WASTE STREAM 5C39 Solid Waste Complex Operational LLW

SITE	Harwell
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	29.5 m³
Future arisings -	1.4.2019 - 31.3.2028.....	942.7 m³
Total future arisings:		942.7 m³
Total waste volume:		972.2 m³

Comment on volumes: Rates of arisings depend on operations carried out. Waste processing operations are programmed to cease before 2030. 141m3 transferred to 5C55 (New Stream - Miscellaneous Legacy LLW) to aid clarity. Disposals during 2013-2016 of 233m3.

Uncertainty factors on volumes:

Stock (upper):	x 1.2	Arisings (upper)	x 1.2
Stock (lower):	x 0.8	Arisings (lower)	x 0.8

WASTE SOURCE Laboratory and Operational LLW.

PHYSICAL CHARACTERISTICS

General description: Range of items, most not large. None.

Physical components (%wt): Metal 19%, Concrete/rubble 41%, Soil 1%, biodegradables 13%, plastics 13%, rubber 7%, wood 1%, Others 5%;

Sealed sources: -

Bulk density (t/m³): ~1.03

Comment on density: taken from WCH mass divided by volume

CHEMICAL COMPOSITION

General description and components (%wt): Metal 19%, Concrete/rubble 41%, Soil 1%, biodegradables 13%, plastics 13%, rubber 7%, wood 1%, Others 5%;

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Unknown
Ra: Unknown
Th: Probably metal, oxide or nitrate.
U: Probably metal, oxide or nitrate.
Np: Unknown
Pu: Probably metal, oxide or nitrate.

Metals and alloys (%wt): Sheet metal may be present in a range of thicknesses.

Stainless steel.....	~3.3	Alloy - drums, tools, pipe etc
Other ferrous metals.....	~15.5	Alloy (Drums etc)
Iron.....	TR	Solid pieces of metal
Aluminium.....	TR	
Beryllium.....		
Cobalt.....		
Copper.....	TR	Solid pieces of metal
Lead.....	~0.02	Various solid metal, sheets, pipes, items
Magnox/Magnesium.....	NE	
Nickel.....		
Titanium.....		
Uranium.....		

WASTE STREAM	5C39	Solid Waste Complex Operational LLW	
	Zinc	TR	
	Zircaloy/Zirconium	NE	
	Other metals	0.19	Cadmium solid metal sheets
Organics (%wt):	Plastics and rubbers will be present but the split between halogenated or non-halogenated is unknown at present so 50/50 estimate made.		
	Total cellulosics	~1.0	
	Paper, cotton		
	Wood	~1.0	
	Halogenated plastics	~7.0	Solid materials from decontamination Ops, PVC and PTFE
	Total non-halogenated plastics	~6.0	
	Condensation polymers	~3.0	Solid materials from decontamination Ops
	Others	~3.0	Solid materials from decontamination Ops
	Organic ion exchange materials	TR	
	Total rubber	~7.0	
	Halogenated rubber	~3.5	Neoprene and hypalon
	Non-halogenated rubber	~3.5	
	Hydrocarbons	~0.48	
	Oil or grease		
	Fuel		
	Asphalt/Tarmac (cont.coal tar)	~0.32	Solid ex-building or flooring materials
	Asphalt/Tarmac (no coal tar)	~0.16	Solid ex-building or flooring materials
	Bitumen		
	Others		
	Other organics		
Other materials (%wt):	-		
	Inorganic ion exchange materials.		
	Inorganic sludges and flocs		
	Soil	~1.0	
	Brick/Stone/Rubble	~41.0	
	Cementitious material		
	Sand		
	Glass/Ceramics		
	Graphite	0	
	Desiccants/Catalysts		
	Asbestos		
	Non/low friable		
	Moderately friable		
	Highly friable		
	Free aqueous liquids	0	
	Free non-aqueous liquids	0	

WASTE STREAM	5C39	Solid Waste Complex Operational LLW

Powder/Ash..... ~1.0

Inorganic anions (%wt): TEC powder consists of chlorides. Anion content should be negligible, except as component of concrete

Fluoride..... NE

Chloride..... ~0.30

Iodide..... NE

Cyanide..... NE

Carbonate..... NE

Nitrate..... NE

Nitrite..... NE

Phosphate..... NE

Sulphate..... NE

Sulphide..... NE

Materials of interest for waste acceptance criteria: Trace combustible metals mainly comprise uranium and other finely divided metals. Powder is ~0.3% TEC powder (BaCl2/ KCl/ NaCl) and hoover bag dust.

