

Evaluation of TENORM in Drinking Water and Wastewater Treatment Systems Report

Tetra Tech Project# 117-8296103
DEQ EDMS Document No. 2023BCJ143

September 26, 2023

PRESENTED TO

Idaho Department of Environmental Quality

1410 North Hilton
Boise, Idaho 83706

PRESENTED BY

Tetra Tech

3380 Americana Terrace,
Suite 201
Boise, Idaho 83706

P +1-406-489-2826
tetrattech.com

Prepared by:

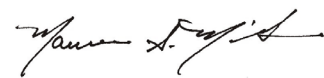


9/26/23

Jerold A. Armstrong
Sr. Hydrogeologist

Date

Reviewed by:



9/26/23

Maureen McGraw, PhD, PE
Sr. Engineer/Project Manager

Date

TABLE OF CONTENTS

1.0 INTRODUCTION	1
2.0 BACKGROUND	1
3.0 SITE INVESTIGATION METHODS	1
3.1 Sampling	1
3.1.1 Fruitland.....	2
3.1.2 Glenns Ferry	2
3.1.3 Greenhill Estates	3
3.1.4 Moyie Springs.....	4
3.1.5 Orofino	4
3.1.6 Priest River	5
3.2 Quality Assurance Sample Collection	5
4.0 INVESTIGATION RESULTS	6
4.1 Analytical results	6
4.2 Comparison to Expected Soil Background	7
5.0 IDW MANAGEMENT	7
6.0 QUALITY ASSURANCE REVIEW	7
6.1 Stage 2A Data Review, Verification, and Validation	7
6.1.1 Precision	8
6.1.2 Representativeness.....	8
6.1.3 Comparability.....	9
6.1.4 Completeness.....	9
6.1.5 Sensitivity.....	9
6.1.6 Summary	9
6.2 Deviations from the QAPP	9
7.0 SUMMARY AND RECOMMENDATIONS	9
8.0 REFERENCES	10

APPENDICES

APPENDIX A – TABLES

APPENDIX B – FIELD NOTES

APPENDIX C – LABORATORY ANALYTICAL REPORTS

APPENDIX D –QUALITY CONTROL REVIEW

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
%	Percent
%R	Percent recovery
DEQ	Department of Environmental Quality
DQOs	Data quality objectives
EPA	Environmental Protection Agency
HASP	Health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDAPA	Idaho Administrative Procedures Act
MDA	Minimum detectable activity
MDC	Minimum detectable concentration
NORM	Naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PARCC	Precision, accuracy, representativeness, comparability, and completeness
pCi/g	picocuries per gram
PM	Project manager
PPE	Personal protective equipment
POTW	Publicly owned treatment works
QA	Quality assurance
QC	Quality control
QAM	Quality assurance manual
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QA/QC	Quality assurance/quality control
QMP	Quality management plan
RPD	Relative percent difference
SOP	Standard operating procedure
TENORM	Technologically enhanced naturally occurring radioactive materials
TO	Task order
TPU	Total propagated uncertainty
US	United States

1.0 INTRODUCTION

Tetra Tech investigated the presence of technologically enhanced naturally occurring radioactive materials (TENORM) in water treatment residuals for the Idaho Department of Environmental Quality (DEQ) at participating communities in Idaho. The activities were performed to fulfill Task Order (TO) No. 50 of DEQ's Contract No. K306 with Tetra Tech.

Tetra Tech's scope of work under TO 50 includes:

- Prepare a site health and safety plan (SSHP) to guide field activities.
- Conduct sampling from up to 7 PWS and 6 POTW facilities;
- Perform data review and analysis including QA/QC review of data.
- Prepare a project report.

