Soil data gaps were filled to remove uncertainty in source zone areas; in particular, the angled bores drilled underneath the Gasholders removed substantial uncertainty in these source areas.

Additional significant findings relative to Site contamination included:

- The depth of construction of the Northern Gasholder being 6.0mbgl and the backfilled contents;
- The tarry material at the base of the Northern Gasholder;
- The depth and tarry contents of the Tar Wells;
- The extensive impact of free tar in natural soils in the area of the former gasworks;
- The extensive impact of soluble organic compounds (benzene and naphthalene) in deep shale fractures;
- The extensive network of underground pipes containing tarry residues;
- The relatively high ash/coke surface materials over the entire Site; and
- The relatively low impacts in natural soils in areas other than the former gasworks area.

***Decision 3: Do the findings of the investigation provide sufficient data that will enable an assessment of remedial screening options for contaminated soils and fills requiring management?***

The findings have obtained sufficient information to enable a robust assessment of appropriate remedial options. The findings included pertinent information for the screening to be diligent, which included:

- Identification of different material types;
- Better understanding of geological and hydrogeological conditions;
- Better understanding of extent of depth of contamination impact;
- Contaminant concentrations; and
- Acidic and neutral leaching characteristics.

The screening of applicable remedial options identified a number of options that have potential application at the Site. These are outlined in **Section 13.3.**

***Decision 4: Is there sufficient and definitive Site data to enable remedial cost estimates to be developed?***

The findings of the Delineation Investigation provide a high level of understanding of contaminant distribution, both laterally and vertically, and of subsurface conditions, particularly subsurface structures and contents remaining at the Site. This enabled relatively sound remedial volumes to be estimated based on information obtained for:

- source materials;

- free tar impacted materials; and
- other material types.

The information obtained from this investigation for volume estimates can be used to develop remedial cost estimates for separate reporting to RailCorp.

## 14.2 Remediation Requirements and Recommendations

The investigation has identified the following as contamination sources:

- the Tar Wells;
- the network of underground pipework;
- the base annulus of the Northern Gasholder;
- the tar in soil pores and soil fractures;
- the base annulus of the Southern Gasholder (although not a major source, this area should be identified as a secondary source);
- the demolition wastes containing asbestos sheeting; and
- Ash and coke fill materials across the majority of the Site in the surface and shallow subsurface layers.

The investigation has identified the following exposure scenarios:

- Construction/maintenance/long term RailCorp employees and contractors may be exposed to impacted soil (including dusts), water and vapours;
- Employees and residents of surrounding properties may be exposed to impacted dusts, water and vapours;
- Users of extracted groundwater down gradient of the Site may be exposed to impacted waters;
- Hypogean ecosystems may be exposed to impacted waters; and
- Receiving waters ecosystem (Alexandra Canal) may be exposed to impacted waters.

The investigation has identified the following available remedial options for site remediation:

- No Action;
- Institutional Controls including a Site Management Plan (SMP) and site access restrictions;
- Insitu Physical/Chemical Treatment including chemical oxidation and soil vapour extraction;
- Insitu Thermal Treatment;
- Exsitu Biological Treatment including biopiles, composting and landfarming;
- Exsitu Physical/Chemical Treament including solidification/ stabilisation/ immobilisation and chemical extraction;

- Exsitu Thermal Treatment including incineration/co-burning and thermal desorption;
- Containment including capping and containment;
- Off site Disposal; and
- Reuse and Recycle.

The investigation has identified that remediation of the contamination sources will adequately reduce the risks associated with this Site by:

- Preventing leaching and inturn controlling/minimising ongoing groundwater contamination;
- Controlling the generation of vapours from impacted soils;
- Controlling the generation of vapours from impacted groundwater;
- Preventing exposure of onsite workers to impacted soils and vapours;
- Preventing exposure of employees and residents of adjoining properties to impacted dusts and vapours; and
- Improving the groundwater quality migrating from the Site and inturn controlling exposure of users of extracted groundwater down gradient of the Site, controlling exposure of hypogean ecosytems to toxic groundwater and controlling exposure of receiving waters to poor quality groundwater.

To assess the effectiveness of site remediation in reducing these risks, ongoing groundwater monitoring will be required, utilising the network of monitoring wells already established on and off site, or new wells installed post remediation to monitor site boundary conditions. Ongoing groundwater monitoring will monitor the status of natural attentuation (monitored natural attenuation – MNA) of the contamination plume on and off site in both the shallow groundwater and deeper bedrock groundwater systems.

CH2M HILL recommend that RailCorp proceed with a Remedial Action Plan (RAP) to enable a full assessment of the remedial requirements of the Site, based on the findings of this investiagtion.

