

Comprehensive Radiation Protection Plan

September, 2024



Plan Prepared By:

K2 Environmental LLC.

40330 Kelly Park Rd.
Leetonia, Ohio 44431



Contents

1. Introduction	1
2. Background	2
3. CNX Company Policy	3
4. Purpose/Scope/Applicability	4
5. Training	4
6. Program Self-Assessment	5
7. Radiation Protection Program Administration	5
8. General Survey and Monitoring Requirements	6
9. Packaging and Transport of Radioactive Materials	10
10. Radioactive Material Handling	16
Designated Storage and Holding Areas.....	16
Disposition.....	16
11. Waste or Equipment Characterization	17
Initial Characterization.....	17
Follow-up Characterization	17
Alternate Characterization Methods.....	17
Determination of Origin	18
12. Instrumentation Use, Maintenance and Calibration	19
13. Records	21
Surveys	21
Instrumentation	21
Characterization and Analysis Data.....	21
Disposition and Shipping Records	21

1000 Horizon Vue Drive Canonsburg, PA 15317

Appendices

Appendix A – Drilling Operations

Appendix B – Completions Operations

Appendix C – Production Operations

Appendix D – Midstream (Compressor Station)

Appendix E – Waste Water Storage and Transfer, ASTs and Impoundments

Appendix F – Equipment Storage Facility

Appendix G – Plugging Operations

1. Introduction

In December of 2000, the Pennsylvania Department of Environmental Protection (PADEP) promulgated regulations requiring monitoring for radiation and radioactive materials (Pennsylvania Code, Article IX). The State has also prepared a companion guidance document, "*Final Guidance Document on Radioactivity Monitoring at Solid Waste Processing and Disposal Facilities*" (PADEP Document Number: 250-3100-001). CNX operations involve the collection and handling of drill cuttings, production water, flow-back solids/sludge, and pipe scale resulting in waste products containing elevated levels of Naturally Occurring Radioactive Materials (NORM) and Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). This Comprehensive Radiation Protection Plan (CRPP), in conformance with 25 PA Code 293.111 requirements, has been developed to provide radiological monitoring, safety guidance, and regulatory requirements to personnel working at CNX locations.

While most experts agree there is "little potential for significant radiological exposure to workers and members of the general public related to E&P operations" (PADEP 2015), there can be environmental and regulatory issues of importance.

This CRPP identifies potential sources of radiation across the gambit of CNX oil/gas operations. It details the type of monitoring needed to identify potential sources of radiation, steps to keep worker exposure as low as reasonably achievable (ALARA), proper handling, as well as transportation and disposal of each potentially radioactive waste stream generated throughout CNX operations.

The intent of this CRPP is to provide a common-sense graded approach to radiation hazards identification and mitigation. The suggested surveys and controls made throughout are designed to be commensurate with the potential hazards that workers could encounter while working at CNX sites.

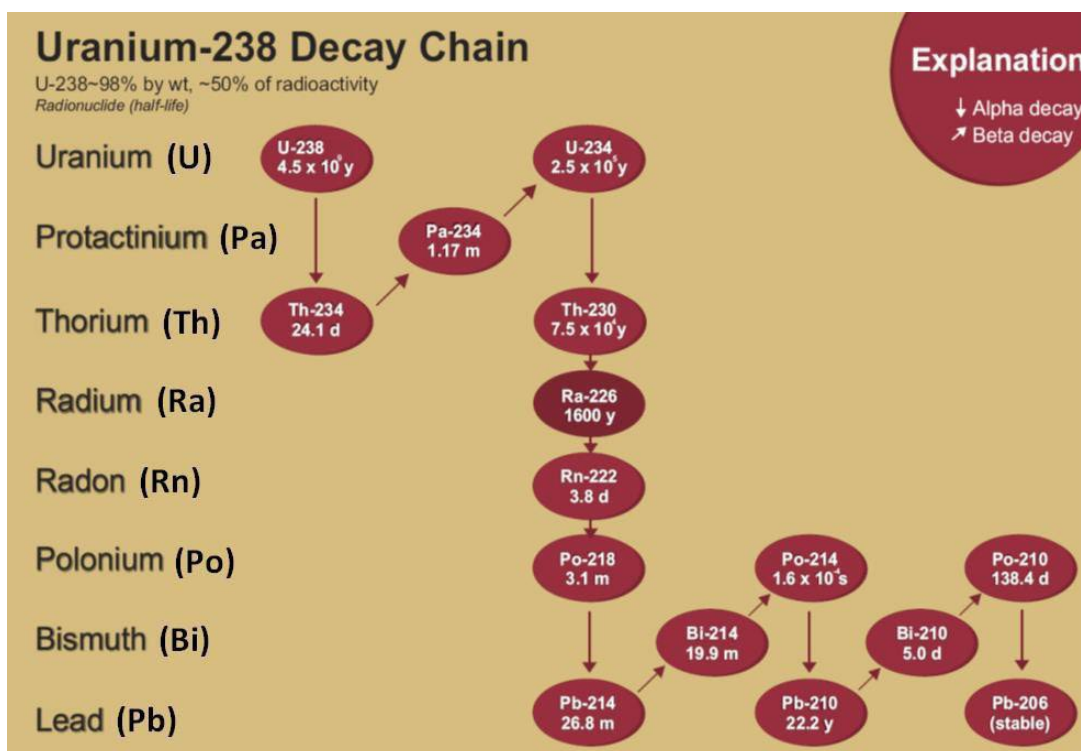
2. Background

Marcellus Shale and other geologic formations rich in O&G resources may contain NORM, specifically uranium (U), U-238 parent and thorium (Th), Th-232 parent, and their decay progeny, as well as Potassium-40 (K-40). These series occur naturally and are the most prevalent of the three natural decay series, the third being the actinium (Ac), U-235 parent. The decay series of U and Th are illustrated in **Figures 2-3** and **2-4**, respectively. Surface soil typically contains approximately 1 to 2 picocuries per gram (pCi/g) of both the U and Th series radionuclides with all of the series members at approximately equal activity, i.e., secular equilibrium. The radioactive materials, including TENORM, are brought to the land surface by O&G activities.

O&G Activities concentrate the natural concentration of primordial radionuclides to create TENORM.

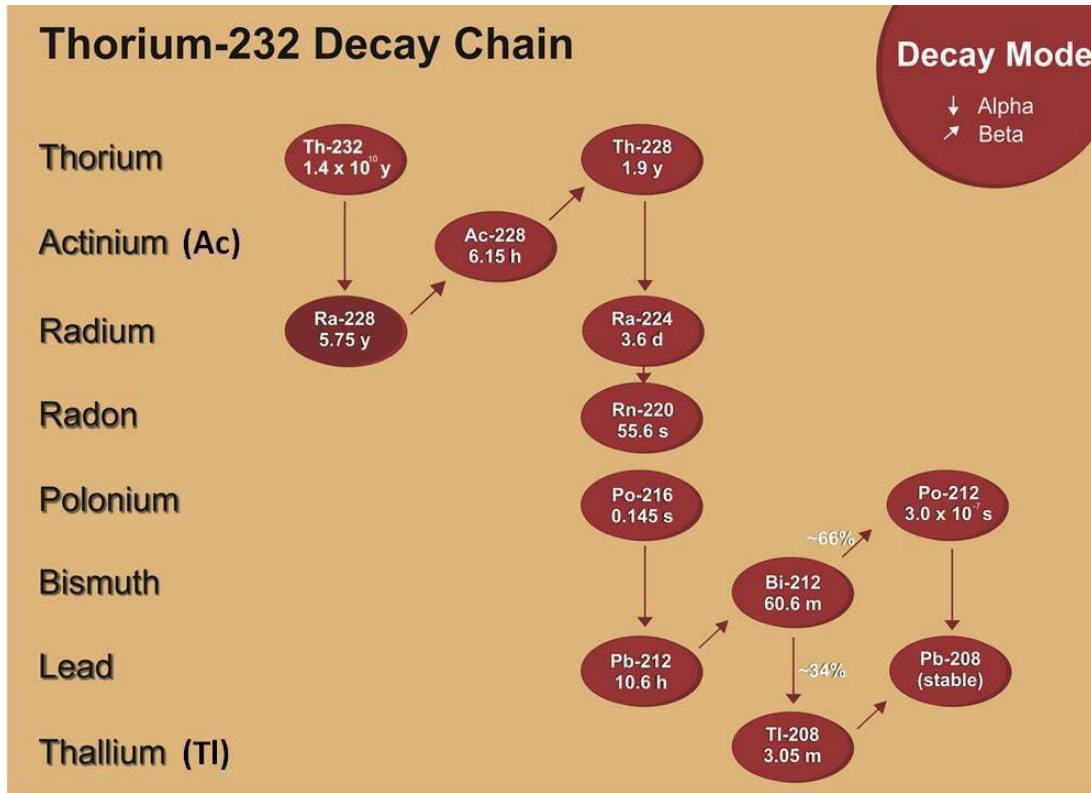
While no clear national standard currently exists regarding the generation and control of TENORM, CNX is taking proactive steps to ensure the protection of our workers, contractors, subcontractors and the environment.

