4.1.2. Requirements for additional PPE

During the ground disturbance work, all workers and site supervisors were required to wear specific Personal Protective Equipment (PPE) as requested by Incoll OH&S consultant in addition to the standard PPE (i.e. hard hat, safety vest, safety glasses and steel capped boots). The specific PPE requested by Incoll was:

- Disposable overalls
- Nitrile safety gloves
- Half face respirator that is fitted with particulate and gas/vapors filters (A1 filter and P2 filter)

The requirement for the additional PPE was outside the scope of the original proposal and resulted in extended duration of the fieldwork component.

4.1.3. Boreholes

A total of four (4) geotechnical boreholes were drilled vertically to a target depth of 8 m below the existing ground level. The boreholes were specifically requested by RailCorp which stated:

> *"RailCorp's geotechnical engineers recommend that this scope of work be supplemented with an additional 4 boreholes with Standard Penetration Testing (SPT) to assist in correlating the CPT data and other site information (such as groundwater conditions). The additional boreholes will need to be of a sufficient depth to assess bedrock conditions, and will need to be located strategically such that future construction methodologies near critical structures can be developed with confidence."*

The boreholes were drilled using a 4 tonne track drill rig (JK300). Three (3) boreholes (BH01, BH03 and BH04) were augered to the target depth of 8 m. One borehole (BH02) was initially advanced by augering to 5.9 m below the ground level, and then cored using NMLC coring techniques to the target depth of 8.0 m.

Standard penetration tests (SPTs) were undertaken in all the boreholes at approximately 1.5 m centres in soil to a maximum depth of 6 m.

Two standpipe piezometers were installed at BH02 and BH04 to allow monitoring of the groundwater level. These piezometers have since been decommissioned. The detail constructions of the piezometers are presented in Appendix A. The groundwater levels in the standpipe piezometers in BH02 and BH04 were measured by a PSM geotechnical engineer of 2 July 2010.

BH01 and BH03 were backfilled with excavated spoil upon completion of augering. During drilling some tar contaminants were exposed, particularly at BH03 and BH04 in the form of sludge/foam.

All boreholes were drilled in the full time presence of PSM Geotechnical Engineers who set out the test locations, and prepared engineering logs. Engineering borehole logs together with the explanation sheets and core photograph are presented in Appendix A.

Point load tests were performed on the core. The results of the point load testing have been tabulated and are included in Appendix A.

4.1.4. Cone Penetration Tests

A total of sixteen (16) cone penetration tests (CPTs) were completed to a depth between 3.5 m and 6.0 m. The tests were performed by an 18 tonne truck mounted cone rig (EFCP rig). The soil resistances were digitally recorded at 10 mm intervals of penetration of the cone into the ground.

The purpose of the CPT testing was to:

- Better define the top of the natural material.
- Estimate the strength of the subsurface materials.
- Estimate the deformation characteristics of the subsurface materials.

The CPTs were typically terminated upon achieving the target depth of 6.0 m. CPT01, CPT12, CPT14, CPT15 and CPT16, however, refused at depths of 4.1 m, 3.6 m, 3.4 m and 5.6 m respectively. The refusal was inferred to have occurred on higher strength shale or an ironstone layer.

CPT03 and CPT05 refused at shallow depths (less than 1.0 m) on buried foundations and slabs. These were relocated up to three times until at the final location (i.e. CPT03A and CPT05B) we were able to test to the target depth of 6 m.

The CPT results together with the inferred subsurface conditions as interpreted from the CPT test results are presented in Appendix B.

4.1.5. Testpits

A total of six (6) six testpits were completed to a depth of between 0.7 m and 0.9 m. The test pits were excavated in the existing access road located within the rail corridor (between track kilometrage: 2.561 km to 2.668 km). The test pits were excavated by a 3 tonne excavator fitted with toothed bucket. The testpits were backfilled with the excavated spoil upon completion of excavation.

All testpits were excavated in the full time presence of PSM Geotechnical Engineers who set out the test locations, and prepared engineering logs. Engineering test pit logs together with the explanation sheets and test pit photographs are presented in Appendix C.

Bulk samples were recovered from the test pits and forwarded to the geotechnical laboratory for testing.

4.2. Laboratory Testing

The following samples were recovered from the test pits and sent to the geotechnical laboratory for testing:

- Six (6) bulk samples were recovered from TP01 to TP06 respectively between 0.1 m to 0.4 m below the ground surface for California Bearing Ratio (CBR) testing.
- Three (3) bulk samples were recovered from TP01, TP03, and TP05 respectively between 0.1 m to 0.4 m below the ground surface for California Bearing Ratio (CBR) testing.

The geotechnical laboratory test results are attached in Appendix D. The CBR test results are summarised in Table 1 below.

TABLE 1
SUMMARY OF CBR TESTING RESULTS

SAMPLE	DEPTH (m)	CBR [1] (%)	MOISTURE CONTENT (%)	STANDARD MAXIMUM DRY DENSITY (t/m^3)	OPTIMUM MOISTURE CONTENT (%)
TP01-CBR	0.3	60	21.8	1.393	23.7
TP02-CBR	0.3	25	25.5	1.397	27.0
TP03-CBR	0.2	18	25.1	1.623	22.0
TP04-CBR	0.2	45	28.3	1.539	23.9
TP05-CBR	0.2	60	16.6	1.759	18.0
TP06-CBR	0.2	35	14.1	1.837	14.0

[1] 4 day soaked CBR, 4.5 kg surcharge

5. GEOLOGICAL SETTING

The 1:100,000 Sydney Geological map indicates that the site is underlain by the Wianamatta Group comprising black to dark grey shale and laminite.