# 15 References


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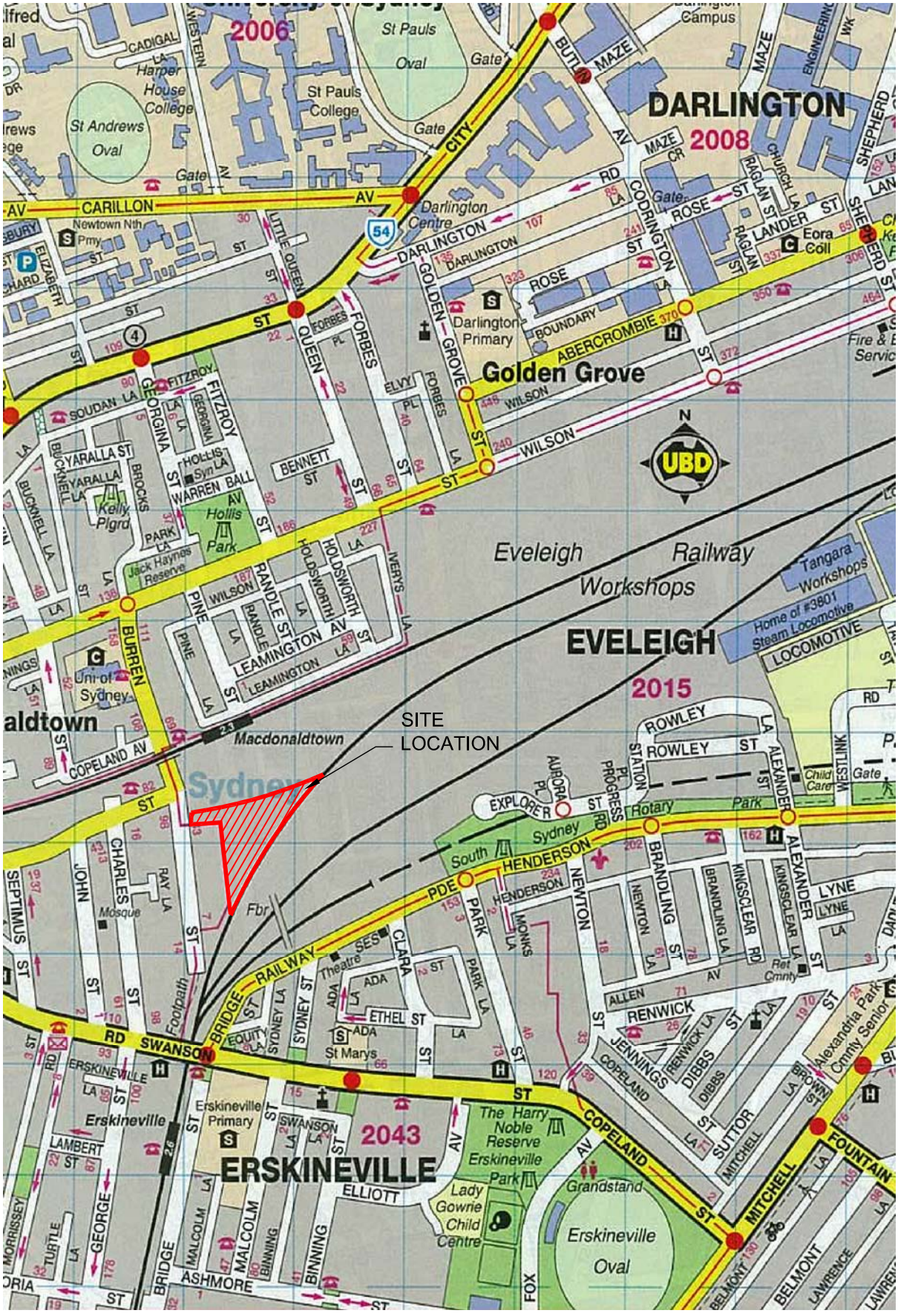
# Figures




SOURCE WITH PERMISSION: 2006 UBD SYDNEY STREET DIRECTORY (42nd EDITION)