Combustible metals..... TR

Low flash point liquids..... 0

Explosive materials..... 0

Phosphorus..... 0

Hydrides..... 0

Biological etc. materials..... 0

Biodegradable materials..... ~13.0

Putrescible wastes..... ~2.0

Non-putrescible wastes..... ~11.0

Corrosive materials..... NE

Pyrophoric materials..... 0

Generating toxic gases..... 0

Reacting with water..... 0

Active particles.....

Soluble solids as bulk chemical compounds.....

Hazardous substances / non hazardous pollutants: Lead (trace). Trace quantities of asbestos, barium compounds and uranium may be present.

Acrylamide.....

Benzene.....

Chlorinated solvents.....

Formaldehyde.....

Organometallics.....

Phenol.....

Styrene.....

Tri-butyl phosphate.....

Other organophosphates.....

Vinyl chloride.....

Arsenic.....

WASTE STREAM	5C39	Solid Waste Complex Operational LLW

	Barium.....		
	Boron.....		
	Cadmium.....	~0.19	Solid metal sheets
	Caesium.....		
	Selenium.....		
	Chromium.....		
	Molybdenum.....		
	Thallium.....		
	Tin.....		
	Vanadium.....		
	Mercury compounds.....		
	Others.....		
	Electronic Electrical Equipment (EEE)		
	EEE Type 1.....	P	100 off computers and controls from remote retrieval machines
	EEE Type 2.....	P	100 off Equipment from retrieval machines
	EEE Type 3.....	P	50 off Maintenance equipment used to refurbish retrieval machines
	EEE Type 4.....		
	EEE Type 5.....		
Complexing agents (%wt):	Yes		
	EDTA.....		
	DPTA.....		
	NTA.....		
	Polycarboxylic acids……		
	Other organic complexants.....		
	Total complexing agents.....	TR	

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)	Off-site	7.0
Incineration	Off-site	74.0
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		19.0

Comment on planned treatments: 17% of this stream is expected to be disposed of as VLLW to landfill

WASTE STREAM 5C39 Solid Waste Complex Operational LLW

Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	9.0
Expected to be consigned to a Landfill Facility	17.0
Expected to be consigned to an On-Site Disposal Facility	
Expected to be consigned to an Incineration Facility	74.0
Expected to be consigned to a Metal Treatment Facility	
Expected to be consigned as Out of Scope	
Expected to be recycled / reused	
Disposal route not known	

Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m³	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	7.0	21.6	4
1/2 Height IP-2 Disposal/Re-usable ISO	2.0	10	2
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: 21.6m3 loading volume is calculated based on the fact that you can fit 36 off (200 litre/0.2m3) drums (7.2m3) into a ½ height ISO, each drum can be super-compacted to a 1/3 of its original volume so therefore we can get 3 x the amount of un-compacted drums into the final disposal container (21.6m3).

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC). The waste has a current WCH.

Waste consigned for disposal to LLWR in year of generation: Yes.

Potential for the waste to contain discrete items: -

Non-Containerised Waste for In-Vault Grouting: (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

WASTE STREAM	5C39	Solid Waste Complex Operational LLW

Other information: -

RADIOACTIVITY

Source:	Contamination from range of waste management operations
Uncertainty:	Arisings content will vary with building operations.
Definition of total alpha and total beta/gamma:	Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.
Measurement of radioactivities:	Activities measured/ estimated by a range of methods including sampling/analysis and radiation measurements. Data taken from WCH: 1RSR-2HAR-0-WCH-0-4033 and decayed by two years from 2017 activity ref date.
Other information:	-

