the outfall. The risk estimated if the mass of COCs is released to the sewer system and all COCs are released through the city's NPDES outfall is 5.1 x 10^{-9}. The latter estimate assumes that all mass released into the sewer system is at the proposed WETF sewer discharge limits. This latter value is two orders of magnitude less than the value modeled for the WETF outfall.

The hazard index for exposure to COCs are summarized in ***Table H.6.*** The HI for both ingestion and inhalation pathways is less than the EPA threshold of one at both outfalls. The HI at the WETF outfall, assuming all releases are at the permit limit for all COCs, is between 0.71 to 0.51. This range is based on the valence state of chromium, the former value estimated assuming all is in the hexavalent state. The HI at the WETF outfall, calculated assuming all releases are at the maximum measured concentrations of all COCs, is 0.17. The valence state chromium has less of an impact at maximum measured outfall concentrations because its concentration is two orders of magnitude below the discharge limit. The HI calculated assuming all mass released at the WETF sewer discharge point is at the proposed sewer discharge limits and all mass is released at the LEFPC outfall is 0.0001. This value is four orders of magnitude below the EPA threshold of 1 and three orders of magnitude less that the HI modeled for the WETF outfall.

Table H.6. Modeled Health Effects

Health Effects	UEFPC Y-12 OUTFALL		LEFPC CITY OUTFALL
	NPDES-Limits	Maximum Release	Modeled on Sewer Release Limits
Hazard Index (All Cr-IV)	0.71	0.17	0.00014
Hazard Index (All Cr-III)	0.51	0.17	0.00012
Risk (Non Radiological)	7.4E-07	5.0E-07	7.9E-10
Risk (Uranium)	1.0E-07	5.0E-08	4.1E-09
Total Risk	8.4E-07	5.5E-07	4.9E-09

References

EPA 1988, Superfund Exposure Assessment Handbook, Office of Emergency and Remedial Response. EPA/540/1-88/001

EPA 1989, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*. EPA/540/1-89/002.

EPA 1990, *Exposure Factors Handbook*. Environmental Protection Agency, Office of Health and Environmental Assessment. EPA/600/8-89/043.

EPA 1991, *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors*, Office of Solid Waste and Emergency Response, OSWER Directive 9285.6-03, Washington, D.C., March 25.

EPA 1992, *Dermal Exposure Assessment: Principles and Applications*. EPA, Office of Research and Development. EPA 600/8-91/011A.

EPA 1994 *Integrated Risk Information System (IRIS)*, Health and Environmental Criteria and Assessment Office, Cincinnati, Ohio.

EPA 1995, *Health Effects Assessment Summary Tables, Table 4: Radionuclide Carcingenicity - Slope Factors*, Office of Emergency and Remedial Response, Washington D.C.

EPA 1997, Exposure Assessment Handbook, Office of Emergency and Remedial Response, Washington D.C.

APPENDIX I

ORR BIOSOLIDS LAND APPLICATION SITE
AIR DISPERSION MODEL

OFFSITE DOSE IMPACT FROM DISPERSION OF RADIONUCLIDES FROM LAND APPLICATION SITE

August 1, 2002

OFF-SITE RISK AND DOSE IMPACTS

The Department of Energy (DOE) carefully monitors the off-site consequences of operations at the Oak Ridge Reservation. The National Emissions Standards for Hazardous Substance regulations establish an off-site does limit of 10 mrem/year (10 CFR 62) for all emissions at DOE facilities; however, it is DOE policy (DOE Order 5400.5) to maintain radiological doses to the public As Low As Reasonably Achievable (ALARA). For example, the 1999 DOE Oak Ridge Reservation (ORR) Annual Site Environmental Report (ASER) indicates that the calculated radiation dose to maximally exposed off-site individuals from airborne releases to be 0.007 mrem, total effective dose equivalent (TEDE). The purpose of the following dose/risk model is to evaluate the maximum potential contribution the land-application of municipal sewage sludge has to the ORR's total dose impact to the public.

Air dispersion is the primary mechanism for off-site release of radioactive material contained in land applied sludge. To model the potential impact of land applied sludge, off-site risk and doses were estimate using an EPA (1991) recommended particulate emission factor (PEF). The PEF relates the contaminant concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from surface contamination sites. The PEF (***Exhibit I.1.***) provides a simple, but conservative estimate of the particulate flux between the soil and air. It does not take into account other factors such as dispersion, mixing, and particle precipitation that attenuate radionuclide concentrations as particles of soil are transported off site. The particulate emissions from contaminated sites are due to wind erosion and, therefore, depend on the erodibility of the surface material. The PEF models a surface with unlimited erosion potential, that is characterized by bare surfaces of finely divided material such as sandy agricultural soil with a large number ("unlimited reservoir") of erodible particles. Such surfaces erode at low wind speeds, and particulate emission rates are relatively time-independent at a given wind speed. Exhibit 1 presents the PEF equation, default values necessary to calculate the flux rate for an "unlimited reservoir" surface (i.e., G, U_m , U_t , and F(x)) are EPA (1991), and the remaining input values appropriate to the site. The average wind speed of 6.9 m/s is the 1999 National Weather Service estimate. Area of contamination is considered to be one acre, a reasonable size application area. Most of the sites are densely vegetated, particularly in summer months; however, it is conservatively assumed that half the site is exposed soil.

Table I.1. Dose and Risk Estimates for Inhalation Exposure Route

Radio-Nuclide	Activity (pCi/g)	Activity Air (pCi/m^3)	Intake pCi	h_i (mrem/pCi)	Dose (mrem)	Risk
^{60}Co	0.214	1.18E-07	8.08E-04	1.92E-05	1.55E-08	5.67E-14
^{137}Cs	0.083	4.57E-08	3.20E-04	3.19E-06	1.05E-09	6.11E-15
^{235}U	0.016	8.81E-09	6.16E-05	1.23E-02	7.56E-07	8.01E-13
^{238}U	1.861	1.02E-06	7.17E-03	1.18E-02	8.48E-05	8.89E-11

The annual dose to an off-site receptor was estimated using maximum predicted activities for ^{60}Co, ^{137}Cs, ^{235}U, and ^{238}U that are reported for the Rogers Site (the most heavily loaded site) in ***Appendix E*** of the *Environmental Assessment for Proposed Changes to Sanitary Biosolids Land Application Program on the Oak Ridge Reservation* (DOE 2003). The main exposure routes used to estimate an annual dose include inhalation and external exposure.

EXHIBIT I.1.: PARTICULATE EMISSION FACTOR

$$PEF\ (m^3/kg) = \frac{LS \times V \times DH \times 3600\ s/hr \times 1000\ g/kg}{A \times 0.036\ (1-G)\ (U_m/U_t)^3 \times F(x)}$$

Parameter	**Definition and units**	**Values**
LS	width of contaminated area (m)	63.6
V	wind speed in mixing zone (m/s)	2.25
DH	diffusion height (m)	2
A	area of contamination (m^2)	4046.8
0.036	respirable fraction (g/m^2-hr)	0.036
G	fraction of vegetative cover (unitless)	0
U_m	mean annual wind speed (m/s)	6.9
U_1	equivalent threshold value of wind speed at 10 m	12.8
F(x)	function dependent on U_m/U_1 (unitless) (EPA 1991)	0.0497

The dose and risk to off-site receptors was modeled according to the parameters listed in ***Exhibit I.2.*** and the soil activities listed in ***Table I.1***. Intake (pCi) estimates included a correction for radioactive decay over the period of a year. The dose coefficient (h_i) for inhalation were taken from EPA (1988) and include the effects of daughter products generated once the parent radionuclide is inhaled. Risk values were estimated for comparison using the slope factors reported in (EPA 1995). Risk values are several orders of magnitude below the recommended EPA 10^{-6}-10^{-4} acceptable levels for life time exposure. (Note that since these values are for one year of exposure, life time risk can be estimated by multiplying these values by 70 years, still leaving risks less than 10^{-8}.)

For external exposure through immersion in air, it was assumed that the daughters were all in secular equilibrium and no attempt was made to estimate the effects of differential weathering, environmental mobility, or air dispersion properties of these various isotopes. The dose estimates for external exposure based on the air emersion dose coefficients from EPA (1993) were negligible even for the gamma emitters ^{60}Co and ^{137}m-Ba, 1.99 x 10^{-10} and 1.84 x 10^{-11} mrem, respectively (***Table I.2.***). (Only a few of the daughter isotopes are shown since the dose from the ^{235}U and ^{238}U decay chains, predominantly alpha emitters, with the exception of the small fractions of ^{234}Pa produced, result in doses three order of magnitude below the major gamma emitters ^{60}Co and ^{137}m-Ba. Because external dose is so small, the total estimated dose to the off-site receptor is essentially the sum of the doses listed ***Table I.1.*** for inhalation: 8.6 x 10^{-5} mrem/year. This is an insignificant contribution to the 7 x 10^{-3} mrem off site dose impact reported in the 1999 DOE ORR ASER for all stack emissions of radionuclides. It emphasized, however, the dose estimated here is based on extremely conservative assumptions including: no dispersion, mixing or precipitation of contaminates between the application site and off site receptor and an infinitely erodible surface that is only 50% vegetated. The dose impact from these sites should be much lower that modeled here and the values reported in ***Table I.1.*** should be considered bounding conditions only.

Exhibit I.2. Dose Intake and External Exposure Models

COMMITTED DOSE FROM INHALATION

$$Dose\ (mrem) = h_i\ x\ IR\ x\ \frac{A_0}{PEF}\ x\ \frac{(1-e^{-kT})}{k}$$

DOSE

FROM EXTERNAL EXPOSURE (AIR IMMERSION)

Parent Isotope dose Parent Isotope dose at T

$$Dose\ (mrem) = h_e\ x\ \frac{A_0}{PEF}\ x\ \frac{(1-e^{-kT})}{k}$$

Daught

er Isotope dose after time T

See Bateman equations (EPA 1993)

Parameter	Definition and Units
h_i	committed dose equivalent per unit intake (mrem/pCi) (EPA 1988)
h_e	air immersion dose coefficient (mrem-m^3/pCi-s) (EPA 1993)
IR	inhalation rate of 20 m^3/day
A_0	activity in soil at t=0
T	days of exposure: 365
k	decay constant in days: 0.693/$t_{½}$(days)

Table I.2. External exposure

Isotopes *	Activity-Soil(t=0) pCi/g soil	Time Integrate Exposure pCi-yr/m^3	h_e mrem-m^3/pCi-s	mrem
Co-60	0.214	1.18E-07	5.36E-11	1.99E-10
Cs-137	0.083	4.57E-08	3.19E-12	4.59E-12
Ba-137	-	4.25E-08	1.38E-11	1.84E-11
U-235	0.016	8.81E-09	2.66E-12	7.39E-13
Th-231	-	8.81E-09	1.93E-13	5.36E-14
Pa-231	-	3.73E-13	1.93E-13	2.27E-18
U-238	1.861	1.02E-06	1.07E-14	3.47E-13
Th-234	-	1.02E-06	1.25E-13	4.03E-12
Pa-234m	-	1.02E-06	2.66E-13	8.57E-12

*Only Co-60, Cs-137, U-235 and U-238 are routinely sampled and analyzed in application site soils

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EPA 1988, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors
For Inhalation, Submersion, And Ingestion: Federal Guidance Report No. 11.

EPA 1991, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development for Risk-Based Preliminary Remediation Goals).

EPA 1993, External Exposure to Radionuclides in Air, Water, And Soil: Federal Guidance Report No. 1

EPA 1995, Health Effects Summary Table, Table 4, Radionuclide Carcinogencity - Slope Factors

APPENDIX J

BIOLOGICAL ASSESSMENT FOR THE ORR BIOSOLIDS LAND APPLICATION SITES

Endangered Species Act

BIOLOGICAL ASSESSMENT

City of Oak Ridge
Sanitary Biosolids Land Application on the
Oak Ridge Reservation
Anderson and Roane Counties, Tennessee

Prepared by
Joseph W. Birchfield III, REM, LARO

June 2002

U. S. Department of Energy
Oak Ridge Operations Office
Oak Ridge, TN

July 2002

BIOLOGICAL ASSESSMENT FOR THREATENED AND ENDANGERED SPECIES UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE CITY OF OAK RIDGE SANITARY BIOSOLIDS LAND APPLICATION SITES ON THE OAK RIDGE RESERVATION

SUMMARY

This biological assessment (BA) assesses potential impacts on federally listed plant and animal species that could result from the increase in lifetime application site soil radionuclide limits from a cumulative dose of 4 to 10 mrem/yr by the Department of Energy (DOE) on TDEC-approved, EPA-permitted sites on the Oak Ridge Reservation (ORR). The species considered in this BA are those listed in the letter from the U.S. Fish and Wildlife Service to the U.S. Department of Energy, dated May 10, 2001 (FWS 2001a) and included in Section 8.0 of the Draft Environmental Assessment for the proposed project (DOE 2001). These listed species are the endangered gray and Indiana bats.

DOE staff concludes, for the reasons described in the main text of this BA, that the project is not likely to adversely affect either species. Also, since no proposed or designated critical habitats are present on the site, none would be affected. This BA is intended to finalize concurrence.

INTRODUCTION AND PROJECT DESCRIPTION

The City of Oak Ridge, Tennessee, owns and operates a publicly owned treatment works (POTW) that receives wastewater from a variety of industrial, commercial, and residential generators in the Anderson/Roane County area. One of the chief contributors, with approximately 20% of the POTW's total influent (DOE/EA-1042 1996), is the U.S. Department of Energy (DOE) Y-12 Plant. All industrial generators are required by Oak Ridge City Ordinance Number 9-91 to obtain an industrial discharge permit (IDP) from the City, which prescribes discharge limits and monitoring/reporting requirements.