The project was conducted in general accordance with the project Quality Assurance Project Plan (QAPP) developed for the Site (Tetra Tech, 2023). **Section 1** of this report presents an introduction; **Section 2** provides background site information as well as the investigation methods; **Section 3** presents the site investigation methods; **Section 4** present site investigation results; **Section 5** discusses IDW management; **Section 6** presents results of a quality assurance review; **Section 7** presents a summary and recommendations; and **Section 8** includes references. **Appendix A** presents tabulated analytical data for samples obtained during this investigation. **Appendix B** provides copies of the field notes. **Appendix C** provides the laboratory analytical report for samples obtained during this investigation. **Appendix D** includes the data evaluation checklist.

2.0 BACKGROUND

All rocks and soils contain some trace amounts of Naturally Occurring Radioactive Materials (NORM). When a drinking water source, either surface or groundwater, comes in contact with NORM-bearing rocks and soils, radionuclides can accumulate in the source water. The most frequently occurring radionuclides of concern (and their decay products) found in source water are radium-226 and -228 (Ra-226 and Ra-228).

Technologically enhanced naturally occurring radioactive materials (TENORM) is NORM whose radionuclide concentrations were caused or increased by human practices. TENORM does not include background radiation or the natural radioactivity of rocks and soils. TENORM is not federal Nuclear Regulatory Commission (NRC) licensed material. TENORM is not nuclear waste.

IDAPA 58.01.10 (DEQ, 2022) prohibits disposal of TENORM at a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill (a landfill that accepts nonhazardous waste and household waste). DEQ is evaluating TENORM-containing wastes generated by certain drinking water and wastewater treatment facilities in Idaho. The ultimate objective is to determine if IDAPA 58.01.10 should be modified to ensure TENORM management is protective of human health and the environment.

3.0 SITE INVESTIGATION METHODS

3.1 SAMPLING

The following section presents methods used to sample the various media from the treatment systems at participating communities. Sampling equipment included stainless steel spoons, stainless steel bowls, stainless steel augers and a Sludge Judge sampling system. Equipment was decontaminated between samples according

to method outlined in the Project QAPP (Tetra Tech, 2023). All samples were submitted to Pace and analyzed for Ra-226 and Ra-228.

3.1.1 Fruitland

Fruitland Water Treatment Facility

Tetra Tech obtained samples from the Fruitland water treatment facility on March 07, 2023. The facility has two drying ponds. The southern pond was completely dry and the northern pond contained approximately 4 feet of water at the time of sampling. The water treatment facility also has filter media but it was not due to be replaced therefore no sample of the media was collected.

The dry southern pond was divided into two equal area halves. Six subsamples were obtained from each half using a stainless steel spoon which were placed in a stainless steel bowl. The sample from the south half of the southern pond was labeled FRUITLAND-WT-SLUDGE-1. The sample was also used by the laboratory for the field duplicate FRUITLAND-WT-SLUDGE-DUP. The sampling equipment was decontaminated and a composite sample was obtained from the north half of the southern pond, placed into a 1-gallon Ziploc bag and labeled FRUITLAND-WT-SLUDGE-2. The bag was then placed into a 2-gallon Ziploc bags for shipment to the analytical laboratory.

A composite sample was obtained from the northern pond by obtaining six subsamples from the edge of the water filled pond using a stainless steel auger. Two subsamples were obtained from the ramp area using wading boots and a stainless steel bowl/spoon. The remaining four sub samples were obtained from the edge of the concrete pad, where the field scientist reached through the fence with the auger to collect the samples. The contents of each auger sample was poured into the bowl so as much liquid as possible could be drained off. The subsample locations were limited to this location due to the deep water and steep sides of the pond. The subsamples were placed into a one gallon Ziploc bag and labeled FRUITLAND-WT-SLUDGE-3. The bag was then placed into a 2-gallon Ziploc bag for shipment to the analytical laboratory.

Fruitland Waste Water Treatment Facility

Samples were obtained from the Waste Accumulation Settling (WAS) tank and the biosolids pile on March 07, 2023. A Fruitland Waste Water Treatment Facility employee used a Sludge Judge sampling system to collect the sediment from the bottom of the WAS tank. The relatively small diameter of Sludge Judge sampler requires numerous subsamples to obtain sufficient volume of material to comprise the composite sample. The Sludge Judge samples were placed into stainless steel bowls and decanted of free liquid. The solids in the bowls were then placed in two 1-gallon Ziplock bags and labeled FRUITLAND-WW-WASTANK-3. Each bag was then placed into 2-gallon Ziploc bags for shipment to the analytical laboratory.

