

WASTE STREAM	2D11	Pond Sludge
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SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Ltd

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025	= 128.4		
Future arisings:				
Total future arisings:		0.0		
Total waste volume:		128.4		

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: There are no future arisings. Sludge is to be removed from pond. Estimated volume of sludge reduced for 2025 RWI submission due to retrievals to date and rebaseline of estimated total arisings.

Additional information on quantities: Estimate of pond sludge volumes indicates uncertainty in the range from 260 to 390m³ from previous estimate, and also reflects the 27m³ sludge exported to WEP since December 2016.

Uncertainty factors on volumes: Stock (upper): x 1.20 Arisings (upper): x -
Stock (lower): x 0.80 Arisings (lower): x -

WASTE SOURCE The waste is from corrosion of items stored in the pond, the pond structure and general pond debris (eg. wind blown, wildlife deposition).

PHYSICAL CHARACTERISTICS

General description: The sludge is a dark, brownish-green, flocculant material containing a small proportion by volume of gritty material. It comprises approx 14.5 wt% solids in aqueous medium. No large items present.

Changes since waste generated: The waste has not undergone any change since it was generated.

Bulk density (t/m³): = 1.1

Comment on density: The given density is the material density. Samples taken in October 1987 had a settled wet density of 1.0 - 1.2 t/m³ and a solids concentration of up to 22 wt%.

CHEMICAL COMPOSITION

General description and components (%wt): Fe (1.3%), Mg (1.2%), Zn (0.1%), Al (0.1%), mostly as oxides. Others include U (0.6%), Pu (6E-4%). The most recent sampling indicates that the soluble organic fraction is less than 1%. Also H₂O (85.5%), SiO₂ (balance).

Chemical state: Alkali

Sheet metal proportion / thickness: No sheet or bulk metal is present.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	P	Trace within sludge matrix from corrosion.	
Iron.....	~ 1.3	-	
Aluminium.....	~ 0.10	-	
Beryllium.....	TR	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	~ 1.2	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	~ 0.60	May be traces of uranium metal fines.	
Zinc.....	~ 0.10	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	TR	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	= 0	-	
Paper, cotton.....	= 0	-	
Wood.....	= 0	-	
Halogenated plastics.....	= 0	-	
Total non-halogenated plastics.....	= 0	-	
Condensation polymers.....	= 0	-	
Others.....	= 0	-	
Organic ion exchange materials.....	= 0	-	
Total rubber.....	= 0	-	
Halogenated rubber.....	= 0	-	
Non-halogenated rubber.....	= 0	-	
Hydrocarbons.....		-	
Oil or grease.....		-	
Fuel.....		-	
Asphalt/Tarmac (cont.coal tar).....		-	
Asphalt/Tarmac (no coal tar).....		-	
Bitumen.....		-	
Others.....		-	
Other organics.....	P	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	= 0	-	
Inorganic sludges and flocs.....	~ 72.7	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	TR	-	
Cementitious material.....	TR	-	
Sand.....	~ 24.0	Assumed from MAIS, could also be concrete dust.	
Glass/Ceramics.....		-	
Graphite.....	TR	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	= 0	-	
Non/low friable.....		-	
Moderately friable.....		-	
Highly friable.....		-	
Free aqueous liquids.....	~ 0	-	
Free non-aqueous liquids.....	= 0	-	
Powder/Ash.....	= 0	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride.....	NE	-
Chloride.....	< 0.05	-
Iodide.....	NE	-
Cyanide.....	= 0	-
Carbonate.....	TR	-
Nitrate.....	NE	-
Nitrite.....	P	-
Phosphate.....	TR	-
Sulphate.....	TR	-
Sulphide.....	NE	-

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals.....	P	<1%.
Low flash point liquids.....	= 0	-
Explosive materials.....	= 0	-
Phosphorus.....	= 0	-
Hydrides.....	= 0	-
Biological etc. materials.....	P	<1%.
Biodegradable materials.....	= 0	-
Putrescible wastes.....	= 0	-
Non-putrescible wastes.....	= 0	-
Corrosive materials.....	= 0	-
Pyrophoric materials.....	= 0	-
Generating toxic gases.....	= 0	-
Reacting with water.....	= 0	-
Higher activity particles.....	= 0	-
Soluble solids as bulk chemical compounds.....	= 0	-

Hazardous substances / non hazardous pollutants:

	(%wt)	Type(s) and comment
Acrylamide.....	= 0	-
Benzene.....		-
Chlorinated solvents.....		-
Formaldehyde.....		-
Organometallics.....	= 0	-
Phenol.....		-
Styrene.....		-
Tri-butyl phosphate.....		-
Other organophosphates.....	P	Trace within sludge matrix.
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	= 0	-
Boron (in Boral).....		-
Boron (non-Boral).....		-
Cadmium.....		-
Caesium.....	= 0	-
Selenium.....		-
Chromium.....		-
Molybdenum.....		-
Thallium.....	= 0	-
Tin.....		-
Vanadium.....		-
Mercury compounds.....		-
Others.....	= 0	-

Complexing agents (%wt):

Not yet determined		
	(%wt)	Type(s) and comment
EDTA.....	0	-
DPTA.....		-
NTA.....		-
Polycarboxylic acids.....		-
Other organic complexants.....	NE	Not estimated but unlikely to be present.
Total complexing agents.....	NE	

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		-
EEE Type 2.....		-
EEE Type 3.....		-
EEE Type 4.....		-
EEE Type 5.....		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration Drying/dewatering/liquid separation Tie down/fixatives/strippable coating/painting application Decontamination Metal treatment Recycling / reuse Thermal treatment, including vitrification Encapsulation Polymer encapsulation Other physical treatment Other chemical treatment Containerisation Treatment not yet determined None	On-site	= 100.0

Comments on planned treatments:

Sludge is concentrated in the Local Sludge Treatment Plant and containerised in the Drum Filling Plant.