Under a land-lease agreement (DOE 2001) with DOE, the City of Oak Ridge has been applying municipal biosolids as a beneficial soil amendment on the ORR since 1983 (DOE/EA-1042 1996). To date, no spills or traffic accidents have occurred since the program began. The City of Oak Ridge Biosolids Land Application Program has been recognized for excellence in beneficial re-use and program management by the Tennessee/Kentucky Water Environment Association (WEA) in 1997 and EPA, Region IV in 1999.

In October 1996 the ORR Biosolids Land Application Program underwent an Environmental Assessment (EA) (DOE/EA-1042 1996) that evaluated total site capacity, the addition of ORNL and ETTP sanitary wastewater treatment plant biosolids and the establishment of application site soil and biosolids radionuclide limits based upon a 4 mrem/yr cumulative dose modeling scenario. Upon completion of the EA, a Finding of No Significant Impact (FONSI) was issued in November 1996.

Municipal biosolids are not considered a Resource Conservation and Recovery Act (RCRA) waste but are regulated under the provisions of 40 *Code of Federal Regulations* (CFR) Part 503 of the Clean Water Act (CWA). EPA establishes standards for biosolids use and disposal, including risk-based, metal-loading criteria for the receiving soil, as specified in 40 CFR Part 503. Non-radiological program requirements are imposed by the State of Tennessee via the city's NPDES permit, State Land Application Approval, EPA permit #TNL024155 and EPA regulations listed in 40 CFR Part 503 (EPA 1993).

Although Oak Ridge biosolids contains trace amounts of heavy metals and radionuclides, as do most municipal biosolids, levels are well within prescribed limits as mandated by the Tennessee Department of Environment and Conservation (TDEC), EPA and DOE. For example, the most heavily loaded site, the Rogers Site in operation since 1988, has achieved only 6.5% of the prescribed EPA lifetime loading limit for mercury.

Biosolids recycling and land application, which are the terms EPA uses for biosolids applied to land for its beneficial properties (58 *FR* 9321 Standards for the Use or Disposal of Biosolids; Final Rule 1993), consists of distributing liquid, solid, or composted biosolids on or just below the soil surface where it is employed as a fertilizer or soil conditioner. For example, beneficial uses may include improving tree growth for hardwood reforestation, increasing organic matter and enhancing soil tilth for hay production or growth of native species, or helping to restore disturbed areas by providing nutrients for new seedlings.

In the past, the City produced a Class B, liquid biosolids product which contained some residual pathogenic organisms that were destroyed by exposure to UV rays and the environment upon application at the ORR sites. The City of Oak Ridge is in the process of implementing a new de-watering and thermal treatment system that will increase the solids content and sterilize the biosolids hauled and dispersed at the ORR land application sites, resulting in a more manageable, safer Class A (i.e., no pathogens) material. This material will be applied using manure spreading equipment in a calibrated dispersion pattern during daylight hours.

There are six active land application sites totaling 133 ha (329 acres) on the ORR (***Table 1.1***).

Table 1.1. Oak Ridge Reservation Biosolids Land Application Sites

Site #	Site Name	Status	Acres (Ac)	Hectares (ha)
1	Upper Hayfield #1	Active	30	12.15
2	Upper Hayfield #2	Active	27	10.93
3	High Pasture	Active	46	18.62
4	Rogers	Active	32	12.96
5	Watson Road	Active	117	47.37
6	Scarboro Road	Active	77	31.17

Because there are currently no applicable federal biosolids radioactivity standards, the state, the City of Oak Ridge and DOE established conservative biosolids land application site soil limits for 23 specific radionuclides based upon a 4 mrem/yr, 365-day per year homesteader (i.e. living on site) utilizing 9 pathways of exposure for a human in the previously approved EA. Residual Radioactivity (RESRAD) modeling of the previously-approved EA summarizes the methodology for establishing dose-based radionuclide limits for the land application program. In addition, the City of Oak Ridge operates an on-site gamma spectrometer system that analyzes biosolids that are land applied each day. This system has established action levels that prevent the land application of biosolids in excess of acceptable radionuclide levels. The city also contracts with ORNL to perform independent radionuclide analyses as a cross-check to ensure compliance with the established 4 mrem/yr criteria. Since many of the 23 radionuclides are not present in the City of Oak Ridge biosolids, analytical action levels are only established for known, key radionuclides to prevent the inadvertent application of biosolids confirmed to contain elevated levels of radionuclides. To date, no action levels have been triggered. A proposed radionuclide limit increase from 4 to 10 mrem/yr for a human dose is required to assist the City of Oak Ridge in commercial and government industrial development. It is important to note that the proposed increase is not expected to be achieved because the lifetime nitrogen loading limit of 50 tons/acre will be attained within the next 7 to 8 years and site radionuclide soil concentrations are presently found at extremely low levels.

A Threatened and Endangered Species Study (TN & Associates 1997) was performed on all active Oak Ridge Reservation Biosolids Land Application Sites for vertebrates in 1997.

ECOLOGICAL DESCRIPTION OF THE SITES

The following brief description is taken from descriptions of each application site as described in the 1997 T&E species survey (TN & Associates 1997). In addition, a wetlands survey (SAIC 1996) was also performed in 1996 that specifically identified all bodies of water (***Table 1.2***) present on the active biosolids land application sites. ORR application sites were selected specifically to avoid perennial streams, lakes and other bodies of water. As noted in ***Table 1.2,*** some very small ponds exist which have been appropriately flagged and have a 500 foot buffer zone surrounding the perimeter of each water body prohibiting the application of biosolids.

Table 1.2 ORR Biosolids Land Application Site Designated Wetlands

Application Site	Wetland Type	Wetland Size (acres)
Rogers	Pond	0.9
High Pasture	Pond	0.3
Scarboro	Pond	0.4
	Pond	0.2
	Pond	0.07
	Pond	0.07
	Pond	0.1
	Pond	0.7
Watson Road	None	-
Upper Hayfield #1	Pond	0.7
	Pond	0.3
Upper Hayfield #2	Pond	0.05
	Pond	0.7

Watson Road

Biosolids application on the Watson Road site is generally defined by Watson Road on the north, Old County Road on the west, and East Fork Road on the south. This site is completely forested:

- a cutover loblolly pine plantation (42 ac) is located on both sides of Watson Road,
- a natural pine and cedar stand which receives biosolids is located along the eastern side of Old County Road (6 ac),
- and a mature upland forest (41 ac) stand is located north of East Fork Road.

From the northern entrance, Old County Road forks to the right and Watson Road forks to the left. Biosolids are applied into the woods on both sides of Watson Road. From the fork to the utility right-of-way there is a short stretch of mature white oak, white pine, and poplar, with subcanopy development, and herbaceous understory and leaf litter. From the power line to the eastern boundary, the overstory consists of remnants of the loblolly stand that is undergoing secondary succession. Where the canopy was completely killed, the understory is dominated by blackberry and where the canopy still shades the understory poison ivy is dominant. U-shaped Biosolids application roads have been bulldozed off Watson Road into the loblolly stand.

From the northern entrance, Old County Road forks to the right. Biosolids are applied only to the left side of this road, away from the turnpike. The overstory is dominated by oak with scattered eastern red cedar and naturally occurring pine. The understory contains an abundance of woody seedlings. Poison ivy and honeysuckle dominated the understory.

Rogers

The Rogers application area is bounded on the east by an access road and farm pond, on the north by the High Pasture site, on the west by Roger's Quarry, and on the south by Bethel Valley Road. Most of the site is rolling pasture land dominated by fescue, blackberry, and strips of planted cottonwood, and black walnut. The forested slope at the back of the site contains mature upland hardwood species of red oak, white oak, hickory, red maple, hophornbeam, and ash.

There is little subcanopy development and the ground cover is dominated by weedy invaders of honeysuckle and nepal grass. The base of the slope has extensive pawpaw, mayapple, skullcap and heartleaf violet.

High Pasture

The High Pasture site consists of two hayfields on a fairly flat ridgetop. The fields are connected by a short road through a hardwood stand. The fields are mowed in the late summer and winter. The most northern field is bounded on the northwest by a mature upland hardwood stand. The closed canopy consists of chestnut oak, hickory, and yellow poplar. Honeysuckle vine was the dominant understory species. The southern boundary runs along the top of the ridge slope above the Rogers Quarry site. The eastern boundary is the access road. The second field is a clearly defined ridgetop bounded by a steep-sloped forest.

Upper Hayfield # 1

Upper Hayfield # 1 is bounded by upland hardwood forests on the east, south and west, and by a road to the north. The eastern boundary forest has three canopy layers: overstory, subcanopy, and a sapling layer, as well as a diverse herb layer of commonly occurring species. The mature hardwood forest on the western boundary was unusual because of the size of the trees (~70 cm dbh), the extent of the forest, and the lack of disturbance. Species include Southern red oak, white oak, beech, and sugar maple. The soil is cherty, with practically no understory.

Upper Hayfield # 2

Upper Hayfield # 2 is on a hilltop bounded by access roads on the east, south and west. The western boundary forest is mature, upland hardwoods. The southern boundary forest is younger, on a fairly steep slope which gets drier as it progresses towards Scarboro Road. Virginia pine has established in the canopy in this area.

Scarboro

The Scarboro site is a rolling hayfield bounded by mesic forest on the west and Scarboro Road on the east. The lower portion of the field is not used because of proximity to Bethel Valley Road. There is a hardwood forest remnant with limestone outcroppings in the south cental part of the site.

This forest has 100% canopy coverage, species include black walnut, poplar, cherry, white oak, and hackberry. The understory is disturbed, and Nepal grass is dominant. The upland forest on the western boundary is dry, on a west-facing slope. It is out of the Biosolids application range and contains an abundance of native species, including ferns, rattlesnake plaintain, little brown jugs, and heartleaf violets.

LISTED SPECIES AND POTENTIAL IMPACTS OF THE PROJECT

The general ecology of federally listed species that may occur on the site (FWS 1999a) and the expected impacts from the project on them are summarized below. Unless otherwise noted or referenced, general biological information on the species is derived from Harvey (1992) and Webb (2000).

Gray Bat (*Myotis grisescens*)

The endangered gray bat is concentrated in cave regions of Arkansas, Missouri, Kentucky, Tennessee, and Alabama. Although the population is over 1.5 million and improving, about 95 percent hibernate in only eight known caves, two of which are located in Tennessee. During the summer gray bats are usually found in caves, though frequently different caves than those used for hibernation. Females form maternity colonies of at least several hundred individuals, while males and non-reproductive females form smaller summer bachelor colonies. Summer caves, especially for maternity colonies, are rarely more than three km (two miles) and usually less than 1.6 km (one mile) from the rivers and lakes used as foraging areas. During the spring and autumn transient periods the bats occupy a wider variety of caves. During all seasons males and yearling females seem less restricted to specific caves and roost types. In general, bats enter hibernation in September through October and emerge in late March and April; timing depends on age and gender. Young are born in late May or early June. Bats forage over water, mostly along rivers, large creeks, and lakes, primarily within about five m (15 feet) above the surface. Gray bat populations are on the upswing as a result of improved breeding success due to better protection measures, such as cave gates, fences and informational signs near caves.

There are no caves physically located on any of the application sites or in wooded areas that serve as boundaries for the open hay fields. The closest caves on the ORR are the Walker Branch cave and Big and LittleTurtle caves, were surveyed by Mitchell et al. (1996) and no gray bats were found. There have been a number of unverified reports of gray bats roosting on the ORR but no positive identification could be made (J.W. Webb 2000).

Although the ORR Biosolids Application Sites could provide suitable foraging habitat, this is unlikely due to the fact that five of the six application sites are open hayfields devoid of caves, bordered by mature tree stands. The other application site is a mature tree stand that has been drastically affected by the infestation of the Pine Beetle. This application site is also devoid of caves. In addition, all bodies of water physically located on the application sites are very small and have a 500 foot buffer zone prohibiting the application of biosolids per TDEC requirements. Biosolids land application operations are performed during daylight hours and normally conclude by 4:00 pm in the afternoon so any foraging by Gray bats would therefore not be disrupted.

Trace radionuclides in the City of Oak Ridge biosolids are monitored daily prior to application on the ORR application sites. Action levels have been established to prevent the application of biosolids that are in excess of established radionuclide levels <u>**before**</u> application operations occur. To date, no radionuclide action levels have been triggered. Site soils and vegetation are also thoroughly monitored through sampling and analysis performed by ORNL. Historical radionuclide levels observed in application site soils and vegetation have been extremely low and are routinely reported to TDEC and EPA by February 19 of each year in the Annual Biosolids Management Report (City of Oak Ridge 2001). ***Table 1.3*** provides a summary of soil radionuclide data collected and reported to EPA and TDEC annually. Note that soil samples were also collected for comparison from adjacent areas that had not received biosolids application. A comparison of the biosolids treated soils vs. non-treated soils indicates a slight increase in the concentration of some radionuclides within the site soils while others demonstrated levels lower than those observed in the non-applied areas. ***Table 1.4*** also provides a summary of radionuclide data from random vegetation collected since 1998. Vegetative radionuclide levels were extremely low and in most cases were non-detectable.

