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EVALUATION OF ENVIRONMENTAL MONITORING PROGRAM (EMP) FOR SOLID RADIOACTIVE WASTE STORAGE FACILITY IN AL-TUWITHA SITE

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ABSTRACT

Environmental Monitoring program (EMP) is one of important means used in safety assessment studies for place planed to construct new storage facility for solid conditioned short lived low-Intermediate short level radioactive waste on it .The (EMP) includes radiological measurements of environmental samples such as (soil , water ,plants and air dust) selected from the storage facility area and surrounding zones reach reached to (4) Km distance from the store location where public villages are occupied .The results show background levels of radiation exposure and others are below the risk impacts to the workers and local people. This study is accomplished during the construction period of the storage facility and there will be continued study through (EMP) to operation period of the store to inspect and observe the safety standards for environmental monitoring impacts on the workers and public through the store operation process.

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INTRODUCTION

AL-Tuwaitha site is one of past nuclear sites in Iraq which located 30 Km south of the southern edge of the capital Baghdad as in fig (1). AL-Tuwaitha site is surrounded by 30 m height burms as show in fig (2).The government by (MoST) owned the site and most of the employees workers lived in adjacent populating zones such as Ishtar and Diylah Bridge far from the site about 1-2 Km. A storage facility for conditioned short lived solid low-intermediate level solid radioactive waste was designed and constructed for applying save ,isolate ,secure and safe storing of conditioned radioactive waste drums in purpose of limited radiological impacts to people health and environment in present and future[1-3] as located in Scheme(1). The storage dimention is (20*70) m^2 area constructed as one room storage design .The constructed materials were examined by consulting engineering Bureau-college of engineering Baghdad university– Iraq; according to Iraqi standards.

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The environmental monitoring program and inspection will provide primary containment for the purpose of reworking out-of specification waste drums or the robust of the store.[4-6]The primary containment will be provided by the evaluation ,assessment , inspection, robust of design and construction criteria and other safety aspects.[7] Here, EMP refer to define and excite measurements of external dose rate in the area and radionuclide activity concentration in air, water, soil samples to determined radio nuclides and which pathways that make major contribution to individual dose and environment Safety assessment here 2.

