RADIOACTIVE DECONTAMINATION OF THE FORMER CSIRO APPLIED ORGANIC CHEMISTRY DIVISION LORIMER STREET FISHERMENS BEND

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Owen J. Wilson

DEPARTMENT OF COMMUNITY SERVICES AND HEALTH

Australian Radiation Laboratory

LOWER PLENTY ROAD, YALLAMBIE, VICTORIA 3085 :: TELEX AA31726 :: TELEPHONE: 433 2211 :: FAX: 432 1835

Abstract

The decontamination of the CSIRO Fishermens Bend property was carried out by ANSTO and TNT, under the guidance and surveillance of This Laboratory. The $1.6M operation commenced on 8 January, 1990, took eleven weeks to complete and required the removal of approximately 1650 tonnes of radioactive waste and contaminated soil and items. The active materials were sealed in 5492 X 200 litre drums and transported to Lucas Heights for storage. The work was carried out efficiently and professionally and used all reasonable radiological safety precautions.

Apart from a few small areas of minor contamination, which will be removed during the decontamination operation to be carried out at the adjacent Aeronautical Research Laboratory property, the CSIRO property is now clear of all known deposits of radioactivity.

TABLE OF CONTENTS

1. Introduction

In the 1940's, 50's and early 60's, CSIRO carried out, at its Lorimer Street Fishermens Bend property, industrial scale research projects which involved the separation and concentration of radioactive ores.[1] A radiation survey made by This Laboratory [2] discovered substantial deposits of radioactive waste buried on site, contamination in some buildings and drainage systems and indicated the presence of contamination on the adjacent Aeronautical Research Laboratory (ARL) property. A CSIRO Task Force on Fishermens Bend [3] and surveys of the CSIRO buildings [4] and of ARL [5] confirmed the findings of the initial survey.

Removal of the radioactivity was required prior to the occupation of the property by ARL. On 8 January, 1990, ANSTO and TNT commenced the extraction, transport and storage at Lucas Heights, of all contaminated material found on the property. The operation was carried out under the guidance and surveillance of This Laboratory, which was contracted to represent the interests on ARL.

The objective of the operation was to return the radiation levels to within the normal range of natural background for the general area. The following report presents the outcome of this decontamination operation.

2. Methodology

This section briefly describes the methods, equipment and criteria used in the decontamination operation.

2.1 Radioactive waste removal

A mechanical excavator was used to extract contaminated soil and load it into lined 200 litre drums, by use of an hopper. The excavator was also

used to remove contaminated drainage pipes and crush them prior to drumming. An average of approximately 110 drums per day were filled, labelled and transported to Lucas Heights by road (up to 80 drums per load).

Hand tools were used in those areas inaccessible to the excavator. Other methods of removal included vacuuming, scrubbing and flushing.

2.2 Radiological precautions

The radiological precautions taken during the operation included personal and site air sampling, personal monitoring, protective clothing, safety equipment and water spray to minimise dust. Regular monitoring of the decontamination staff and of areas surrounding the local work site were carried out to ensure the minimal spread of contamination. Continuous air sampling at the main air conditioning inlet in ARL Building 21 was carried out during the entire operation.

2.3 Radioactive waste detection

The affected areas were monitored, both during and after extraction of the radioactivity, by use of an Eberline ESP-1 ratemeter (ARL Serial No. 4923) with an Eberline SPA-3 scintillation probe (ARL Serial No. 4922) attached. This instrument is highly sensitive to gamma radiation and high energy beta radiation and can readily detect small variations in the background radiation level. This instrument is most appropriate for measuring buried material such as the uranium decay products found under the CSIRO car park.[2] Identical items of monitoring equipment were made available to the decontamination team in order to improve their detection sensitivity and to ensure consistency between on site and inspectorial monitors.

Surface contamination which emits alpha and/or beta radiation was monitored

by use of a Nuclear Enterprise PCM5 ratemeter with DP2 probe attached. This instrument was used to measure a contaminated tile in Building 51 and a drainage pit in Building 52.