Two composite samples were collected from the end product biosolid pile using a stainless steel spoon and stainless steel bowls. The Waste Water Treatment Facility employee indicated that the biosolids are taken to a landfill several times a week. Each composite sample from the biosolids consisted of six subsamples taken at random locations in the pile. The composite samples were placed in two 1-gallon Ziplock bags and labeled FRUITLAND-WW-BIOSOLIDS-1 and FRUITLAND-WW-BIOSOLIDS-2. The sample FRUITLAND-WW-BIOSOLIDS-1 was also used by the laboratory for the field duplicate (FRUITLAND-WW-BIOSOLIDS-DUP). Each bag was then placed into 2-gallon Ziploc bags for shipment to the analytical laboratory.

3.1.2 Glenns Ferry

Glenns Ferry Water Treatment Facility

Tetra Tech obtained samples from the Glenns Ferry water treatment facility on March 13, 2023. The water treatment facility also has filter media however it could not be sampled due to access issues. The system includes a former Poly Aluminum Chloride (PAC) basin located inside the facility building that is now reportedly only used as a water basin prior to chemical treatment.

A Sludge Judge sampling system was used to collect three 1-gallon Ziplock bags of sample which were labeled GLENN'S FERRY-WT-PAC BASIN-1. The sample was also used by the laboratory for the field duplicate (GLENN'S FERRY-WT-PAC BASIN-DUP). Each sample was then placed into 2-gallon Ziploc bags for shipment to the analytical laboratory.

Glenn's Ferry Waste Water Treatment Facility

Samples were collected from the Glenn's Ferry waste water treatment system on March 13, 2023. The waste water treatment facility consists of multiple settling ponds. Due to accessibility issues (i.e. steep slopes, concrete walls) and lack of sediment, only the first (eastern most) pond could be sampled.

A stainless steel auger was used to obtain subsamples along the sides of the pond. Each composite sample consisted of at least three subsamples. The first sample (GLENN'S FERRY-WW-SLUDGE-1) consisted of raw solids/sewage collected along the north side of the pond, nearest the inflow of the pond. The sample was also used by the laboratory for the field duplicate (GLENN'S FERRY-WW-SLUDGE-DUP). The samples were placed into three 1-gallon Ziplock bags of sample that was then placed into 2-gallon Ziploc bags for shipment to the analytical laboratory.

The second sample was taken from the westernmost banks of the settling pond (GLENN'S FERRY-WW-SLUDGE-2). The third sample was taken from the southern bank of the pond (GLENN'S FERRY-WW-SLUDGE-3). The outflow of the ponds to the river contained some moss but did not have sufficient solids volume for a sample.

3.1.3 Greenhill Estates

Tetra Tech field staff met with IES Waterworks (IES) personnel on March 2, 2023 and obtained water filter cartridges that were reportedly obtained from six residential homes that had high water usage. IES had recorded the gallons for each of the filters on the bag they had been placed into as 1200, 500, 2100, 500, 600, and 1000 gallons. The filters used to make the composite sample for GREENHILL-DW-RESIN-1 were marked 1200, 500, 2100, 500, 600, and 1000 gallons. Tetra Tech field staff transported to the Boise office and stored them over night in the sample refrigerator.

The following morning a pipe cutter was used to cut off the inlet end of the filter and approximately ½ of the contents (small beads) from each cartridge taken from the inlet side was removed using a decontaminated stainless steel spoon and placed in a stainless steel strainer inside of a plastic tub that was designed to capture any free water and any resin that may be spilled during sample collection. Paper towels were used to clean the tub and wipe down the strainer and spoon.