6. SITE CONDITIONS

6.1. Surface Conditions

The site is triangular in shape and covers an area of approximately 7,700 m^2. It is bounded by residential properties to the west, stabling yards to the north and Illawarra line to the south and east

At the time of the fieldwork, the site was vacant with the remains of two heritage listed gas holders occupying the western portion of the site. Some stockpiled building rubble was also located in the western area.

Gravel, sand and building rubble was observed in the fill embankment located along the northern boundary adjacent to the stabling yards.

The temporary construction access road was located within the rail corridor at the southern boundary of the site. The surface of the road was sealed with bitumen and was observed to be in relatively good condition.

6.2. Site History

A detailed description of the site history is provided in Section 2 of the CH2MHILL March 2007 report. The site was used between 1892 and 1958 as a manufactured gas plant. This activity required excavation and construction of subsurface structures such as the gas tanks and tar wells. This activity and subsequent activities have resulted in the presence of significant volume of uncontrolled fill on site.

7. SUBSURFACE CONDITIONS

7.1. Geotechnical units

Based on the conditions encountered within PSM investigation boreholes and CPTs, and the conditions described in test pit and borehole logs from the previous environmental site investigations we have divided the subsurface profile into the following geotechnical units:

1. **FILL**. The fill is described in previous investigation reports as including:
   - (a) Ash and coke gravels, primarily located in the near surface layers.
   - (b) Reworked clays, present in the majority of areas of filling.
   - (c) Sands, gravels, gravelly sand and gravelly clay with minor ash.
   - (d) Gravel, sand, demolition waste and building rubble.

   Our site observations and conditions observed in the PSM boreholes confirm the fill types described above.

   The CPTs completed in the FILL unit indicate that strength (density or consistency) of the FILL unit is variable. From the CPT, we infer the following strengths:

   - (a) A well compacted/dense or hard layer between 0.5 m and 1.0 m thick is present in the upper metre of the FILL profile. These areas are characterised by cone resistance generally greater than 5 MPa. This zone is likely to be associated with the gravels and sand materials observed near the surface.
   - (b) A zone between 2.0 m and 4.0 m thick comprising reworked clays, sands and gravels. These areas are characterised by cone tip resistance values generally greater than 1.0 MPa with layers of limited thickness with cone tip resistance of between 0.5 MPa and 1.0 MPa present in some of the CPTs. That is, the materials are likely to have a consistency of stiff and very stiff, with some minor layers of firm or loose fill present. SPT completed in this zone in BH01, BH02 and BH04 resulted in N-values of 4, 5 and 2 respectively which confirm the lower bound strengths inferred from the CPT.

(c) A layer of reduced cone resistance is observed to occur at the inferred base of the FILL unit in many of the CPTs. This may represent a thin (less than 0.5 m) topsoil horizon buried as part of the filling operations.

2. **RESIDUAL CLAY**. The residual clay unit is located below the FILL unit and comprises Clay and Sandy Clay, medium to high plasticity, orange, red, brown, mottled in parts. The RESIDUAL CLAY is typically stiff, very stiff and hard.

The CPTs in this unit indicate that:

(a) A 1.0 m thick firm to stiff layer is present at the top of the RESIDUAL CLAY unit. An SPT undertaken within this area in BH03 resulted in an SPT N-value of 5.

(b) The strength of this material increases gradually with depth.

(c) Ironstone bands or higher strength shale bands may be present within this unit.

SPT N-values in the residual clay units ranged between 5 and 33. The SPT results also indicated increase in strength with depth.

In some areas including at BH01 and BH03, the RESIDUAL CLAY unit is impacted by tar. The tar impact is associated with the previous site activities.

3. **SHALE**. The shale unit is located below the RESIDUAL CLAY unit. The shale encountered within the CPTs and the PSM boreholes can be described as extremely low strength, extremely weathered, and grey. The strength can be expected to increase rapidly with depth.

Based on the conditions observed and reported in the environmental site investigation logs, shale of medium to high strength greater than low strength is unlikely to be present above 10 m depth. However, SPT and CPT refusal well above this depth indicates that there is potential for some medium to high strength shale or ironstone layers to be present at shallower depths.

7.2. Inferred subsurface profile

Figure 2 and Figure 3 present the inferred top of the RESIDUAL CLAY and SHALE units respectively at each test location.

The inferred levels are based on:

1. The conditions described in the borehole and test pit logs from the previous environmental investigations. We have reviewed these logs and consider that the top of RESIDUAL CLAY unit and SHALE units have been identified adequately.
2. The conditions observed in the PSM boreholes.
3. The conditions as inferred from the CPTs. CPT refusal has been inferred as top of shale. It may however in some tests represent a higher strength shale or ironstone band within the RESIDUAL CLAY unit.