Case Study Tailings (and Other Bulk Wastes)

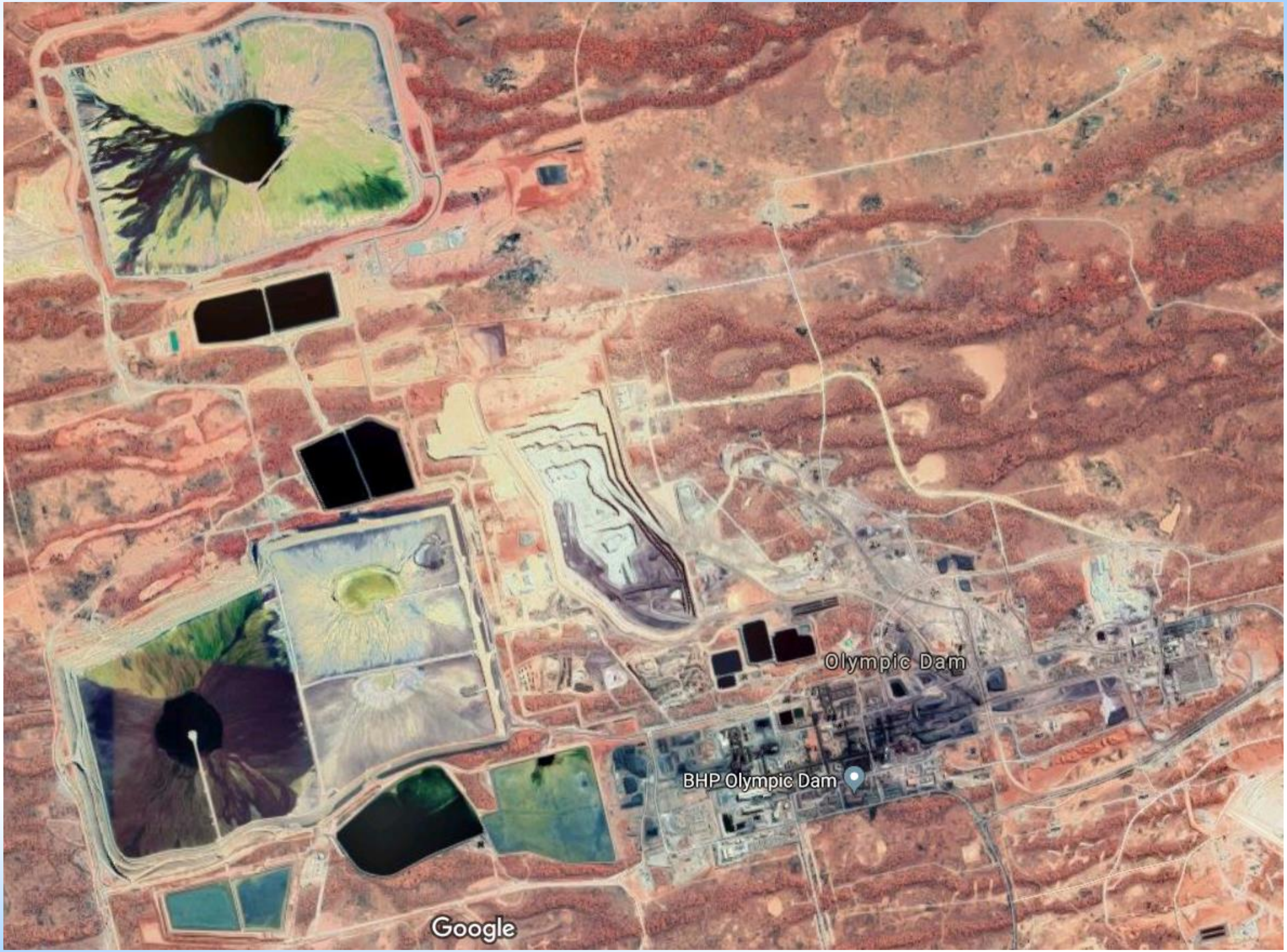
Training Package on Occupational Radiation Protection in Uranium Mining and Processing Industry

Tailings (and other Bulk Wastes) Description

- Every uranium operation generates wastes which will require management and eventual disposal
- For most mines the major waste will be tailings (the residual solid material after milling and leaching), with exception ISL
- Other wastes can include mineralised waste rock or below grade ore, heap leach residues, scales arising from piping and vessels, etc.

Some Aspects of Disposal Facilities

- Site selection and construction;
- Treatment;
- Thickening;
- Deposition;
- Backfill;
- Long term storage and isolation.