Figure 2-3. Uranium-238 Decay Chain



Note: y = years, d= days, h = hours, and m = minutes

Figure 2-4. Thorium-232 Decay Chain



Note: y = years, d= days, h = hours, and m = minutes

3. CNX Company Policy

CNX management recognizes the obligations of the corporation to its employees, neighbors, customers, contractors and subcontractors and the environment. The company's primary responsibility is to balance the business with a strong commitment towards compliance with all aspects of environmental, health, and safety requirements.

4. Purpose/Scope/Applicability

The body of this CRPP provides a general/programmatic approach to radiation protection and radioactive waste management. The appendices break down each facet of CNX O&G exploration and production and provide site specific information to workers at each type of facility.

The three primary purposes of this CRPP are:

- Provide information regarding the nature and extent of radiological hazards related to exploration and production of oil/gas.
- Detail actions necessary to ensure protection of our workers and the environment.
- Ensure that CNX operations comply with all applicable federal, state and local laws.

5. Training

Radiation Awareness Training will be provided to CNX employees performing work with or around NORM/TENORM or other radioactive material. Trainings will be provided to new employees and annual refreshers for existing employees. Elements of the Radiation Awareness Training include:

- Types and properties of radiation
- Biological effects of radiation
- Radiation Hazards Perspective
- Units of measure
- As Low As Reasonably Achievable (ALARA) concept
- Contamination control
- Pregnant worker declaration
- Survey techniques
- Waste survey, transportation and disposal

6. Program Self-Assessment

This program will be reviewed, as a minimum, on an annual basis by the Radiation Safety Officer or a third-party Health Physics consultant and the results documented in writing. The procedures and protocols used to implement this program will be used as working documents, for training, and operational guides and will, therefore, be continually reviewed.

7. Radiation Protection Program Administration

A. Management Responsibilities:

The CNX Operational Excellence Department is primarily responsible for the programmatic oversight of this CRPP. Field operations supervisors and other personnel should be familiar with the information and requirements of this plan and should contact the RSO with questions regarding its implementation.

B. Contractor and Subcontractor Responsibilities

Contractors and subcontractors working with NORM/TENORM and other radioactive material shall have a Radiation Protection Plan similar in scope and nature. CNX will review applicable contractor/subcontractor radiation protection plans to ensure contractor/subcontractor personnel are aware of the sources, control measures and effects of NORM/TENORM and other radioactive materials they may encounter at CNX facilities.

C. The Radiation Safety Officer (RSO) is [REDACTED]. The RSO will be responsible for the implementation and compliance of the CRPP and will provide the technical assistance and direction for conducting the program. The RSO will have the authority to stop any work activity that is determined to be radiologically unsafe. The RSO will also have unfettered access to communicate directly with CNX executive leadership on issues of radiological safety. The RSO shall have written authority from CNX management to immediately stop any work activity that the RSO determines to be radiologically unsafe. The RSO is responsible for:

- Making the notifications to the State as specified in this CRPP.
- Modifying or updating this CRPP.
- Ensuring a periodic audit of the CRPP implementation to ensure personnel understand and implement the actions specified in this CRPP.
- Ensuring all personnel assigned to implement elements of this CRPP have received the Training specified in this CRPP.

D. Radiological Consultant(s)

In addition to developing this RPP, Radiological Consultant(s) are responsible for providing assessments and advice on the nature, analysis, and disposition of material identified as exceeding the levels noted in this Plan.

8. General Survey and Monitoring Requirements

To ensure personnel are not exposed to radiation above regulatory limits and to ensure regulatory compliance, radiological surveying and monitoring will be performed. Listed below are different types of surveys associated with the CRPP procedures:

General Area Gamma Survey – Performed with a gamma instrument with proper sensitivity to identify 5-5000 uR/hr (Ludlum Model 19 or equivalent). Dose readings should be taken at waist level with the objective being to observe fluctuations in general area dose rates. Readings taken 30 cm from a source are considered general area.

Contact Dose Rate Survey – Can be used to evaluate elevated general area dose rates and determine the source. Contact dose rates are also used to estimate waste concentrations.

DOT Shipping Surveys – Required if waste exceeds 270 pCi/g for combined Ra-226 and Ra-228 or if a container exceeds 90 uR/hr on contact. Shipping surveys include removable contamination wipe evaluation and driver's cab dose evaluation.

Removable Contamination Surveys – Smears or "swipes" are taken using a dry filter paper or NuCon type smear. Using moderate pressure, the surveyor wipes a ~20 cm "S" area (approximately 100 cm²). Wipes are counted on an alpha/beta smear counter (Ludlum 2929 or equivalent) and reported in units of disintegrations per minute per 100 cm² (DPM/100 cm²).

Airborne Radioactivity Survey – Can be taken to determine radioactive airborne particulate and/or Radon concentration. Particulate samples are taken by drawing a known volume of air through a 47mm filter, counting the filter for alpha/beta using a Ludlum 2929 or equivalent, and calculating Derived Air Concentration (DAC)

Radon air samples can be taken using a passive charcoal filter (Accustar or equivalent) or by real time measurements (FemtoTech CRM-510 or equivalent).

Table 8-1 below details the types of surveys that should be performed at the frequency listed. It is meant to allow CNX to establish a baseline understanding of radiological hazards across the gambit of our operations and facilities. The RSO will survey every site in every stage monthly. If unexpected conditions are observed at the representative location/facility, additional surveys of like facilities should be performed to determine if the condition is systematic.

This survey schedule should be reviewed on a yearly basis and adjusted according to the prior years results. Survey frequency at sites and during activities where minimal radiological hazards are identified may be reduced to quarterly. Conversely, if an adverse/unexpected condition is recognized the survey frequency and or type can be expanded.

It should be noted that the tables below list various types of radiological measurements that can be confusing. While this information is discussed in detail during worker awareness training, a brief summary of the various units of measurement commonly encountered are discussed below.

REM (Roentgen Equivalent Man) – A gamma dose measurement which combines the amount of energy (from any type of ionizing radiation that is deposited in human tissue), along with the medical effects of the given type of radiation.

- A worker in a nuclear plant is permitted to receive a maximum of 5 REM/yr.
- Each man, woman and child receive 360 mRem/yr from natural sources.
- Employers are required to monitor workers if they are expected to exceed 100 mRem/yr from all occupational sources (direct exposure, inhalation and ingestion).

Gamma Radiation Units	
Unit	Equals
1 REM	1000 MilliRem (mRem)
1 mRem	1000 MicroRem μ Rem

Curie – Is a unit of decay that was originally defined as “the quantity or mass of radium emanation in equilibrium with one gram of radium (element)” but is currently defined as 1 Ci = 3.7×10^{10} decays per second. Curies, or fractions thereof are typically used to measure concentrations (activity per unit mass).

