3.2.4 Phosphorus

No yellow phosphorus was encountered in Zone 2A. A number of bricks and concrete fragments impregnated with red phosphorus were identified during excavation and screening. All red phosphorus was removed to skips and processed through the mud stills.

3.2.5 Hydrocarbons

Initially, hydrocarbon contaminated material, including oily pipes and contaminated concrete and brick, was excavated and taken to an off-site tip facility. At an early stage it was realised that the volumes of hydrocarbon contamination were likely to be far greater than originally expected and at that point the disposal of hydrocarbons off-site ceased. Further excavated hydrocarbon material was placed in Stockpile E and Stockpile Q, while alternative disposal methods were investigated. A&W ceased excavation of hydrocarbon contaminated material in this area in March 1998 and the hydrocarbon decontamination in this zone was taken over by Churngold Construction Limited on 26 October 1998.

3.2.6 Structures

All structures uncovered in this zone were broken out, and clean concrete taken to Stockpile F. Concrete contaminated with hydrocarbons was stockpiled in location Q.

3.3 Bioremediation

3.3.1 General

Following successful small scale trials and competitive tendering, a contract for the bioremediation of the hydrocarbon contamination was let to Churngold Construction Limited. The bulk earthworks, excavation and other physical works were undertaken by Churngold whilst the technical control and biochemical aspects were undertaken by Biologic Remediation Limited.

One of their first tasks was to create a firm working platform using crushed concrete and imported stone across the area to be used for the laying out of bioreactor windrows (Zone 2B and Zone 3).

3.3.2 Excavation and Treatment

As the working surface was established, so material was excavated from Stockpile E and Q, screened to remove oversize material and placed in windrows on the bioremediation area. The hydrocarbon contaminated material was thoroughly mixed with a nutrient rich substrate, compost, and sprayed with further nutrient solutions, in accordance with Churngold's method statement, Appendix F. Besides oversize material, the screening also allowed removal of metal and grossly contaminated tar lumps, these materials were placed in suitable skips for disposal off-site.

Oversize stone, concrete and brick rubble was put to one side for subsequent crushing and treatment.

Once the existing stockpiles had been cleared, excavation of the remaining in situ material commenced following a similar procedure.

4.0 DECONTAMINATION - ZONE 2B

4.1 General

4.1.1 Stratigraphy

Zone 2B had an average starting level of about 8m AOD. A thin layer of overburden overlaid distinct layers of Phosphate Rock Fines (PRF) and Calcium Silicate Slag (CSS). Where railway lines had run in the site, crushed stone imported from the adjacent power station site had been used as sub-base. Generally, below the materials placed by A&W was the surface left after the demolition of the previous structures occupying the site. This included paved areas and slabs. Historically, the area had been filled with ash and clinker from the adjacent power station to make up levels. Below the ashy fill, at varying depths, was the in situ alluvium.

▼ Ground Level 8.0-8.3m AOD approx.

Thickness varies	'Overburden' - Ash/Slag/Brick/Clay/Gravel	Albright & Wilson Era Made Ground
Thickness varies	Calcium Silicate Slag (CSS)	
0.75-1.3m bgl ▼	Phosphate Rock Fines (PRF)	
Thickness varies	Silty Clay/Ash/Brick/Gravel	
Thickness varies	Sandstone and Limestone gravel - referred to as 'stone' or 'quarry waste'	
1.5-2.3m bgl ▼	Ash and clinker, some slabs and substructures.	Pre-A&W Made Ground
To depth	Silty Clay	Natural Alluvium

4.1.2 Phosphorus Pits

There were two known pits in Zone 2B which had been used for the storage of phosphorus waste (Pits 1 and 2). The pits had been formed by filling the space between the disused railway platforms with process waste. A&W carried out some decontamination works in 1993, prior to the works set out in the SDW.

The 1993 decontamination involved the removal of 'field mud residues', which contained approximately 0.5% phosphorus, and processing it through the on-site mudstills. The distilled phosphorus was taken by tanker to the A&W works at Oldbury and the mudstill residue was landfilled offsite. For further details see Appendix C.

