Remediation of Occupied Commercial Property Subject to Widespread Radium-226 Contamination: Update from Wm2012 Paper -16652

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ABSTRACT

Summary of Work

Amec Foster Wheeler was contacted by a company that managed commercial office space. High Rn-222 measurements had been observed throughout the facility and the landlord had been advised to commission a radiological survey of the site. The site had been purchased by the client in the 1990's. Initial desk studies found that the building had operated for around 50 years as a compass factory.

Non-intrusive investigation identified widespread Ra-226 contamination. Ra-226 was found in the fabric of the building, in attic spaces, buried under floor boards and underlying car parks.

Intrusive investigation was undertaken to estimate volume(s) of waste, waste categories, activity concentrations and the total inventory of radioactive materials on site. This work identified the presence of 180 GBq of Ra-226 on site.

A programme of work is currently underway to remediate the site tackling areas posing the greatest risk to site occupants as a priority. We have worked closely with Regulators, our client, and tenants, to decontaminate the fabric of the building whilst areas of the building remain occupied.

Early decontamination works identified that radon levels within the building were stubbornly high despite the removal of radium contamination. An independent radon source was suspected. A contaminated drain was discovered leading to a blocked-off river race running under the old mill building. A significant quantity of radium contaminated sludge was identified within the river race. This was believed to be the source of the excessive radon concentrations within the building.

The paper will present work undertaken to investigate and remediate the inventory of sludge from beneath the building. It will describe the operational difficulties of working within a dynamic environment impacted by high dose rates, high radon concentrations, water ingress and waste retrieval challenges. The paper will present the radiological and environmental impacts of the work and detail the achieved end points.

Importance and Benefits of this Work

This was a challenging project working in confined spaces impacted by physical and radiological constraints. The remedial action undertaken significantly reduced radon concentrations in the building metres above the river race. It also significantly

reduced the likelihood of radium contamination being mobilised into the river and the wider environment.

The achieved end point permitted the building to return to uncontrolled commercial use. The end point achieved within the river race will ensure a safe working environment for future regular structural survey work.

INTRODUCTION

Any work within the blocked-off river race required a significant planning effort. Numerous potential hazards were to be assessed and mitigated including confined spaces, structural stability, water ingress, trip/slip hazards and high radon concentrations.

Once the working environment was proved to be safe, investigation work could begin.

DESCRIPTION

Investigation

The working area was vented in order to reduce radon concentrations. Crawl boards were installed over the accumulated sludges along the length of the river race. The depth of sludge was measured by penetration tests at regular intervals in order to estimate the total volume of sludge present. The inventory of radioactivity was assessed by both direct probe measurement and sampling followed by radiochemical analysis. This work yielded to following information:

- Radioactive contamination indicative of exempt and Low Level Waste (LLW) identified in silt;
- Exempt waste present up to between 16 m and 23 m from open end;
- LLW present from between 16 m and 23 m up to 54 m;
- Elevated radon concentrations in the River Race of up to 4800 Bq/m3;
- Silt thickness typically between 0.6 m and 0.7 m with radium concentrations increasing through the depth profile;
- Manhole in Courtyard – Contamination extends the full height of the manhole chamber which is constructed directly on blocked River Race arch.

A schematic of the blocked River Race developed during the investigation is shown in Figure 1.