- TENORM waste must not exceed 270 pCi/g (combined Ra-226 and Ra-228) without proper transportation controls.
- Allowable waste concentration in West Virginia 50 pCi/g (combined Ra-226 and Ra-228)
- Allowable waste concentration in Ohio 6.99 pCi/g (combined Ra-226 and Ra-228)

Table 8-1 Survey Frequency and Type

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Active Drilling Site (survey a different facility each time)	X	Monthly	Perform gamma surveys of tanks, process equipment and drill cuttings.
Active Completions Sites (survey a different facility each time)	X	Monthly	Perform gamma surveys of tanks and process equipment.
Wells in Production (survey a different facility each time)	X	Monthly	Focus gamma surveys on wastewater storage tanks and process equipment.
Midstream Compressor Stations (survey a different facility each time)	X	Monthly	Perform gamma surveys of process equipment and upon system breach when performing maintenance and/or pigging. Survey pigging equipment, work area and waste containers.
Waste Water Storage and Transfer, ASTs and Impoundments (survey a different facility each time)	X	Monthly	Perform gamma surveys around perimeter of impoundment, on waste containers and associated piping.
Equipment Storage Facilities (survey a different facility each time)	X	Monthly and upon receipt of potentially contaminated equipment, prior to recycling	Survey potentially contaminated equipment when accepted for storage and prior to sending to a landfill or recycling facility.
Well Plugging (survey a different location each time)	X	Monthly	Survey piping and equipment that will be recycled. Release to recycle melting facilities is 50 uR/hr.
Transportation Surveys	X	Periodic	Periodic gamma survey of inbound waste containers. Periodic gamma dose rate survey of outgoing waste containers prior to transportation.

Table 8-2 provides permissible exposure thresholds for radiation workers and members of the general public. Typically, individuals working at CNX facilities will not receive >100 mRem/yr, similar to members of the general public.

Table 8-2 Exposure Information/Limits

Target Group	Average Gamma Exposure (mR/yr.)
Average Annual Exposure to Members of the General Public from All Naturally Occurring Sources	360
Annual Occupational Dose Limit for Untrained, Unmonitored Workers from All Work-Related Sources (direct gamma+innhalation)	100
Annual Occupational Dose Limit for Radiation Workers from All Work-Related Sources (direct gamma+innhalation)	5000

Table 8-3 provides additional definitions and limits related to the CRPP.

Table 8-3 Radiation /Contamination Limits

	Definition	Applicable Regulatory Citation
Radiation Area	An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.	10CFR20.1003
Equipment Unconditional Release	Equipment, room or area with removable contamination <20 dpm/100 cm ² alpha, 1000 dpm/100cm ³ beta	Reg Guide 1.86
Airborne Radioactivity Area	A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations—(1) In excess of the derived air concentrations (DACs) specified in appendix B, to §§ 20.1001-20.2401, or (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours	10CFR20.1003
Landfill Alarm Set Point	10 uR/hr above background at portal monitor face	Various State Rules
Recycle Facility Alarm Set Point	50 uR/hr	Various State Rules

ACTION LEVEL RESPONSES

Action Level 1:

For this CRPP, radiation monitoring equipment at the facility or well site indicating the following dose rate readings shall be used as Action Level 1 thresholds:

- General areas measuring greater than 10 $\mu\text{R/hr}$ above background
- For inbound trucks measuring greater than 50 $\mu\text{R/hr}$ above background

If the dose rate readings from the surface of an inbound truck is measured to be greater than 50 $\mu\text{R/hr}$, the truck may still be accepted and offloaded to an AST. Facilities greater than 10 $\mu\text{R/hr}$ above ambient background at a distance of 5 cm require further survey activities. If dose rate readings 5 cm from the surface of an AST is measured to be greater than 50 $\mu\text{R/hr}$, then review by the RSO is required to determine whether action should be taken to reduce the concentration of TENORM in the tanks or to remove sediment.

Note: If dose rates of 2 mrem/hr or greater are measured on any vehicle, AST, or waste container, the event becomes Action Level 2. Terminate any further actions, restrict access to areas with dose rates of 2 mrem/hr or greater and refer to the Radiation Protection Action Plan (RPAP) for the site to determine if notification to the Regional PA DEP BRP Office is required.

Action Level 2:

For this CRPP, the following dose rate readings shall be used as Action Level 2 thresholds:

- Radiation dose rates of 2,000 $\mu\text{R/hr}$ (2 mrem/hr) or greater measured on any vehicle, container surface, or anywhere at the site

Note: If dose rates of 2,000 $\mu\text{R/hr}$ (2 mrem/hr) or greater are measured, terminate any further actions, restrict access to areas with dose rates of 2 mrem/hr or greater and refer to the Radiation Protection Action Plan (RPAP) for the site to determine if notification to the Regional PA DEP BRP Office is required.

If an Action Level 2 event occurs, immediately notify the RSO. Disposition of waste containers with material measuring in excess of 2,000 $\mu\text{R/hr}$ from any surface shall be at an approved low level radioactive waste disposal facility. Additional characterization will be required.

9. Packaging and Transport of Radioactive Materials

Several types of waste are generated during the E&P process. Table 9-1 details the various types of waste, how/where they can be expected, transportation precautions disposal options. Table 9-2 provides additional detail about various local and out of area disposal facilities with pros and cons of each. If suspect class 7 is encountered (sample

results >270 pCi/g for combined Ra-226 and Ra-228 or contact gamma exposure rate of >90 uR/hr above bkgd), contact the RSO for further instructions.

While equipment is not likely to exceed the Class 7 concentration threshold due to the nature of contaminate distribution (surface contamination only), equipment found in excess of 90 uR/hr should be further evaluated prior to transportation. If you have any questions regarding packaging and/or transportation of contaminated equipment, contact the CNX RSO for further instructions.

Applicable transportation rules are defined in 49 CFR Parts 100-185 and 10 CFR 20 Part 71.

Waste in excess of 270 pCi/g (combined Ra-226 and Ra-228) or in excess of 90 uR/hr and < 500 uR/hr is considered Class 7 (LSA-1 UN 2910) radioactive waste and requires special surveys and paperwork. Waste containers in excess of 500 uR/hr is (LSA-1 UN 2912) and requires special surveys, paperwork, placarding and labeling.

Table 9-1 Waste Summary

Waste Type	Typical Ra-226 and Ra-228 Concentration	Typical Gamma Dose Rate	Where its found	Disposal Option	Hazard Rating	Transportation considerations
Vertical Drill Cuttings	< 5 pCi/g	Similar to background	Generated during vertical phase of drilling	Drill cuttings are considered NORM (not TENORM) and can be disposed at most PA, WV mono cell and Ohio landfills	Worker Exposure - Extremely Low Environmental Impact - Very low however spills can potentially have a negative environmental impact. Transportation risk - Very Low	Transport in liquid tight container
Horizontal Drill Cuttings	<5 to 30 pCi/g (PADEP Avg was 9.82 pCi/g)	Similar to background	Generated during horizontal phase of drilling	Drill cuttings are considered NORM (not TENORM) and can be disposed at most PA, WV mono cell and Ohio landfills	Worker Exposure - Extremely Low Environmental Impact - Very low however spills can potentially have a negative environmental impact. Transportation risk - Very Low	Transport in liquid tight container
Hydraulic fracturing fluids (combination of fresh water, produced water and flowback fluid)	Ra-226 64.0-21,000 pCi/L, Ra-228 4.5-1,640 pCi/L	Similar to background	Commingled fluids used for hydrofracturing. Found in flowback tanks, gas busters, produced water tanks, ASTs and centralized impoundment ponds	Brine recycling facility or Class II Injection well	Worker Exposure - Extremely Low Environmental Impact - Very low however spills can potentially have a negative environmental impact. Transportation risk - Very Low	Transport in liquid tight container
Flowback Fluid	Ra-226 551 pCi/L-25,500 pCi/L, Ra-228 248-1,740 pCi/L	Similar to background	Commingled fluids used for hydrofracturing. Found in flowback tanks, gas busters, produced water tanks, ASTs and centralized impoundment ponds	Brine recycling facility or Class II Injection well	Worker Exposure - Very Low Environmental Impact - Low however spills could adversely affect the environment.	Transport in liquid tight container
Produced water	Ra-226 40.5 pCi/L-26,600 pCi/L, Ra-228 26.0-1,900 pCi/L	Similar to background	Commingled fluids used for hydrofracturing. Found in flowback tanks, gas busters, produced water tanks, ASTs and centralized impoundment ponds	Brine recycling facility or Class II Injection well	Worker Exposure - Very Low Environmental Impact - Low however spills could adversely affect the environment.	Transport in liquid tight container
Completions Solids/Sludge	Average <5 to 75 pCi/g* as high as 3000 pCi/g	Dose rates up to several hundred uR/h	Drill plug residual, flowback and AST bottoms, centralized impoundments	Landfill or third-party waste processing facility based on concentration (see Table 4-2)	Worker Exposure - Low avoid inhalation/ingestion, practice good hygiene. Environmental Impact - Low however spills could adversely affect the environment. Transportation Hazard - Moderate	Waste in excess of 270 pCi/g (combined Ra-226 and Ra-228) or in excess of 90 uR/hr AND < 500 uR/hr is considered Class 7 (LSA-1 UN 2910) radioactive waste and requires special surveys and paperwork. Waste containers in excess of 500 uR/hr is LSA-1 UN 2912) and requires special surveys, paperwork, placarding and labeling.