2.4 Range of natural background levels

The range of count rates due to natural background was established for the Eberline instrument from measurements made using the same instrument settings which were maintained throughout the decontamination operation. A minimum background count rate of 85 $c.s^{-1}$ (counts per second) was found at the front nature strip adjacent to Lorimer Street. Maximum count rates of up to 260 $c.s^{-1}$ were found next to any external brick wall on the property. The elevated count rates found near brick walls were due to the naturally occurring radioactivity in brick clay. Count rates which were well in excess of 300 $c.s^{-1}$ were almost exclusively found at radioactive deposits which did not occur on the property naturally. For the Eberline monitor, most of the measurements of natural background were in the range of 100 to 300 $c.s^{-1}$.

For the Nuclear Enterprise PCM5 the beta/gamma background rate was found to be within the range of 2 to 5 $c.s^{-1}$. The alpha rate was less than 2 $c.m^{-1}$ (counts per minute).

2.5 Acceptable level of decontamination

The decontamination of an area was considered acceptable to all interested parties when the levels were brought down to within the normal range of natural background. The following criteria was used throughout the decontamination operation.

(a) A value of 200 $c.s^{-1}$ was the target limit when using the Eberline instrument. This was approximately mid way in the natural background

range for that instrument.

(b) In areas where the count rate may have been affected by an adjacent brick wall, count rates of up to 300 $c.s^{-1}$ were considered acceptable.

(c) For the Nuclear Enterprise instrument, decontamination was considered acceptable if the surface count rate was restored to within the range of 2 to 5 $c.s^{-1}$ for beta/gamma radiation or to 2 $c.m^{-1}$ for alpha radiation.

(d) The acceptability of a decontaminated area was adjudged on inspection by This Laboratory.

2.6 Sample measurements

Samples of contaminated soil and drain water were taken from the site. These samples along with the ARL air filters were measured by use of an high resolution solid state detector, which was connected to a Nuclear Data NE-6600 computerized data acquisition and spectral analysis system. This instrument is capable of measuring accurately the radioactive content in samples taken from the natural environment.

3. Radioactivity Removed

Significant levels of radioactivity were detected at various sites on the property.[2,4] On excavation, the true extent of these finds was revealed. The site positions (numbered in order from the back of the property to the front), and the approximate areas of the excavations are given on the property diagram, see Annex 1.

3.1 Site 1

This site is at the rear of the property, in the general area of Buildings

70, 71 and 87.[2] Radioactivity was removed from three locations on this site. The most active location was in the pathway between Buildings 70 and 87. The second location was outside the south-west corner of Building 70, at the base of the rain water down pipe. The third location was beside the doorway to Building 70, at the base of sand storage bins attached to the front of Building 71. The depth of the excavations were in each case less than 0.5m.

Sand samples taken from the storage bins were tested. The measurements showed that the sand was not radioactive.

This site is now free of all known radioactive contamination.

3.2 Site 2

A garbage bin and a fibre board drum left in Building 79 [4], were removed. This site is now free of all known radioactive contamination.

3.3 Site 3

Radioactivity found within and around the toilet block of Building 72C [2], was removed. Radioactivity in concrete used in stands for rain water down pipes, sewerage vents and drain pipes and in the floor underneath a large stainless steel wash trough was removed. Contamination was removed from the S-bend for the sink at the eastern end of the toilet block and from the garden area surrounding the pipe outside the building. Sections of the drain pipe for the sink were also removed.

Minor contamination remains in the garden area, in the remaining pipe from the sink and possibly underneath the adjacent footpath. This area will require further attention.

Smoke detectors found in a store room in Building 72 [4] had been removed prior to this operation.

3.4 Site 4

This site is at the south-west corner of Building 74.[2] Radioactive contamination was removed from the ground underneath and surrounding the electrical switching substation adjoining the main building. A drainage pit was removed during the excavation. At some locations the excavation extended to a depth of approximately 0.8 m. The contamination was found to continue through the boundary fence with ARL. Difficulties were encountered due to the location of a high voltage power cable passing through the excavation site.

Despite considerable efforts, some contamination remains in this area. The measurements required for completion and acceptance of the area cannot be carried out without the removal of the surrounding contamination on ARL property. This area will require further attention.

