Disposal of Water Treatment Plant Waste Containing Radionuclides

Options for Disposal are Influenced by. . .

- Concentration of radionuclides and co-occurring contaminants in the waste stream
  - Hazardous Waste
  - Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)
  - Low-Level Radioactive Waste (LLRW)
  - Mixed Waste
- Federal, State, & Local Regulations
  - Disposal facility policies
- Type of residuals
  - Liquid or solid

Definitions for Waste

Hazardous Waste

Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)

Low-Level Radioactive Waste (LLRW)

Mixed Waste

Hazardous Waste

- Regulated under RCRA
- Hazardous waste is solid waste:
  - Not excluded from regulation under 40 CFR 261.4(b)
  - Exhibits toxicity, corrosivity, reactivity, or ignitability criteria listed under 40 CFR 261.3(a)(2) and (b)
- Presence of radionuclides does not *ITSELF* make the waste hazardous

TENORM

- Regulated by numerous federal regulations
- Defined as naturally occurring materials whose radionuclide concentrations or potential for exposure is enhanced as a result of human activities
  - Includes waste streams generated by water treatment plants
  - Also includes mining, fertilizer production, and oil and gas production.

LLRW

- Defined by The Low-Level Radioactive Waste Policy Act
  - Not high level radioactive waste, spent nuclear fuel, or byproduct material; and,
  - The Nuclear Regulatory Commission (NRC)…classifies as LLRW

LLRW

- Can contain source or special nuclear material
  - Radium (Ra) is not source or byproduct material by definition
  - Uranium (U) & thorium (Th) are source material and may be subject to NRC licensing requirements

HOWEVER. . .

LLRW: Uranium & Thorium

- If U or Th makes up <0.05% by weight (totaling less than 15 lbs.), it is source material an “unimportant quantity” and exempt from NRC Regulations
  - Approximately 335 pCi/g for natural U

Mixed Waste

- Regulated under RCRA and the Atomic Energy Act (AEA)
  - Contains both hazardous waste and source. . . or byproduct material subject to the AEA

>0.05% U/TH by weight (totaling <15 lbs.)	+	Hazardous Waste	=	Mixed waste subject to general license from NRC or Agreement State
>0.05% U/TH by weight (totaling >15 lbs.)	+	Hazardous Waste	=	Mixed waste subject to specific license from NRC or Agreement State

Statutes and Regulations

RCRA

SDWA

AEA/NRC

CWA

DOT

State Requirements

Things to Consider

- Numerous federal regulations
  - No federal waste disposal regulation specifically for TENORM
- Key definitions vary among regulations
- States, locality, and waste disposal facility may have additional requirements

RCRA
42 USC 6901 et. seq.

- The identification, management, and disposal of solid wastes (including sludge)
- If you generate solid waste, you must determine whether the waste is hazardous
  - Use a method described in 40 CFR 262.11

RCRA: Hazardous Waste

- Solid waste exhibiting toxicity, corrosivity, reactivity, or ignitability characteristics is hazardous
- Requirements depend on the amount of hazardous waste produced monthly and the amount of hazardous waste stored on site at any given time
  - Large Quantity, Small Quantity, or Conditionally Exempt Small Quantity
- “Cradle to Grave” liability

RCRA

- RCRA Subtitle C requirements apply to hazardous waste disposal
  - Hazardous Waste Landfill
  - LLRW Landfill
- RCRA Subtitle D requirements apply to non-hazardous waste solid waste disposal
  - Municipal Solid Waste Landfill (MSWLFs) requirements
    - Some MSWLFs can accept commercial solid waste, nonhazardous sludge, CESQG waste, and industrial nonhazardous solid waste
  - Hazardous Waste Landfill
  - LLRW Landfill

Clean Water Act (CWA)
33 USC 1251 to 1387

- Direct discharges under a National Pollutant Discharge Elimination System (NPDES) permit
- Discharges to a publicly owned treatment works (POTW)
- Federal NPDES regulations do not set specific limits on radionuclides in discharges
- EPA regulations on the use and disposal of the sewage sludge produced by POTWs currently do not cover radioactive material

CWA

- Systems should:
  - Contact the state NPDES program to determine if the system needs an NPDES or other permit
  - Contact the state NPDES program to determine if the system is capable of meeting the applicable local limits
  - Contact their POTWs to ensure that the wastes will be accepted

SDWA
42 USC 300f et seq.

- EPA required to develop minimum requirements for underground injection control (UIC) programs
- Stay tuned. . .

DOT Regulations
49 CFR 171 to 180

- Govern shipping, labeling, and transport of hazardous materials
- DOT definition of hazardous includes radioactive materials

HOWEVER. . .