WASTE STREAM 5C39 Solid Waste Complex Operational LLW

Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	5.12E-07	C C 2	5.12E-07	C C 2	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	2.27E-09	C C 2	2.27E-09	C C 2	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36		8		8	Lu 174		8		8
Ar 39		8		8	Lu 176		8		8
Ar 42		8		8	Hf 178n		8		8
K 40		8		8	Hf 182		8		8
Ca 41		8		8	Pt 193		8		8
Mn 53		8		8	Tl 204		8		8
Mn 54		8		8	Pb 205		8		8
Fe 55	6.69E-08	C C 2	6.69E-08	C C 2	Pb 210	1.58E-07	C C 2	1.58E-07	C C 2
Co 60	1.99E-06	C C 2	1.99E-06	C C 2	Bi 208		8		8
Ni 59	1.27E-07	C C 2	1.27E-07	C C 2	Bi 210m		8		8
Ni 63	9.78E-06	C C 2	9.78E-06	C C 2	Po 210	1.57E-07	C C 2	1.57E-07	C C 2
Zn 65	1.67E-09	C C 2	1.67E-09	C C 2	Ra 223	1.01E-07	C C 2	1.01E-07	C C 2
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226	1.7E-07	C C 2	1.7E-07	C C 2
Kr 85	2.56E-07	C C 2	2.56E-07	C C 2	Ra 228	2E-08	C C 2	2E-08	C C 2
Rb 87		8		8	Ac 227	1.01E-07	C C 2	1.01E-07	C C 2
Sr 90	3.19E-05	C C 2	3.19E-05	C C 2	Th 227	9.93E-08	C C 2	9.93E-08	C C 2
Zr 93	1.73E-09	C C 2	1.73E-09	C C 2	Th 228	1.76E-08	C C 2	1.76E-08	C C 2
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230	1.33E-08	C C 2	1.33E-08	C C 2
Nb 93m	4.76E-09	C C 2	4.76E-09	C C 2	Th 232	2E-08	C C 2	2E-08	C C 2
Nb 94	6.8E-09	C C 2	6.8E-09	C C 2	Th 234	2.01E-08	C C 2	2.01E-08	C C 2
Mo 93	6.67E-09	C C 2	6.67E-09	C C 2	Pa 231	9.56E-08	C C 2	9.56E-08	C C 2
Tc 97		8		8	Pa 233	1.67E-09	C C 2	1.67E-09	C C 2
Tc 99	1.47E-09	C C 2	1.47E-09	C C 2	U 232	1.64E-09	C C 2	1.64E-09	C C 2
Ru 106		8		8	U 233	6.67E-09	C C 2	6.67E-09	C C 2
Pd 107		8		8	U 234	6.8E-09	C C 2	6.8E-09	C C 2
Ag 108m	1.75E-08	C C 2	1.75E-08	C C 2	U 235	6.67E-09	C C 2	6.67E-09	C C 2
Ag 110m		8		8	U 236	1.67E-09	C C 2	1.67E-09	C C 2
Cd 109	4.45E-09	C C 2	4.45E-09	C C 2	U 238	2.01E-08	C C 2	2.01E-08	C C 2
Cd 113m	1.72E-06	C C 2	1.72E-06	C C 2	Np 237	1.67E-09	C C 2	1.67E-09	C C 2
Sn 119m		8		8	Pu 236		8		8
Sn 121m	2.05E-07	C C 2	2.05E-07	C C 2	Pu 238	7.15E-07	C C 2	7.15E-07	C C 2
Sn 123		8		8	Pu 239	2.79E-07	C C 2	2.79E-07	C C 2
Sn 126		8		8	Pu 240	2.34E-07	C C 2	2.34E-07	C C 2
Sb 125	3.47E-09	C C 2	3.47E-09	C C 2	Pu 241	6.03E-06	C C 2	6.03E-06	C C 2
Sb 126		8		8	Pu 242	6.67E-09	C C 2	6.67E-09	C C 2
Te 125m		8		8	Am 241	8.48E-07	C C 2	8.48E-07	C C 2
Te 127m		8		8	Am 242m		8		8
I 129	6.67E-09	C C 2	6.67E-09	C C 2	Am 243		8		8
Cs 134	1.16E-09	C C 2	1.16E-09	C C 2	Cm 242		8		8
Cs 135		8		8	Cm 243	6.37E-09	C C 2	6.37E-09	C C 2
Cs 137	2.89E-05	C C 2	2.89E-05	C C 2	Cm 244	1.04E-07	C C 2	1.04E-07	C C 2
Ba 133		8		8	Cm 245	6.67E-09	C C 2	6.67E-09	C C 2
La 137		8		8	Cm 246		8		8
La 138		8		8	Cm 248		8		8
Ce 144		8		8	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147	5.26E-09	C C 2	5.26E-09	C C 2	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151	1.15E-07	C C 2	1.15E-07	C C 2	Other a				
Eu 152	6.73E-06	C C 2	6.73E-06	C C 2	Other b/g				
Eu 154	4.21E-06	C C 2	4.21E-06	C C 2	**Total a**	**2.92E-06**	**C C 2**	**2.92E-06**	**C C 2**
Eu 155	1.16E-07	C C 2	1.16E-07	C C 2	**Total b/g**	**9.30E-05**	**C C 2**	**9.30E-05**	**C C 2**

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 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