3.5 Site 5

This site is along the nature strip to the south of Buildings 74 and 89. A narrow strip of low level contamination was removed. The maximum depth of the excavation was approximately 0.3 m. This site is now free of all known radioactive contamination.

3.6 Site 6

This site covers the main car park [2], which is to the east of the approximate centre of the property, and includes some of the adjacent buildings. It had by far the largest radioactive deposit on the property, yielding approximately 5000 drums of contaminated soil and waste material.

The main excavation extended from the northern entrance of the gardener's hut, Building 95, through to the boundary fence adjacent to Building 21 on the opposite side of the car park, a length of approximately 45 m. At its widest point the excavation was approximately 45 m. Radioactivity was also removed from locations extending from the boundary fence in the south-east corner of the car park and along the eastern nature strip.

The depth of the main deposit extended from the surface, or just below, down to depths of up to 1.3 m. At the northern end of the excavation the contamination had almost reached down to the water table. An active seam of mustard coloured clay like material was observed to extend through most of the excavation and at some locations a thin layer of black material was found directly underneath. The thickness of the seam ranged from a few centimetres to approximately 40 cm at its greatest thickness. The thin black layer had a consistency similar to that of a thick crude oil residue and it was found to be contaminated.

Contamination from the seam appeared to have leached into the subsoil. Removal of the seam and of the contaminated subsoil continued until the levels were below the target value. Once the general area was cleared, it was thoroughly surveyed and any local pockets of remaining contamination were removed.

This site is now free of all known radioactive contamination.

It was noted that the contamination, on ARL property, in the garden and lawn area to the north east of Building 21 [5], was most concentrated and deepest at the north east corner of the building and it reduces in depth and concentration towards the west. The western boundary of the contamination appears to occur at the contaminated concrete pipe described

in Site 13.

3.7 Site 7

Minor radioactivity was found in two drainage pits [4] and in an electric furnace in Building 52. The pits were scrubbed and flushed and some of the fire bricks were removed from the furnace. This site is now free of all known radioactive contamination.

3.8 Site 8

A deposit of radioactivity was found underneath room 2, Building 55.[4] On inspection, additional deposits were discovered under two other rooms. The floors of the affected rooms were lifted and the radioactivity was removed. A small drainage pit outside Building 55 was removed during the excavation. This site is now free of all known radioactive contamination.

3.9 Site 9

This site was in the street behind Building 1. Radioactivity found in a brick and concrete cupboard attached externally to Building 52N [2] had been removed [4] prior to this operation and required no further action. This site is free of all known radioactive contamination.

3.10 Site 10

Trace levels of beta/gamma contamination were found on a stainless steel sink in room 56, Building 53.[4] The levels were not considered by ANSTO to be of significance and required no further action.

3.11 Site 11

This site includes a number of items found in Building 51 [4]. Apart from the fixed contamination on a ceramic tile in a fume hood in room C30, all of the other finds were due to the naturally occurring radioactivity

normally found in such items. The ceramic tile was removed. This site is now free of all known radioactive contamination.

3.12 Site 12

This site is in the road behind the south east corner of Building 51. An acid pit which serviced Building 51 was found to contain significant levels of contamination (up to 9000 $c.s^{-1}$). Following unsuccessful attempts to decontaminate the pit, it was found necessary to extract it and to remove some of the surrounding soil. The excavation was approximately 3m X 2.5m and extended to a depth of approximately 1.6m. Contamination found in one of the inlet pipes to the pit was removed by flushing. This site is now free of all known radioactive contamination.

Subsequent investigations down stream from the acid pit did not reveal any further contamination. Recommended sludge sampling of the main acid pit behind Building 53, to be carried out by ANSTO, should indicate whether or not all of the contamination had been trapped in the pit behind Building 51.

3.13 Site 13

This site includes a 380 mm concrete pipe which extends from the north of Building 21, through the main car park, underneath Building 53 and out to Lorimer street, where it appears to subsequently discharge into the Yarra river. This pipe contained large quantities of contaminated soil and at some locations it was more than half full. Count rates of up to 3000 $c.s^{-1}$ were encountered in the pipe.