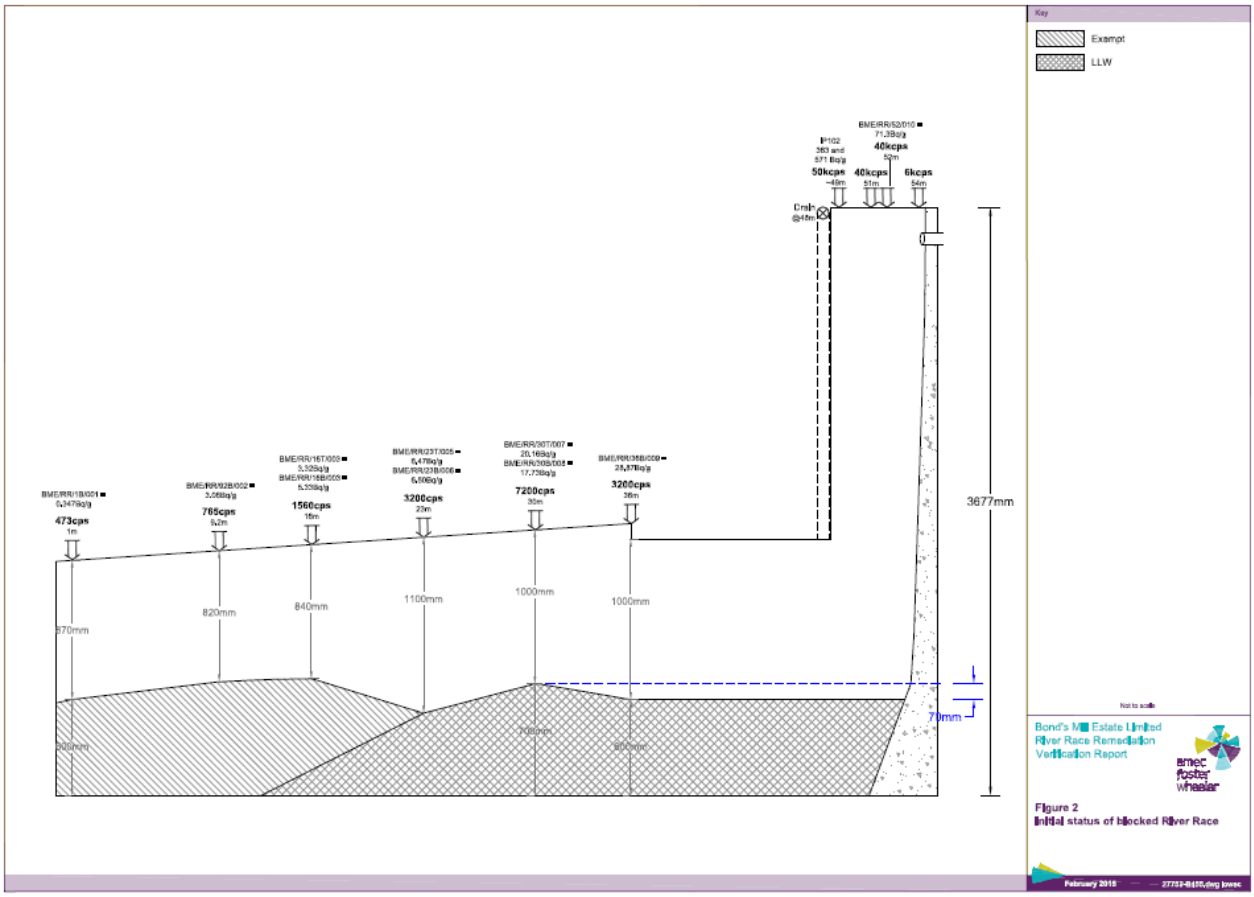

Fig. 1. Initial Status of Blocked River Race

REMEDIATION

The methodology for the remediation was designed to ensure the systematic removal of all accessible radioactive contaminating materials from identified areas of the site. This was achieved through the following remediation process:

- Stitch drilling using a concrete corer to remove the concrete slab in the courtyard overlying the blocked River Race to create a courtyard access point;
- Excavation by hand from downstream end of the blocked River Race. All material excavated by hand from the open end was bagged, characterised and sentenced appropriately. Bagged LLW was placed into 200L drums and bagged exempt waste was placed into three cubic yard skips;
- Pumping and excavation by hand of LLW from the courtyard access point. Materials were placed directly into 200L drums, which were filled approximately two thirds full, and then stabilised, if required, to remove free water using 'DryAdd';
- Breaking out of manhole brick work and hand excavation of surrounding contaminated soils. All wastes were double bagged in plastic bulk bags and sealed. Waste characterised as LLW was then placed into 200L metal drums and exempt waste was placed into skips;

- Upon filling and stabilisation, where required, the outside of the drums were monitored to ensure no contamination to the outside of the drum had occurred and, if so, contamination was removed from the outside surfaces prior to transfer to the waste storage area.

Monitoring was undertaken on a continuous basis throughout the duration of the works as each targeted area was remediated. The principal methodology for the verification of each remediated area comprised:

- Delineation of target areas by hand held instrumentation and the subjection of identified areas to remedial action e.g. excavation or scabbling to remove contamination;
- Contamination removed laterally and vertically to chase out contamination above natural background levels that would have existed prior to the luminising activity commencing;
- Areas were considered to have been decontaminated when there was no evidence of contamination above natural background levels that would have existed prior to the luminising activity commencing; and
- Remediation validated by a combination of surface probe measurement, radiochemical analysis, visual examination, prior knowledge and the judgement of the site supervisor, based around the following criteria:
    - Results of gamma spectroscopy analysis(>0.01 (exempt waste), >5.0 Bq/g (Low level waste));
    - Averaging of residual contamination across excavation volumes; and
    - Dose assessments by Ionising Radiation Risk Assessment (IRRA) to determine magnitude of potential residual hazard to current and future site users.