**Figure 1**
**Site Location**

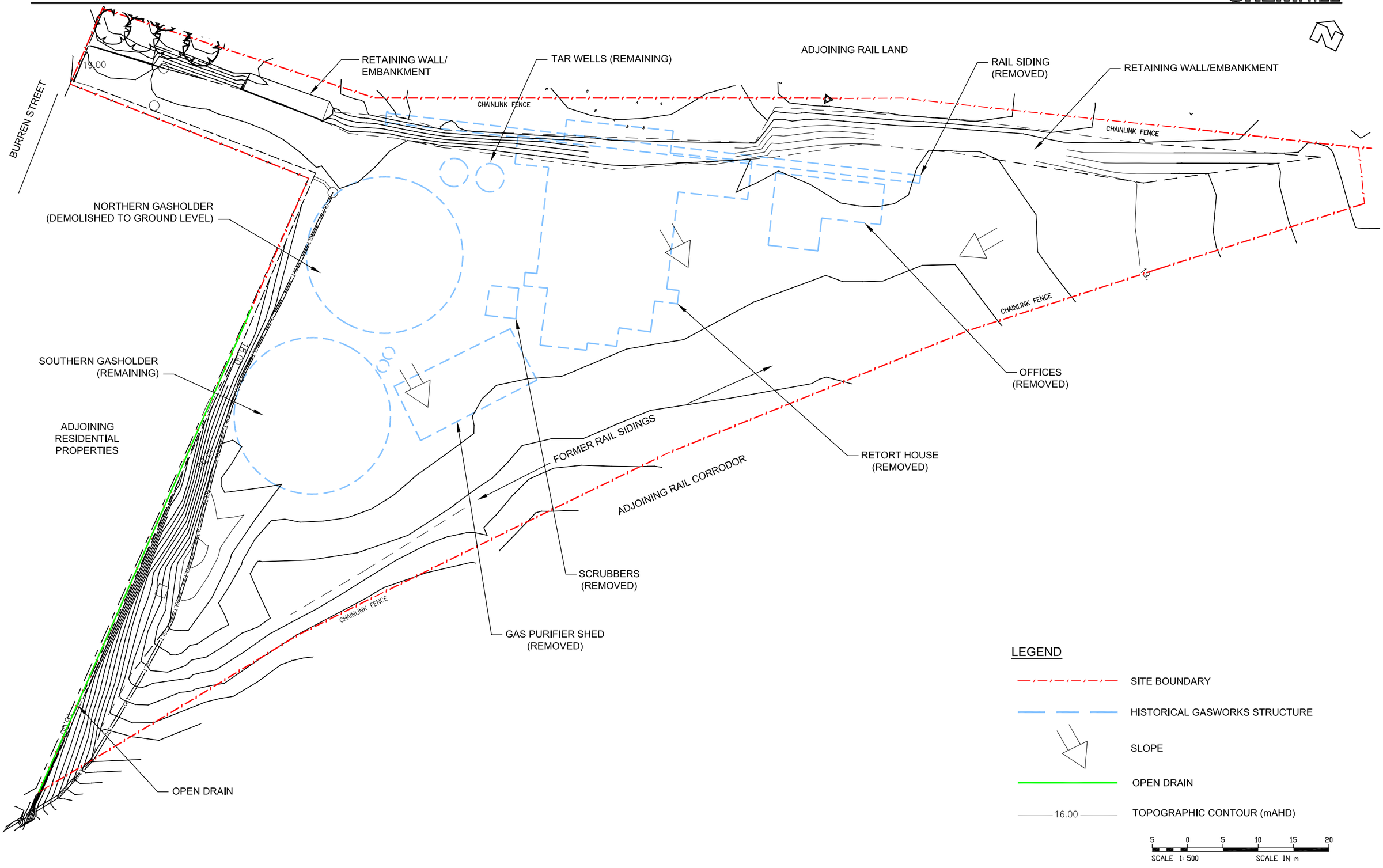
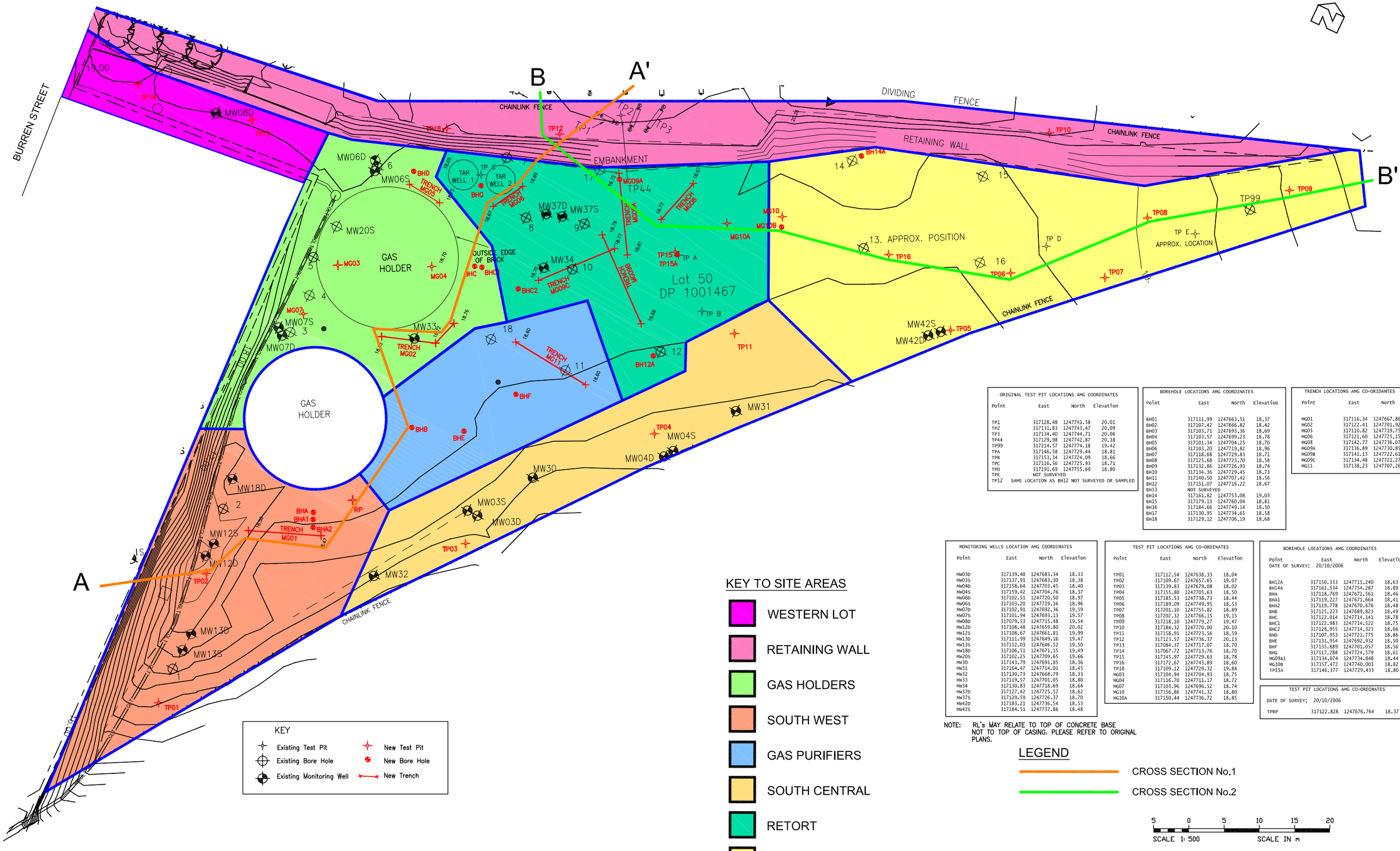