It was noted that some sections of the pipe contained large quantities of contaminated material while other sections were relatively clean. Sections such as those between the pit, which connected to the outlet from Building

52, and the road to the north of Building 53 contained little contamination because the water flow had not been restricted. Over the years, the contamination in those sections would have been slowly washed away. The sections of pipe between the car park and the abovementioned pit and the sections in the lawn area in front of Building 51 were heavily contaminated because these were either cut or blocked. It was found that a matted root system from the local vegetation had grown in the pipe near to the front boundary fence. This acted as a natural filter which trapped most of the contaminated material, blocking the pipe and preventing further contamination from leaving the property.

The pipeline was excavated and the active lengths of pipe were decontaminated or crushed and drummed. Crushing depended on the effectiveness of the decontamination procedure. The pit which connected the outlet from Building 52 to the pipeline was removed. A small pit found behind Building 53 was decontaminated and a 100 mm pipe, which connected the pit to the main pipe, was removed.

This site is now free of all known radioactive contamination.

4. Areas Requiring Additional Attention

On completion of the decontamination operation, it was found that the CSIRO property had been almost completely cleared of radioactive contamination. Due to logistic difficulties a few areas of minor contamination remain. It was decided that these areas will be completed during the decontamination operation at ARL. The areas requiring additional attention are:

(a) the garden outside Building 72 (see Site 3);

(b) the electrical substation attached to Building 74 (see Site 4); and

(c) two very small deposits in the roadway and footpath to the north of Building 61.

5. Discussion

The decontamination operation removed 5492 X 200 litre drums (approximately 1650 tonnes) of radioactive waste and contaminated material from the CSIRO property. The operation was carried out efficiently and professionally and used all reasonable safety precautions for the on-site personnel and for those in the surrounding area.

It can be demonstrated that ARL staff members were not, as a result of any stage of the operation, exposed to radiation levels in excess of natural background. The principle hazards from radioactivity are due to external exposure, inhalation and ingestion. Measurements indicated that the external exposure levels at the boundary fence between ARL and CSIRO, either due to exposed material or material stock piled in drums, were not significant above background. The principle mode of transport of contamination from CSIRO to ARL would have been by air. Although dust was raised, independent air sampling measurements carried out by ANSTO and by This Laboratory did not detect the presence of airborne contamination. The contamination found in large deposits in the car park was of a heavy clay like consistency which was unsuitable for air suspension. Laboratory tests indicated that the material was in an insoluble form and therefore its biological uptake would have been small. The probability of any harmfull effects due to inhalation or ingestion were therefore negligable. The heavy consistency of the material, which would retard the release of radon gas, and the ample natural ventilation rate, explains the normal radon levels found on the property.[2]

The discovery of large amounts of contaminated soil in the concrete pipe at Site 13 raises a number of issues. Plumbing diagrams for the property [6]

indicate that the pipe may have been originally connected to a pit at the north of Building 89. The original location of this pit is now underneath Building 21 Extension. It is believed that the uranium ore processing was carried out in the general area near by.

Aerial photographs [7] indicate that Building 53 was constructed between 1945 and 1951. As the concrete pipe was located underneath Building 53, it is likely that it existed prior to construction of the building and therefore existed during the ore processing experiments. The original purpose for this pipe is unclear.

The inlet to the concrete pipe appears to have been cut on construction of Building 21. This was built after the ore processing projects are believed to have ceased. Other sections of the pipe were cut down stream after it had been contamination.

The large deposits of contaminated material found in the pipe leads to the following scenarios, which are not mutually exclusive:

(a) the pipe may have been used as a waste disposal facility to dump contaminated waste into the Yarra; and/or

(b) the contamination may have entered the pipe during the construction of Building 21.

The implication of (a) is that an unknown quantity of material may have been discharged into the Yarra prior to the pipe becoming blocked and unserviceable. It could be speculated that the CSIRO decisions to bury the material on the property and to vacate the property may have followed as a consequence.

The implication of (b) is that a considerable deposit of the contaminated

material would have existed, and still may, at the new inlet created in the pipe when it was cut. This would place the material to the south of the existing CSIRO car park. An aerial photograph taken in 1964 indicates that the southern end of the then car park was used for the construction of Building 21 and part of Building 21 Extension. This would be consistent with the contamination found around and underneath Buildings 21 and 21 Extension.[5] It would appear that the full length of the original car park may have been used as the primary dump site.