Table 1.3 ORR Application Site Soil Radionuclide Monitoring Data for 2000

Application Site	^{60}Co (pCi/g, dry) Biosolids Treated	^{60}Co (pCi/g, dry) Ref.	^{137}Cs (pCi/g, dry) Biosolids Treated	^{137}Cs (pCi/g, dry) Ref.	^{238}U (pCi/g, dry) Biosolids Treated	^{238}U (pCi/g, dry) Ref.	^{235}U (pCi/g, dry) Biosolids Treated	^{235}U (pCi/g, dry) Ref.
Rogers Site	.526	.009	.556	.215	2.73	.725	.156	.071
High Pasture	.045	.009	.371	.215	1.68	.725	.063	.071
Scarboro Road	.007	.009	.459	.415	1.37	1.05	.075	.102
Upper Hayfield #1	.029	.009	.575	.415	1.96	1.05	.123	.102
Upper Hayfield #2	.018	.009	.627	.415	2.18	1.05	.10	.102
Watson Road	.003	.010	.333	.498	1.55	.888	.087	.033

Table 1.4 ORR Application Site Vegetation Radionuclide Monitoring Data Since 1998

Application Site	^{60}Co (pCi/g, dry)	^{137}Cs (pCi/g, dry)	^{238}U (pCi/g, dry)	^{235}U (pCi/g, dry)
Rogers Site	0.014	0.056	2.34	N/D
Scarboro Road	N/D	0.619	N/D	N/D
Upper Hayfield #1	N/D	0.046	1.10	N/D
Watson Road	N/D	N/D	N/D	N/D

N/D - Non-detectable

Mist netting was conducted on the lower portion of East Fork Poplar Creek and its tributaries in May 1992 and again in May - June, 1997 (Harvey 1997). The 1997 survey included portions of lower Bear Creek near its confluence with lower East Fork Poplar Creek; this location is about 2 km from the closest biosolids land application site (Watson Road). The creeks in this area provided good gray bat foraging habitat and excellent Indiana bat summer roosting and foraging habitat at the time of the surveys. No Gray or Indiana bats were recorded among six species captured.

Accordingly, DOE staff concludes that the activity would be unlikely to adversely affect the endangered Gray bat. The reasons for our conclusion are:

- the absence of caves from the ORR application sites, reducing the likelihood of roosting habitat;
- the absence of large water bodies present on the application sites, reducing the likelihood of foraging habitat;
- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Gray bat is present; and
- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils and vegetation, reducing the likelihood of accumulation of radionuclides within insects that consume vegetation or live in application site soils that represent a food source for the Gray bat.

Indiana bat (*Myotis sodalis*)

The range of the endangered Indiana bat is in the eastern U.S. from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida. Distribution is associated with major cave regions and areas north of cave regions. The present total population is estimated at ca. 352,000, with more than 85% hibernating at only nine locations — two caves and a mine in Missouri, three caves in Indiana, and three caves in Kentucky.

Indiana bats usually hibernate in large dense clusters of up to several thousand individuals, in sections of the hibernation cave where temperatures average 38 - 43°F and with relative humidities of 66 to 95 percent. They hibernate from October to April, depending on climatic conditions. Density in tightly packed clusters is usually estimated at 300 - 484 bats per square foot.

Female Indiana bats depart hibernation caves before males and arrive at summer maternity roosts in mid May. A single offspring, born during June, is raised under loose tree bark, primarily in wooded streamside habitat. Maternity colonies use multiple primary roost trees which are used by a majority of the bats most of the summer, and a number of secondary roosts that are used intermittently and by fewer bats, especially during periods of precipitation or extreme temperatures.

Thus, there may be more than a dozen roosts used by some Indiana bat maternity colonies (FWS 1999a). Kurta et al. (1996) found that female Indiana bats may change roosts about every three days, and a group of these bats may use more than 17 different trees in a single maternity season. During September they depart for hibernation caves. The summer roost of adult males is often near maternity roosts, but where most males spend the day is unknown. Other males remain near the hibernaculum. A few males can be found in caves during summer.

Until relatively recently, little was known about the summer habitat and ecology of the Indiana bat. The first maternity colony was discovered in 1974, under the loose bark on a dead butternut hickory tree in east-central Indiana. The colony, numbering about 50 individuals, also used an alternate roost under the bark of a living shagbark hickory tree. The total foraging range of the colony consisted of a linear strip along approximately 0.5 mi. of creek. Foraging habitat was confined to air space from 6 ft to ca. 95 ft high near the foliage of streamside and floodplain trees.

Two additional colonies were discovered during subsequent summers, also in east-central Indiana. These had estimated populations of 100 and 91 respectively, including females and pups. Habitat and foraging area were similar to the first colony discovered. Additional evidence gathered during recent years indicates that, during summer, Indiana bats are widely dispersed in suitable habitat throughout a large portion of their range.

Through the use of radio telemetry techniques, several additional maternity colonies have recently been discovered and studied at several locations. These studies reinforced the belief that floodplain forest is important habitat for Indiana bat summer populations. However, maternity colonies were also located in more upland habitats. It was also discovered that Indiana bats exhibited fidelity to specific roosting and foraging areas to which they returned annually.

Between early August and mid September, Indiana bats arrive near their hibernation caves and engage in swarming and mating activity. Swarming at cave entrances continues into mid or late October. During this time, fat reserves are built for hibernation. It is thought that Indiana bats feed primarily on moths. A longevity record of 13 yr 10 mo has been recorded for this species.

Hibernating bats leave little evidence of their past numbers; thus, it is difficult to calculate a realistic estimate of the overall population decline for this species. However, population estimates at major hibernacula indicated a 34% decline in the total Indiana bat population from 1983 to 1989.

The only record of Indiana bats on the ORR is from a single specimen in the 1950s (Webb 2000). No maternity roosts have been located on the ORR (FWS 1999a). In general, limited information suggests that the bats roost primarily north of their hibernacula and more often in the northerly parts of their range. During mist netting on lower East Fork Poplar Creek and its tributaries, described above for gray bats and in Harvey (1997), no Indiana bats were captured out of six species recorded.

A large percentage of the known population of the Indiana bat hibernates in two caves in Kentucky and a cave and a mine in Missouri. Nursery roosts are found under loose bark of dead trees. Open riparian corridors along streams are required for foraging habitat. No confirmed sightings in Anderson or Roane counties are on record with TDEC. Mitchell *et al.* (1996) did not report any sightings during their investigations, nor did they report any records of previous sightings on the ORR. The ORR Biosolids Land Application Sites were selected to avoid streams and riparian areas. In addition, the vast majority of trees present on the application sites form the border of each site and are of the mature hardwood variety and do not typically produce loose bark or exfoliate. For the most part, trees are allowed to grow undisturbed. Trees that die are allowed to remain in place or where they fall and are only removed if they happen to fall over an site access roadway. Accordingly, DOE staff concludes that the activity would be unlikely to adversely affect the endangered Indiana bat. The reasons for our conclusion are:

- the rarity of the Indiana bat species on the ORR;
- the land application sites are not located in designated floodplains;
- the absence of streams present on the application sites, reducing the likelihood of foraging habitat;
- the absence or rarity of exfoliating tree stands that are present or serve as the borders to application sites, reducing the likelihood of roosting habitat;
- the non-disturbance of existing tree stands by the current operations (e.g., lack of tree removal operations), reducing the likelihood of roosting disturbance if the Indiana bat is present;

- the established buffer zone of 500 feet around existing bodies of water on the application sites prohibiting the application of biosolids, reducing the likelihood of direct or indirect contact with biosolids being applied if the Indiana bat is present; and
- the rigorous radionuclide monitoring program in place and the extremely low to non-detectable levels of radionuclides found in application site soils (***Table 1.3***) and vegetation (***Table 1.4***), reducing the likelihood of accumulation of radionuclides within insects that consume vegetation that represent a food source for the Indiana bat.

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APPENDIX K

WEST END TREATMENT FACILITY DOSE TECHNICAL MEMORANDUM

Technical Memorandum

To: Joe Birchfield
Alliant Corporation

Date: March 28, 2001

From: Lisa Stetar, CHP
Performance Technology Group

Subject: Dose Estimates for WETF Discharge of Uranium

As we discussed previously, the discharge of wastewater that contains only 2 mg/l (1350 pCi/l) of uranium from WETF into the Y-12 sewer system would not result in a measurable external exposure and does not represent a potential source of exposure via inhalation. Additionally, because the sewer connection is not accessible to the public, potential ingestion of the wastewater does not appear to be a plausible exposure pathway either.

If you have any questions or need additional information, please contact me.

PUBLIC COMMENTS RECEIVED

Many Voices Working for the Community

Oak Ridge Site Specific Advisory Board

November 14, 2002

Mr. David Allen
DOE Oak Ridge Operations
P.O. Box 2001, SE-30
Oak Ridge, TN 37831

Comments on the *Environmental Assessment for Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation*, DOE/EA-1356

The Oak Ridge Site Specific Advisory Board (ORSSAB) has reviewed the subject environmental assessment. We offer the following comments and questions, which should be addressed in determining whether an environmental impact statement will be prepared or a Finding of No Significant Impact will be issued to proceed with the proposed action:

1. More information is needed on the soil hydraulic conductivity and other physical properties of the soils for the six active sites, which total 329 acres.

2. The map on page 1-6 needs to be revised and enlarged to show soils (i.e., recent soils map showing soil application series).

3. The map should have corresponding tables and legends, which identify the six active sites with data that incorporate estimates of exposure under worst scenario antecedent moisture conditions and lowest hydraulic conductivity.

4. More history on the six active sites as well as the inactive sites would be helpful in narrative form. Site history should also be taken into account in the estimation of the margin of safety for the maximally exposed individuals.

5. What were the prior uses and proximity of individuals over time to the sites? This information needs to be provided for the other sites: Watson Road, Scarboro Road, Rogers, McCoy, Cottonwood, and Site 8.

6. On page 1-5, the paragraph relating to the city of Oak Ridge's plans, as of the summer 2001, needs to be updated. Some discussion of what has transpired since then is needed. Change the tense from "plans" to "planned."

7. In light of the August 2002 referendum's defeat, the financial status of the city's operations and planned improvements needs to be re-evaluated and discussed. Some cost data on the new system and also on its long-term maintenance are necessary.

P.O. Box 2001, EM-90, Oak Ridge, TN 37831 • Phone 865-241-3665; 1-800-382-6938 • Fax 865-576-5333
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8. Please explain the statement on page 1-5 that refers to the city's planned new treatment system, which would "increase solids content and sterilize biosolids ... resulting in more manageable and safer material." What is meant by "more manageable and safer?"

9. The Executive Summary identifies an alternative to the proposed dose rate increase being "to leave the existing Oak Ridge Reservation land application sites altogether in favor of free distribution of the biosolids material to the public." It would seem that this option could be a cheap and easy alternative, and it should be evaluated.

10. How close to the 4 mrem/yr are we actually now? Or does the gamma monitoring not give enough data for this to be calculated?

11. Appendix D is based on a 20-year program, and it is also stated that we have 7 years remaining in that program; this would give a start date of 1989. What does 1989 correspond to, in reference to the Land Application Program started in 1984 and Oak Ridge National Laboratory (ORNL) adding waste in 1999?

12. Europium-155 has a higher limit than uranium (Table D.3). Does this imply that europium is a fairly large contributor? What is its source?

13. Why does the Rogers site have 56.8 percent of the allocated dose, according to Table 4.2?

14. Why are the cesium-137 concentrations in 1999 increased, uranium-235 concentration in 1996 high, and the uranium-238 concentration usually low compared to the limit (Table B.4)?

15. Section 1.0, page 1-1, 2nd paragraph. The ORSSAB presentations and tour of the biosolids land application sites involved the ORSSAB Waste Management Committee, not the full Board, and were informational. ORSSAB has taken no previous position on this proposal.

16. Section 1.1, page 1-2, 3rd paragraph. The 4 mrem/yr limit is coincidentally a drinking water maximum contaminant level for beta particles and photon radioactivity from man-made radionuclides. Use of the descriptor "self-imposed" oversimplifies the issue of setting a standard for radionuclides in sewage sludge and conveys a lack of objectivity in preparation of this environmental assessment.

17. Section 1.2.1, page 1-5, 2nd paragraph. More details on the proposed thermal treatment system need to be provided and the fate of radionuclides undergoing thermal treatment in the proposed system evaluated as part of this environmental assessment.

18. Section 1.2.1, page 1-7, 2nd paragraph. The results of the survey of publicly owned treatment works for baseline radioactivity associated with biosolid products needs to be discussed in this document if available from late 2001.

19. Section 1.2.1, page 1-8, 2nd paragraph. The letter from the Tennessee Department of Environment and Conservation–Division of Radiological Health claimed as approving the increase to 10 mrem/yr appears to only acknowledge concurrence at a planning level. The letter provided in Appendix A does not appear to be personally signed by the past division director.

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20. Section 1.2.2, page 1-11, 1st paragraph. According to the *Oak Ridge Reservation Annual Site Environmental Report for 2001*, Outfall 502 (West End Treatment Facility) had zero discharge for the calendar year. Please provide details on what portions of the approximately $133,000 cost are due to effluent monitoring and treatment process changes, and be clear whether the proposal comparison is based on past or current operations.

21. Section 1.3, page 1-11, 1st paragraph. Why not evaluate additional alternatives, such as retaining the 4 mrem/yr limit with addition of Y-12 West End Treatment Facility discharge and excluding ORNL or East Tennessee Technology Park biosolids or other problematic discharges?

We appreciate the opportunity to provide comments and questions on this environmental assessment and look forward to learning about their resolution.

Sincerely,

David N. Mosby, Chair

cc: Gerald Boyd, DOE-ORO
Martha Crosland, DOE-HQ
Sherry Gibson, DOE-ORO
Pat Halsey, DOE-ORO
Connie Jones, EPA Region 4
John Owsley, TDEC
John Patterson, Bechtel Jacobs

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CITY OF
OAK RIDGE

OFFICE OF THE MAYOR

POST OFFICE BOX 1 • OAK RIDGE, TENNESSEE 378

October 20, 2002

Mr. David Allen
U.S. Department of Energy
Oak Ridge Operations
SE-30, P. O. Box 2001
Oak Ridge, TN 37831

Comments on the Draft Environmental Assessment on Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (DOE/EA-1356, August 2002)

Dear Mr. Allen:

Enclosed is a copy of Resolution Number 11-149-02 as adopted by the Oak Ridge City Council on November 18, 2002. This resolution authorizes transmittal of the comments of our Environmental Quality Advisory Board on the subject draft environmental assessment as the official comments of the City of Oak Ridge.