Waste Type	Typical Ra-226 and Ra-228 Concentration	Typical Gamma Dose Rate	Where its found	Disposal Option	Hazard Rating	Transportation considerations
Scale	Average <480 to 400,000 pCi/g*	Dose rates up to several hundred uR/h	Flowback, production and midstream piping and equipment. Water lines associated with separators, (separate gas from the oil and water). Heater treaters (divide the oil and water phases). Gas dehydrators, where scale deposits as thick as four inches may accumulate	Radioactive Waste Landfill or third-party waste processing facility based on concentration (see Table 4-2)	Worker Exposure - Moderate avoid inhalation/ingestion, practice good hygiene. Environmental Impact - Moderate however spills could adversely affect the environment. Transportation Hazard - High, likely Class 7 Radioactive Waste.	Waste in excess of 270 pCi/g (combined Ra-226 and Ra-228) or in excess of 90 uR/hr AND < 500 uR/hr is considered Class 7 (LSA-1 UN 2910) radioactive waste and requires special surveys and paperwork. Waste containers in excess of 500 uR/hr is LSA-1 UN 2912) and requires special surveys, paperwork, placarding and labeling.
Filter socks	<5 to several hundred pCi/g	Dose rates up to several hundred uR/h	All phases of water filtration	Landfill, Radioactive Waste Landfill or third-party waste processing facility based on concentration (see Table 4-2)	Worker Exposure - Moderate avoid inhalation/ingestion, practice good hygiene. Environmental Impact - Moderate however spills could adversely affect the environment. Transportation Hazard - High, likely Class 7 Radioactive Waste.	Waste in excess of 270 pCi/g (combined Ra-226 and Ra-228) or in excess of 90 uR/hr AND < 500 uR/hr is considered Class 7 (LSA-1 UN 2910) radioactive waste and requires special surveys and paperwork. Waste containers in excess of 500 uR/hr is LSA-1 UN 2912) and requires special surveys, paperwork, placarding and labeling.
Gas Plant Equipment	<5 to several hundred pCi/g if scale is present	30-70 uR/hr average with 1000 uR/hr max.	Reflux pumps, propane pumps and tanks, other pumps, and product lines	Decontamination and release, Landfill, Radioactive Waste Landfill or third-party processor	Worker Exposure - Avoid disturbing scale during maintenance activities. Equipment with visible scale will likely exceed 10 uR/hr and may set off portal alarm at landfill. Environmental Impact - Moderate however spills could adversely affect the environment. Transportation Hazard - Moderate, likely Class 7 Radioactive Waste.	Waste in excess of 270 pCi/g (combined Ra-226 and Ra-228) or in excess of 90 uR/hr AND < 500 uR/hr is considered Class 7 (LSA-1 UN 2910) radioactive waste and requires special surveys and paperwork. Waste containers in excess of 500 uR/hr is LSA-1 UN 2912) and requires special surveys, paperwork, placarding and labeling.

Table 9-2 Landfill Option Summary

SOLID WASTE FACILITIES ACCEPTING TENORM	Portal Monitors	Radium Testing	Allowable Dose Rate	Allowable Concentration	Pros	Cons
Ohio Landfills	Suggested but not required*	Suggested but not required**	10 uR/hr above bkgd	6.99 pCi/g combined Ra-226 and Ra-228	No limit on volume, drill cuttings with De Minimus recycled drill mud are exempt from radium testing	Radium testing required, low concentration limit, restricted hours of operation
Apex	No	Yes, sample required for each conveyance	N/A (no portal)	6.99 pCi/g combined Ra-226 and Ra-228	No limit on volume, drill cuttings with De Minimus recycled drill mud are exempt from radium testing	Radium testing required, low concentration limit, restricted hours of operation
WM	Yes	Yes, will allow batch samples	10 uR/hr above bkgd	6.99 pCi/g combined Ra-226 and Ra-228	No limit on volume, allows batch sampling for Ra-226 and Ra-228, drill cuttings with De Minimus recycled drill mud are exempt from radium testing	Low concentration limit, restricted hours of operation
Republic	Yes	Yes, sample required for each conveyance	10 uR/hr above bkgd	6.99 pCi/g combined Ra-226 and Ra-228	No limit on volume, no Radium testing required for drill cuttings	Low concentration limit, restricted hours of operation, requires Ra-226 and Ra-228 testing per conveyance.
Properly permitted WV Landfills	Yes	Yes, sample required for each conveyance	10 uR/hr above bkgd	50 pCi/g combined Ra-226 and Ra-228	No limit on volume, low cost	Ra-226 and Ra-228 testing required per conveyance, limited hours of operation
WM Meadowfill	Yes	Yes, sample required for each conveyance	10 uR/hr above bkgd	50 pCi/g combined Ra-226 and Ra-228	Relatively high concentration limit, no limit on volume, low cost	Ra-226 and Ra-228 testing required per conveyance, limited hours of operation
J.P Mascaro Wetzel County Landfill	Yes	Yes, sample required for each conveyance	10 uR/hr above bkgd	50 pCi/g combined Ra-226 and Ra-228	Relatively high concentration limit, no limit on volume, low cost	Ra-226 and Ra-228 testing required per conveyance, limited hours of operation
Pennsylvania Landfills	Yes	No	up to 140 uR/hr	N/A, acceptance based on gamma dose rate	Relatively high limit, No Ra-226/Ra-228 analysis required	Form U, volume limit (landfill curtails TENORM waste acceptance mid-month), elevated dose rate waste >10 uR/hr costs more per ton
WM	Yes	No	up to 140 uR/hr	N/A, acceptance based on gamma dose rate	Relatively high limit, No Ra-226/Ra-228 analysis required	Form U, volume limit (landfill curtails TENORM waste acceptance mid-month), elevated dose rate waste >10 uR/hr costs more per ton
Republic	Yes	No	up to 140 uR/hr	N/A, acceptance based on gamma dose rate	Relatively high limit, No Ra-226/Ra-228 analysis required	Form U, volume limit (landfill curtails TENORM waste acceptance mid-month), elevated dose rate waste >10 uR/hr costs more per ton

SOLID WASTE FACILITIES ACCEPTING TENORM	Portal Monitors	Radium Testing	Allowable Dose Rate	Allowable Concentration	Pros	Cons
Third party facilities						
Petta	No	No	Check for dose rate limit	Check for concentration limits and pricing	Open 24/7, no Ra-226/Ra-228 testing required, permit revision filed to allow acceptance of high concentration material	Transportation/disposal costs often times greater than going directly to a landfill
Mud Masters	No	No	Check for dose rate limit	Check for concentration limits and pricing	Open 24/7, no Ra-226/Ra-228 testing required, can accept high concentration material	Transportation/disposal costs often times greater than going directly to a landfill
Belmont Solids	No	No	Check for dose rate limit	Check for concentration limits and pricing	Open 24/7, no Ra-226/Ra-228 testing required, can accept high concentration material	Transportation/disposal costs often times greater than going directly to a landfill

Outgoing (from site) Transport Containers

Inspect the exterior of the container for sludge/debris build-up; where present, remove the material and place inside transport container or back in process container.