At the start of the SDW works, Pits 1 and 2 were approximately 2m deep and flooded with water. Residual phosphorus contamination was expected in the clay base of the pits and the surrounding material.

4.1.3 Albright & Wilson Domestic Tip

A&W were known to have buried office related waste and rubbish associated with the demolition of the workshop in Zone 2B. This tip was located during the course of the excavation.

4.1.4 Buried Drums

Anecdotal evidence collected during the early investigations suggested that two pallets of drums had been buried in this part of the site, one allegedly containing arsenic, the other cyanide. The area was entirely excavated to undisturbed alluvial clay during the course of the works and no such drums were found, see 4.2.6.

4.2 Excavation

4.2.1 Overburden

Overburden was visually inspected for phosphorus and excavated to Stockpile A.

4.2.2 Calcium Silicate Slag and Phosphate Rock Fines

CSS and PRF were visually identified and excavated to Stockpile B.

4.2.3 General Fill

General fill was excavated, screened and used as backfill within the site.

4.2.4 Phosphorus

Yellow phosphorus was encountered in Zone 2B in the fill and clay excavated from the vicinity of Pits 1 and 2, as expected. A number of bricks and concrete fragments impregnated with red phosphorus were also identified during excavation and screening. All red phosphorus was removed to skips and processed through the mud stills. All fiery yellow phosphorus and a number of crushed drums containing phosphorus were excavated to the skips and processed through the mud stills. Material contaminated with 'phossy water' only, ie sufficient phosphorus to cause minor fuming (up to 5ppm) was taken to Processing Area 1 (Zone 2C) for oxidising by rotavation.

4.2.5 Hydrocarbons

Small amounts of hydrocarbon contaminated material were encountered adjacent to Zone 2A (grids H and I21) and at depth in grids K/L25. All hydrocarbon contaminated material was excavated to Stockpile Q for treatment (see sections 3.2 and 3.3 above).

4.2.6 Buried Drums

A pallet of eight 25 litre drums was uncovered in grid K18. This was around the expected location of the alleged burial of the arsenic and cyanide drums so work was stopped in this area and the residue in the drums and the surrounding backfill material were quickly tested for both arsenic and cyanide. Detailed analysis concluded that the substance was strontium sulphate, a substance at one time mined as 'celestite' in the Bristol area. The drums were disposed of at a suitable offsite tip. A&W's laboratory report is included in Appendix H.

4.2.7 Domestic Waste Tip

The expected waste tip was uncovered in grids K21-23. The general constituents of the tip were metal, pipe lagging, asbestos cement sheeting, glass, plastics, cardboard and the like. It was found in discontinuous pockets about 1m below ground and a metre or two thick and amounted to some 500 tonnes. The material was taken off site to a licensed tip.

4.2.8 Asbestos

Adjacent to the waste tip area a number of red plastic bags were uncovered, presumably having been tipped at the same time as the general waste. Once spotted, excavation ceased and the area was cordoned off. Investigations proved the bagged material to be asbestos. Cabot Thermals, a specialist contractor, was brought in by A&W to excavate the asbestos, which was taken off-site to a suitably licensed tip facility. For information see Appendix I.

4.2.9 Structures

All structures uncovered in this zone were broken out, and clean concrete taken to Stockpile F. Small amounts of phosphorus contaminated concrete were excavated to the skips for processing through the mud stills. Any concrete, stone brick or rubble contaminated with hydrocarbons was stockpiled in location Q prior to being crushed and treated, see Section 3.3.

4.2.10 Landslip

On the 17 February 1998, the ground beneath Stockpile B (grids L17-L20) slipped towards the adjacent ditch. A rotational slide blocked the Portbury Ditch with alluvial clay, but the stockpiled site won CSS and PRF did not move beyond the boundaries of the site. The CSS/ PRF stockpile was moved away from the ditch, and the CSS/PRF which had moved below original ground level due to the slip was excavated. The clay was removed from the ditch and temporarily stockpiled on site and the bank reprofiled. The void left by the excavation of the slip was backfilled with site won fill from Stockpile A layered with clay excavated from the ditch. The area was capped with site won crushed stone (railway ballast), initially to a level of 8.2m AOD, which was reduced to the specified level of 7.5m AOD during September/October 1998.