Please ensure that our comments are given due consideration as you proceed with this project.

Very truly yours,

David R. Bradshaw

David R. Bradshaw
Mayor

jb

Enclosure

NUMBER 11-149-02

RESOLUTION

WHEREAS, the U.S. Department of Energy's (DOE) Oak Ridge Operations (ORO) office is proposing to increase approved radionuclide land loading limits for the Oak Ridge Reservation (ORI Biosolids Land Application Sites from a cumulative dose of 4 mrem/yr to 10 mrem/yr and to add treated, effluent discharges from the Y-12 West End Treatment Facility (WETF) into the Y-12 and Ci of Oak Ridge Sanitary Sewer Systems; and

WHEREAS, the DOE ORO has prepared a document entitled *Draft Environmental Assessment Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridg Reservation (DOE/EA-1356, August 2002);* and

WHEREAS, the DOE is soliciting comments on the Environmental Assessment (EA); and

WHEREAS, the City of Oak Ridge desires to officially comment to DOE on the EA; and

WHEREAS, the City of Oak Ridge's Environmental Quality Advisory Board (EQAB) has reviewed the EA and prepared a report to City Council with comments and recommendations for DOE's consideration in preparation of the final EA; and

WHEREAS, the assessment in the EA supports a conclusion that the proposed action does not pose a threat to human health and safety, regardless of future land use; and

WHEREAS, EQAB concludes that the proposed action appears to be environmentally responsible; and

WHEREAS, the City Manager recommends transmittal of the attached document entitled *Report on Environmental Quality Advisory Board Review of DOE Draft Environmental Assessment c Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservatic (DOE/EA-1356, August 2002).*

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCILMEN OF THE CIT OF OAK RIDGE, TENNESSEE:

That the recommendation of the City Manager is approved and the attached comments entitled *Report on Environmental Quality Advisory Board Review of DOE Draft Environmental Assessment on Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (DOE/EA-1356, August 2002)* be transmitted to the U.S. Department of Energy a the official comments of the City of Oak Ridge.

This the 18th day of November 2002.

APPROVED AS TO FORM AND LEGALITY:

Kenneth R. Krushenski
City Attorney

David R. Bradshaw
Mayor

Jacquelyn J. Bernard
City Clerk

Report on Environmental Quality Advisory Board Review of DOE Draft Environmental Assessment on Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (DOE/EA-1356, August 2002)

Background

This DOE Environmental Assessment (EA) discusses the environmental aspects of a proposal to increase the allowable amounts of radioactive substances in City of Oak Ridge sanitary sewage sludge that is applied on lands on the DOE Oak Ridge Reservation. It also discusses a related proposal for a specialized industrial wastewater treatment unit at the Y-12 Plant to discharge treated wastewater to the City sanitary sewer system instead of discharging directly to Upper East Fork Poplar Creek.

As EQAB understands it, the City and DOE have a long-standing arrangement in which the DOE Y-12 Plant discharges its sanitary wastewater into the City sewer system and DOE allows the City to apply wastewater sludge (the solid residue from wastewater treatment) on DOE land. The City also has agreed to process sludge from the ORNL (X-10) sanitary wastewater facility and apply this sludge on DOE land.

Currently, the sludge program operates under criteria that limit land application of radionuclides to ensure that a hypothetical resident farmer would receive a radiological dose of no more than 4 millirems (mrem) per year. The proposal would increase this dose ceiling to 10 mrem per year. The proposed higher radionuclide limit would give the program flexibility under which the City could continue to apply sludge on the current land-application sites until these areas have reached "lifetime" limits of 50 tons of sludge per acre (this means the existing sites could be used for an additional 20 years), the City could consider requests for increased discharges of radioactivity by industrial wastewater customers, and ORNL sludge could be processed together with the City sludge. Without an increase in the limit, the City might need to refuse to process ORNL sludge, refuse future requests for increases in radioactive discharges, or find new places to apply sludge.

The regulatory situation regarding land application of sewage sludge is unusual, particularly regarding radioactivity in sewage sludge. Land application of sewage sludge is subject to restrictions related to pathogens, nutrients, and metals, but there are no regulations on radionuclides in sewage sludge. Therefore, the City and DOE must (in effect) set our own standards. All sanitary wastewater and sludge contains some radioactive substances (from natural sources, medical procedures, and other sources), but few wastewater utilities have any information on the radioactivity in their wastewater and sludge. Oak Ridge is unique in having extensive data on these topics, and the City and DOE conduct extensive monitoring of sludge application activities.

Land application of metals in sewage sludge is regulated by the Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC) to ensure that the total amounts of heavy metals applied to a site would not cause future exceedances of health-based standards for people using crops grown on that land. DOE has used a risk analysis approach to derive a comparable set of standards for radionuclides, but this must be done without regulatory direction on a "safe" level of exposure. However, the TDEC Division of Radiological Health, has concurred that a hypothetical radiological dose of 10 mem per year is a reasonable value to use. For comparison, the average person's annual background radiation dose from natural sources is 300 mrem, the Nuclear Regulatory Commission (NRC) dose limit for members of the public exposed to radiation from NRC or state-licensed facilities is 100 mrem per year, the NRC limit for deriving radiological criteria for unrestricted use following decontamination and decommissioning of a licensed facility is 25 mrem per year, the EPA dose limit on radioactive air emissions is 10 mrem per year, and the EPA dose limit for certain radionuclides in drinking water is 4 mrem per year.

Recommendations from EQAB review

The assessment in the EA supports a conclusion that the proposed action does not pose a threat to human health and safety, regardless of future land use. Thus, it appears to be environmentally responsible. However, in adopting the higher limit, it is prudent for the City to seek assurance that sludge application at the higher radiological loading levels would not add to the local inventory of lands that future regulators might consider to be "contaminated." The analysis in the EA and the 10 mrem per year limit are both intended to avoid future restrictions on land use. Unfortunately, TDEC concurrence in the 10 mrem per year value does not necessarily guarantee that land where sludge was applied might not be considered "contaminated" at some time in the future.

We have some specific concerns and recommendations for DOE to consider in finalizing this document, to provide a more accurate record and to help inform DOE's and the City's decisions on this proposal.

1. It is not completely accurate to call the November 3, 1999, letter from Michael Mobley of TDEC an "approval," since there is no state regulatory authority under which TDEC could approve or deny radiological criteria for land application of sewage sludge. It would be more accurate to describe this letter by quoting the words it contains: "TDEC concurred in the use of 10 mrem/year as a planning level." Therefore, references to this letter in Page 6-1, paragraph 2, and elsewhere in the EA should be revised to quote this language or describe the letter as a "concurrence letter."

2. The EA should be revised to eliminate the statements that suggest that the purpose of the proposed action is to enable a private radioactive laundry facility to locate in Oak Ridge. Instead, state that a relaxation in the current 4 mrem/year standard would give the City flexibility to allow increases in discharges of radioactive substances to the sanitary wastewater system, while continuing to accept ORNL sewage sludge in the biosolids program.

3. The EA should be revised to eliminate statements that imply that existing restrictions on people's access to solids application sites on the Oak Ridge Reservation would continue forever.

However, we suggest that if these sites are ever transferred into private ownership, prospective owners should be made aware that the land was used for biosolids application.

4. To supplement the risk assessment in the EA, the EA should compare projected radionuclide concentrations in the top 6 inches of soil at the various land application sites with EPA's preliminary remediation goals (PRGs) for radionuclides. The EPA PRGs were cited and discussed in the recent EPA report on soils investigations in Oak Ridge's Scarboro neighborhood. These values are used by EPA to determine whether a site requires additional assessment under the Superfund program. It would be useful to have assurance that EPA would not come in and identify the sludge application areas as sites requiring Superfund investigation. Additional information about the PRGs for radionuclides is available on the Internet at http://epa-prgs.ornl.gov/radionuclides/.

5. An alternative approach to reducing average radionuclide loading at any individual site would be to add additional sludge application sites to the program and set lower limits on sludge loading at each site. The EA should consider and explore the potential impact of this alternative.

Specific comments

Page 7-2, lines 5-6. The 1996 EA is DOE/EA-1042. Please include the document number in the reference citation.

LOC INC
Oak Ridge Reservation
Local Oversight Committee

November 14, 2002

David R. Allen
U.S. Department of Energy
Oak Ridge Operations Office
SE-30-1
PO Box 2001
Oak Ridge, Tennessee 37831

Subject: Comments on Draft Environmental Assessment Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation (August 2002; DOE/EA-1356)

Dear Mr. Allen:

The Citizens' Advisory Panel of the Oak Ridge Reservation Local Oversight Committee, Inc. submits the comments below on the subject document. These comments were approved by the CAP at its regular meeting of November 12, 2002. These comments have not been reviewed or approved by the LOC Board, thus they should be considered as being submitted by the CAP only.

In general, the document doesn't do a good job of separating the two issues under consideration (discharge of West End Treatment Facility [WETF] effluents into the Oak Ridge sanitary sewer system and increase of dose limit from biosolids land application). The CAP comments will deal with these separately.

The CAP supports adding the WETF effluents to the Oak Ridge sanitary sewer system. This not only saves DOE money by eliminating a costly NPDES permit, but it removes what in the past had been one of the more problematic discharges into Upper East Fork Poplar Creek. Treatment via the sanitary sewer system, including any required pretreatment, helps ensure that the ultimate discharge is much cleaner.

The question of dose limit increase at first seems inconsequential; however, this raises questions regarding whether other alternatives were adequately investigated. The no-action alternative is vaguely stated, and one scenario includes possible exclusion of sludge from ORNL, forcing it to dispose of it as low-level waste. It's not clear why ORNL sludge could not be applied to ORR lands under a separate program.

No other alternatives are proposed, and that is a deficiency of the document. One may be that the City of Oak Ridge ensures that dischargers have adequate measures in place to reduce radioactive discharges, which would eliminate the need for raising the limit. The other is to model the influence of sewer rehabilitation, which has already substantially decreased the uranium content of biosolids (page B-4).

Further, the comparison of alternatives do not discuss one of the largest classes of generators in a community—medical facilities. It would be helpful to know the relative contribution of radionuclides by Methodist Medical Center, the typical half-life, and whether this is a significant contribution to the dose rate calculation.

In addition, the reviewers found it difficult to follow the analysis of loading at application sites (Appendix E). What is the "lifetime" of the system? Does this assume that dispersion and decay will be in steady state with respect to application rates? The results as summarized on page E-2 do not support

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raising the limit; the Rogers Site, which has the greatest percentage of the proposed radionuclide loading limits, attains just 56.8% of the existing 4 mrem/yr limit under the predictive model.

The inclusion of Potassium-40 in Table G.3. is puzzling. Since that is a common naturally occurring radionuclide, does the amount listed represent the additional K-40 added to the system by other sources? If not, what proportion is considered natural background vs. what is added? K-40 is not known to be produced at any of the DOE sites.

Also confusing is that the lists of radionuclides of interest in various sampling schemes and models do not correspond to each other. This leads the reviewer to doubt whether the models are comparable and applicable. Tables 4.1 and 4.4 list Co-60, Cs-137, U-235, and U-238 for known radionuclides currently monitored. In Appendix B, four additional radionuclides (I-131, Be-7, K-40, Ra-228) are listed in Table B.4. as being found in city biosolids, although it is noted on page B-4 that medical facilities also contribute Tc-99m (not mentioned elsewhere). The RESRAD model in Appendix D addresses a suite of radionuclides that drop some of the ones in the previous tables (I-131, Be-7, K-40, Ra-228) and add others not noted previously (Eu-152, Eu-154, Eu-155, U-234, Mn-54, Zn-65, Sr-90, Cs-134), apparently based on the possibility that they might in the future demonstrate detectable levels. The Appendix E model is apparently based on historical average radionuclide levels observed in the sewer system—it is unknown whether these are the ones listed in the Section 4 tables or in Appendix B. The human health risk assessment in Appendix G uses six radionuclides, including all from Section 4 tables and two (K-40, Ra-228) from Appendix B. The Appendix G risk assessment notes that Be-7 and I-131 have half-lives of less than two months and so they were not considered (although one would expect that the risk from these could have been calculated based on application rate as their presence is being consistently renewed). The NPDES risk assessment in Appendix H only looks at the radiological risk from uranium. The dose impact model in Appendix I and the biological assessment in Appendix J consider only the four radionuclides listed in the Section 4 tables.

Similarly, the models that deal with the hazardous constituents also vary widely and thus may not be comparable and applicable.

The document refers to many actions that were to have happened in 2001. It needs to be updated to reflect all actions that have occurred up to the time that the draft EA was released for comment.

The CAP does not object to either of the actions. The proposed discharge of WETF effluents into the Oak Ridge sewer system is probably a net benefit. Certainly the decision to raise the dose limit from biosolids land application is more a value judgment than a significant technical or regulatory issue. The models and their underlying assumptions seem to be extremely conservative, calling into question the real need for the administrative action.

The CAP appreciates the opportunity to comment on the subject EA. If you have any questions on these comments, please contact the LOC office at 483-1333.