ENVIRONMENTALMONITORING PROGRAM

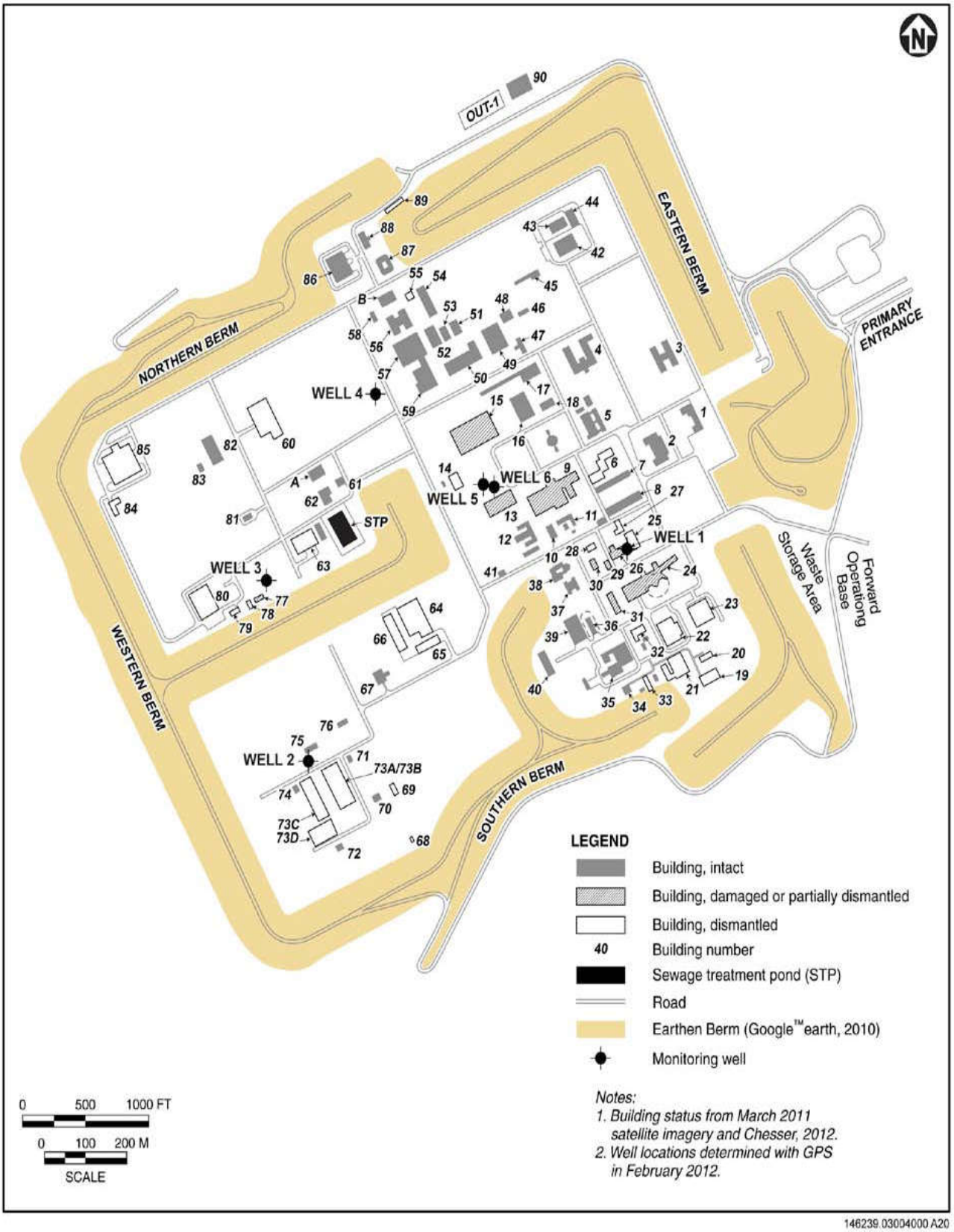
Environmental monitoring program refers to the measurements of external dose rates in the environment and Safety assessment here concerned with source and environment monitoring of practices and normal activities in AL-Tuwitha site (Decommissioning program activities) and where radioactive waste drums that will be accepted, conditioned, treated, characterized, and stored. Arrangement to determined radiological impacts, if any inside and outside the site for about (2-3 Km) distance, with particular reference to:-

Fig.1. Pointed Position of RWMTD in Twuitha Iraq map.Site.

Fig. 2.Google Image of Al-

- Pathways to human populations, including water, soil, air dust or other environments samples;
- The possible accumulation of radioactive materials in the physical environment (by exposure and dose rate measurements);
- The possibility of any unauthorized discharge routs.

In addition to radiological impact monitoring, climatic monitoring established using climatic monitoring system (type Vantage VUE, Davis company) in RWTMD field. Table (1), scheme (2) show the exposure rates from the storage location (R0) and environmental sample locations which have been analyzed using gamma spectroscopy with (HPGe) detector. [8]