Preparation

Remediation works in the Blocked River Race were undertaken between 10 June and 9 October 2014. As contamination was identified throughout the silt profile within the Blocked River Race, all deposited silt required removal down to the solid river bed.

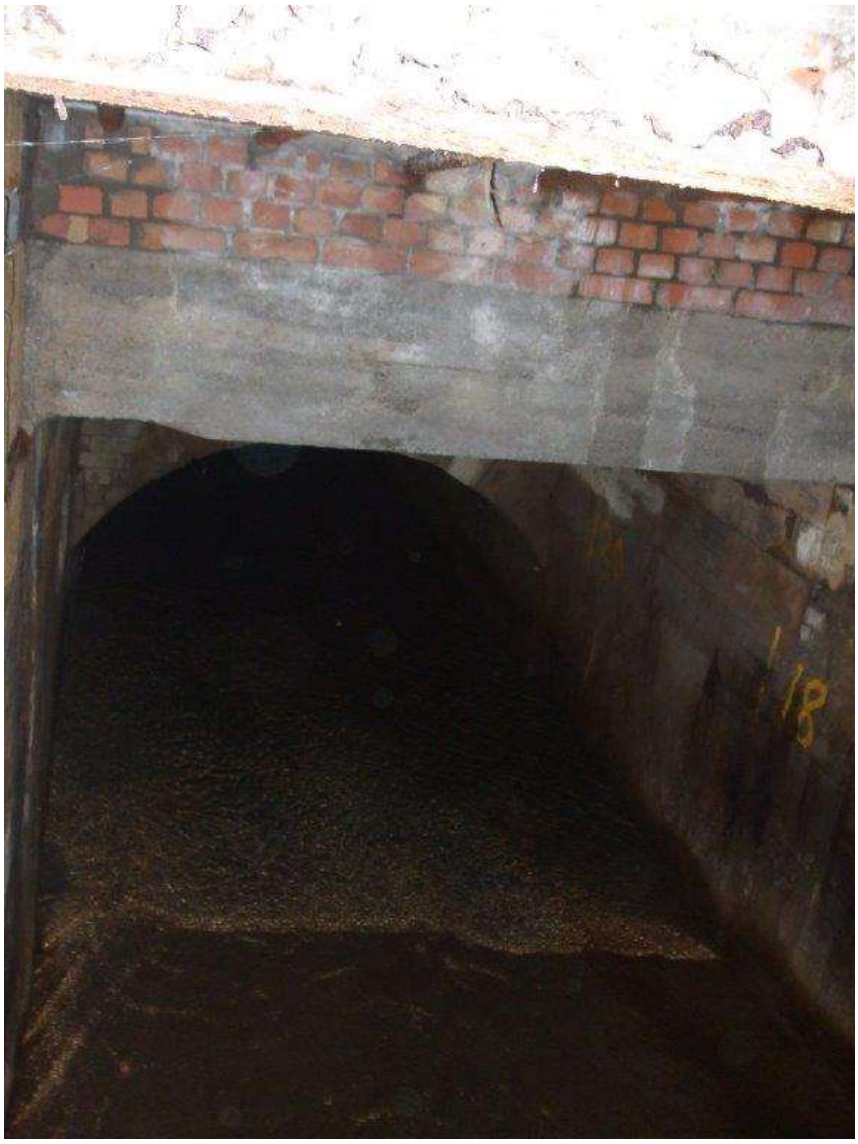

Fig. 2. Sludge Deposits in the River Race

Works were commenced in the courtyard with the removal of a section of the overlying slab to gain access into the Blocked River Race. The section of slab was stitch drilled using a concrete corer and the remaining slab removed using a lifting gantry and hoist.

To limit water ingress from the adjacent river channels a dam was installed across the River Frome to divert the main flow of the river away from the work area to the south of the site. Initially the dam was constructed with sandbags, however following a period of heavy rain this dam failed on 16 June leading to a flooding of the works area. A replacement, flood defence type dam was installed on 23 June to replace the sandbag dam. The river diversion remained in place until 10 November.

Fig. 3. River Diversion

To mitigate against potential elevated radon gas concentrations a ventilation system using a Mobile Filtration Unit (MFU) was set up.