The resin from the six cartridges was composited in a new one-gallon sealable freezer bag. The process yielded an approximately 1-gallon volume of resin. The sample was labeled GREENHILL-DW-RESIN-1. The sample was also used by the laboratory for the field duplicate (GREENHILL-DW-RESIN-DUP). The sample was then placed inside of a 2 gallon freezer bag for shipment to the analytical laboratory.

The IES representative met again with Tetra Tech staff on March 3, 2023 and provided an additional 12 filters that were used to make two additional composite samples. Six of these filters were used for GREENHILL-DW-RESIN-DW-2 and were marked as 500, 1300, 1400, 800, 900, and 500 gallons. The sample time was 16:30. The remaining six filters were used for GREENHILL-DW-RESIN-3 and were marked as 1000, 1100, 400, 500, 500, and 1700 gallons. IES also provided one unused filter so that the lab can use the media for a control sample (GREENHILL FILTER MEDIA CONTROL SAMPLE). The samples were collected in 1-gallon Ziploc bags, labeled in the same method as described above then placed in 2-gallon Ziploc bags for shipment to the laboratory.

The remainder of the opened cartridges with resin, water that drained from the cartridges, used paper towels, and nitrile gloves worn during sample collection were packaged and returned to IES for disposal.

3.1.4 Moyie Springs

Moyie Springs Water Treatment Facility

Samples were obtained from the Moyie Springs water treatment facility on March 21, 2023. The water for this facility is from a clear well which flows into a sediment basin. A Sludge Judge was used to attempt to obtain a sample from the basin however the sandy sediment fell out before it was able to be collected. A stainless steel auger was then used in an attempt to collect a sample however it too fell out before the sample could be collected. A City of Moyie Springs employee used a backhoe to scrape the sandy sediment from the basin. Three samples were collected from the sandy sediment removed using the backhoe; MOYIE SPRINGS-WT-SLUDGE-1, MOYIE SPRINGS-WT-SLUDGE-2, and MOYIE SPRINGS-WT-SLUDGE-3. The sample MOYIE SPRINGS-WT-SLUDGE-1 was also used as a field duplicate (Moyie Springs-WT-Sludge-Dup). The samples were collected in 1-gallon Ziploc bags, labeled in the same method as described above then placed in 2-gallon Ziploc bags for shipment to the laboratory.

Moyie Springs Waste Water Treatment Facility

Samples were obtained from the Moyie Springs waste water treatment system on March 21, 2023. The waste water is collected in an 80 foot concrete basin/clarifier before entering a settling basin. The waste water system is comprised of an aerator basin with 3 feet of sludge and a settling pond that has 2 feet of sludge.

Two samples were collected from the aerator (clarifier) basin using a Sludge Judge sampling system; MOYIE SPRINGS-WW-SLUDGE-1 and MOYIE SPRINGS-WW-SLUDGE-2. The sample MOYIE SPRINGS-WW-SLUDGE-1 was also used as a field duplicate (MOYIE SPRINGS-WW-SLUDGE-DUP). The samples were collected in 1-gallon Ziploc bags, labeled, then placed in 2-gallon Ziploc bags for shipment to the laboratory.

One sample was obtained from the settling pond using the Sludge Judge sampling system. The sample consisted of several subsamples that were collected in a 1-gallon Ziploc bag, labeled as MOYIE SPRINGS-WW-SLUDGE-3, then placed in 2-gallon Ziploc bags for shipment to the laboratory.

3.1.5 Orofino

Orofino Water Treatment Facility

Samples were collected from the Orofino water treatment facility sediment retention basin system on March 20, 2023. A Sludge Judge was used to collect samples from three different locations across the basin; OROFINO-WT-SLUDGE-1, OROFINO-WT-SLUDGE-2, and OROFINO-WT-SLUDGE-3. Sludge Judge samples were placed into stainless steel bowls to decant off free liquid. The sample OROFINO-WT-SLUDGE-1 was also used as a field duplicate (OROFINO-WT-SLUDGE-DUP). Each was sample was then placed into 1-gallon Ziploc bags, labeled and then placed into 2-gallon Ziploc bags for shipment to the laboratory.