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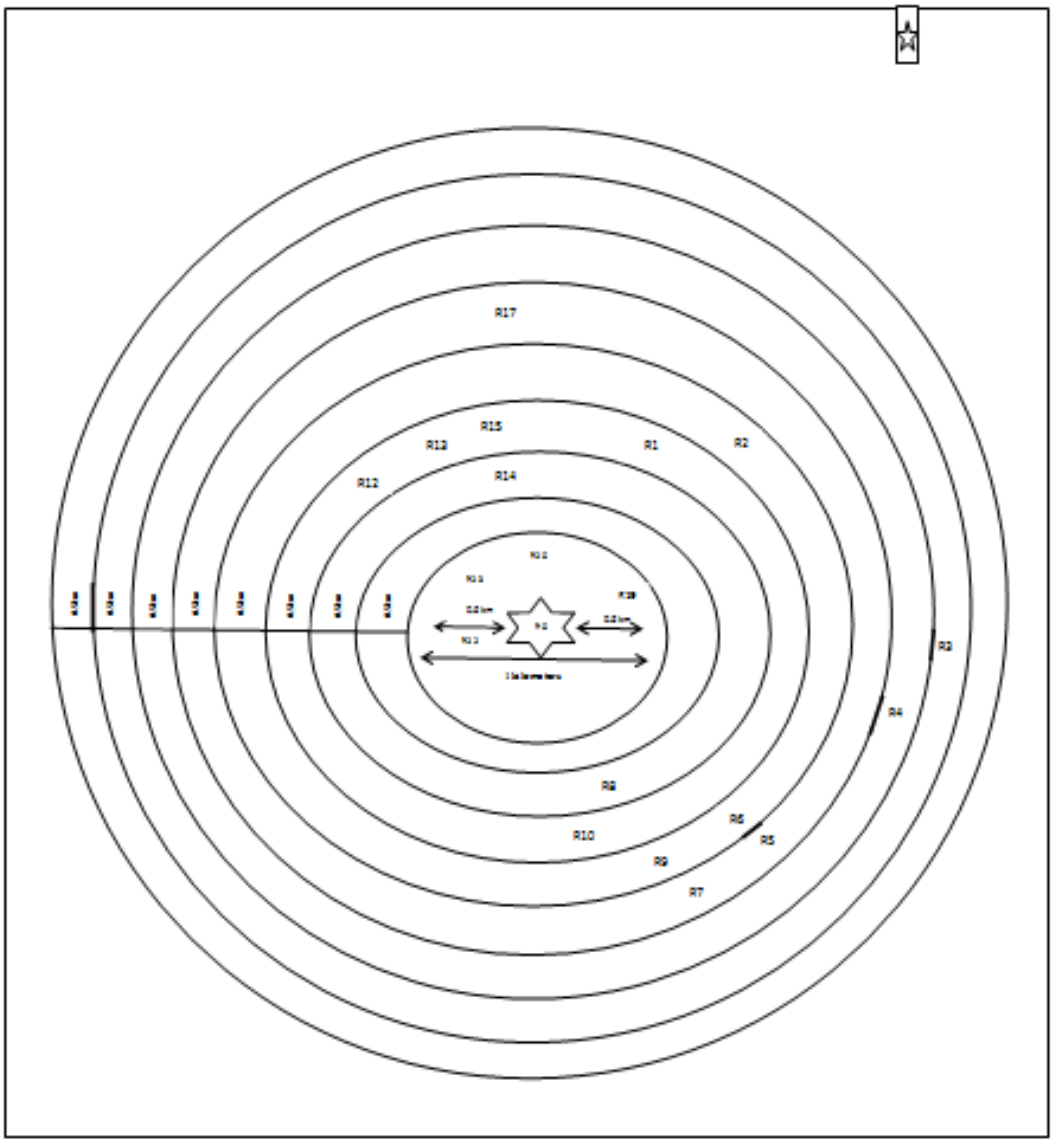


Scheme 2. Environmental monitoring locations around new storage facility Ro

Figs (3,4) show Google images of environmental samples locations around the storage facility (R0) while the activity concentration of radionuclides related to soil, air dust and tap water samples collected from these locations show in Table (1,2,3,4 and 5). For external environmental dose rate measurement, TLD dosimeters have been planted in elected positions as in scheme (3) which including the dose rate results.