Phase 1

Initial silt retrieval works were undertaken by remote pumping using a 'Grindex Solid' pump to remove contaminated silt directly into 200L drums. The pump was supplemented by a hydrocyclone to reduce the water content within the drums. The returned water from the hydrocyclone was used to further agitate the silt with the Blocked River Race. Following removal of silt from the area immediately beneath the opening, man-entry was undertaken to move the pump to areas of silt starting with the area upstream towards the blocking wall and then heading downstream towards the manhole. All drums of silt were cleaned, stabilised with 'dry add' where required, sentenced and transferred to the waste storage compound. As silt removal works reached the area immediately beneath the courtyard manhole the measured dose levels became too high to continue man-entry. Works from the courtyard access were suspended pending dose assessments and a revision to the Ionising Radiation Risk Assessment (IRRA).

Phase 2

Works were moved to the downstream end where contaminated silt was excavated by hand. Silt was placed directly in to bulk bags which were sealed and then transported using a system of conveyors to the waste monitoring area, where each bag was monitored and sentenced appropriately. Exempt waste bags were placed directly into open three yard skips and LLW bags were placed into 200 L drums. Drums were then monitored and transferred to the waste storage compound. Stoppages were encountered during the hand excavations due to excessive water ingress and elevated radon concentrations.

During excavation, pumps were placed in a shallow sump within the central river race in an effort to reduce groundwater level beneath the area which was giving rise to water infiltration in the southern Blocked River Race.

Following revision to the IRRA works were recommenced from the courtyard end running simultaneously with excavations from the downstream end. Man-entry was undertaken in to the Blocked River Race and contaminated silt was excavated by hand directly into 200 L drums. Filled drums were removed from the Blocked River Race on a hoist, cleaned, stabilised with 'dry add' where required, sentenced and transferred to the waste storage compound.

Following silt removal, a walk over survey identified significant residual contamination in the floor of the River Race immediately beneath the courtyard manhole. Further excavation work was undertaken to remove partially cemented material that had accumulated beneath the manhole down to the stone bed of the River Race. Concentrations of radioactivity were significantly reduced. Further excavation/breaking out of remnant contamination in the floor not undertaken to avoid structural damage to the building.

Fig. 4. River Race following Remediation

Encapsulation

After all excavation works were concluded, a survey was completed. The base of the River Race was then encapsulated in concrete with the aim of preventing river water ingress mobilising residual contamination.

A poured concrete floor approximately 100 mm thick was laid from 34 m to 54 m at the courtyard end of the River Race. Due to the presence of standing water, concrete canvas consisting of approximately 3.5 m x 1.2 m strips was laid on the from the open end to 34 m. A retaining wall of approximately 0.7 m height was constructed of poured concrete across the open end of the River Race to reduce the turbulence of river ingress.

Court Yard Manhole Remediation

Remediation works to remove the manhole were undertaken on 1 October 2014. The manhole structure was removed from the top down and all materials collected and bagged for sentencing and disposal.

The manhole structure was removed and surrounding soils were removed until no further contamination was encountered.

The area was surveyed to check for the presence of any residual contamination following completion of the works. Elevated readings up to 5000 cps (7.8 Bq/g) were detected at the base of the excavation where the manhole chamber sat on the River Race arch. It was not practical to remove this contamination with compromising the structural integrity of the River Race arch.

VERIFICATION

River Race Verification

A walkover survey of the River Race was conducted following completion of the concrete pour and prior to the installation of the concrete canvas of the courtyard end of the River Race. The final survey was conducted prior to the installation of the concrete canvas due to it requiring time to cure and it not being suitable to bear weight before the river diversion was removed.

Two instruments were used to complete the survey a G2 probe at approximately 2 cm from the surface to measure activity and a Mini 1000 dose meter at waist height to measure whole body dose rates. Readings in the River Race from the open end were found to be representative of background levels. Slightly elevated count rates were detected over the concrete surface from 32 m to 54 m, ranging from 848 cps (indicative 1.3 Bq/g) at 52 m to 5364 cps (indicative 8.4 Bq/g) at an isolated hotspot at 46 m. Whole body dose rates, recorded at waist height, throughout the whole River Race were 0.5 μSv/hr, which is approximately natural background. No evidence of any contamination, defined as no discernible increase in count rate, on the shallow walls of the River Race was identified during the verification surveys.

CONCLUSIONS

The work described above has led to a significant reduction in the risks posed by radioactive materials to the present and future occupants of the buildings.

Post remediation radon measurement of buildings overlying the River Race were necessary for the client's RPA for radon contamination to advise on the future use of these facilities.

In the majority of the River Race and Courtyard Manhole, contaminating radioactivity, above the remediation standard set, has been removed. Several areas of residual radioactivity have been highlighted and future management plans established.

The completed work provides a better understanding of the widespread use of radioactive materials at the site. This knowledge should inform future activity on site where undetected radioactive material may be present within the fabric of the building and the wider site.