Orofino Waste Water Treatment Facility

Two biosolids samples were collected from the Orofino waste water treatment facility on March 20, 2023. The samples were collected from material on the conveyor belt that piles the sediment into a dump truck. The biosolid samples are the end product and are mixed with a polymer before disposal. Facility employees stated the dump truck is sent to the landfill every 2-3 days. Samples OROFINO-WW-BIOSOLIDS-1 and OROFINO-WW-BIOSOLIDS-2 and field duplicate OROFINO-WW-BIOSOLIDS-DUP were collected using stainless steel spoon and stainless steel bowls. Each was sample was then placed into 1-gallon Ziploc bags, labeled and then placed into 2-gallon Ziploc bags for shipment to the laboratory.

One sample was obtained from the Return Activated Sludge (RAS) sink inside the facility. The RAS sink receives the water/sediment that comes from the clarifiers. A stainless steel screen was used to collect solid sample from the sink and placed into 1-gallon Ziploc bags, labeled OROFINO-WW-RAS-3 and then placed into 2-gallon Ziploc bags for shipment to the laboratory.

3.1.6 Priest River

Priest River Water Treatment Facility

Samples were collected from the Priest River waste water treatment facility on March 21, 2023. The water treatment facility includes rapid sand filters that are changed bi-annually however they were not scheduled to be changed so a sample of the sand filters was not obtained. The waste water treatment facility samples were collected from two dry ponds located north of the facility using decontaminated stainless steel spoons and stainless steel bowls. The north pond was divided into roughly equal halves. Six subsamples were obtained from the north half of the north pond, composited, placed into a 1-gallon Ziploc bag and labeled PRIEST RIVER-WT-SLUDGE-1 and placed into a 2-gallon Ziploc bag for shipment to the laboratory. The sample PRIEST RIVER-WT-SLUDGE-1 was also used as a field duplicate (PRIEST RIVER-WT-SLUDGE-DUP).

Six subsamples were obtained from the south half of the north pond, composited, placed into a 1-gallon Ziploc bag and labeled PRIEST RIVER-WT-SLUDGE-2 and placed into a 2-gallon Ziploc bag for shipment to the laboratory.

Six subsamples were obtained from the south pond, composited, placed into a 1-gallon Ziploc bag and labeled PRIEST RIVER-WT-SLUDGE-3 and placed into a 2-gallon Ziploc bag for shipment to the laboratory.

Priest River Waste Water Treatment Facility

Three samples were obtained from the Priest River Waste Water treatment facility on March 21, 2023: one sample was taken from the belt press and biosolids pile; one sample was taken from the foam/aeration pond; and one sample was obtained from the clarifier pond.

The sample from the belt press and biosolids pile was collected using a stainless steel spoon and bowl. The sample was collected in Ziploc bags, labeled PRIEST RIVER-WW-BIOSOLIDS-1 and then placed in a 2-gallon Ziploc bag for shipment to the laboratory. The sample PRIEST RIVER-WT-BIOSOLIDS-1 was also used as a field duplicate (PRIEST RIVER-WT-BIOSOLIDS-DUP).

The sample from the foam/aeration pond was collected using a stainless steel spoon and bowl. The sample was collected in Ziploc bags, labeled PRIEST RIVER-WW-BIOSOLIDS-2 and then placed in a 2-gallon Ziploc bag for shipment to the laboratory.

The sample from the clarifier pond was collected using the Sludge Judge sampler. The subsamples were placed into a decontaminated stainless bowl and free liquid was decanted. The sample was collected in Ziploc bags, labeled PRIEST RIVER-WW-BIOSOLIDS-3 and then placed in 2-gallon Ziploc bag for shipment to the laboratory.