**Figure 2**
**Current & Historical Site Layout**




KEY

| | |
|---|---|
| Existing Test Pit | New Test Pit |
| Existing Bore Hole | New Bore Hole |
| Existing Monitoring Well | New Trench |

## KEY TO SITE AREAS

- WESTERN LOT
- RETAINING WALL
- GAS HOLDERS
- SOUTH WEST
- GAS PURIFIERS
- SOUTH CENTRAL
- RETORT
- NORTH WEST

ORIGINAL TEST PIT LOCATIONS AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| TP1 | 317128.48 | 1247741.58 | 20.01 |
| TP2 | 317131.83 | 1247743.47 | 20.09 |
| TP3 | 317134.40 | 1247744.71 | 20.06 |
| TP44 | 317129.98 | 1247742.87 | 20.18 |
| TP99 | 317214.57 | 1247774.18 | 19.42 |
| TPA | 317146.58 | 1247729.44 | 18.81 |
| TPB | 317153.34 | 1247724.09 | 18.66 |
| TPC | 317116.56 | 1247725.93 | 18.71 |
| TPD | 317191.69 | 1247755.69 | 18.80 |
| TPE | NOT SURVEYED | | |
| TP12 | SAME LOCATION AS BH12 NOT SURVEYED OR SAMPLED | | |

BOREHOLE LOCATIONS AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| BH01 | 317111.99 | 1247663.51 | 18.37 |
| BH02 | 317107.42 | 1247666.82 | 18.42 |
| BH03 | 317103.71 | 1247693.36 | 18.69 |
| BH04 | 317103.57 | 1247699.23 | 18.78 |
| BH05 | 317101.34 | 1247704.25 | 18.70 |
| BH06 | 317103.20 | 1247719.82 | 18.96 |
| BH07 | 317118.68 | 1247729.83 | 18.71 |
| BH08 | 317125.68 | 1247723.70 | 18.58 |
| BH09 | 317132.86 | 1247726.93 | 18.74 |
| BH10 | 317134.36 | 1247729.45 | 18.73 |
| BH11 | 317140.50 | 1247707.42 | 18.56 |
| BH12 | 317151.07 | 1247716.22 | 18.67 |
| BH13 | NOT SURVEYED | | |
| BH14 | 317161.82 | 1247753.08 | 19.03 |
| BH15 | 317179.13 | 1247760.04 | 18.81 |
| BH16 | 317184.66 | 1247749.14 | 18.50 |
| BH17 | 317130.95 | 1247734.65 | 18.58 |
| BH18 | 317129.12 | 1247706.19 | 18.68 |