Conditioning method:

Drums are sent from the Drum Filling Plant to Wastes Encapsulation Plant, mixed with grout in-drum to create the final encapsulated disposal product.

Conditioning plants:

Plant Name	Location
Wastes Encapsulation Plant (WEP)	Sellafield

Likely conditioning matrix:

-

Further information on the conditioning matrix:

BFS/OPC; PFA/OPC

Waste Packaging:

Likely container type:	Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
	500 l drum	100.0	0.24	0.47	529	-

Range in container waste loading: Limited range. Drums should be full in most cases.

Other information on packaging and conditioning: -

Conditioned density (t/m³): ~ 1.6

Conditioned density comment: This is the bulk density of the waste ~1.1 t/m3 with the addition of conditioning material.

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)	= 100.0		
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The source of the activity is corrosion debris from fuel elements, isotope cartridges and miscellaneous active wastes stored in the pond. The main components are Cs-137 and Sr-90, with isotopes of Mn, Co, Zr, Ru, Nb, Ce, Sb, Am, U, Pu and Eu also present.

Uncertainty: The accuracy of the information is the best available. It is derived from 2 separate sampling exercises, yielding 21 samples from various areas of the pond, and from sampling of 14 batches of PFSP sludge processed through the Local Sludge Treatment Plant before export to WEP. Wide variations were observed in the analyses of differing samples.

Measurement of radioactivities: By theoretical calculation, except Cs and Sr which are measured activities.

Chemical form of radionuclides:

- H-3: -
- C-14: -
- Cl-36: -
- Se-79: -
- Tc-99: -
- I-129: -
- Ra: -
- Th: No characterisation data available.
- U: Oxides.
- Np: -
- Pu: Oxides.

WASTE STREAM		2D11		Pond Sludge					
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	3.35E-06	B B 2			Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	1.48E-16	A A 2			Pb 205				
Fe 55					Pb 210	3.77E-12	C C 2		
Co 60	3.39E-06	B C 2			Bi 208				
Ni 59					Bi 210m				
Ni 63	1.35E-03	C C 2			Po 210	3.54E-12	C C 2		
Zn 65					Ra 223	2.90E-10	C C 2		
Se 79					Ra 225	6.17E-14	C C 2		
Kr 81					Ra 226	1.83E-11	C C 2		
Kr 85					Ra 228	4.93E-20			
Rb 87					Ac 227	2.91E-10	C C 2		
Sr 90	1.59E-01	C D 2			Th 227	2.86E-10	C C 2		
Zr 93	1.70E-06	C C 2			Th 228	1.40E-20			
Nb 91					Th 229	6.21E-14	C C 2		
Nb 92					Th 230	3.53E-09	C C 2		
Nb 93m	1.07E-06	C C 2			Th 232	3.15E-19			
Nb 94					Th 234	1.60E-05	C C 2		
Mo 93					Pa 231	6.87E-10	C C 2		
Tc 97					Pa 233	7.22E-07	C C 2		
Tc 99	6.70E-06	C C 2			U 232				
Ru 106	6.88E-14	B C 2			U 233	6.01E-11	C C 2		
Pd 107					U 234	1.60E-05	C C 2		
Ag 108m					U 235	6.40E-07	C C 2		
Ag 110m					U 236	2.27E-09	C D 2		
Cd 109					U 238	1.60E-05	C C 2		
Cd 113m					Np 237	7.23E-07	C C 2		
Sn 119m					Pu 236				
Sn 121m					Pu 238	4.93E-04	C D 2		
Sn 123					Pu 239	4.80E-04	C D 2		
Sn 126					Pu 240	3.19E-03	C D 2		
Sb 125	9.27E-08	B C 2			Pu 241	1.69E-03	C D 2		
Sb 126					Pu 242	6.40E-07	C D 2		
Te 125m	2.32E-08	B C 2			Am 241	3.67E-02	C D 2		
Te 127m					Am 242m				
I 129	1.30E-09	C C 2			Am 243	5.58E-07	C C 2		
Cs 134	9.71E-10	B C 2			Cm 242				
Cs 135	3.30E-07	C C 2			Cm 243				
Cs 137	6.50E-02	B D 2			Cm 244	9.03E-07	C C 2		
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	1.23E-19	C C 2			Cf 249				
Pm 145					Cf 250				
Pm 147	4.08E-07	C C 2			Cf 251				
Sm 147	5.74E-15	C C 2			Cf 252				
Sm 151	1.93E-04	C C 2			Unsp a	5.65E-02	C D 2		
Eu 152	2.71E-05	C C 2			Unsp b/g	3.83E-01	C C 2		
Eu 154	7.75E-05	A B 2			Total a	9.74E-02	*	0	*
Eu 155	1.01E-05	C C 2			Total b/g	6.11E-01	*	0	*

Bands (Upper and Lower)

A a factor of 1.5
B a factor of 3
C a factor of 10
D a factor of 100
E a factor of 1000

Note: Bands quantify uncertainty in the mean radioactivity.

Code

1 Measured activity
2 Derived activity (best estimate)
3 Derived activity (upper limit)
4 Not present
5 Present but not significant
6 Likely to be present but not assessed
7 Present in significant quantities but not determined
8 Not expected to be present in significant quantity
* Total calculated from the 114 declared radionuclides