Sincerely,

Norman A. Mulvenon

Norman A. Mulvenon
Chair, LOC Citizens' Advisory Panel

cc: LOC Document Register
LOC CAP
LOC Board
John Owsley, Director, TDEC DOE-O
Jim Turi, Acting Manager, DOE ORO
Gerald Boyd, Assistant Manager for EM, DOE ORO
Pat Halsey, FFA Coordinator, DOE ORO
David Adler, Team Leader, Integrated Waste Disposition Planning and External Interface
Andrea Perkins, Acting Team Leader, Y-12/ORNL Projects
William Brumley, Manager, Y-12 Area Office
David Mosby, Chair, ORSSAB
Amy Fitzgerald, City of Oak Ridge

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-7072

November 22, 2002

David Allen
NEPA Compliance Officer
DOE Oak Ridge Operations
PO Box 2001, SE-32
Oak Ridge, TN 37831-8739

Dear Mr. Allen

Draft Environmental Assessment (EA) for proposed changes to the sanitary biosolids land application program on the Oak Ridge Reservation

The Tennessee Department of Environment and Conservation (TDEC), DOE Oversight Division and the Division of Radiological Health (DRH) have reviewed the above subject document in accordance with the requirements of the National Environmental Policy Act and associated regulations of 40 CFR 1500-1508 and 10 CFR 1021 as implemented.

<u>General Comments:</u>

It should be noted that the subject sludge fails to meet the definition of Class A sludge according to 40 CFR 503 regulations in view of the proposed changes to add radiological constituents in the sludge. Class A sludge by definition are sludge with pathogens or other non- radiological constituents.

A map to identify areas of interest is necessary for this document. The wetlands, springs, and other pertinent topographical features are not obviously located on Figure 1.1 (the only map in the document). Perhaps a 1/2000 scale of the six application sites (include topography, streams, wetlands, sinkholes, ponds, buildings, roads, etc.) would be useful as a supplement to Figure 1.1. The lack of detail of Figure 1.1 does not allow for the projection of the Division of Natural Heritage Threatened and Endangered Species map data upon the biosolids map sites. This information is necessary to help determine potential impacts.

How often is the site sprayed with radioactive waste?

If the West End Treatment Facility (WETF) becomes a pretreatment facility before discharging wastewater to the sanitary sewer system, the city of Oak Ridge (COR) could require sampling and analysis at the facility. Costs would still be associated with this sampling and analysis.

Although the city requires monthly sampling of a 24-hour composite at the East End Sanitary Sewer Monitoring Station, this sampling is not continuous. Therefore, it is very likely that an upset condition of elevated radionuclide levels would not be recognized. Also, an exceedance of the derived concentration guideline (DCG) for radionuclides in DOE Order 5400.5 would not be recognized until after the elevated levels have entered the COR sewer system. This situation was seen in February 2000 when the Y-12 Central Pollution Control Facility (CPCF) batch discharge exceeded the DOE 5400.5 DCG for uranium by 14 fold. Due to dilution, this exceedance was not seen at the Station 17 sampling station and was not recognized until after receipt of the NPDES data results.

Since pretreatment requirements are usually less stringent than National Pollution Discharge Elimination System (NPDES) permit requirements; it is likely that there will be a decrease in the removal efficiency of the WETF. An interim goal of the NPDES program is to ensure that treatment facilities improve treatment capabilities over the life of the NPDES program. Maximum efficiency of the WETF will not be achieved when the sampling is performed at the East End Sanitary Sewer Monitoring Station after mixing with other Y-12 wastewater (including the landfill leachate).

Since Y-12's sanitary sewage, the Y-12 Steam Plant Wastewater Treatment Facility, the Y-12 Landfill V leachate, and now potentially the Y-12 West End Treatment Facility all discharge to the COR's sewer system, DOE Orders are applicable to the Biosolids Program. How does DOE intend to ensure that the Biosolids Program is in compliance with the applicable DOE Orders?

References were made as to TDEC-approved land application sites. The TDEC approval for the land application sites expired in 1999. TDEC does not provide lifetime approvals for sludge application sites. It should be noted that the 40 CFR 503 sludge concentration tables are based upon a lifetime application of 20 years. The city of Oak Ridge's program has been conducted for 19 years.

The Y-12 Modernization Program includes the addition of the Highly Enriched Uranium Facility, the Special Materials Complex, and the Enriched Uranium Manufacturing Facility. What wastewater will be produced from these facilities and does DOE plan to discharge wastewater from these facilities to the sanitary sewer system?

Specific Comments:

Page vii, 1st Paragraph, Last Sentence: states that *"In addition, ...discharge of treated wastewater from the West End Treatment Facility (WETF)...resulting in an operational cost savings of approximately $133,000 per year."* This statement and a similar statement on Page 2-5, Second Paragraph is incorrect or misleading because during the June 2002 Biosolids Working Group meeting DOE stated that the operational cost savings associated with the WETF have already been achieved by changes in the sampling and analysis strategy.

Page 1-2, Paragraph 30-32: states *"The long-term solution recommended by TDEC involved increasing land application site loading criteria from a cumulative dose-based on 4 mrem/yr to one based on 10 mrem/yr for a maximally exposed individual. The approval letter from TDEC is available in Appendix A."* The implication of this statement is misleading to the public and misguiding to COR and DOE in that TDEC does not recommend or provide long-term planning strategies or solutions for localities in this context of waste management.

Page 1-5, 1st Sentence: *"In the summer of 2001 the COR plans to implement a new de-watering and thermal treatment systems..."* The sentence is written in the future tense. What is the present status of the new system?

Page 1-7, Line 23: refers to a 2001 NRC survey that will be available to the public. The sentence is written in the future tense. What are the results of the survey?

Page 2-2, Lines 1-2: states *"Since contaminant levels are very low, DOE proposes a controlled, monitored discharge to the Y-12 Sanitary Sewer System..."* Please provide estimates or averages of the contaminant levels.

Page 2-2, Lines 9-11: states *"only a small portion of the total uranium... would be land applied."* Please explain the process that removes the greater portion of uranium before land application.

Page 2-6, Lines 7-13: *"The city could leave the ORR land application sites in favor of freely distributing the treated biosolids material to public outlets consistent with EPA regulations. All, present and future DOE sanitary wastewater and biosolids bearing any level of radionuclides requiring treatment in all likelihood, would not be accepted... forcing DOE to explore other more costly treatment alternatives... The acceptance and treatment of ORNL biosolids could also be discontinued."*

The above statement is made in reference to the No Action Alternative.

(1) If the biosolids are freely distributed to the public, will the public be aware of the radioactive constituents in the biosolids? The current EPA regulations for biosolids do not address radiological contamination in the biosolids.

(2) What is meant by "freely distributing?" Does this phrase mean cost free or widely distribute?
(3) Due to operational difficulties with the renovations of the POTW, it should be noted that the COR has not accepted or treated ORNL biosolids since the spring of 2001, which is approximately 19 months. The reason given for the non-acceptance is due to the operational difficulties with the current renovations to the POTW.
(4) Currently, the COR is experiencing operational difficulties with its renovations and is still producing Class B sludge during these difficulties. What is the COR contingency for land application sites during these and future operational difficulties?

Page 2-6, Lines 23-24: states *"An estimated cost savings of $133,000 projected in the Sanitary Sewer Assessment (WSMS 2000) would not be realized."* During the June 2002 Biosolids Working Group meeting DOE stated that the operational cost savings associated with the WETF have already been achieved by changes in the sampling and analysis strategy.

Pages 3-10, Lines 25-26: states *"Watson Road and Rogers sites do provide listed plant habitat for shade tolerant species."* and **Pages 3-11, Lines 14-16:** states *"One site, Rogers, is planted with a diverse array of shrubs, trees, and grasses which provide abundant wildlife and food habitat, but do not contain listed species or habitat."* There appears to be a contradiction between these statements. It is confusing to the reader as to whether Rogers site contains listed species or does not contain listed species or habitat. These statements need more explanation or clarification.

Page 4-4, Table 4.1: Cobalt-60 is shown with a risk of 2 X 10-4 for both 4 mrem/yr and 10 mrem/yr risk factors. Cobalt 60, although a short half-life (5.3 years) is a higher energy radionuclide than the others on the list. Is the chart correct?

Page 4-22, Line 33: *"Impacts of any additional pip installation."* Is this supposed to be pipe installation?

The following comments were provided by the Division of Radiological Health (DRH):

Page vii, Line 18-22
Recommend to include the 10 mrem/yr composite of 10 years of deposition in the resrad calculation. Does the calculation include what has already been deposited with the 4mrem limit? If not, why not?

Page viii, Line 31
Does the cost savings $133,000 come from the reduction of the utilization of the EPS?

Page 2-1, Lines 17-21
Include the composite of 10+years of deposition, current deposition plus expected.

Page 4-17, Line 21
Refers to concentration release limits or regulated concentration limits

Page 4-19
Can add risk factor from background radiation.

Page 4-19, Lines 30-33, and Page 4-20, Lines 1-5
Explain if the resrad calculation includes the sludge from the WETF and the POTW together, if your intention is for both sources of sludge to go on the same land area.

Page 5-4, Line 1-2
I don't understand why you state "no impacts" as oppose to negligible impacts.

Page 6-1, Line 33
Refers to release concentration limits.

Acknowledge documentation on:

1. Risk factors on page 4-4
2. CEDE to worker on page 4-12
3. External exposure for worker on page 4-17
4. POTW discharge to EFPC on page 4-8

If you have any questions concerning these comments, please contact Bill Childres or me at (865) 481-0995 or Sandra Szendy of DRH at (615) 532-0392.

Sincerely

John A. Owsley
Director

xc: Dodd Galbreath, TDEC-EPO
Eddie Nanny, TDEC-DRH
Paul Davis, TDEC-WPC

Jao686.99

COMMENT RESPONSES

DOE Oak Ridge Operations Environmental Management Comment Resolution for the Environmental Assessment for Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation, DOE/EA-1356

Comment Number	Comment Author	Comment	Response
1	ORSSAB	More information is needed on the soil hydraulic conductivity and other physical properties of the soils for the six active sites, which total 329 acres.	All of the 6 active land application sites had full hydrogeologic evaluations (November 22, 1983 and August 24, 1989) that were performed by Mr. Glenn N. Pruitt, Geologist of TDEC-Division of Solid Waste Management and Mr. Terry Gupton of TDEC-Division of Water Pollution Control **prior** to commencement of biosolids land application operations. Each evaluation recommended the sites that are currently active for land application operations. Detailed descriptions of soils and geology on the sites are available in Section 3.4.2, Site-Specific Geology. References to the hydrogeologic evaluations that have been performed will be added to this section as well as to Section 7.0, References.
2	ORSSAB	The map on page 1-6 needs to be revised and enlarged to show soils (i.e., recent soils map showing soil application series).	The map that is provided on page 1-6 is the standard map that has been and is currently being used in documentation for the Oak Ridge Biosolids Land Application Program. The desired objective of the original map which is to simply show the location of the active land application sites on the Oak Ridge Reservation.
3	ORSSAB	The map should have corresponding tables and legends, which identify the six active sites with data that incorporate estimates of exposure under worst scenario antecedent moisture conditions and lowest hydraulic activity.	The map that is provided on page 1-6 is the standard map that has been and is currently being used in documentation for the Oak Ridge Biosolids Land Application Program. The desired objective of the original map which is to simply show the location of the active land application sites on the Oak Ridge Reservation. For the dose modeling the RESRAD default values for hydraulic conductivity were used which are 100 meters/year for the saturated zone and 10 meters/year for the unsaturated zone. In the RESRAD model, the volumetric water content of the contaminated zone is the product of the saturated water content of the contaminated zone (0.4) and the saturation ratio of the contaminated zone which is the ratio of the infiltration rate in meters/year and the saturated hydraulic conductivity raised to $1/(2b+3)$ where b is a soil-specific exponential parameter (default value for $b = 5.3$). As indicated by the sensitivity analysis, these parameters do not greatly influence the dose calculation. This is the reason the RESRAD defaults are used, they are generally considered conservative.

Comment Number	Comment Author	Comment	Response
4	ORSSAB	More history on the six active sites as well as the inactive sites would be helpful in narrative form. Site history should also be taken into account in the estimation of the margin of safety for the maximally exposed individuals.	Extensive work has gone into providing complete and detailed information relative to all active sites and is available in Section 3.0 and Appendix B, Section B.2, Tables B.5 through B.10. The tables condense the verbiage from various sections and tables into a fact sheet for each site, aiding the reader in the understanding of what levels of contaminants are currently found at what levels and other important environmental factors such as bodies of water, wetlands, etc. for each site. To the knowledge of the authors and DOE-ORO the sites that are currently being used for land application operations did not have any past historical experimental or operational projects conducted on them. Modeling assumptions for the land application site RESRAD and Risk Assessment portions of this EA utilize an extremely conservative 24-hour/365-day exposure scenario using 9 pathways for an on-site individual and are therefore considered "worst-case". Because there is no prior history on these sites, it is assumed that sites began with no contaminants. Therefore, application soil radionuclide limits for 23 separate nuclides utilizing a maximum dose of 10 mrem/yr for on-site individual was developed. Biosolids limits were back-calculated for these nuclides in Appendix D. The margin of safety is calculated by using the predictive modeling performed in Appendix E. This model predicts the concentration of radionuclide levels within the application site soils at the end of site life. The maximum projected level is at the Rogers Site which is 56.8% of the 4 mrem/yr limit or 20.1% of 10 mrem/yr limit. This demonstrates a safety factor of almost 80% for the proposed limit of 10 mrem/yr. Inactive sites are not discussed as they are not planned for future use and are therefore, not part of the scope of this EA.