3.2 QUALITY ASSURANCE SAMPLE COLLECTION

Quality assurance samples consisted of the following natural samples and their corresponding field duplicates;

SDG:L1593797 Greenhill
DW-Resin-1/DW-Resin-Dup

SDG:L1593799 Fruitland
WT-Sludge-1/WT-Sludge-DUP
WW-Biosolids-1/WW-Biosolids-Dup

SDG:L1594711 Glennsferry
WT-Pacbasin1/WT-Pacbasin-Dup
WW-Sludgeg-1/WW-Sludge-Dup

SDG:L159821 Orofino
WT-Sludge-1/WT-Sludge-Dup
WW-Biosolids-1/WW-Biosolids-Dup

SDG:1598520 Moyie Springs
WT-Sludge-1/WT-Sludge-Dup
WW-Sludge-1/WW-Sludge-Dup

SDG:L1598523 Priest River
WT-Sludge-1/WT-Sludge-Dup
WW-Biosolids-1/WW- Biosolids -Dup

4.0 INVESTIGATION RESULTS

4.1 ANALYTICAL RESULTS

The following presents analytical results for the various media that was obtained from the water treatment systems at the participating communities. Tabulated data for each of the systems at the participating communities is presented in Table 1 (**Appendix A**). **Appendix B** presents field notes and **Appendix C** provides a copy of the laboratory reports.

Water Treatment System Sludge Samples

Sludge samples were obtained from the water treatment facilities at the City of Moyie, Fruitland, Orofino and Priest River.

- Concentrations of Ra-228 ranged from 0.478 (± 0.216) picocuries per gram (pCi/g) in the sample PRIESTRIVER-WT-SLUDGE-1 to 1.040 (± 0.274) pCi/g in the sample FRUITLAND-WT-SLUDGE-2.
- Concentrations of Ra-226 ranged from 0.37 pCi/g (± 0.0969) in the sample PRIESTRIVER-WT-SLUDGE-2 to 0.928 (± 0.314) pCi/g in the sample OROFINO-WT-SLUDGE-2.

Waste Water Treatment System Sludge Samples

Sludge samples were obtained from waste water treatment facilities at City of Moyie, Glens Ferry, and Orofino.

- Concentrations of Ra-228 ranged from 0.623 (± 0.423) pCi/g in the sample MOYIE-WT-SLUDGE-3 to 1.52 (± 0.615) pCi/g in the sample MOYIE-WT-SLUDGE-2.
- Concentrations of Ra-226 ranged from 0.344 pCi/g (± 0.270) in the sample MOYIE-WT-SLUDGE-3 to 0.974 (± 0.17) pCi/g in the sample GLENSFERRY-WT-SLUDGE-1.

Waste Water Treatment System Biosolid Samples

Biosolids samples were obtained from waste water treatment facilities at Fruitland, Orofino and Priest River.

- Concentrations of Ra-228 ranged from 0.052 (± 0.399) pCi/g in the sample OROFINO-WT-BIOSOLIDS-2 to 0.904 (± 0.553) pCi/g in the sample PRIESTRIVER-WT-BIOSOLIDS-2.
- Concentrations of Ra-226 ranged from -0.0235 pCi/g (± 0.0580) in the sample FRUITLAND-WT-BIOSOLIDS -2 to 0.669 (± 0.309) pCi/g in the sample PRIESTRIVER-WT- BIOSOLIDS -1.

Drinking Water Treatment System Resin Samples

Resin samples were obtained from the drinking water treatment system at the community of Greenhill Estates.

- Concentrations of Ra-228 ranged from -0.0357 (± 0.045) pCi/g in the sample GREENHILL-DW-RESIN-2 to 0.0404 (± 0.972) pCi/g in the sample GREENHILL-DW-RESIN-1.
- Concentrations of Ra-226 ranged from -0.00413 (± 0.0344) pCi/g in the sample GREENHILL-DW-RESIN-2 to 0.0428 (± 0.0708) pCi/g in the sample GREENHILL-DW-RESIN-1.