Exposures from natural radiation sources

The exposure of human beings to ionizing radiation from natural sources is continuing and inescapable feature of life on earth. There are two main contributor to natural radiation exposures: high-energy cosmic ray particles incident on the earth's atmosphere and radioactive nuclides that originated in the earth's crust. External exposures arise from terrestrial radio nuclides present at trace level in soil and building materials. Only those radionuclide with half –lives comparable to the age of the earth, and their decay products, exist in significant quantities in these materials. Irradiation is mainly by gamma radiation from radionuclide in the U-238, Th-232, series and K-40. Tens of soil samples from all over Al-Tuwitha site were measured in the physical lab using gamma spectroscopy analysis detector, the dose conversion coefficients from the UNSCEAR 2000 report and the resulting absorbed dose rates in air calculate using the equation (1) for total absorbed dose rate out doors from soil measurements:

$$D(nGy/h)=0.46A\ ^{238}U+0.604A\ ^{232}Th+0.0417A\ ^{40}K \quad (1)$$

The tree components of external radiation field make approximately equal contribution to the gamma radiation dose. At the same locations where the soil samples were taken direct measurement of absorbed dose rate in air carried out and exposure radiation (above 1m height) carried also. Excluding cosmic ray exposure, an average value of absorbed dose rate (26.84nGy/h) was found for 23 locations (refer to table 2) which close to the value inferred from the soil concentration results. To estimate annual effective dose, account must be taken of the conversion coefficient from absorbed dose in air to effective dose. Gamma radiation is less absorbed in children and an infants resulting in a higher dose conversion coefficient (adults: 0.7, children: 0.8 and an infants: 0.9).

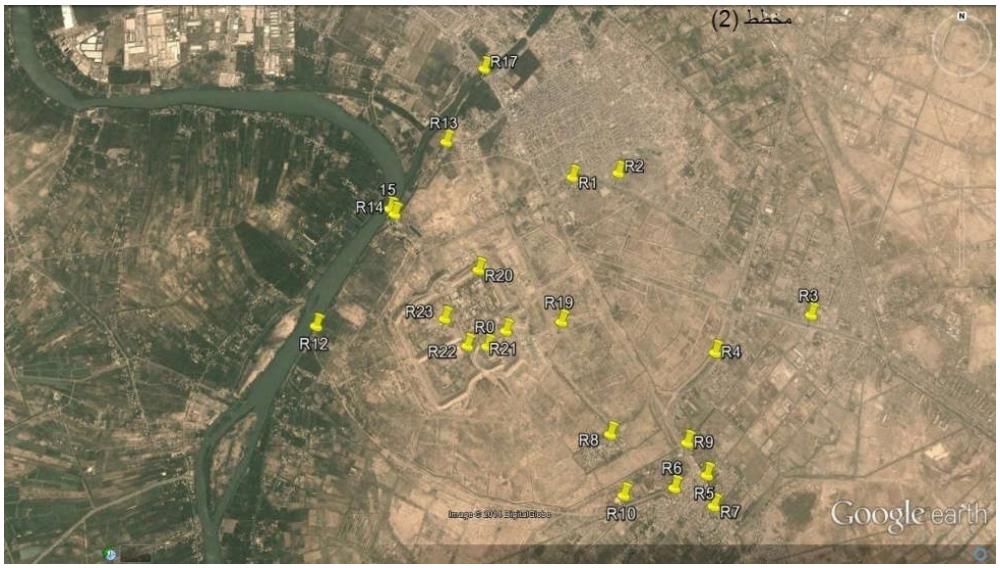


Fig. 3. Google Image to Environmental Measurements Locations

Table 1. External Radiation Exposure Rates From Storage Location (R0)