DOT: Exemptions

- DOT exempts, “other natural materials or ores… when these have been subjected to physical or chemical processing, when the processing was not for the purpose of extracting radionuclides…provided that their radionuclide concentration does not exceed 10 times the activity concentration in the table in 49 CFR 173.436.”

- For example
  - Uranium is listed in the table in 49 CFR 173.436 at 27 pCi/g
  - Radium-226 and -228 are listed at 270 pCi/g
    - Therefore, a system would need to transport over 270 pCi/g of uranium or 2,700 pCi/g of radium before meeting the “10 times” exemption threshold

AEA
42 USC Chapter 23

- AEA regulates the development and use of nuclear facilities, and the creation, generation, and disposal of source, special nuclear, and byproduct material
- Uranium and thorium are source material
  - NRC has exempted some source material
    - Uranium or thorium makes up <0.05% by weight

State TENORM Regulations

- Currently regulated by 13 states
- http://www.tenorm.com/regs2.htm#States

Residual Type

Solid Residuals

Liquid Residuals

Waste Streams

- Liquid Residual Stream
  - Brine
  - Backwash Water
  - Rinse Water
  - Acid Neutralization Water
  - Concentrate
- Solids
  - Spent Resins
  - Spent Filter Media
  - Spent Membranes
  - Sludges

Solid Residuals by Treatment Type

Treatment	Spent Resins/ Media	Spent Membranes	Sludge
IX	X		
RO		X	
AA	X		
Coagulation/Filtration	X		X
Lime Softening	X		X
Green Sand Filtration	X		X
Co-Precipitation w/Barium Sulfate	X		X
Electrodialysis/Reversal		X	
Pre-formed Hydrous Manganese Oxide Filtration	X		X

Liquid Residuals by Treatment Type

Treatment	Brine	Backwash	Rinse Water	Acid Neutral Water	Concentrate
IX	X	X	X		
RO					X
AA		X	X	X	
Coagulation/Filtration		X			
Lime Softening		X			
Green Sand Filtration		X			
Co-Precipitation w/Barium Sulfate		X			
Electrodialysis/Reversal					X
Pre-formed Hydrous Manganese Oxide Filtration		X			

Disposal Options

Direct Discharge
Discharge to POTW
Underground Injection
Landfill

Disposal Options

Residual Waste	Disposal Options				
	Direct Discharge	Discharge to POTW	Recycle	Underground Injection	Landfill
Liquids	X	X	X	X	
Sludge					X
Spent Media					X
Spent Membranes					X

Other Options?

- Incineration
- Evaporation ponds
- Surface impoundments
- Sludge dewatering

Intermediate processing methods each creating its own residual stream

- Landspreading or soil mixing

Not encouraged unless there is a demonstrated benefit and the benefits are weighed against potential hazards & risks

Liquids: Direct Discharge

- CWA
- Need accessible and appropriate receiving body
- Must have a National Pollutant Discharge Elimination System (NPDES) permit

- Federal NPDES regulations do not set specific limits on radionuclides in discharges but:
  - State anti-degradation policies
  - Source water protection policies
  - Co-occurring contaminant limits set in NPDES

May limit the use of this disposal option

Liquids: POTW

- Discharges to a POTW
  - POTW will have NPDES permit
  - System may need local permit or contract
  - Both the system and the POTW are responsible for:
    - Preventing the introduction of any pollutants that may interfere with the POTW treatment process, contaminate POTW sewage sludge, or violate POTWs NPDES permit
    - Meeting technically based local limits (TBLLs)
    - Meeting pretreatment regulations
- POTW owners can refuse to accept waste

Solids: Landfill

- Determine if the waste is hazardous through knowledge of the waste generation process, analytical testing, or both
  - Toxicity Characteristic Leaching Procedure (TCLP) (EPA Method 1311)
- Determine if waste contains any “free liquids”
  - Perform the Paint Filter Liquids Test (or PFLT; EPA SW 846 Method 9095)
  - Conduct intermediate processing to remove any liquids
- No federal requirement to test residuals specifically for radionuclides
- No specific federal regulation governing landfill disposal of water treatment plant solids or sludges containing TENORM

Solid Waste Landfill

- Municipal solid waste landfills may accept:
  - Non-hazardous, solid, TENORM wastes from all water systems
  - Hazardous waste from Conditionally Exempt Small Quantity Generators
- Industrial solid waste landfills may also accept:
  - Non-hazardous solid TENORM waste