4.2 COMPARISON TO EXPECTED SOIL BACKGROUND

The analytical results are summarized in Table 1 and compared to State of Idaho background surface soil concentrations from Myrick 1983. Radium-226 and radium-228 are naturally occurring radioactive isotopes that can be found in soil due to the decay of uranium and thorium minerals, which are also naturally present in the Earth's crust. Because some amount of soil or other materials derived from the Earth's crust could be expected to be present in the waste water and drinking water treatment residuals, the detection of radium-226 and radium-228 in the samples should not be unexpected. If radium-226 and radium-228 concentrations in the residual samples were elevated compared to expected soil background, this could be an indication that concentrations have been enhanced through the water treatment processes. As shown in Table 1, the radium concentrations in the samples do not exceed the range of concentrations found in Idaho surface soils determined by Myrick 1983.

Table 1. Comparison of analytical results to expected soil background radium concentrations. Media	Range of Concentrations	
	Radium-226 (pCi/g)	Radium-228 (pCi/g)
Water Treatment System Sludge Samples	0.37 – 0.928	0.478 – 1.040
Waste Water Treatment System Sludge Samples	0.344 – 0.974	0.623 – 1.52
Waste Water Treatment System Biosolid Samples	ND – 0.669	0.052 – 0.904
Drinking Water Treatment System Resin Samples	ND – 0.0428	ND – 0.972
State of Idaho Background Surface Soil Study by Meyrick 1983 (12-13 Samples) ¹	0.64 – 1.6	0.42 – 1.9

Notes

ND Nondetect

¹ State of Idaho background surface soil concentrations are from *Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S.* by T.E. Myrick, B.A. Berven, and F. F. Haywood. Published in *Health Physics* Vol 45, No. 3 (September), pp. 631-642, 1983. The background radium-228 concentration range listed is inferred from the thorium-232 concentrations reported in the study. Radium-228 concentrations are not reported in the study; however, approximate secular equilibrium between thorium-232, which is reported in the study, and its daughter radium-228 is expected for background soils.

5.0 IDW MANAGEMENT

IDW consisted predominantly of PPE such as nitrile gloves donned during sample collection at each site. The used gloves were placed into plastic trash bags and discarded as municipal waste. Water that was decanted from the samples was disposed of at the corresponding facility where the sample was obtained.

The remainder of the opened cartridges with resin, water that drained from the cartridges, used paper towels, and nitrile gloves worn during sample collection of the samples from the Greenhill Estates site were returned to IES personnel for disposal were packaged and returned to IES for disposal.

6.0 QUALITY ASSURANCE REVIEW

Appendix D provides copies of the Data Review, Data Verification and Data Validation checklist.

6.1 STAGE 2A DATA REVIEW, VERIFICATION, AND VALIDATION

A review of the chain of custody forms and laboratory case narratives indicate that proper chain of custody was maintained. The appropriate preparation and analysis methods were performed on the samples based on the

intended use of the data. All samples were received intact and in good condition. All samples were analyzed within method holding time requirements.

Laboratory quality control (QC) sample analyses performed for each analytical method are summarized as part of the laboratory analytical package, included as **Appendix D** of this report.

The following Stage 2A verification and manual validation checks were performed as part of this project

1. Requested methods were performed;
2. Method dates for handling, preparation and analysis were present, as appropriate;
3. Sample-related QC data and QC acceptance criteria were provided in the laboratory report and linked to the project samples including the field QC samples;
4. Requested spike analytes were added, as appropriate;
5. Sample holding times were evaluated;
6. Frequency of QC samples was checked and considered appropriate; and
7. Sample results were evaluated by comparing holding times and sample-related QC data to EPA and project data validation guidelines.

6.1.1 Precision

Precision is the measure of agreement among individual measurements of the same property under similar conditions. Precision for this project has been expressed in terms of the relative percent difference (RPD) between two samples. Duplicate samples can be evaluated quantitatively for precision only when contaminants are detected in both the sample and the duplicate. Duplicates with RPDs within the control limits indicate adequate sampling practices and/or good analytical precision. Duplicates with RPDs outside the control limits may result from inappropriate sampling procedures, matrix interferences, or non-homogeneity of the sample matrix. In addition, poor precision can be attributed to deviations from the analytical methodology or to poor reproducibility of target analyte concentrations at or near the detection limits.