Details of the ditch remedial works can be found in the Final Decontamination Report for Zone 6 which includes Portbury Ditch.

4.3 Backfill

4.3.1 Site-Won Fill

Site won fill was used as backfill up to 7.5m AOD. The material was compacted in accordance with the Specification for Highway Works. The backfill was laid in 300mm layers and a minimum of four passes were made with a D6 bulldozer pulling a 5 tonne vibrating roller. Compaction advice was provided to A&W by Pearce Project Management, who were appointed as their earthworks advisor.

4.3.2 7.5-8.05m AOD

Imported clean clay was used as backfill in the layer between 7.5m AOD and 8.05m AOD. When imported clay was not available, site won crushed concrete was used for this layer.

This was covered with up to 300mm of clean crushed concrete or imported stone to form a working platform for hydrocarbon bioremediation process.

DECONTAMINATION - ZONE 2C

5.0 General Stratigraphy

5.1 5.1.1 G13 to I17

The surface was covered with A&W road and tank base slabs. These slabs had been constructed some years after the start of phosphorus refining on site on an area that had been used as a dumping ground similar to the rest of Zone 2 and as a 'laydown' area for pieces of equipment for repair or scrapping from the plant. Below the slabs were occasional pockets of slag and general rubbish over ash/clinker fill which had historically been imported from the adjacent power station to make up levels. This area became Processing Area 1 and was used for oxidising low level phosphorus contaminated material until its own removal.

▼ Ground Level 8.3m AOD approx.

Thickness varies	A&W concrete slabs (where present)	
0.8-1.2m bgl ▼	'Overburden' - Ash/Slag/Brick/Clay/Gravel, also occasional general rubbish, including carbon furnace bricks.	Albright & Wilson Era Made Ground
1.4-2.2m bgl ▼	Ash and clinker	Pre-A&W Made Ground
To Depth	Silty Clay	Alluvium

5.1.2 F13 to F17

This area is adjacent to the dock and the water level in the granular material adjoining was continuous with the dock at approximately 6.5m AOD. A clay bund approximately along gridline G was built to cut off the dock water and prevented flooding of the rest of the site during high tide. Ashy overburden covered a slag layer, over ashy fill again, which extended below water level to the clay at varying depth.

5.1.3 J13 to J17

Ashy overburden covered a layer of CSS and general rubbish here, which included asbestos cement pipes/sheeting and carbon blocks. More ashy fill was below the slag, down to the in situ alluvium.

5.2 Excavation

5.2.1 General Fill

Ashy fill was excavated, visually inspected for phosphorus and backfilled in Zone 4 and elsewhere in Zone 2C.

5.2.2 Calcium Silicate Slag and Phosphate Rock Fines

CSS and PRF were visually identified and excavated to direct to lorries and taken to an off-site tip, or to stockpile for later off-site disposal.

5.2.3 General Rubbish

General rubbish, metal, wood etc, was visually separated and taken to an off-site tip facility.

5.2.4 Phosphorus

Yellow phosphorus was encountered in Zone 2C in the fill excavated from below the tank base slabs. This was mainly in the form of phossy water contaminating the general fill but was also found impregnating some buried concrete. It had not been expected initially, but was probably a result of the area being used to wash down phosphorus contaminated equipment prior to the construction of the tank bases. The contaminated fill was excavated to Stockpile L which was then oxidised using hot air and manual turning in skip. A number of bricks impregnated with red phosphorus were also identified during excavation. All red phosphorus contaminated material was removed to skips and processed through the mud stills.

5.2.5 Structures

The tank base slabs were approximately 500mm thick, but overlay a number of previous structures. All concrete slabs and beams were broken out and the concrete taken to Stockpile F for crushing. The piles were surveyed for position and cut off down to the alluvium level. The road slabs were approximately 200mm thick and were broken up and taken to Stockpile F for crushing.