DOE Oak Ridge Operations Environmental Management Comment Resolution for the Environmental Assessment for Proposed Changes to the Sanitary Biosolids Land Application Program on the Oak Ridge Reservation, DOE/EA-1356

Comment Number	Comment Author	Comment	Response
5	ORSSAB	What were the prior uses and proximity of individuals over time to the sites? This information need to be provided for the other sites: Watson Road, Scarboro Road, Rogers, McCoy, Cottonwood and Site 8.	Wording will be added to Section 1.2.1 regarding the past history of the application sites. To the knowledge of the authors and DOE-ORO the sites that are currently being used for land application operations did not have any past historical experimental or operational projects conducted on them. The sites are not adjacent to existing structures, houses, landmarks, recreational areas and are somewhat isolated from the public except for coordinated turkey and deer hunts and security personnel. Inactive sites are not discussed as they are not planned for future use and are therefore, not part of the scope of this EA.
6	ORSSAB	On page 1-5, the paragraph relating to the city of Oak Ridge's plans, as of the summer 2001, needs to be updated. Some discussion of what has transpired since then is needed. Change the tense from "plans" to "planned."	Wording has been changed to reflect the past tense. The city of Oak Ridge has already installed and begun processing the new biosolids product.
7	ORSSAB	In light of the August 2002 referendum's defeat, the financial status of the city's operations and planned improvements needs to be re-evaluated and discussed. Some cost data on the new system and also on its long-term maintenance are necessary.	This request is not within the current scope of this environmental assessment. The city of Oak Ridge is responsible for the treatment and processing of biosolids produced at the wastewater treatment plant. The active land application sites are authorized to accept Class B (lower classification of biosolids). The city's new system produces Class A (highest classification of biosolids) and can land apply biosolids produced from their wastewater treatment plant on the Oak Ridge Reservation or private property. How the city's system operates and what it costs is not relevant to this environmental assessment as long as all state and federal regulations are followed during the application of biosolids.

Comment Number	Comment Author	Comment	Response
8	ORSSAB	Please explain the statement on page 1-5 that refers to the city's planned new treatment system, which would "increase solids content and sterilize biosolids…resulting in more manageable and safer material." What is meant by "more manageable and safer?"	A detailed discussion of why the process is safer and more manageable is available on Pages 4-6 and 4-7 of the EA. The city of Oak Ridge produced liquid, Class B biosolids which had low biological activity and was difficult to handle due to the highly fluid mobility of the biosolids (approximately 98% water). The new biosolids treatment system produces >90% solids (<10% water) which can be easily transferred to the application vehicle and any spills of the material are immobile as compared to the highly manuervable liquid previously applied on the application sites. Also, solid biosolids produced by the city are sterilized or biologically inactive and can be land applied without the restrictions that Class B biosolids must meet. The result, a safer, more manageable material.
9	ORSSAB	The Executive Summary identifies an alternative to the proposed dose rate increase being "to leave the existing Oak Ridge Reservation land application sites altogether in favor of free distribution of the biosolids material to the public." It would seem that this option could be a cheap and easy alternative, and it should be evaluated.	This statement was made in regards to a potential city of Oak Ridge action not a DOE action. Non-federal activities conducted on private property are not required to undergo a NEPA evaluation.
10	ORSSAB	How close to the 4 mrem/yr are we actually now? Or does the gamma monitoring not give enough data for this to be calculated?	Appendix B, Tables B.5 through B.10 provides an up-to-date calculation of how much of each radionuclide has been applied on each active site. Each site level is well under the established 4 mrem/yr limit using the sum of fractions methodology (limit = 1).
11	ORSSAB	Appendix D is based on a 20-year program, and it is also stated that we have 7 years remaining in that program; this would give a start date of 1989. What does 1989 correspond to, in reference to the Land Application Program started in 1984 and Oak Ridge National Laboratory (ORNL) adding waste in 1999?	Although all of the sites received approval for the land application of biosolids in 1984, with the exception of the Watson Road site (1989), the city of Oak Ridge began using the active sites in 1989. From 1984 to 1989 other inactive program sites were used. The city of Oak Ridge began accepting ORNL biosolids in 1999.

Comment Number	Comment Author	Comment	Response
12	ORSSAB	Europium-155 has a higher limit than uranium (Table D.3). Does this imply that europium is a fairly large contributor? What is its source?	A higher soil guideline value implies less of a contribution to dose (i.e., it takes more Eu-155 to give a 10 mrem/year dose (for our exposure scenario) than most of the other radionuclides. The soil guideline for Eu-155 and uranium are very similar (i.e., they both make comparable contributions to dose), but the biosolids limit for Eu-155 is much higher than the biosolids limit for uranium. The reason for this is that the Eu 155 has a much shorter half-life (less than 2 years) so you can put more on the site each year without it building up over time. The ORNL biosolids are the potential source of Eu-155 in the city system.
13	ORSSAB	Why does the Rogers site have 56.8 percent of the allocated dose, according to Table 4.2?	Table 4.2 represents the predictive model results that 56.8% of the established limit would be attained at the end of the Rogers Site application site life. This site has the highest amount of calculated radioactivity loading to date as demonstrated in Table B.8 and therefore, would project to attain the highest level of radioactivity in site soils at the end of application site life.
14	ORSSAB	Why are cesium-137 concentrations in 1999 increased, uranium-235 concentration in 1996 high, and the uranium-238 concentration usually low compared to the limit (Table B.4)?	The cesium-137 concentrations increased in 1999 due to the acceptance of the ORNL biosolids. The U-235 level of 1.85 pCi/g is 1.1% of the 4 mrem/yr limit and is not considered "high". The decrease of U-238 is due to the Y-12 Plant sewer system rehabilitation project that was completed in 1999.
15	ORSSAB	Section 1.0, page 1-1, 2nd paragraph. The ORSSAB presentations and tour of the biosolids land application sites involved the ORSSAB Waste Management Committee, not the full Board, and were informational. ORSSAB has taken no previous position on this proposal.	Reference will be changed to the ORSSAB Waste Management Committee and in no way implied that ORSSAB has taken a position on the environmental assessment being reviewed. The reference was simply stated to point out public involvement activities prior to the issuance of this document.

Comment Number	Comment Author	Comment	Response
16	ORSSAB	Section 1.1, page 1-2, 3rd paragraph. The 4 mrem/yr limit is coincidentally a drinking water maximum contaminant level for beta particles and photon radioactivity from man-made radionuclides. Use of the descriptor "self-imposed" oversimplifies the issue of setting a standard for radionuclides in sewage sludge and conveys a lack of objectivity in preparation of this environmental assessment.	There are no radionuclide limits for biosolids products in the United States. The original RESRAD modeling for radionuclides performed for the Oak Ridge Biosolids Land Application was originally based upon the 4 mrem/yr drinking water standard and expanded from 4 to 21 radionuclides in the 1996 environmental assessment on the program. This list was expanded to 23 radionuclides for the 10 mrem/yr planning limit in the current environmental assessment. Because of the fact that there are no radionuclide limits for the application of biosolids, the limits presented for the biosolids and application site soils are by definition "self-imposed", as no other regulatory body has developed and implemented these standards for any land application program in the nation.
17	ORSSAB	Section 1.2.1, page 1-5, 2nd paragraph. More details on the proposed thermal treatment system need to be provided and the fate of radionuclides undergoing thermal treatment in the proposed system evaluated as part of this environmental assessment.	Years of operational monitoring for radionuclides within the Oak Ridge Wastewater Treatment System have demonstrated that the vast majority of radionuclides contained within the discharges end up in the biosolids phase of the treatment process. This data was based upon a liquid biosolids treatment system. With the installation of the new solids treatment system, the system further enhances the removal of any residual nuclides from wastewaters and the "fate" of these nuclides is assumed to be the land application sites. All modeling assumes 100% of the radionuclides will go to the biosolids phase of the treatment process, which is extremely conservative as discussed on Page 4-9 of the EA. In reality, a loss of radionuclides could occur at the wastewater treatment plant; however, these treatment operations are conducted by a non-federal entity (city of Oak Ridge) on private property which is not required to be evaluated by a NEPA review. Moreover, specific details of the city biosolids treatment process equipment does not have any value added since 100% of the radionuclides are assumed to be land-applied on the active sites.
18	ORSSAB	Section 1.2.1, page 1-7, 2nd paragraph. The results of the survey of publicly owned treatment works for baseline radioactivity associated with biosolid products needs to be discussed in this document if available from late 2001.	The results of this survey were expected to be published by the EPA and NRC within the original referenced timeframe; however, they were not available at the time of publication of this environmental assessment. Reference will be changed to "in future months."

Comment Number	Comment Author	Comment	Response
19	ORSSAB	Section 1.2.1, page 1-8, 2nd paragraph. The letter from the Tennessee Department of Environment and Conservation-Division of Radiological Health claimed as approving the increase to 10 mrem/yr appears to only acknowledge concurrence at a planning level. The letter provided in Appendix A dose not appear to be personally signed by the past division director.	Acknowledged. The reference will be changed from "approval" to "concurrence". Both the 4 and 10 mrem/yr are "planning levels" as it is not expected that the maximum limit will ever be achieved especially given the fact that the active sites have been in use for some time and have varying levels of life expectancy remaining. Because of a lack of radionuclide standards for any land application program, "concurrence" rather than "approval" is appropriate. The letter provided by the city of Oak Ridge was produced on TDEC-Division of Radiological Health Letterhead and properly signed. There is no reason to doubt the authenticity or content of the concurrence letter in question.
20	ORSSAB	Section 1.2.2, page 1-11, 1st paragraph. According to the Oak Ridge Reservation Annual Site Environmental Report for 2001, Outfall 502 (West End Treatment Facility) had zero discharge for the calendar year. Please provide details on what portions of the approximately $133,000 cost are due to effluent monitoring and treatment process changes and be clear whether the proposal comparison is based on past or current operations.	The management and operations contractor for the West End Treatment Facility (WETF) is WSMS-MK. Since work began on the preparation of this environmental assessment, WSMS-MK gained approval from TDEC to begin bulking treated wastewaters for a bulk discharge through Outfall 502. In 2001, wastewaters were bulked and not discharged. Approximately $58,000 of estimated $133,000 in cost savings is based upon past operations and includes all analytical costs, additives, etc associated with the final WETF discharge operation.
21	ORSSAB	Section 1.3, page 1-11, 1st paragraph. Why not evaluate additional alternatives, such as retaining the 4 mrem/yr limit with addition of Y-12 West End Treatment Facility discharge and excluding ORNL or East Tennessee Technology Park biosolids or other problematic discharges?	Authorization to discharge to the city of Oak Ridge Sewer System is a city of Oak Ridge Management decision. The city of Oak Ridge has stated that if the 10 mrem/yr planning limit is not adopted, the city of Oak Ridge would have no choice but to reduce the radionuclide discharges to the city sewer system beginning with the most recent discharger (ORNL biosolids), not allow the addition of WETF and lower other DOE and commercial contributors in an effort to accommodate any new entities. This would severely limit all new and existing radionuclide discharges to the city system. The city could also leave the Oak Ridge Reservation and sell or give away Class A biosolids to anyone that expressed an interest in using the material.

Comment Number	Comment Author	Comment	Response
22	EQAB	It is not completely accurate to call the November 3, 1999, letter from Michael Mobley of TDEC an "approval," since there is no state regulatory authority under which TDEC could approve or deny radiological criteria for land application of sewage sludge. It would be more accurate to describe this letter by quoting the words it contains: "TDEC concurred in the use of the 10 mrem/year as a planning level." Therefore, references to this letter in Page 6-1, paragraph 2 and elsewhere in the EA should be revised to quote this language or describe the letter as a "concurrence letter."	Acknowledged. See response to comment #19. Wording will be revised on page 6-1 and elsewhere throughout the document.
23	EQAB	The EA should be revised to eliminate the statements that suggest that the purpose of the proposed action is to enable a private radioactive laundry facility to locate in Oak Ridge. Instead, state that a relaxation in the current 4 mrem/year standard would give the city flexibility to allow increases in discharges of radioactive substances to the sanitary wastewater system, while continuing to accept ORNL sewage sludge in the biosolids program.	Acknowledged. Reference to the laundry will be deleted throughout the document and the requested verbiage added where appropriate.
24	EQAB	The EA should be revised to eliminate the statements that imply existing restrictions on people's access to solids application sites on the Oak Ridge Reservation would continue forever. However, we suggest that if these sites are ever transferred into private ownership, prospective owners should be made aware that the land was used for biosolids application.	Modeling assumes a home-steader scenario which is a person that lives on the application sites 24-hours per day/365-days per year for 100 years. The wording referenced implied that access is restricted during normal biosolids land application operations and in no way implied the future use of the sites. Wording will be changed to clarify the reference. 40 CFR 503 regulations require notification that land application of biosolids has occurred on the property prior to change of ownership and all regulated contaminant levels be maintained.

Comment Number	Comment Author	Comment	Response
25	EQAB	To supplement the risk assessment in the EA, the EA should compare projected radionuclide concentrations in the top 6 inches of soil at the various land application sites with EPA's preliminary remediation goals (PRGs) for radionuclides. The EPA PRGs were cited and discussed in the recent EPA report on soils investigations in Oak Ridge's Scarboro neighborhood. These values are used by EPA to determine whether a site requires additional assessment under the Superfund program. It would be useful to have assurance that EPA would not come in and identify the sludge application areas as sites requiring Superfund investigation. Additional information about the PRGs for radionuclides is available on the Internet at http://epa-prgs.ornl.gov/radionuclides/.	The purpose of the EA is to evaluate land application of city Oak Ridge bisolids relative to a proposed 10 mrem/yr dose limit, not a risk-based cleanup level. The EPA's Risk Assessment Guidance for Superfund: Vol. 1 Human Health Evaluation Manual Part B notes that PRGs are established early in the scope phase of a CERCLA cleanup project, and are modified as more site specific data are collected during the RI/FS process. PRGs are meant to be used by remedial design staff during the RI/FS to focus the selection of remedial alternatives and may change as the RI/FS is completed. They are also an important tool for establishing data quality objectives early on in the cleanup process. The PRG is, therefore, not a fixed target during the cleanup process and may change as the RI/FS evolves. Inclusion of the PRGs would be very misleading because 1) the EA does not assess remedial actions under CERCLA and 2) there is not intention of refining the preliminary risk-based value. The Interagency Steering Committee on Radiation Standards (ISCORS), which includes EPA, DOE, NRC, DOD, DOT and DHHS released ISCORS Technical Report No. 1 in July 2002, reporting a does to risk conversion factor of approximately 8 x 10-7 to cancer risk/mrem, plus or minus an order of magnitude. A 10 mrem dose is therefore roughly equivalent to 8 x 10-6 risk of cancer incidents (30 year exposure). Even within the range of uncertainty, 10 mrem translated into 8 x 10-5 to 8 x 10-7: all within the National Contingency Plan acceptable risk range of 10-4 to 10-6.
26	EQAB	An alternative approach to reducing average radionuclide loading at any individual site would be to add additional sludge application sites to the program and set lower limits on sludge loading at each site. The EA should consider and explore the potential impact of this alternative.	This alternative has already been assessed in the previous EA, DOE/EA-1042, Dated October 1996 and use of the current sites was selected as the preferred alternative.
27	EQAB	Page 7-2, lines 5-6. The 1996 EA is DOE/EA-1042. Please include the document number in the reference citation.	Acknowledged. Document number has been added.
28	LOC	The no-action alternative is vaguely stated, and one scenario includes possible exclusion of sludge from ORNL, forcing it to dispose of it as low-level waste. It's not clear why ORNL sludge could not be applied to ORR lands under a separate program.	This alternative has already been assessed in the previous EA, DOE/EA-1042, Dated October 1996 and use of the city of Oak Ridge Biosolids Program was selected as the preferred alternative.