TRENCH LOCATIONS AMG CO-ORIDANTES

| Point | East | North |
|---|---|---|
| MG01 | 317116.34 | 1247667.86 |
| MG02 | 317122.41 | 1247701.92 |
| MG05 | 317110.82 | 1247719.75 |
| MG06 | 317121.60 | 1247725.15 |
| MG08 | 317142.77 | 1247736.07 |
| MG09A | 317136.89 | 1247730.85 |
| MG09B | 317141.13 | 1247722.61 |
| MG09C | 317134.48 | 1247721.27 |
| MG11 | 317138.23 | 1247707.26 |

MONITORING WELLS LOCATION AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| MW03D | 317139.48 | 1247683.34 | 18.33 |
| MW03S | 317137.91 | 1247683.30 | 18.38 |
| MW04D | 317158.64 | 1247703.45 | 18.40 |
| MW04S | 317159.42 | 1247704.76 | 18.37 |
| MW06D | 317102.51 | 1247720.50 | 18.97 |
| MW06S | 317103.20 | 1247719.16 | 18.96 |
| MW07D | 317102.91 | 1247692.36 | 19.59 |
| MW07S | 317101.94 | 1247693.13 | 19.57 |
| MW08D | 317079.53 | 1247715.48 | 19.54 |
| MW12D | 317108.48 | 1247659.80 | 20.02 |
| MW12S | 317108.67 | 1247661.81 | 19.99 |
| MW13D | 317111.99 | 1247649.16 | 19.47 |
| MW13S | 317112.03 | 1247646.52 | 19.50 |
| MW18D | 317106.51 | 1247671.15 | 19.49 |
| MW20S | 317102.25 | 1247709.65 | 19.66 |
| MW30 | 317143.79 | 1247691.85 | 18.36 |
| MW31 | 317164.47 | 1247714.01 | 18.45 |
| MW32 | 317130.73 | 1247668.79 | 18.33 |
| MW33 | 317119.57 | 1247701.05 | 18.80 |
| MW34 | 317130.83 | 1247718.69 | 18.64 |
| MW37D | 317127.42 | 1247725.52 | 18.62 |
| MW37S | 317129.59 | 1247726.37 | 18.70 |
| MW42D | 317183.21 | 1247736.54 | 18.53 |
| MW42S | 317184.51 | 1247737.86 | 18.48 |

TEST PIT LOCATIONS AMG CO-ORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| TP01 | 317112.54 | 1247638.33 | 18.04 |
| TP02 | 317109.67 | 1247657.65 | 19.07 |
| TP03 | 317139.83 | 1247679.08 | 18.02 |
| TP04 | 317155.80 | 1247705.63 | 18.50 |
| TP05 | 317185.53 | 1247738.73 | 18.44 |
| TP06 | 317189.09 | 1247749.95 | 18.53 |
| TP07 | 317201.10 | 1247755.82 | 18.89 |
| TP08 | 317202.32 | 1247766.15 | 19.15 |
| TP09 | 317218.10 | 1247779.27 | 19.47 |
| TP10 | 317184.32 | 1247770.00 | 20.10 |
| TP11 | 317158.91 | 1247723.56 | 18.59 |
| TP12 | 317123.57 | 1247736.37 | 20.13 |
| TP13 | 317084.37 | 1247717.07 | 18.70 |
| TP14 | 317067.72 | 1247713.76 | 18.70 |
| TP15 | 317145.97 | 1247729.63 | 18.78 |
| TP16 | 317172.67 | 1247743.89 | 18.60 |
| TP18 | 317109.12 | 1247729.32 | 19.84 |
| MG03 | 317104.94 | 1247704.93 | 18.75 |
| MG04 | 317116.70 | 1247711.17 | 18.72 |
| MG07 | 317103.96 | 1247696.52 | 18.74 |
| MG10 | 317156.86 | 1247741.32 | 18.80 |
| MG10A | 317150.44 | 1247736.72 | 18.85 |

BOREHOLE LOCATIONS AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| DATE OF SURVEY: 20/10/2006 | | | |
| BH12A | 317150.333 | 1247715.240 | 18.63 |
| BH14A | 317162.534 | 1247754.287 | 18.89 |
| BHA | 317118.769 | 1247672.561 | 18.46 |
| BHA1 | 317119.227 | 1247671.664 | 18.41 |
| BHA2 | 317119.778 | 1247670.676 | 18.48 |
| BHB | 317125.223 | 1247689.823 | 18.49 |
| BHC | 317122.014 | 1247714.141 | 18.78 |
| BHC1 | 317122.083 | 1247714.522 | 18.75 |
| BHC2 | 317128.955 | 1247714.323 | 18.66 |
| BHD | 317107.953 | 1247721.775 | 18.86 |
| BHE | 317131.954 | 1247692.932 | 18.50 |
| BHF | 317135.889 | 1247701.057 | 18.56 |
| BHG | 317117.288 | 1247724.579 | 18.61 |
| MG09A1 | 317134.074 | 1247734.848 | 18.44 |
| MG10B | 317157.472 | 1247740.001 | 18.82 |
| TP15A | 317146.377 | 1247729.433 | 18.80 |

TEST PIT LOCATIONS AMG CO-ORDINATES

| | | | |
|---|---|---|---|
| DATE OF SURVEY: 20/10/2006 | | | |
| TPRP | 317122.828 | 1247676.764 | 18.37 |

NOTE: RL's MAY RELATE TO TOP OF CONCRETE BASE NOT TO TOP OF CASING. PLEASE REFER TO ORIGINAL PLANS.