Perform an exterior exposure rate survey using a slow "S" motion from top to bottom of the sides. The meter should be held at 30 cm (12") from the container sides during the survey.

If	Then
Exposure rate ≤ 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate ≥ 10 and ≤ 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate > 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

10. Radioactive Material Handling

Designated Storage and Holding Areas

Each facility will designate a location for temporary storage and handling of containers or equipment with elevated levels of radioactive materials.

A survey of the storage or sequester location for will be performed daily (only if containers sequestered or material in storage) to ensure the postings and boundaries are still intact.

If	Then
Equipment, Material or Vehicle indicate exposure rates between 10 and 2000 uR/hr above background	Area will be posted as a Radioactive Materials Storage Area
Equipment, Material or Vehicle indicate exposure rates \geq 2000 uR/hr above background at 30 cm (12") away	Area will be posted as a Radioactive Materials Storage Area and Area will be roped off and signs placed on the ropes or barricades indicating RSO approval required for entry or Area will be continuously monitored to prevent unauthorized access

Disposition

Outgoing containers that exhibit high levels of radioactive material can only be shipped for disposal after a full characterization has been made and the RSO has signed a DOT exemption form/ DOT Special Permit and authorization to dispose of the material has also been granted. If an alarming vehicle is found to be leaving location without authorization, the state police/local authorities will be contacted.

Depending on the NORM levels, a risk assessment for the disposed material and acceptance by the disposal facility may be required. The Radiological Consultant will assist in this effort if these steps are needed.

11. Waste or Equipment Characterization

Initial Characterization

Determine whether the source is volumetric or a point source. The source is a point source if the elevated levels are localized to one or several spots on the truck or piece of equipment. The source is volumetric if a scan along the truck or equipment indicates the exposure rates remain consistent for most of the surface.

Note the time of the initial survey and wait 30 minutes and resurvey. If the exposure rate has reduced by more than 25% then the source is likely radon or radon progeny in the system or truck. If the exposure rate remains the same, then the source is likely to be radium or a radionuclide with a half-life longer than several hours.

Follow-up Characterization

After consulting with the RSO and the Action Plan Radiological Consultant determine if there is a need for sampling and analysis of the suspect materials.

If sampling is required, then perform the following steps:

- For water samples collect the water samples in a 1-liter glass container, seal the lid to prevent leakage, and label the container.
- For solid samples collect at least 500 ml of solid material in a plastic container, seal the lid and label the container.
- Under the direction of the Action Plan Radiological Consultant complete the Chain of Custody (ies) for the sample(s) and ship the samples to the designated lab for analysis.

Alternate Characterization Methods

Alternate characterization methods include the use of a portable isotope identification system to determine the radionuclides principally responsible for the elevated exposure rates.

A calculation using software such as Microshield and the detected exposure rates can be used to determine the approximate activity concentration in the water or process materials.

Determination of Origin

Because the origin of the material is known to be from the drilling muds and flow back water, origin determination will not be needed. There is the potential for build-up of tracer radionuclides and if these are present then the Action Plan Consultant will provide additional handling guidance.

12. Emergency Response

Drilling, exploration, processing, and transportation presents numerous inherent risks. Several studies have determined there is, “little potential for significant radiological exposure to workers and members of the general public related to E&P operations” (PADEP 2015). However, spills of waste material generated during the E&P process can have negative impacts to the environment. Plausible emergencies related to radioactive material include:

- Transport vehicle accidents
- Hose or transfer line rupture
- Line fitting leakage
- Tank overflow or puncture

When dealing with the spill, reference to the Prevention, Preparedness and Contingency Plan will be made as well as Emergency Response Plans if necessary.

Report spills involving TENORM to the RSO. In the case of a vehicle spill on public roads, provide first responders with as much information as possible including the type of waste, container dose rate and radium concentration (if known).

13. Instrumentation Use, Maintenance and Calibration

Gamma detection instruments to be used for survey of process facilities and wastes will be a Ludlum Model 19 or equivalent detection capabilities.

The Ludlum Model 19 has detection capabilities of below 10 uR/hr and its use ensures the facility can meet the required guideline of detecting increases in radiation exposure rates at levels greater than 10 uR/hr above the facility background rates.

The initial calibration of the instruments will be performed by a calibration facility licensed by the Nuclear Regulatory Commission, or equivalent State agency, for the purpose of calibrating radiation detection equipment. National Institute of Standards and Technology (NIST) traceable sources will be used to calibrate the instruments in accordance with ANSI N323a-1997, *Radiation Protection Instrumentation Test and Calibration* requirements.

Upon receipt of the instrument from the calibration facility, an instrument inspection will be made to ensure operability and a functional check of instruments' response will be made with an appropriate check sources. This functional check will be used to establish the acceptance range for subsequent random quarterly functional checks.

Upon instrument acceptance and functional checks, a background exposure rate value will be established for the truck/container staging area where surveys are to be conducted.

Additional calibration and maintenance of the instrument will be performed under the following conditions:

- Annually
- Instrument malfunctions
- Failure to meet the established functional check range

A check of the instrument will be performed before each shift's use and include the following:

- Background check – compare instrument response to previously established background in instrument storage area
- Battery check – check to ensure sufficient DC voltage meets the manufacturer's operational specification
- Range check – movement of range switch to ensure no response is occurring on higher level exposure rate detector ranges
- Functional check – compare instrument exposure rate response to initially established acceptance range

A Ludlum 2929 or equivalent dual channel scaler will be used to count smears and air samples for alpha and beta. In lieu of purchasing and maintaining this instrument, swipes and air samples can be counted by an accredited lab or radiological service provider.

14. Records

All survey forms, records of training, instrument calibration and check forms, and audits or assessment records will be maintained for at least five years.

Surveys

Log data or maps provided are used to document work areas and/or specific waste surveys. These records will be retained at CNX Headquarters-Southpointe. The log will note the date/time of survey, the surveyor, and a notation of whether the exposure rates exceeded the action levels specified in this Plan.

Truck/Container survey forms will be used for equipment or outgoing vehicle surveys that exceed the action levels specified in this Plan.

Instrumentation

The daily instrument check will be completed for each day's use of the Ludlum Model 19 and/or Ludlum 2929 (or equivalent instruments). Records of the checks will be maintained at the Facility CNX Headquarters-Southpointe. Calibration records for the detection equipment will also be maintained at the Facility.

If supplemental instrumentation such as a portable isotope identifier instrument is used, then the daily check and annual calibration records for that instrument will also be maintained at the Facility.

Characterization and Analysis Data

All characterization and analysis data including calculations, laboratory analytical data and print-outs for portable spectroscopy survey meters will be maintained at the CNX Headquarters-Southpointe.