5.3 Backfill

5.3.1 Site Won Fill

The zone was filled with site won fill, including oxidised site won fill from Stockpile L, up to a level of 7.5m AOD. The material was compacted in accordance with the Specification for Highway Works. The backfill was laid in 300mm layers and a minimum of four passes were made with a D6 bulldozer pulling a 5 tonne vibrating roller. Compaction advice was provided to A&W by Pearce Project Management, who were appointed as their earthworks advisor.

5.3.2 7.5m-8.05m AOD

Clay was imported from offsite to fill between 7.5m and 8.05m AOD. Imported clay was not initially available for the filling of this area, so crushed demolition material was used in grids G17-J17.

5.3.3 Capping (8.05-8.2m AOD)

The final capping layer will be site-won clean crushed hardcore/imported granular fill of Class 6F2.

VERIFICATION

General

The decontamination objectives in Zone 2 were met, as recorded in A&W's log sheets and lab book for the phosphorus decontamination and Churngold/Biologic's records for the hydrocarbon remediation works. Daily log sheet and lab book information has been collated to give a history of excavation, backfilling and sampling activities for each grid in a Grid Decontamination Sheet, which can be found in Appendix A. Churngold and Biologic's records can be found in Appendix G.

Routine Sampling

Samples were taken from all material excavated to stockpile and all material used as backfill at an approximate rate of 1 per 200m³, or one per hour, whichever was the more onerous. Samples were taken in accordance with A&W Standing Instruction (SI) Nos 1-5 and tested in accordance with SI Nos 7 and 8 (see Appendix J). A total of 1800 samples were recovered from zone 2 and subjected to the on site phosphorus test. None of the samples taken failed the test for phosphorus.

Proving

The exposed alluvium was sampled on a 5m x 5m grid as prescribed by the SDW, and there was no visible hydrocarbon or phosphorus contamination. All samples were tested for phosphorus and where hydrocarbons had been encountered in the overlying fill the grid samples were also tested for hydrocarbons. Samples were tested in accordance with A&W's Standing Instructions (Appendix J). All grid proving samples passed the tests.

All areas were excavated to the alluvium level with the exception of grids F13-F17, adjacent to the dock, which was excavated to dock water level. Proving samples were taken at the excavated level and from trial holes dug in the general fill, to demonstrate the absence of process waste below the water level. All samples taken from this location were shown to be free from phosphorus.

Sampling and Final Decontamination Level

The SDW required the backfilled material to be monitored for radiation at the 7.5m AOD level, to verify the removal of CCS. The radiation survey can be found in Appendix K. None of the readings reached the intervention level of 10cps.

Additional Testing

6.5.1 Site Won Fill

The EC took samples from the top level of the site won fill. These were sent to TES Bretby and tested for heavy metals. Results can be found in Appendix L. Occasional mildly elevated levels of zinc and lead were found, but as the material was capped with 1m of clean material, this was not considered significant.

North Somerset Council also took a number of samples from the site won fill for testing. Results can be found in Appendix L.

6.6 Off-Site Testing

Ten per cent of samples of backfill material were sent off-site to A&W's laboratories at Oldbury for quantitative analysis. All samples tested were found to be below the detection level for phosphorus, for reporting of results see Appendix L. Samples were tested in accordance with A&W's SI No 10 (see Appendix J).

6.7 Verification Pits

A number of trial pits were dug across the whole site between February and August 2000 to confirm or otherwise, that the aims of the remediation works had been achieved. The locations of pits in Zone 2 as shown on Figure 4, detailed trial pit logs and results of chemical analyses by TES Bretby on samples recovered from them are included in Appendix M and N respectively.

6.8 Remedial Works

As a result of the findings of the trial pits additional works were carried out in a number of areas to remove or further investigate suspect material.

The location of these works are included on Figure 4 and a summary of the work done or intended to be done is included in Appendix O. 'Intended to be done' work is included in the S106 Agreement amendment. They are also referenced on the GDR (Appendix A).

Briefly the remedial works were necessary to remove 'site-won fill' containing unacceptable levels of 'total' or polyaromatic hydrocarbons, pipework and residual phosphorus. Upon completion, the excavations were inspected and if necessary sampled and tested to confirm that the unacceptable material was gone, the results of the tests are also included in Appendix O.