Measurements and sampling of the main storm water drainage system (excluding the pipe, Site 13) showed that it was essentially free from contamination. Levels of 0.1 $Bq.l^{-1}$ (Becquerel per litre) of insoluble radium were found at the boundary outlet. The samples were taken following moderate rain and while the decontamination operation was well under way. The levels were found to be very much less than the acceptable discharge limits for the State of Victoria.[8] Insignificant trace levels were found in the system at a few inspection pits. Although already at acceptable levels, these pits were flushed as an added precaution. As the primary source of contamination has been removed, if any contamination remains in the drainage system it will be naturally flushed as time progresses.

A number of observation were made during this operation which may be of interest for the forthcoming decontamination of ARL. As the storage facility at ANSTO for the drums of contamination may not provide full weather cover, it is recommended that galvanized (i.e. rust proof) drums be used. It is believed that the re-drumming costs may be substantial. If, ultimately, the drums are to be buried in a shallow ground burial facility at a national repository, the following is recommended:

(a) the drums should be completely full and the material reasonably compacted; and

(b) the specific activity of the radium contamination should be kept below 3 $Bq.g^{-1}$.

The reason for (a) is to prevent land fill collapse at the burial site. It also minimizes the storage charges at ANSTO. The specific activity given in (b) is a current notional limit for burial at a depth of 2 m. Samples taken from the car park [2] and from the garden area at ARL [5] indicated that specific activities were well in excess of this. The observance of these recommendations may remove the need for further and nodoubt costly preparation of the material before final burial.

It was noted that previous estimations of the amount of material to be removed from CSIRO were substantially lower than that which required removal. The primary reason for the inaccuracy is that the depth is often unknown prior to excavation and that material can exist at depths where it cannot be detected from the surface. It is also unavoidable that clean soil can become contaminated during excavation and this must be removed as well. The removal of approximately 100 m^{-3} of material was estimated for the decontamination of ARL. Recent experience would indicate that the final value could vary from the estimate by up to a factor three, in either direction.

6. Acknowledgements

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Also many thanks to Richard Tenhave (ANSTO), David Penny (ANSTO), Richard Horsington (TNT) and all the other members of the decontmaination team for their total cooperation throughout this operation.

7. References

[1] Commonwealth Scientific and Industrial Research Organization (CSIRO), Sixth Annual Report (for the year ending 30 June 1954).

[2] Owen J. Wilson, "Radiation Survey of the CSIRO Applied Organic Chemistry Division, Lorimer Street, Fishermen's Bend", Australian Radiation Laboratory, March 31, 1989, under contract to The Australian Construction Services.

[3] Minutes of the CSIRO Task Force on Fishermens Bend Radioactivity, held at the CSIRO Division of Mineral Products, Port Melbourne, 22 June, 1989.

[4] P. Wright, J. Sykes, B. O'Brien and G. Collings, "Radiation Survey of the CSIRO Applied Organic Chemistry Division, Lorimer Street, Fishermen's Bend, Melbourne", ANSTO, May, 1989, under contract to CSIRO.

[5] Owen J. Wilson, "Radiation Survey of the Aeronautical Research Laboratory, Lorimer Street, Fishermen's Bend (CSIRO waste only)", Australian Radiation Laboratory, 9 June, 1989, under contract to The Australian Construction Services.

[6] Service Plan - Fisherman's Bend, Sewerage and Stormwater Drains, CSIRO, Chemical Research Laboratories, Drawing No. B-875, 11 June 1969.

[7] Aerial photographs of CSIRO Fishermens Bend, by courtesy of the Aeronautical Research Laboratory.

[8] Victorian, "Health (Radiation Safety) Regulations", as amended from time to time, statutory rules pursuant to the powers of the Health Act 1958.

8. Definitions

Becquerel (Bq)	Unit of the activity of a radioactive source. One Bq equals one atomic transition per second.
Specific activity	The activity of a radioactive source per unit mass of material.

Annex 1: Property Diagram CSIRO Fishermens Bend