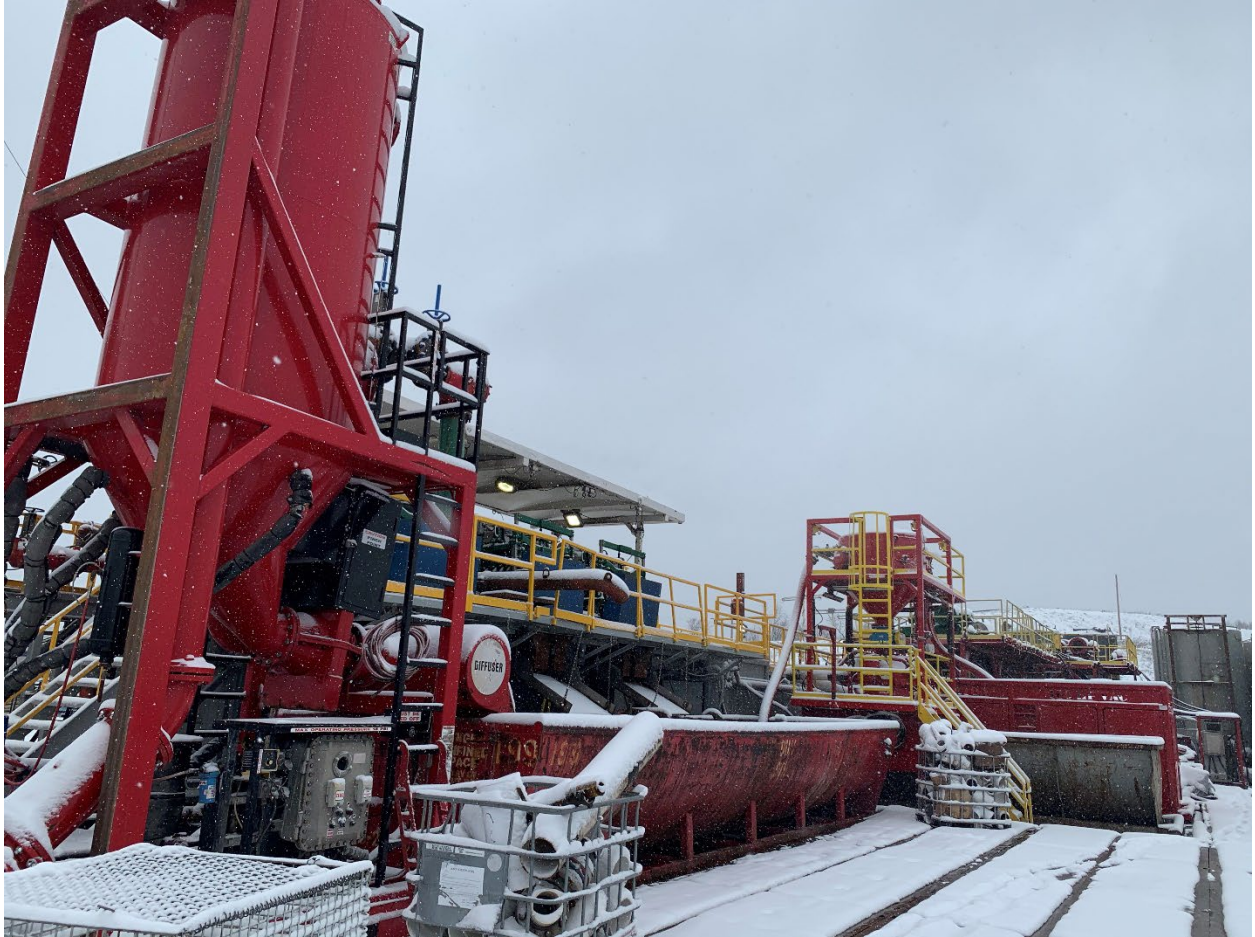
Disposition and Shipping Records

- Waste packages include the following:
 - Approved waste profile
 - Radium analytical results (if required)
 - Gamma survey information (if used to make shipping determination)
 - Waste disposal tickets (from a landfill or properly permitted third party waste processing facility) that shows the amount of waste disposed.

An important part of protecting workers, the general public and environment is learning from our mistakes. Development of a lessons learned tracking database is encouraged. Reviewing the elements that created a potential hazard, mitigating steps that were taken and what could have been done better provides valuable information under actual field conditions. Lessons learned should be incorporated into annual refresher training.

Appendix A

Drilling Operations



A. Drilling Operations Description

The following provides a general description of Drilling operations at CNX Well Pad facilities. Not all aspects at each facility will be exactly the same as those described in this Plan. The Plan action levels and responding actions are designed to be responsive for any of the differences between Well Pad facilities.

Applicable CNX contractors and subcontractors performing work at drilling facilities should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level – Extremely Low

Equipment to Monitor/Survey – Survey shakers/Centrifuge Primary Cuttings containers/halfrounds.

Incoming Container Survey – Periodic surveys of incoming waste containers, biased towards visibly unclean containers.

Outgoing Waste Surveys - cursory scan of waste containers/Trucks to ensure dose rates are <10 uR/hr at 12” from the container surface. If in the unlikely event dose rates are found in excess of 10 uR/hr above bkgd at 12” from the containers surface, notify on site rep/RSO for further instructions.

Drilling Facility Survey – The CNX RSO will select a single representative pad with active drilling operations and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new drilling site for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Active Drilling Site (survey a different facility each time)	X	Monthly	Perform gamma surveys of tanks and process equipment.

Waste Generated – Vertical and horizontal drill cuttings (NORM)

DOT Transportation concerns – No

TLD Monitoring Required – No

Air Sampling - No

Waste Disposal Logic

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment is considered Class & DOT hazardous
Shipment is classified as Class 7 DOT hazardous	Perform wipe tests at locations where dirt/soil appear to be present and on all four sides. and Survey drivers cab and ensure exposure rate less than 2000 uR/h And If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck

Process Facilities and Equipment

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal system process exposure rates	No action needed – note findings on survey log
Exposure rates \geq 2 times the normal system process exposure rates	Contact On site rep and determine cause of increase. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed

Exposure rate \geq 5000 uR/hr	<p>Complete current process and then cease operations</p> <p style="text-align: center;">and</p> <p>Post the area such that only personnel needing access to the equipment are authorized entry</p> <p style="text-align: center;">and</p> <p>Contact the RSO/On site Rep</p> <p style="text-align: center;">and</p> <p>Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>)</p> <p>NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings</p>
---------------------------------	--

Equipment Unrestricted Release

Note: This section is written as a temporary survey program designed to determine if contamination levels over the time of the work consistently remain below release criteria. In the event, it is shown that contamination levels never exceed the action levels in this plan, contamination surveys can be suspended.

DOT Transportation concerns – Unlikely. Waste containers in excess of 90 uR/hr on contact or total radium concentration of 270 pCi/g must undergo additional evaluation or be shipped in accordance with 49CFR173.436. Contact RSO/On site Rep for further directions.

Appendix B

Completions Operations



B. Completions Process Description

The following provides a general description of completion operations at CNX Well Pad facilities. Not all aspects at each facility will be exactly the same as those described in this Plan. The Plan action levels and responding actions are designed to be responsive for any of the differences between Well Pad facilities.

Applicable CNX contractors and subcontractors performing work at completions facilities should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level – Low (except for potential exposure to nuclear gauges)

Exposure minimization

- Minimize time spent near nuclear density gauges or ensure adequate shielding is in place to minimize worker exposure to gamma radiation.
- No welding, burning, grinding or use of volatile chemicals to remove pipe scale without proper controls.
- When practical, cover ends of piping and equipment with obvious signs of pipe scale.
- Workers should minimize contact with sludge/solids to the extent possible.
- Workers should practice good hygiene (wash hands and face upon exit from controlled areas and prior to eating/drinking).

Survey Requirements

- Periodic check of incoming waste containers biased towards visibly unclean areas.
- Scan of waste outgoing waste containers to ensure dose rates are <10 uR/hr at 12" from the container surface. In the event readings are found to be greater than 10 uR/hr at 12" from the waste container, contact RSO/On site Rep for further directions.
- Gamma Survey of area near nuclear density gauges on contact and at 30 cm from the source (pictured below)



Completions Facility Survey – The CNX RSO will select a single representative pad with active completions operations and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new completions site for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Active Completions Sites (survey a different facility each time)	X	Monthly	Perform gamma surveys of nuclear density gauges, tanks and process equipment.

Required Area Posting - Radiation Area signage if gamma dose rate exceeds 5 mR/hr at 30 cm from density gauges (USNRC 10CFR20).

Suggested Area Posting – “Radioactive Material” stickers on nuclear density gauges with signage alerting workers not to loiter in the immediate area.

Supplementary Audit Criteria – Review contractor and subcontractor radioactive material license and ensure compliance.

Waste Generated – Flowback liquids and solids, plug remnants, contaminated equipment, filter socks and cartridges.