Precision was evaluated for this project by comparing field duplicate results, and laboratory control sample/laboratory control sample duplicate (LCS/LCSD) RPD results for project samples. However, if the laboratory duplicate analysis was performed by the laboratory on samples for another client's project within the same method batch, any qualifiers applied to the data are not applicable to this project's samples as it could not be determined whether those samples were sufficiently similar.

All LCS/LCSD and field duplicate RPDs were within the QC limits or did not require qualification. Accuracy

The assessment of accuracy is evaluated by comparing the percent recoveries (%R) computed from the known concentration of analyte spikes and their recovered concentration versus the analytical method acceptance criteria. Spike recoveries provide an indication of bias, where the reported data may either overestimate or underestimate the actual concentration of detected compounds and/or the detection limits. Accuracy was assessed using LCS/LCSD recovery data. All LCS/LCSD and internal standard response and retention times were within control limits.

6.1.2 Representativeness

Representativeness of the environmental sample analytical data was assessed by evaluating holding times, trip blank, and laboratory method blank results.

- Holding Times. All samples were analyzed within the method-required preparation and analytical holding times.
- Method Blanks. All method blanks were free of contamination or did not require qualification.

6.1.3 Comparability

All samples were analyzed using appropriate EPA analytical methods. Sample results were reported in appropriate units. The analytical methods are considered acceptable for generating analytical data for the purpose of this project.

6.1.4 Completeness

Completeness is the quantitative measure of the amount of data obtained from a measurement process compared with the amount expected to be obtained under the conditions of measurement. It confirms that the contractor and laboratory have provided the deliverables required by the contract, method, and/or project plan. Data collection for this project segment are considered to be complete, although additional samples, provided by other wastewater treatment and water treatment facilities in Idaho, would provide additional useful information if samples can be acquired during a future project segment.

6.1.5 Sensitivity

MDL results were determined to be acceptable.

6.1.6 Summary

Overall, the analytical data are considered acceptable and have met the quality control and quality assurance objectives and goals of this project. No data were rejected. All results, as qualified, are considered usable for meeting project objectives. Qualifications made during this project are discussed above, provided within the data validation reports in **Appendix D**.

6.2 DEVIATIONS FROM THE QAPP

The following identifies changes to the scope of work presented in the QAPP:

- None

7.0 SUMMARY AND RECOMMENDATIONS

The ranges of results for both Ra-226 and Ra-228 in these waste residuals are within the normally encountered range for natural soils that show no TENORM influence. The uncertainty and minimum detectable activity (MDA) results shown for all samples, including the occasional less-than-zero reported results, are as expected for analyses at these low levels of radioactivity. The uncertainty and MDA data shown for the samples analyzed in duplicate indicate that sample preparation and analysis were performed properly, given that the uncertainty ranges overlap between the original and duplicate samples in all cases.

Because the number of facilities sampled for this study is small compared to the number of drinking water and wastewater treatment facilities in Idaho and because the number of background soil samples in the referenced background study (Myrick 1983) is small (12 samples), Tetra Tech recommends developing a scope of work for further study that may include additional sampling of treatment residuals as well as sampling various environmental media (for example soil, groundwater, and surface water) to assess background concentrations of isotopes of interest.

8.0 REFERENCES

Tetra Tech, 2023. Quality Assurance Project Plan, Evaluation of TENORM in Drinking Water and Waste Water Treatment Systems. Document submitted to the Idaho Department of Environmental Quality. February 6, 2023.

APPENDIX A - TABLES

APPENDIX B – FIELD NOTES

APPENDIX C – LABORATORY ANALYTICAL REPORTS

APPENDIX D – QUALITY CONTROL REVIEW