LEGEND

- CROSS SECTION No.1
- CROSS SECTION No.2

5 0 5 10 15 20

SCALE 1: 500 SCALE IN m

**Figure 3**
**Stratified Site Areas, Sampling Locations & Cross Section Transects**

| BHG | |
|---|---|
| mbgl | Bz |
| 6.00 | 2.4 |

| BH06 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 0.30 | 190.0 | 2,374.0 | 20,000.0 |
| 0.40 | 30.0 | 137.3 | - |

| TP44 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | Bz |
| 0.30 | 150.0 | 2,472.4 | 15.0 |

| MG09A1 | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Bz |
| 0.70 | 8.2 | 416.60 | 3,520.0 | 1.7 |

| MG10A | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Xy |
| 0.70 | 339 | 4,758.2 | 234,950.0 | - |
| 2.80 | 6.3 | 206.9 | 4,070.0 | 1.1 |

| TP14 | | |
|---|---|---|
| mbgl | BaP | C10 - C36 |
| 0.25 | 7.4 | 3,500.0 |

| TPC | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | Xy | |
| 1.00 | 8.4 | 750.6 | 48.0 | |

| TP1 | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | |
| 0.30 | 67.0 | 898.1 | 9,390.0 | |

| TP3 | | | | | |
|---|---|---|---|---|---|
| mbgl | C6-C9 | C10-C36 | Bz | Xy | |
| 0.30 | 150.0 | 1,100.0 | 3.2 | 1.7 | |

| MG10 | |
|---|---|
| mbgl | C10 - C36 |
| 0.20 | 1,940.0 |

| BH14 | | | |
|---|---|---|---|
| mbgl | BaP | Bz | Xy |
| 0-0.1 | 5.0 | - | - |
| 0.9-1.0 | nd | 4.6 | 48.0 |

| BH07 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 0.10 | 200.0 | 2,078.0 | 14,400.0 |
| 1.50 | 26.0 | 1,144.8 | - |

| MG06 | | |
|---|---|---|
| mbgl | PAH | C10 - C36 |
| 1.00 | 135.5 | 1,370.0 |
| 2.00 | 103.5 | 1,700.0 |

| BH08 | |
|---|---|
| mbgl | BaP |
| 1.10 | 8.4 |
| 1.70 | 5.4 |

| MG08 | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 |
| 1.50 | 444 | 15,237.6 | - | 435,100.0 |
| 2.10 | 6.9 | 321.2 | 97 | 2,790.0 |

| TP12 | | | | |
|---|---|---|---|---|
| mbgl | BaP | PAH | C10 - C36 | ACM |
| 0.25 | 9.6 | 117.4 | 2,320.0 | fragment |

| TPA | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6-C9 | C10-C36 | Bz | Xy |
| 1.60 | 8.4 | 536.9 | 100.0 | 3,200.0 | 1.6 | 65.0 |

| BH13 | | | | | |
|---|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Bz | |
| 0.30 | 39.0 | 413.2 | 7,100.0 | 1.6 | |

| BH15 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 0-0.1 | 16.0 | - | - |
| 0.2-0.3 | 58.0 | 377.8 | 4,390.0 |

| BHD | |
|---|---|
| mbgl | Bz |
| 7.00 | 5.4 |
| 8.40 | 7.5 |

| TP13 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10 - C36 |
| 0.25 | 45.5 | 512 | 8,870.0 |

| MG04 | | | | | |
|---|---|---|---|---|---|
| mbgl | BaP | Pb | C10-C36 | ACM | |
| 0.50 | 6 | 2,140.00 | 1,860.00 | - | |
| 1.50 | - | - | - | fragment | |

| MW20S | |
|---|---|
| mbgl | BaP |
| 0.30 | 6.1 |

| MG03 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10 - C36 |
| 0.10 | 10.4 | 115.3 | 2,750.0 |

| MG02 | | | | | | | |
|---|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 | Bz | Xy | |
| 0.20 | - | 149.5 | 72 | - | 4.2 | 29.6 | |
| 1.80 | 178 | 5,301.9 | 189 | 36,140.0 | 3 | 165.8 | |