Waste Disposal Logic

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment is considered Class & DOT hazardous

<p>Shipment is classified as Class 7 DOT hazardous</p>	<p>Perform wipe tests at locations where dirt/soil appear to be present and on all four sides.</p> <p style="text-align: center;">and</p> <p>Survey drivers cab and ensure exposure rate less than 2000 uR/h</p> <p style="text-align: center;">And</p> <p>If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck</p>
--	--

Process Facilities and Equipment

Immediate Survey Actions

If	Then
<p>Exposure rate less than 2 times the normal system process exposure rates</p>	<p>No action needed – note findings on survey log</p>
<p>Exposure rates \geq 2 times the normal system process exposure rates</p>	<p>Contact On site rep and determine cause of increase.</p> <p>Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed</p>
<p>Exposure rate \geq 5000 uR/hr</p>	<p>Complete current process and then cease operations</p> <p style="text-align: center;">and</p> <p>Post the area such that only personnel needing access to the equipment are authorized entry</p> <p style="text-align: center;">and</p> <p>Contact the RSO/On site Rep</p> <p style="text-align: center;">and</p> <p>Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings</p>

Equipment Unrestricted Release

Note: This section is written as a temporary survey program designed to determine if contamination levels over the time of the work consistently remain below release criteria. In the event, it is shown that contamination levels never exceed the action levels in this plan, contamination surveys can be suspended.

DOT Transportation concerns – Yes, waste containers in of 90 uR/hr or total radium concentration of 270 pCi/g must undergo additional evaluation or be shipped in accordance with 49CFR173.436. Contact RSO/On site Rep for further directions.

TLD Monitoring Required – No

Air Sampling – No

Appendix C

Production



C. Production Facility Process Description

The following provides a general description of production operations at CNX Well Pad facilities. Not all aspects at each facility will be exactly the same as those described in this Plan. The Plan action levels and responding actions are designed to be responsive for any of the differences between Well Pad facilities.

Applicable CNX contractors and subcontractors performing work at production facilities should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level – Low

Exposure minimization

- No welding, burning, grinding or use of volatile chemicals to remove pipe scale without proper controls.
- When practical, cover ends of piping and equipment with obvious signs of pipe scale.

Survey Requirements

Production sites chosen for survey should differ in age, region, and geologic formation.

- Periodic check of production water holding tanks.
- Survey of miscellaneous scrap pipe, pumps and equipment prior to disposal, pay particular attention to areas with visible scale.
- **Production Facility Survey** – The CNX RSO will select a single representative pad with ongoing production operations and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new production site for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Wells in Production (survey a different facility each time)	X	Monthly	Focus gamma surveys on wastewater storage tanks and process equipment.

Tubing with visible scale



Required Area Posting - None

Suggested Area Posting – None

TLD Monitoring Required – No

Air Sampling – No

Waste Generated – Produced water, tank bottom solids, contaminated equipment, filter socks and cartridges.

Liquid Waste Disposal – Liquid waste can be shipped directly to storage, wastewater processing facility or Class II injection well.

DOT Transportation concerns – Yes, waste containers with surface gamma dose rates of ≥ 90 uR/hr or with a total radium concentration of 270 pCi/g must be shipped in accordance with 49CFR173.436.

Solid Waste Disposal – The following describes logic that should be followed when considering waste disposal options. Waste will only be processed/disposed at facilities on the CNX Approved Vendors List.

if	Then
Exposure rate ≤ 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate ≥ 10 and ≤ 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate > 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

Process Facilities and Equipment

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal system process exposure rates	No action needed – note findings on survey log
Exposure rates \geq 2 times the normal system process exposure rates	Contact Facility Compliance Manager and determine cause of increase. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed
Exposure rate \geq 5000 mR/hr	Complete current process and then cease operations and Post the area such that only personnel needing access to the equipment are authorized entry and Contact the Compliance Manager and Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings

Appendix D

Midstream Operations

Compressor Station



Midstream Compressor Facility Process Description

The following provides a general description of midstream compressor station facilities. Not all aspects at each facility will be exactly the same as those described in this Plan. The Plan action levels and responding actions are designed to be responsive for any of the differences between midstream facilities. Applicable CNX contractors and subcontractors performing work at midstream facilities should have a Radiation Protection Plan similar in scope to this document.

Pigging Operations



Gas Pipe Scale



Worker Radiation Hazard Level – Low primarily due to potential Radon (Rn-222) gas exposure. Pipe scale and pigging waste (see above) can be highly contaminated (up to 400,000 pCi/g) and create a moderate hazard to workers.

Survey Requirements

- Periodic check of pumps, production lines and tanks. Pay particular attention pipe elbows, valves and or where piping decreases in size.
- Survey of scrap pipe, pumps and equipment prior to disposal. Pay particular attention to pipes and equipment with signs of scale build-up. These areas are likely to exhibit elevated gamma dose rates.
- Gamma survey of areas potentially effected by pigging operations (pig catch area).
- The CNX RSO will select a single representative midstream facility with ongoing operations and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new midstream facility for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Midstream Compressor Stations(survey a different facility each time)	X	Monthly	Perform gamma surveys of process equipment quarterly and upon system breach when performing maintenance and/or pigging. Survey pigging equipment, work area and waste containers.

Required Area Posting – None

Suggested Area Posting – “Do not loiter” on exterior doors of unvented buildings with midstream equipment/piping.

Exposure minimization - Indoor areas should be ventilated prior to prolonged occupancy. No welding, burning, grinding or use of volatile chemicals to remove pipe scale without proper controls. Make sure a good containment exists in the pig catch area.

TLD Monitoring Required – No

Air Sampling – No

Waste Generated – Scale, pigging waste, contaminated equipment, filter socks and cartridges, Tank solids.

Liquid Waste Disposal – Liquid waste can be shipped directly to storage, wastewater processing facility or Class II injection well.

DOT Transportation concerns – Yes, waste containers or contaminated equipment in of 90 uR/hr or total radium concentration of 270 pCi/g must be shipped in accordance with 49CFR173.436.

Solid Waste Disposal – Solid waste disposal logic is described below. Waste may only be processed/disposed at facilities on the CNX Approved Vendors List.

Waste Disposal Logic

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment is considered Class & DOT hazardous
Shipment is classified as Class 7 DOT hazardous	Perform wipe tests at locations where dirt/soil appear to be present and on all four sides. and Survey drivers cab and ensure exposure rate less than 2000 uR/h and If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck

Process Facilities and Equipment

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal system process exposure rates	No action needed – note findings on survey log
Exposure rates \geq 2 times the normal system process exposure rates	Contact On site rep and determine cause of increase. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed
Exposure rate \geq 5000 uR/hr	Complete current process and then cease operations and Post the area such that only personnel needing access to the equipment are authorized entry and Contact the RSO/On site Rep and Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings

Appendix E

Wastewater Storage and Transfer Facilities

Aboveground Storage Tanks

Centralized Impoundment Ponds



E. Wastewater Storage Facilities

The following provides a general description of above ground storage tanks (ASTs) and centralized impoundment ponds.

Applicable CNX contractors and subcontractors performing work at wastewater storage facilities should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level – Moderate exposure potential due to tank bottom solids when cleaning.

Exposure minimization

- No welding, burning, grinding or use of volatile chemicals to remove pipe scale without proper controls.
- Above Ground Storage Tanks should be ventilated prior to prolonged occupancy.
- Workers should minimize contact with sludge/solids to the extent possible.
- Workers should practice good hygiene (wash hands and face upon exit from controlled areas and prior to eating/drinking).
- Minimize dust generation when decontaminating tanks and centralized impoundment ponds.

Survey Requirements

- Periodic-Survey of pumps, water lines and tanks. Pay particular attention pipe elbows, valves and or where piping decreases in size.
- Survey of scrap pipe, pumps and equipment prior to disposal.
- The CNX RSO will select a single representative location with wastewater storage and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new location for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Waste Water Storage (survey a different facility each time)	X	Monthly	Perform gamma surveys around perimeter, on waste containers and associated piping.