Comment Number	Comment Author	Comment	Response
29	LOC	No other alternatives are proposed, and that is a deficiency of the document. One may be that the city of Oak Ridge ensures that dischargers have adequate measures in place to reduce radioactive discharges, which would eliminate the need for raising the limit. The other is to model the influence of sewer rehabilitation, which has already substantially decreased the uranium content of biosolids (page B-4.)	This EA only addresses actions conducted by the federal government on federal property, in this case, the Oak Ridge Reservation. How the city of Oak Ridge administers their industrial pre-treatment program and maintenance activities of sewer system rehabilitation program is not within the scope of this EA.
30	LOC	Further, the comparison of alternatives do not discuss one of the larges classes of generators in a community - medical facilities. It would be helpful to know the relative contribution of radionuclides by Methodist Medical Center, the typical half-life and whether this is a significant contribution to the dose rate calculation.	Radionuclide discharges from medical facilities are exempt from EPA and NRC regulation. The chief nuclide of concern in the Oak Ridge sewer system from Methodist Medical Center is Iodine-131. Because I-131 has a half-life of only 8 days and the length of treatment and land application (60 to 90 days) at the wastewater treatment plant, it has virtually decayed off before it is land-applied; therefore, I-131 does not contribute to the dose rate calculation.

Comment Number	Comment Author	Comment	Response
31	LOC	In addition, the reviewers found it difficult to follow the analysis of loading at application sites (Appendix E). What is the "lifetime" of the system? Does this assume that dispersion and decay will be in steady state with respect to application rates? The results as summarized on page E-2 do not support raising the limit; the Rogers Site, which has the greatest percentage of the proposed radionuclide loading limits, attains just 56.8% of the existing 4 mrem/yr limit under the predictive model.	Appendix E represents a predictive modeling analysis that "predicts" what radionuclide levels each of the current land application sites will attain when they reach the end of their site life, which is 50 tons/acre. The model assumes no decay and even dispersion throughout the upper 6 inches of soil on each application site. The purpose of this model is demonstrate that the current and proposed radionuclide planning levels have an extremely low probability of attaining the soil radionuclide levels listed in Appendix D, Table D.3. Although only 56.8% of Rogers Site radionuclide limits would be achieved at the end of site life, the city of Oak Ridge uses "worst-case" discharge modeling for all dischargers and the authorized 4 mrem/yr planning level to determine how much and what radionuclides can be accepted in the sewer system. With the addition of ORNL in 1999, the maximum planning level of 4 mrem/yr for all dischargers both government and commercial, had been achieved. Although it is extremely unlikely that all permitted dischargers will discharge the maximum allocated radionuclide levels to the Oak Ridge Sewer System at one time, EPA requires municipal wastewater treatment plants to use "worst-case" planning to allocate front-end discharges. Front-end limits cannot exceed end-point limits. Put simply, the pre-treatment radionuclide planning levels must be increased to 10 mrem/yr in order to allow the city of Oak Ridge the flexibility to accept new commercial and government customers and therefore, the land application sites planning levels must be increased to 10 mrem/yr as well. This is explained on Pages 1-8 & 1-9 of the EA.
32	LOC	The inclusion of Potassium-40 in Table G.3 is puzzling. Since that is a common naturally occurring radionuclide, does the amount listed represent that additional K-40 added to the system by other sources? If not, what proportion is considered natural background vs. what is added? K-40 is not known be produced at any of the DOE sites.	ORNL has conducted independent testing and analysis of the city of Oak Ridge biosolids. Table G.3 represents historical levels noted in the Oak Ridge Biosolids and was provided as a background analysis by ORNL. The levels of K-40 displayed represent background values for the city of Oak Ridge Biosolids. K-40 is included in the 4 and 10 mrem/yr planning levels because it has the potential to be present in ORNL Biosolids.

Comment Number	Comment Author	Comment	Response
33	LOC	Also confusing is that the lists of radionuclides of interest in various sampling schemes and model do not correspond to each other. This leads the reviewer to doubt whether the models are comparable and applicable. Tables 4.1 and 4.4 list Co-60, Cs-137, U-235 and U-238 for known radionuclides currently monitored. In Appendix B, four additional radionuclides (I-131, Be-7, K-40 and Ra-228) are listed in Table B.4. as being found in city biosolids, although it is noted on page B-4 that medical facilities also contribute Tc-99m (not mentioned elsewhere).	As stated in the response to comment #32, ORNL has independently performed the city biosolids radionuclide. ORNL reports background radionuclides such as K-40, Be-7 and Ra-228 which are not discharged by any known discharger and are considered background values for the city of Oak Ridge Biosolids. I-131 is monitored also but because of its short half-life (8 days) it does not accumulate on the biosolids land application sites and does not contribute to the on-site dose. Tc-99m is a medical isotope that is used to destroy thyroid tissue. It has an extremely short half-life (6 hours) and typically degrades before it arrives at the wastewater treatment plant for treatment. Therefore, it is not monitored and does not contribute to the on-site dose. This is explained in Appendix D, Page D-5 of the EA.
34	LOC	The RESRAD model in Appendix D addresses a suite of radionuclides that drop some of the ones in the previous tables (I-131, Be-7, K-40, Ra-228) and add other not noted previously (Eu-152, Eu-154, Eu-155, U-234, Mn-54, Zn-65, Sr-90, Cs-134), apparently based on the possibility that they might in the future demonstrate detectable levels.	See responses for comments 32 & 33. The new nuclides were added because ORNL informed the city of Oak Ridge of the possibility that they may be present in their biosolids.
35	LOC	The Appendix E model is apparently based on historical average radionuclide levels observed in the sewer system-it is unknown whether these are the ones listed in the Section 4 tables or in Appendix B.	The Tables in Section 4 represent risk factors and dose rates. Appendix B provides characterization data for the Oak Ridge Biosolids. The predictive modeling performed in Appendix E uses historical averages of the nuclides over a 14 year period (since 1988) and includes the data presented in Appendix B for biosolids radionuclides. Appendix B only includes biosolids radionuclide data from 1996 to 2000.
36	LOC	The human health risk assessment in Appendix G uses six radionuclides, including all from Section 4 tables and two (K-40, Ra-228) from Appendix B. The Appendix G risk assessment notes that Be-7 and I-131 have half-lives of less than two months and so they were not considered (although one would expect that the risk from these could have been calculated based on application rate as their presence is being consistently renewed).	Short-lived radionuclides such as Be-7 and I-131 were not included in risk calculations because of their short half life and the time that is required for wastewater treatment and biosolids production to be completed (60 to 90 days from discharge point). By the time of land application, there are minimal amounts of these nuclides present and therefore, are not calculated in the long-term risk scenarios provided as a part of this EA.
37	LOC	The NPDES risk assessment in Appendix H only looks at the radiological risk from uranium.	This is due to the fact that this assessment was primarily for comparing risk factors for discharge of WETF wastewaters directly to EFPC vs. sanitary sewer. Only uranium is found in the WETF wastewaters.

Comment Number	Comment Author	Comment	Response
38	LOC	The dose impact model in Appendix I and the biological assessment in Appendix J consider only the four radionuclides listed in the Section 4 tables.	The four nuclides listed are the ones that are recognized to be present in the Oak Ridge Sewer System, are closely monitored and have the greatest potential to provide the majority of any dose received as a result of the land application of biosolids.
39	TDEC DOE Oversight	It should be noted that the subject sludge fails to meet the definition of Class A sludge according to 40 CFR 503 regulations in view of the proposed changes to add radiological constituents in the sludge. Class A sludge by definition are sludge with pathogens or other non-radiological constituents.	Class A biosolids per the referenced 40 CFR 503 regulations are biosolids that meet Table 3, 40 CFR 503.13 heavy metal pollutants limits, one of Class A Pathogen Reduction requirements as listed in 40 CFR 503.32(a)(1) through (a)(8) and one of vector attraction reduction requirements listed in 40 CFR 503.33(b)(1) through (b)(12). Radionuclides in biosolids are not regulated by the U.S. EPA, NRC or delegated states and are not included in the 40 CFR 503 regulations. Radionuclides are present in all biosolids products as evidence from the 1995 Association of Metropolitan Sewerage Agency survey. Survey results can be found at http://www.amsa-cleanwater.org/pubs/radioactivity/appendixc2.pdf. The presence or absence of radionuclides in biosolids have no bearing on the EPA classification of biosolids products at municipal wastewater treatment plants.
40	TDEC DOE Oversight	A map to identify areas of interest is necessary for this document. The wetlands, springs, and other pertinent topographical features are not obviously located on Figure 1.1 (the only map in the document). Perhaps a 1/2000 scale of the six application sites (include topography, streams, wetlands, sinkholes, ponds, buildings, roads, etc.) would be useful as a supplement to Figure 1.1. the lack of detail of Figure 1.1 does not allow for the projection of the Division of Natural Heritage Threatened and Endangered Species map data upon the biosolids map sites. This information is necessary to help determine potential impacts.	The map that is provided on page 1-6 is the standard map that has been and is currently being used in documentation for the Oak Ridge Biosolids Land Application Program. The requested change is viewed as adding additional information that complicates the desired objective of the original map which is to simply show the location of the active land application sites on the Oak Ridge Reservation. Detailed information on wetlands, threatened and endangered species, etc. is available in Section 3.0 of the EA and the U.S. Fish and Wildlife Service (FWS) has also reviewed the proposed changes with regards to impacts to Threatened and Endangered Species. FWS responded with a request for a biological assessment for the Gray and Indiana Bats. A full BA was performed in Appendix J and was concurred on by FWS on September 25, 2002.
41	TDEC DOE Oversight	How often is the site sprayed with radioactive waste?	The Oak Ridge Reservation Biosolids Land Application Sites are only authorized for use by the city of Oak Ridge to apply **sanitary** biosolids that meet or exceed all 40 CFR 503 requirements. Radioactive waste has never been "sprayed" on the application sites.

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42	TDEC DOE Oversight	If the West End Treatment Facility (WETF) becomes a pretreatment facility before discharging wastewater to the sanitary sewer system, the city of Oak Ridge (COR) could require sampling and analysis at the facility. Cost would still be associated with this sampling and analysis.	Regardless of whether WETF discharges to EFPC or the city sewer system, WETF will treat all wastewaters and is not considered a "pretreatment" facility. Use of this term indicates that the citys wastewater treatment will remove the majority of the WETF contaminants when in fact WETF removes 99.9% of all contaminants through its treatment process. Discharge to the city sewer system offers a more cost-efficient option for WETF operations. While the city could require additional sampling within WETF operable units, WETF operations performs a number of additional samples **prior** to wastewater bulking in order to assess whether treated wastewaters could potentially be discharged to the sewer system. In addition, a final compliance sample will be performed, analyzed and reported **prior** to authorization to proceed discharging which involves over 165 contaminant parameters, as opposed to approximately 25 that would normally be required to discharge to the sewer system. The cost of these analytical samples have been included in all cost savings calculations.
43	TDEC DOE Oversight	Although the city requires monthly sampling of a 24-hour composite at the East End Sanitary Sewer Monitoring Stations, this sampling is not continuous. Therefore, it is very likely that an upset condition of elevated radionuclide levels would not be recognized. Also, an exceedence of the derived concentration guideline (DCG) for radionuclides in DOE Order 5400.5 would not be recognized until after the elevated levels have entered the COR sewer system. This situation was seen in February 2000 when the Y-12 Central Pollution Control Facility (CPCF) batch discharge exceeded the DOE 5400.5 DCG for uranium by 14 fold. Due to dilution, this exceedence was not seen at the Station 17 sampling station and was not recognized until after receipt of the NPDES data results.	Each batch that is treated and bulked at WETF will undergo a 5400.5 evaluation **prior** to discharge to the sewer system. All contaminant data is also forwarded to the Y-12 Sanitary Sewer Coordinator, who will review and approve WETF for discharge, as well as the rate at which treated wastewater will be pumped into the sewer system. All radionuclide levels will be known before discharge and the rate at which it enters the sewer system is controlled such that if an upset situation from flooding, excess radionuclide discharges from any other source within the Y-12 plant sewer system or ruptures within the sewer lines occurs, WETF discharges can be instanteously halted.