| MW33 | |
|---|---|
| mbgl | C16-C35 (aromatic) |
| 0.95 | 2,124.0 |

| BH04 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 0.80 | 140.0 | 1,697.0 | 12,100.0 |

| BH03 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 0.10 | 27.0 | 294.8 | 5,020.0 |

| MG05 | | | | |
|---|---|---|---|---|
| mbgl | PAH | C6 - C9 | C10 - C36 | Xy |
| 0.50 | - | - | 13,340.0 | - |
| 1.80 | 289 | 118 | 3,140.0 | 80.4 |
| 5.00 | - | 92 | 1,420.0 | 35.0 |

| BHA1 | |
|---|---|
| mbgl | Bz |
| 7.00 | 1.6 |
| 10.20 | 1.4 |

| BH02 | | |
|---|---|---|
| mbgl | BaP | PAH |
| 0.10 | 14.0 | 141.8 |
| 0.30 | 35.00 | 203.4 |

| MW12D | |
|---|---|
| mbgl | BaP |
| 1.50 | 7.7 |

| MG01 | |
|---|---|
| mbgl | ACM |
| 0.20 | Fragment |

| MG11 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10 - C36 |
| 0.20 | 42 | 696.6 | 6,210.0 |
| 2.00 | 48.8 | 728.8 | 7,750.0 |

| BH18 | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Bz | Ebz | Xy |
| 0.30 | 220.0 | 3,953.0 | 38,400.0 | - | - | |
| 1.80 | 28.0 | 2,160.8 | - | 7.0 | 80.0 | 210.0 |

| BHF | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10 - C36 |
| 1.00 | 6.4 | - | 1,150.0 |
| 8.50 | - | 134.6 | 1,260.0 |

| BHB | |
|---|---|
| mbgl | BaP |
| 6.00 | 2 |

| BHE | | |
|---|---|---|
| mbgl | C6 - C9 | Bz |
| 2.20 | 155 | - |
| 8.40 | - | 1.6 |

| BHC | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 | Bz | Xy |
| 6.00 | 17.6 | 1,906.4 | 559 | 8,760.0 | 6.4 | 246.7 |

| RP | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 2.00 | 12.8 | 118.2 | 1,730.0 |

| VP01 | | | | | |
|---|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Pb | |
| Surface | 5.9 | - | - | - | |
| | 10.0 | 137.7 | 1,685.0 | - | |
| | 7.1 | 104.3 | 1,995.0 | - | |
| | 15.0 | 219.4 | 2055.0 | - | |
| | - | - | 1725.0 | - | |
| | 10.0 | 134.1 | 3125.0 | 2140.0 | |

| MW13S | | | |
|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 |
| 1.00 | 34.9 | 346.0 | 6,444.0 |

| VP02 | | | | | |
|---|---|---|---|---|---|
| mbgl | BaP | PAH | C10-C36 | Pb | |
| Surface | - | - | 1,245.0 | - | |
| | 12.0 | 258.3 | 2,625.0 | 1,510.0 | |
| | 12.0 | 236.6 | 2,525.0 | - | |

| MG09B | | |
|---|---|---|
| mbgl | C10 - C36 | ACM |
| 0.30 | 20,700.0 | fragment |

| BH10 | | |
|---|---|---|
| mbgl | BaP | PAH |
| 0.10 | 11.0 | 112.0 |

| TP11 | | |
|---|---|---|
| mbgl | BaP | C10 - C36 |
| 0.20 | 6.2 | 1,410.0 |

| BH12 | | | |
|---|---|---|---|
| mbgl | BaP | PAH | Bz |
| 0.10 | 5.8 | - | - |
| 4.50 | 8.4 | 224.4 | 1.0 |

| BH12A | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 | Bz | Xy |
| 4.20 | 13.9 | 515.6 | 228 | 5,350.0 | 20 | 94.9 |