Olympic Dam
BHP Olympic Dam
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Ranger Uranium Mine

Build your own Disposal Facility

- Chose your type of disposal facility: tailings retention system, waste rock pile, heap leaching material, miscellaneous contaminated waste disposal
- Choose your disposal method: surface disposal (ring dyke, valley, mined out pit, surface stockpile), shallow disposal, underground disposal
- Size and activity of the disposal facility
- Disposal methodology: subaerial, subaqueous, slurry, solid, liquid
- Waste characteristics and treatment: thickened, paste, acid, alkali, neutralised, additional material (flyash, cement)
- Site factors: geological, climatic, community, topographical, ground water, surface water,
- Bottom waterproofing of tailing facility

Model Answer Disposal Facility

- Tailings Retention System
- Ring Dyke
- 100ha. in size with a height of 15m and containing material with an activity of 10 Bq/g per radionuclide in the uranium series (1 Bq/g U)
- Material thickened to approximately 45% solids and then deposited as a slurry subaerially
- Decant water collected and returned to the process plant
- Tailings are deposited un-neutralised (acid pH1.6)
- Site is in an arid area on clay terrain with deep saline groundwater and no nearby communities or surface water features
- Bottom waterproofing of tailings facility

Determine the Exposure Pathways for your Disposal Facility

- For each stage assign a relative level for the importance of the exposure pathway
  - VH-very high, H-high, M-medium, L-low, VL-very low
- Special is for unusual cases such as maintenance

Exposure Pathways for your Disposal Facility

Stage/Pathway	Gamma	Radon Progeny	LLRD*	Special
Site selection and construction				
Treatment				
Thickening				
Deposition				
Backfill				
Long term storage				

* LLRD – Long Lived Radioactive Dust

Model Answer: Exposure Pathways for your Disposal Facility

Stage/Pathway	Gamma	Radon Progeny	LLRD*	Special
Site selection and construction	VL	VL	VL	
Treatment	L(H*)	L	L	H* Return of decant liquor may generate ^{226}Ra scale
Thickening	M(H*)	L(H*)	VL	H* Density gauges with gamma potential and radon during vessel entry
Deposition	M	L	VL(M*)	M* If tailing dry out dust may arise
Backfill	-	-	-	
Long term storage	L	L	VL(M*)	M* Worker access infrequent but tailings will be dry

* LLRD – Long Lived Radioactive Dust

What are the potential critical areas for radiation protection

?

Model Answer Critical Areas

- Majority of the normal exposure will be from gamma due to working in close proximity to the material
- If the tailings dry out and there is high winds there may be high dust concentrations
- The use of density gauges during thickening require precautions for gamma
- Maintenance (vessel entries) to thickeners or decant structure which may have radon
- The decant liquor return system may generate scales with a very high quantity of ^{226}Ra and become a significant gamma source

What Monitoring is Required

- Gamma – which groups need personal monitoring, can monitoring be optimised
- Long Lived Radioactive Dust (LLRD) – breakdown what radionuclides in what areas, how to determine, activity measurement
- Radon Progeny – where and when to monitor
- Contamination – what is the critical areas and do you need biological monitoring (uranium in urine)

Model Answer Monitoring

- Gamma – Given the area that tailings workers cover, the cheapest method is to use personal dosimetry for all workers
- Radon progeny – No personal monitoring and some radon alpha track detectors (ATD) for area levels on tailings area. Radon progeny monitor during confined space access and duration of entry logged
- LLRD – Occasional personal area sampling as a low priority
- Contamination monitoring not performed as not expected to be a significant pathway. Urine analysis only considered if there is a accident with the potential for direct ingestion or injection

What are Some of the Critical Controls

?

Model Answer: Critical Controls

- Entry to confined spaces restricted and monitored with entry permits and radon progeny measurements prior to entry. Forced ventilation is used if the radon levels are above a trigger value
- Density gauges clearly identified and only qualified workers may move, operate or modify the density gauges
- Worker access may be restricted during high wind speed events causing dusting
- Periodic gamma monitoring will be undertaken around the decant liquor return pipes, tanks and pumps to determine if the gamma rate is changing and hence indicating the build-up of radium scale

Dose Assessment

- How to determine total dose?

Model Answer Dose Assessment

- For gamma use personal dosimetry results. If a dosimeter is lost then use the workgroup average
- For LLRD use the work group average airborne dust concentration (mg/m^3) and multiply it by the measured activity (Bq/mg) to get the average airborne activity concentration. If the activity is unavailable use the concentration of the higher grades in the ore body (conservative approach)
- Calculate LLRD dose using the time the workers are on site, the workgroup average airborne activity and a dose conversion factor based on equilibrium from ^{230}Th down and an AMAD of 5μm
- Assume radon progeny is not significant unless radon alpha track detectors show enhanced levels

Key Messages

- Doses from normal tailings operation will be primarily the result of gamma exposure
- Other disposal facilities may have different dose characteristics and care is required when dealing with material containing scales
- High levels of dusting may occur if the wastes are dry and there is a high wind speed event

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Thank you!