	Location (code sample)	Gps	Exposure Rate (µR/hr)	Distance Form R0 (Km)
1	R0	N33°12.096 E44°31.002	9	0
2	R1	N 33°13.181 E 44°31.688	6.1	2.28
3	R2	N 33°13.212 E 44°32.053	7.0	2.65
4	R3	N 33°12.294 E 44°33.549	7.7	3.99
5	R4	N 33°12.058 E 44°32.788	8.1	2.76
6	R5	N 33°11.305 E 44°32.691	6.5	3
7	R6	N 33°11.228 E 44°32.440	6.4	2.72
8	R7	N 33°11.119 E 44° 32.737	6.2	3.25
9	R8	N 33°11.553 E 44°31.955	7.0	1.79
10	R9	N 33°11.501 E 44°32.547	8.5	2.65
11	R10	N 33°11.488 E 44°32.534	9.5	2.6
12	R11	N 33°11.183 E 44°32.051	7.9	2.34
13	R12	N 33°12.224 E 44°29.660	8.5	2.1
14	R13	N 33°16.416 E 44°30.699	7.8	2.49
15	R14	N 33°12.940 E 44°30.262	8.5	1.94
16	R15	N 33°12.975 E 44°30.224	7.2	2.03
17	R16	N 33°12.975 E 44°30.223	6.2	2.03
18	R17	N 33°13.909 E 44°30.975	7.5	3.36
19	R18	N 33°12.489 E 44°31.374	8.4	0.95
20	R19	N 33°12.250 E 44°31.585	8.2	0.95
21	R20	N 33°12.580 E 44°30.934	8.0	0.9
22	R21	N 33°12.194 E 44°31.148	8.1	0
23	R22	N 33°12.014 E 44°31.742	8.5	2.28
24	R23	N 33°12.269 E 44°30.669	9.1	2.65

Table 2. Activity Concentration Results of the Soil Samples

Sample no.	Concentration (Bq\kgm)				Radium equivalent activity (Bq/Kg)	(Dose rates in air nGy/h)
	Ac-228 911.2 KeV	Cs-137 661.6 KeV	Bi-214 609.3 KeV	K-40 1461 KeV		
R-1	7.9	-	11.8	141.16	33.96632	16.10957
R-2	10.98	-	23.86	134.74	49.93638	23.2739
R-3	13.16	1.66	18	383.58	66.35446	32.25993
R-4	13.42	-	21.1	350.94	67.31298	32.48808
R-5	8.98	-	23.04	101.4	43.6892	20.29678
R-6	14	2.7	27.4	395.32	77.85964	37.59964
R-7	5.32	1.52	11.3	147.32	30.25124	14.57712
R-8	21.08	3.48	13.24	180.18	57.25826	26.36271
R-9	7.46	-	11.02	141.72	32.60024	15.5068
R-10	17.18	1.44	23.52	433.26	81.44842	39.3099
R-11	20.94	2.22	27.06	452.1	91.8159	44.00205
R-12	11.92	2.86	28.4	508.18	84.57546	41.51159
R-13	-	-	10.58	150.7	22.1839	11.17215
R-14	8.56	1.82	24.08	129.64	46.30308	21.70119
R-15	-	2.18	22.72	305.28	46.22656	23.22682
R-16	7.84	2	20.74	146.68	43.24556	20.4338
R-17	10.22	-	9.84	205.36	40.26732	19.28247
R-18	-	1.74	18.68	208.54	34.73758	17.32628
R-19	20.42	-	25.56	475.64	91.38488	43.97659
R-20	3.66	2.22	41.52	175.52	60.26884	28.71206
R-21	-	4.24	21.9	179.18	35.69686	17.58961
R-22	9.62	-	13.52	351.36	54.33132	26.70843
R-23	19.18	2.48	28.66	459.62	91.47814	43.99179