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44	TDEC DOE Oversight	Since pretreatment requirements are usually less stringent than National Pollution Discharge Elimination System (NPDES) permit requirements; it is likely that there will be a decrease in the removal efficiency of the WETF. An interim goal of the NPDES program is to ensure that treatment facilities improve treatment capabilities over the life of the NPDES program. Maximum efficiency of the WETF will not be achieved when the sampling is performed at the East End Sanitary Sewer Monitoring Station after mixing with other Y-12 wastewater (including the landfill leachate).	All batches will undergo the same treatment and removal efficiencies because wastewaters that are candidates for sewer system discharge are not determined until extensive treatment on each batch has already been conducted. In addition, batches that are bulked for discharge to the city sewer system are sampled and analyzed for 165 priority pollutants **prior** to discharge. NPDES sampling requires less than 20 parameters to be monitored. WETF compliance sampling will not be taken at the East End Sanitary Sewer Monitoring Station but rather at Tank F-8 located at WETF and will be performed **prior** to discharge authorization. Additional information regarding 5400.5 compliance is available in Section 4.1.9 and 6.0 of the EA.
45	TDEC DOE Oversight	Since Y-12's sanitary sewage, the Y-12 Steam Plant Wastewater Treatment Facility, the Y-12 Landfill leachate, and now potentially the Y-12 West End Treatment Facility all discharge to the COR's sewer system, DOE Orders are applicable to the Biosolids Program. How does DOE intend to ensure that the Biosolids Program is in compliance with the applicable DOE Orders?	While all effluent discharges to the city of Oak Ridge Sewer System from Y-12 must meet DOE Order 5400.5 criteria, the Biosolids Program is operated by the city of Oak Ridge, a non-DOE entity. The city of Oak Ridge is not under the purview of any DOE Orders. While biosolids are applied on the Oak Ridge Reservation, DOE intends to ensure the Biosolids Program remains in compliance with all EPA requirements and the proposed 10 mrem/yr radionuclide planning levels through independent oversight activities such as assessments and audits. ORNL also performs independent testing of the biosolids and performs cross calibration analysis of city equipment to ensure radionuclide testing is adequate.
46	TDEC DOE Oversight	References were made as to TDEC-approved land application sites. The TDEC approval for the land application sites expired in 1999. TDEC does not provide lifetime approvals for sludge application sites. It should be noted that the 40 CFR 503 sludge concentration tables are based upon a lifetime application of 20 years. The city of Oak Ridge's program has been conducted for 19 years.	The existing application sites were approved by TDEC on November 28, 1983 and May 8, 1989 and state a limit of 50 tons per acre. There is no date of expiration stated in either letter and there is no letter in the Programs files stating that TDEC is no longer responsible for the Oak Ridge Reservation application sites. The 40 CFR 503 tables referenced are in Section 40 CFR 503.13, Tables 1 through 4 and are not based upon a specific timeframe. Rather, they are based upon pollutant concentrations. The only time-limited application parameters noted in the 503 regulations are for an Annual Pollutant Application Rate (heavy metals) and an Annual Agronomic Rate (nitrogen). While it is correct that they program has been in operation for 19 years, the active sites began use in 1989.

Comment Number	Comment Author	Comment	Response
47	TDEC DOE Oversight	The Y-12 Modernization Program includes the addition of the Highly Enriched Uranium Facility, the Specials Materials Complex, and the Enriched Uranium Manufacturing Facility. What wastewater will be produced from these facilities and does DOE plan to discharge wastewater from these facilities to the sanitary sewer system?	While it is conceivable that wastewaters discharged from the referenced facilities could be treated at WETF, wastewaters discharged from the referenced facilities directly to the Y-12 and city sewer systems are not within the scope of this EA. All treated wastewaters produced at WETF will be required to meet proposed sanitary sewer discharge limits listed in Appendix B, Table B.12 of the EA regardless of wastewater source.
48	TDEC DOE Oversight	Page vii, 1st Paragraph, Last Sentence: states that "In addition, …discharge of treated wastewater from the West End Treatment Facility (WETF)…resulting in an operational cost savings of approximately $133,00 per year." This statement and a similar statement on Page 2-5, Second Paragraph is incorrect or misleading because during the June 2002 Biosolids Working Group meeting DOE stated that the operational cost savings associated with the WETF have already been achieved by changes in the sampling and analysis strategy.	See comment response #20. Yes, a portion of the cost savings have already been realized by the contractor (WSMS-MK) because of authorization to bulk and sample wastewater batches for discharge through NPDES Outfall #502. These activities were accomplished while the proposed action to discharge to the sanitary sewer system are being evaluated in this EA.
49	TDEC DOE Oversight	Page 1-2, Paragraph 30-32: states "The long-term solution recommended by TDEC involved increasing land application site loading criteria from a cumulative dose-based on 4 mrem/yr to one based on 10 mrem/yr for a maximally exposed individual. The approval letter from TDEC is available in Appendix A." The implication of this statement is misleading to the public and misguiding to COR and DOE in that TDEC does not recommend or provide long-term planning strategies or solutions for localities in this context of waste management.	Acknowledged, wording will be changed to remove references that TDEC was involved in the planning strategy process. DOE did not request the proposed limit increase; however, DOE is assessing any potential environment impacts associated with this requested change in this EA.
50	TDEC DOE Oversight	Page 1-5, 1st Sentence: "in the summer of 2001 the COR plans to implement a new de-watering and thermal treatment systems…" The sentence is written in the future tense. What is the present status of the new system?	See comment response #6.
51	TDEC DOE Oversight	Page 1-7, Line 23: refers to a 2001 NRC survey that will be available to the public. The sentence is written in the future tense. What are the results of the survey?	See comment response #18.

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52	TDEC DOE Oversight	Page 2-2, Lines 1-2: states "Since contaminant levels are very low, DOE proposes a controlled, monitored discharge to the Y-12 Sanitary Sewer System…" Please provide estimates or averages of the contaminant levels.	Batches of wastewater are undergoing various stages of treatment continuously, therefore, contaminant levels will vary from batch to batch as pointed out on Page 1-9 of the EA. Presently there are no batches that are ready for discharge to the sewer system as this discharge option is not available due to the NEPA evaluation being conducted in this EA. All treated batches will be required to meet the proposed sanitary sewer discharge limits listed in Appendix B, Table B.12.
53	TDEC DOE Oversight	Page 2-2, Lines 9-11: states "only a small portion of the total uranium…would be land applied." Please explain the process that removes the greater portion of uranium before land application.	Heavy metals and radionuclides are removed at the head end modification unit within WETF. This is the 1st step of the treatment process within WETF and is 99.9% efficient at removing these contaminants. Wastewaters exiting the head end modification unit will then receive treatment for organics and nitrate removal, as well as residual solids removal **prior** to discharge to the Y-12 and city sewer systems.
54	TDEC DOE Oversight	Page 2-6, Lines 7-13: "The city could leave the ORR land application sites in favor of freely distributing the treated biosolids material to public outlets consistent with EPA regulations. All, present and future DOE sanitary wastewater and biosolids bearing any level of radionuclides requiring treatment in all likelihood, would not be accepted...forcing DOE to explore other more costly treatment alternatives...The acceptance and treatment of ORNL biosolids could also be discontinued." The above statement is made in reference to the No Action Alternative. (1) If the biosolids are freely distributed to the public, will the public be aware of the radioactive constituents in the biosolids? The current EPA regulations for biosolids do not address radiological contamination in the biosolids.	The decision to include radionuclide data in biosolids product information is a city of Oak Ridge management decision. The city of Oak Ridge is required by the 40 CFR 503.14(e) to affix a label to a bag or other container that states (1) The name and address of the person who prepared the sewage sludge that is sold or given away in a bag or other container for application to the land. (2) A statement that application of the sewage sludge is prohibited except in accordance with the instructions on the label or information sheet. (3) The annual whole sludge application rate for the sewage sludge that does not cause any of the annual pollutant loading rates in Table 4 of 40 CFR 503.13 to be exceeded.
		What is meant by "freely distributing?" Does this phrase mean cost fee or widely distribute?	The city of Oak Ridge could give away or sell Class A biosolids produced at their wastewater treatment plant to any private entity desiring to use their biosolids product.
		Due to operational difficulties with the renovations of the POTW, it should be noted that the COR has not accepted or treated ORNL biosolids since the spring of 2001, which is approximately 19 months. The reason given for the non-acceptance is due to the operational difficulties with the current renovations to the POTW.	The acceptance of ORNL biosolids is a city of Oak Ridge management decision.

Comment Number	Comment Author	Comment	Response
54	TDEC DOE Oversight	Currently, the COR is experiencing operational difficulties with its renovations and is still producing Class B sludge during these difficulties. What is the COR contingency for land application sites during these and future operational difficulties. What is the COR contingency for land application sites during these and future operational difficulties?	The operational difficulties are in reference with the Class A biosolids treatment system. The existing land application sites can either receive Class A or Class B biosolids. As long as the city of Oak Ridge meets minimum Class B biosolids treatment standards listed in the 40 CFR 503 regulations, the application sites can be utilized.
55	TDEC DOE Oversight	Page 2-6, Lines 23-24: states "An estimated cost savings of $133,000 projected in the Sanitary Sewer Assessment (WSMS 2000) would not be realized." During the June 2002 Biosolids Working Group meeting DOE stated that the operational cost savings associated with the WETF have already been achieved by changes in the sampling and analysis strategy.	See comment response #20.
56	TDEC DOE Oversight	Page 3-10, Lines 25-26: states "Watson Road and Rogers sites do not provide listed plant habitat for shade tolerant species." and Pages 3-11, Lines 14-16: states "One sites, Rogers is planted with a diverse array of shrubs, trees, and grasses which provide abundant wildlife and food habitat, but do not contain listed species or habitat." There appears to be a contradiction between these statements. It is confusing to the reader as to whether Rogers site contains listed species or does not contain listed species or habitat. These statements need more explanation or clarification.	Acknowledged. Wording changed to "possibly provide habitat for shade tolerant species" and "does not contain known listed habitats."
57	TDEC DOE Oversight	Page 4-4, Table 4.1: Cobalt-60 is shown with a risk of 2 x 10-4 for both 4 mrem/yr and 10 mrem/yr risk factors. Cobalt 60, although a short half-life (5.3 years) is a higher energy radionuclide than the others on the list. Is the chart correct?	There is an error in Table 4.1. The 4 mrem/yr risk factor is 9 x 10-5. The correction will be changed in the document.
58	TDEC DOE Oversight	Page 4-22, Line 33: "Impacts of any additional pip installation." Is this supposed to be pipe installation?	Acknowledged. Wording changed from pip to pipe.

Comment Number	Comment Author	Comment	Response
59	TDEC Radiological Health	Page vii, Line 18-22. Recommend to include the 10 mrem/yr composite of 10 years of deposition in the RESRAD calculation. Does the calculation include what has already been deposited with the 4 mrem limit? If not, why not?	The 10 mrem/yr RESRAD modeling assumes no radionuclides are present on a generic land application site. Radionuclide concentrations from past operations will not lower or raise the individual radionuclide planning levels as the maximum limit is 10 mrem/yr regardless or whether they are included in the modeling or not. Dose based limits are calculated using 9 different pathways and the most conservative pathway is utilized to develop application site soil and biosolids limits. Compliance with the established limits is demonstrated by tracking how much of each nuclide has been applied since site use began and comparing the respective nuclide to the established soil limit. By dividing the amount applied by the established limit, a fraction is calculated. All fractions of known, monitored nuclides are calculated and summed. The summed results are compared to a limit of 1 (100% of the proposed 10 mrem/yr limit). Therefore, this activity is being performed to determine compliance with the limit as opposed to developing the planning level.
60	TDEC Radiological Health	Page viii, Line 31. Does the cost savings $133,000 come from the reduction of the utilization of the EPS?	The estimated cost savings of $133,000 includes a reduction in operating materials from EPS and a reduction in sampling and analysis costs associated with NPDES Outfall #502.
61	TDEC Radiological Health	Page 2-1, Lines 17-21. Include the composite of 10+years of deposition, current deposition plus expected.	The proposed 10 mrem/yr planning level provides maximum limits for 23 radionuclides that are currently present or have the potential to occur in the Oak Ridge Sewer System. These limits are available in Appendix D. The calculated amount of radionuclides on each land application site is available in Appendix B, Tables B.5. through B.10. The proposed 10 mrem/yr limits will be evaluated against cumulative radionuclide limits since each site began use for the land application program.
62	TDEC Radiological Health	Page 4-17, Line 21. Refers to concentration release limits or regulated concentration limits.	Acknowledged. Wording will be changed to refer to "concentration release limits."

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Comment Number	Comment Author	Comment	Response
63	TDEC Radiological Health	Page 4-19. Can add risk factor background radiation.	The purpose of the Table 4.5 is to show typical exposure rates from common everyday sources and to place into perspective the maximum dose (10 mrem/yr) being proposed for the land application sites. Because of the numerous pathways and complex variables associated with the common everyday sources of dose exposure, it is inappropriate to calculate risk for comparison with the risk values calculated for the proposed 10 mrem/yr planning level in this EA.
64	TDEC Radiological Health	Page 4-19, Lines 30-33, and Page 4-20, Lines 1-5. Explain if the RESRAD calculation includes the sludge from the WETF and the POTW together, if your intention is for both sources of sludge to go on the same land area.	Only sanitary biosolids (I.e. sludge) produced by the city of Oak Ridge will be land-applied on the active land application sites. Only treated wastewaters from WETF will be discharged to Y-12 and city of Oak Ridge Sewer Systems.
65	TDEC Radiological Health	Page 5-4, Line 1-2. I don't understand why you state "no impacts" as opposed to negligible impacts.	Acknowledged. Wording will be changed from no impacts to negligible impacts.
66	TDEC Radiological Health	Refers to release concentration limits.	Acknowledged. Wording will be changed to reflect release concentration limits.
67	TDEC Radiological Health	Acknowledge documentation on: 1. Risk factors on page 4-4. 2. CEDE to worker on page 4-12. 3. External exposure for worker on page 4-17. 4. POTW discharge to EFPC on page 4-8.	Acknowledged. Literature references added.