Required Area Posting – None

Suggested Area Posting – “Contact CNX RSO For Entry” on fence

Exposure minimization – Impoundment ponds should not be allowed to drain completely. Keeping some water above the sludge mitigates potential airborne fugitive emissions.

Whenever possible, impoundment ponds and ASTs should be cleaned in a way that does not require immersion in the waste material.

TLD Monitoring – No. Options are available to implement upon changing conditions.

Air Sampling – No

Waste Generated – Sand, fracking fluids, piping, HDPE liner.

Liquid Waste Disposal – Liquid waste can be shipped directly to storage, wastewater processing facility or Class II injection well.

DOT Transportation concerns – Yes, solid waste is likely to exceed 270 pCi/g and must be shipped in accordance with 49CFR173.436. Analyze representative samples of waste material prior to cleaning.

Waste Disposal Logic – Waste may only be processed/disposed at facilities on the CNX Approved Vendors List.

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment may be considered Class 7
Shipment is classified as Class 7 DOT hazardous	Perform wipe tests at locations where dirt/soil appear to be present and on all four sides. and Survey drivers cab and ensure exposure rate less than 2000 uR/h and If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck

Process Facilities and Equipment

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal system process exposure rates	No action needed – note findings on survey log
Exposure rates \geq 2 times the normal system process exposure rates	Contact On site and/or RSO and determine cause of increase. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed
Exposure rate \geq 5000 uR/hr	Complete current process and then cease operations and Post the area such that only personnel needing access to the equipment are authorized entry and Contact the RSO/On site Rep and Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings

Appendix F

Potentially Contaminated Equipment Storage Areas



Potentially Contaminated Equipment Storage

The following describes areas designated to store legacy/advanced usage equipment that may be contaminated with TENORM.

Applicable CNX contractors and subcontractors performing work at equipment storage locations should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level – Minimal unless improperly cleaning equipment.

Exposure minimization

- No welding, burning, grinding or use of volatile chemicals to remove pipe scale without proper controls.
- When practical, cover ends of piping and equipment with obvious signs of pipe scale.

Survey Requirements

- Upon receipt or prior to sale
- Survey of scrap pipe, pumps and equipment prior to disposal.

The CNX RSO will select a single representative equipment storage area and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new equipment storage site for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Equipment Storage Facilities (survey a different facility each time)	X	Monthly and upon receipt of potentially contaminated equipment, prior to recycling	Survey potentially contaminated equipment when accepted for storage and prior to sending to a landfill or recycling facility.

Required Area Posting – None

Suggested Area Posting – Legacy equipment contaminated with pipe scale should be posted as “Radioactive Material” if it has shown elevated surveyed levels.

Exposure minimization – Survey legacy equipment prior to working on it. Avoid volatile cleaning solutions and grinding/flapping/burning on contaminated piping or equipment without proper controls.

TLD Monitoring Suggested – No

Air Sampling – No

Waste Generated – Contaminated piping equipment and scale

Recycle Gamma Radiation Limit – 50 uR/hr on contact

DOT Transportation concerns – Yes, solid waste is likely to exceed 270 pCi/g and must be shipped in accordance with 49CFR173.436. Analyze representative samples of waste material prior to cleaning.

Waste Disposal Logic – Waste may only be processed/disposed at facilities on the CNX Approved Vendors List.

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment may be considered Class 7
Shipment is classified as Class 7 DOT hazardous	Perform wipe tests at locations where dirt/soil appear to be present and on all four sides. and Survey drivers cab and ensure exposure rate less than 2000 uR/h and If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck

Process Facilities and Equipment

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal background	No action needed – note findings on survey log
Exposure rates ≥ 2 times the normal background rates	Contact On site and/or RSO and determine cause of the elevated readings and to determine storage requirements. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed
Exposure rate ≥ 5000 uR/hr	Complete current process and then cease operations and Post the area such that only personnel needing access to the equipment are authorized entry and Contact the RSO/On site Rep and Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings

Appendix G

Well Plugging

Well Plugging Operations

The following provides a general description of well plugging operations. Not all aspects at each abandonment site will be exactly the same as those described in this Plan. The Plan action levels and responding actions are designed to be responsive for any of the differences between abandoned well pad facilities. Applicable CNX contractors and subcontractors performing work at plugging sites and contractors that refurbish casing pipe should have a Radiation Protection Plan similar in scope to this document.

Worker Radiation Hazard Level –Scale inside piping and production tanks can be highly contaminated (up to 400,000 pCi/g) and create a moderate hazard to workers.

Survey Requirements

- Periodic check of pumps, production lines and tanks. Pay particular attention pipe elbows, valves and or where piping decreases in size.
- Survey of scrap pipe, pumps and equipment prior to disposal. Pay particular attention to pipes and equipment with signs of scale build-up. These areas are likely to exhibit elevated gamma dose rates.
- Gamma survey of areas potentially effected by pigging operations (pig catch area).
- The CNX RSO will select a single representative well plugging operation with ongoing operations and perform a survey in accordance with Table 8-1 of the CRPP. Survey sites should be alternated (pick a new midstream facility for each survey).

Facility Radiation/Contamination Monitoring	Gamma Survey	Survey Frequency	Comments
Well Plugging (survey a different location each time)	X	Monthly	Survey piping and equipment that will be recycled. Release to recycle melting facilities is 50 uR/hr.

Required Area Posting – None

Suggested Area Posting – None

Exposure minimization – No welding, burning, grinding or machining of contaminated equipment. Look for pipe scale as an indication of radiological contamination.

TLD Monitoring Required – No

Air Sampling – No

Waste Generated – Scale, contaminated equipment, tank solids.

Liquid Waste Disposal – Liquid waste can be shipped directly to storage, wastewater processing facility or Class II injection well.

DOT Transportation concerns – Yes, waste containers or contaminated equipment in of 90 uR/hr or total radium concentration of 270 pCi/g must be shipped in accordance with 49CFR173.436.

Solid Waste Disposal – Solid waste disposal logic is described below. Waste may only be processed/disposed at facilities on the CNX Approved Vendors List.

Waste Disposal Logic

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	Container is acceptable for transport to a regional landfill.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate	Consult with Landfill operator to determine if they require a laboratory analytical for the radium content or whether an estimated level will be acceptable.
Exposure rate $>$ 90 uR/hr above background exposure rate	Obtain laboratory analytical to verify radium content or Do not send material for regional landfill burial and ship container to alternate processing facility

DOT Transport Surveys

If	Then
Exposure rate \leq 10 uR/hr above background exposure rate	No further surveys are required, and container can be shipped as exempt.
Exposure rate \geq 10 and \leq 90 uR/hr above background exposure rate and No analytical result for total radium has been obtained	The activity is likely below 270 pCi/g and the container can be shipped as DOT exempt/DOT Special Permit
If over 90 uR/hr and an analytical result for container contents has been obtained	Use the analytical results to determine if the shipment is considered Class & DOT hazardous
Shipment is classified as Class 7 DOT hazardous	Perform wipe tests at locations where dirt/soil appear to be present and on all four sides. and Survey drivers cab and ensure exposure rate less than 2000 uR/h and If contact dose rate exceeds 500 uR/hr on contact Complete a uniform low level waste manifest, label shipping container "Radioactive LSA" and placard exclusive use truck

Plugging Sites

Immediate Survey Actions

If	Then
Exposure rate less than 2 times the normal system process exposure rates	No action needed – note findings on survey log
Exposure rates \geq 2 times the normal system process exposure rates	Contact On site rep and determine cause of increase. Note: Unless dose rates begin to approach 2000 uR/h no immediate actions are needed
Exposure rate \geq 5000 uR/hr	Complete current process and then cease operations and Post the area such that only personnel needing access to the equipment are authorized entry and Contact the RSO/On site Rep and Determine the nature of the material causing the elevated activity (see <i>Characterization Section</i>) NOTE: General area dose rates around nuclear density gauges may routinely exceed 5000 uR/hr. Area postings