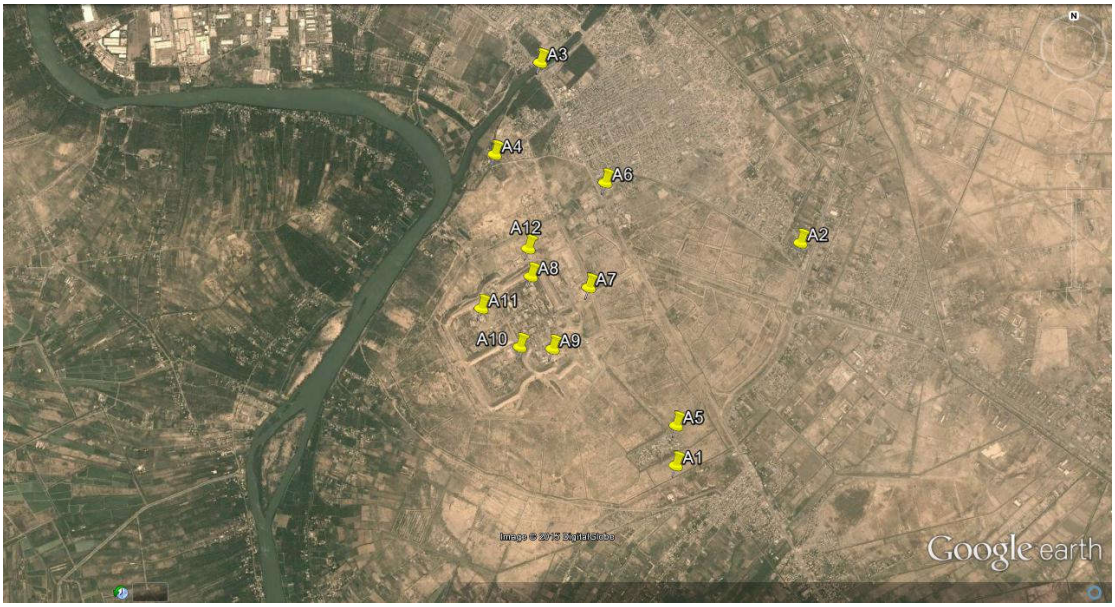
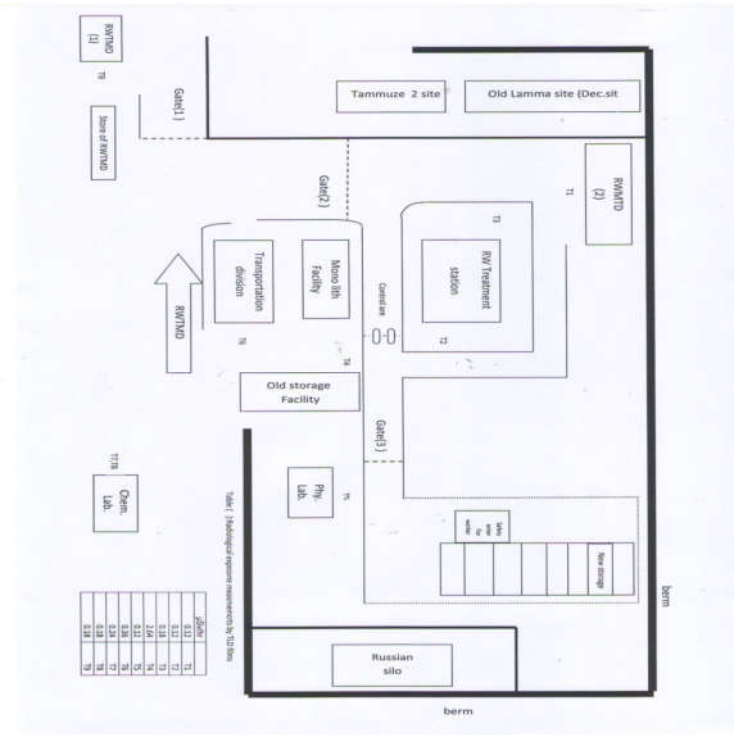