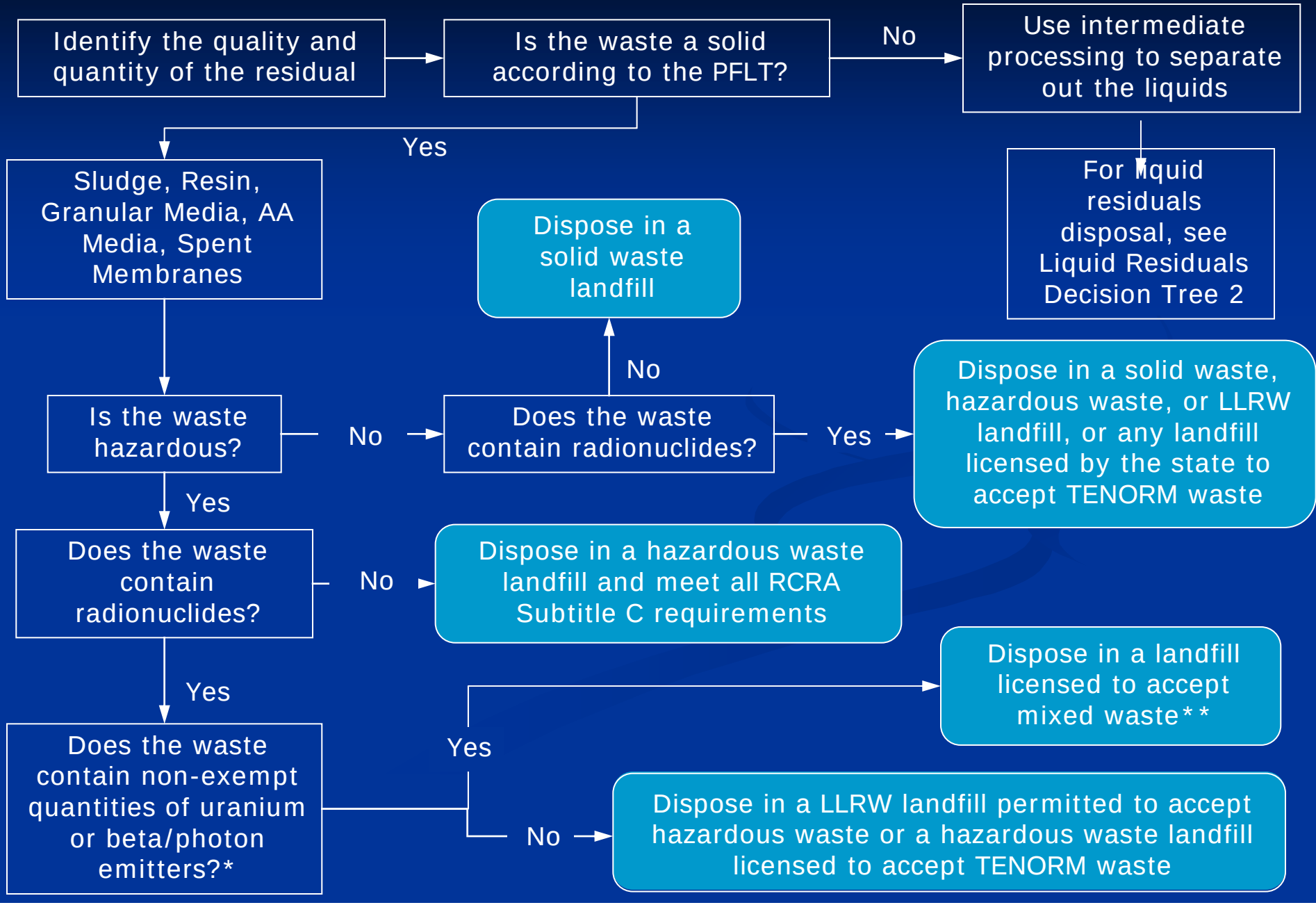
Hazardous Waste Landfill

- May accept hazardous waste from all generator classes
  - Hazardous waste from Large and Small Quantity Generators must meet RCRA Land Disposal Restriction requirements (40 CFR 268.40)
- Some hazardous waste landfills have explicit permit conditions while others may have to request state approval before accepting TENORM wastes

LLRW Landfills

- Licensed by NRC or by a state under agreement with NRC
- Barnwell - South Carolina
  - After June 30, 2008, will accept waste only from organizations in South Carolina, Connecticut, and New Jersey
- Richland - Washington
  - Accepts certain types of TENORM (although not hazardous or mixed) wastes from all states
- Envirocare - Utah
  - Has dedicated TENORM disposal and is the only LLRW landfill authorized to accept certain kinds of mixed waste

Solids Residual Disposal



Liquid Residuals Disposal