| MG09C | | |
|---|---|---|
| mbgl | BaP | C10 - C36 |
| 0.30 | 5 | 1,200.0 |

| MW04S | |
|---|---|
| mbgl | Bz |
| 2.10 | 4.0 |

| TPD | |
|---|---|
| mbgl | BaP |
| 0.20 | 6.2 |

| TP09 | |
|---|---|
| mbgl | BaP |
| 0.50 | 5.4 |

| TP06 | | |
|---|---|---|
| mbgl | BaP | PAH |
| 0.25 | 55 | 690.2 |

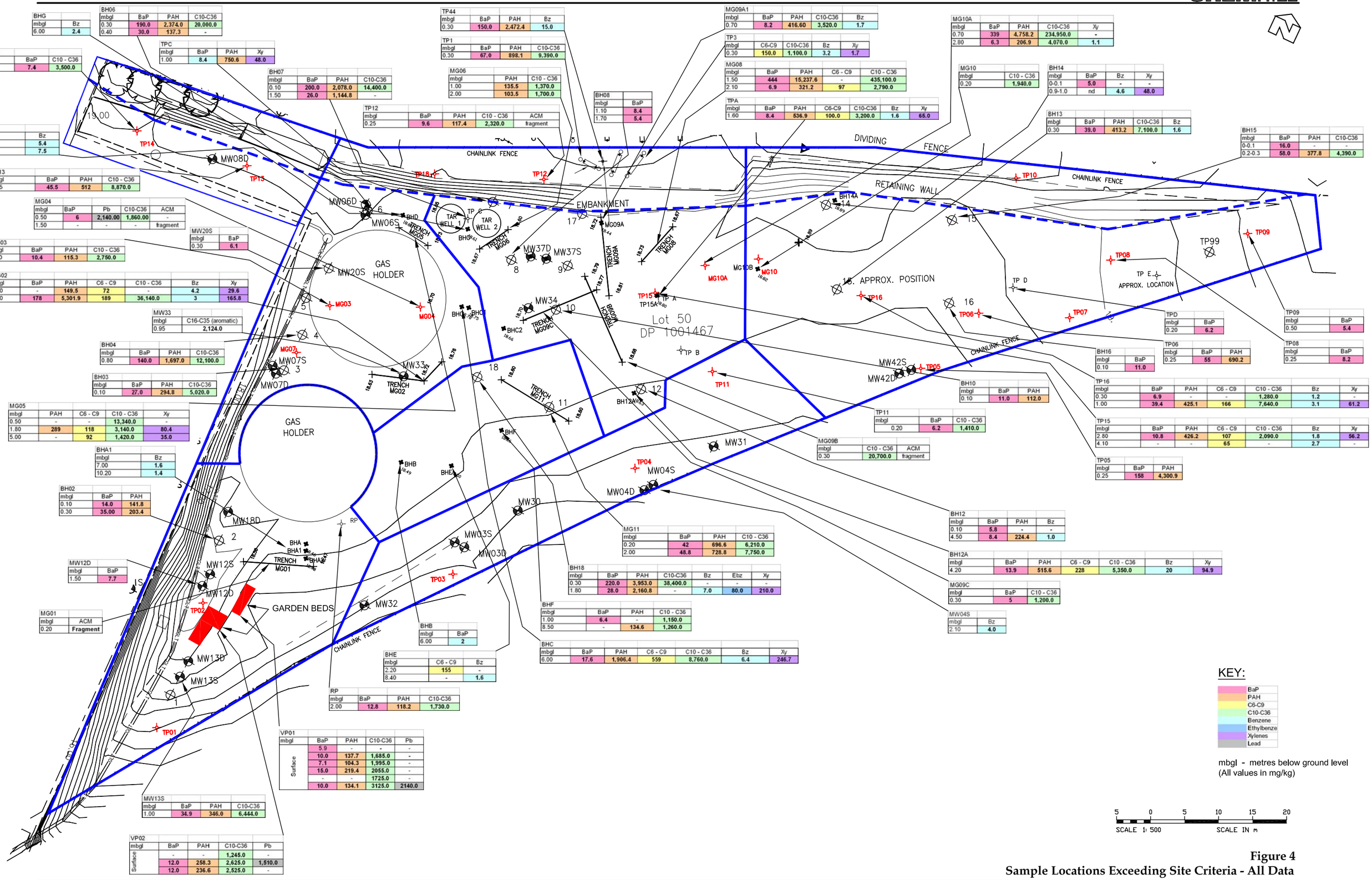
| TP08 | |
|---|---|
| mbgl | BaP |
| 0.25 | 8.2 |

| BH16 | |
|---|---|
| mbgl | BaP |
| 0.10 | 11.0 |

| TP16 | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 | Bz | Xy |
| 0.30 | 6.9 | - | - | 1,280.0 | 1.2 | - |
| 1.00 | 39.4 | 425.1 | 166 | 7,640.0 | 3.1 | 61.2 |

| TP15 | | | | | | |
|---|---|---|---|---|---|---|
| mbgl | BaP | PAH | C6 - C9 | C10 - C36 | Bz | Xy |
| 2.80 | 10.8 | 426.2 | 107 | 2,090.0 | 1.8 | 56.2 |
| 4.10 | - | - | 65 | - | 2.7 | - |

| TP05 | | |
|---|---|---|
| mbgl | BaP | PAH |
| 0.25 | 158 | 4,300.9 |




KEY:

- BaP
- PAH
- C6-C9
- C10-C36
- Benzene
- Ethylbenze
- Xylenes
- Lead

mbgl - metres below ground level
(All values in mg/kg)

SCALE 1: 500 — SCALE IN m (5 0 5 10 15 20)

**Figure 4**
**Sample Locations Exceeding Site Criteria - All Data**