Fig. 4. Google Image to Air Dust and Tap Water Sample Location

Table 3.Air Dust Analysis in Al-Twitha Site

Sample code	Location	Exposure (mR/hr)	Contamination (Bq/m^3)	Alpha (Bq.h/m^3)	Beta (Bq.h/m^3)
A1	N 33°11.194 E 44°32.258	0.013	1.5	0.01	0.060
A2	N 33°12.440 E 44°32.921	0.011	1.8	0.0521	5.58
A3	N 30°13.871 E 44°31.071	0.011	1.4	0.0726	2.22
A4	N 33°13.344 E 44°30.664	0.013	2	0.036	3.27
A5	N 33°11.603 E 44°32.050	0.010	2	0.0424	1.89
A6	N 33°13.157 E 44°31.500	0.009	1.4	0.0702	0.912
A7	N 33°12.491 E 44°31.397	0.011	1.6	0.0544	0.719
A8	N 33°12.550 E 44°30.940	0.012	1.7	0.0502	0.688
A10	N 33°12.013 E 44°30.743	0.008	1.3	0.0272	4.02
A11	N 33°12.361 E 44°30.559	0.013	2	0.155	3.51
A12	N 33°12.732 E 44°30.914	0.015	2	0.073	2.52
A13	N 33°12.115 E 44°30.997	0.011	2.5	0.029	0.693
A14	N 33°12.117 E 44°30.986	0.005	1.7	0.00613	0.503
A15	N 33°12.12 E 44°309.825	0.014	2.2	0.0189	0.464
A16	N 33°12.127 E 44°30.986	0.009	2.6	0.0288	0.509



Scheme 3. External Exposure Dose rate results Using TLD Detectors in RWTMD Site

Table 4. Activity Concentration Results of Tap Water Samples in Al-Twuitha Site

Sample Code	Concentration (Bq/L)	
	Bi-214	Ac-228
	609 KeV	609 KeV
AW1	10.42	7.47
AW2	16.16	7.42
AW5	14.23	-
AW7	2.82	2.62
AW11	15.58	-

Table 5. Activity Concentration Results of Plant (Grass) Samples in Al-Twuitha Site

Sample No	Concentration Bq/Kg			
	Bi-214	Cs137	Ac-228	K-40
	609 KeV	661 Kev	609 Kev	1461 Kev
P4	10.98	8.74	5.78	438.84

Table 6.Total Average Effective Dose for Indoor and Outdoor from Natural Radiation Sources

	Dose conversion coefficient	Total average effective dose (indoor +outdoor)(mSv/y)
Adult	0.7	0.1653
Children	0.8	0.1889
Infants	0.9	0.212
		Total=0.566mSv/y

The annual average effective dose for adults, assuming an occupancy factor out doors of 0.8 (indoor factor 0.85) is summarized in table (6). The resulting average effective dose for the whole population from external terrestrial radiation in Al-Tuwitha-Diyla Bridge state is 0.566 mSv/y which is beyond of 2.4 mSv/y (effective dose to natural radiation sources).

The internal exposures other than radon

The ingestion and inhalation from exposure pathway of population with significant contribution are from ^{40}K , ^{238}U and ^{232}Th decay series. For Radium equivalent activity (Req.) which measured using equation (2) from UNSCEAR report (2000) summarized in table (2).

$$Req.=A^{238}U+1.43A^{232}Th+0.077A^{40}K \quad (2)$$

Conclusion

The results show natural radiological environment within safety limits near to natural background that means no significant risk impacts to individual, public, or environments. Storage design shows that the design, implementation and operation of a single room interim storage facilityare technically proper with clean environmental and safety requirements of IAEA. In conclusion, it can be stated that interim storage for solid conditioned LILW short half life in reference drums is a proven technically against accident and unusual events, in addition to RW conditioning, which are able to meet safe storage requirements. Since in Al-Tuwitha site, decommissioning of nuclear facilities are achieved so the serious accidents will be limited during operation period of the storage. For health protection of workers and public in case of drop one RW drum in ordinary operation or in fire accidents; hazard release will be minimum from solid cemented radioactive waste (could be with the background). The results show annual effective doses per year (2014-2015) from natural sources of radiation in Al-Tuwithasite and acceptable with the UNSCEAR-2000 worldwide annual effective doses.

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