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Report on
Vapour Mitigation System Environmental Management Plan

Glenrose Village
Glen Street, Belrose

Prepared for
ADCO Constructions Pty Ltd

Project 73579.01
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Report on Vapour Mitigation System Environmental Management Plan
Glenrose Village
Glen Street, Belrose

1. Introduction

This report presents the Vapour Mitigation System (VMS) Environmental Management Plan (EMP) for the Glenrose Village at Glen Street, Belrose (the Site). The assessment was commissioned by Mr Simon Rischmiller of ADCO Constructions Pty Ltd and was undertaken in accordance with Douglas Partners' (DP) proposal dated 7 April 2014 (Proposal 140365).

The report has been prepared per the requirements of *Report on Vapour Mitigation System, Glenrose Shopping Centre, Glen Street, Belrose* prepared for Fabcot Pty Ltd, DP Project 73579.00 dated 22 July 2015 (DP 2015).

2. Site Description and Background

The Site is generally rectangular in shape, bounded by Glen Street to the South and Glenrose Place to the West. The Site is currently identified as 56-58 Glen Street, Belrose (Lot 4 DP 548285 and Lot 104 DP 597544), in the Parish of Manly Cove and County of Cumberland. The Site covers an approximate area of 23,145 m² (2.31 ha). The local government authority is Northern Beaches Council.

A Site location and layout plan is presented in Drawings 1, 2 and 3 Appendix A. Glenrose Village was redeveloped in 2015-2017. The redeveloped shopping centre comprises a basement level that is occupied by staff parking, facilities and an OSD tank, a semi-basement car parking level which is occupied by a storage area for multiple tenants (originally proposed as an office for the Woolworths store) and a car park and a ground level shopping centre complex. To the north of the property are residential properties and a tennis club. The retail level design is presented in Drawing 3, Appendix A.

A number of (rounds of) investigations have previously been undertaken at the Site by DP. During the previous investigations tetrachloroethene (PCE) was identified as being the primary contaminant of concern in groundwater and soil vapour. The historic maximum concentrations of the primary contaminant PCE, detected in groundwater and sub-slab vapour at the site for were 130,000 µg/L and 230,000 µg/m^3 respectively.

A vapour management system was incorporated into the car park level during the site redevelopment works (refer to design drawing in Appendix A and As Built Drawings in Appendix B).

3. EMP Management

3.1 Centre Management Responsibilities

The Operations Manager on behalf of Centre Management is responsible for the implementation of this EMP.

To allow for an ongoing knowledge and familiarity with the system by Centre Management, the Operations Manager and at least one other staff member (e.g. the Operations Assistant, the Centre Manager) is to be inducted into this EMP. Inductions are to be recorded.

Where the Operations Manager moves on for any reason, prior to his/her departure a comprehensive induction of this EMP for the new Operations Manager is to be undertaken. Furthermore, in the absence of the Operations Manager (e.g. on leave), it is the responsibility of the Centre Manager to assume the Operations Manager's responsibilities and ensure that the EMP is being appropriately implemented.

The Centre Manager is to be provided with an update (verbal and written) by the Operations Manager on issues relating to this EMP every three months. The update should summarise any issues of concern, works that have been/are being undertaken and any recommendations for additional works to be implemented or under consideration by Management.

As part of his/her responsibilities, the Operations Manager is to be aware:

- Of any changing circumstances that could impact upon the effectiveness of the system(s). These may not necessarily be identified by the routine;
- Of the conditions that existed at the time the systems were installed, why the systems were installed, how the systems function and what the objectives of the systems are;
- Intrusive works require a specific work plan to be prepared by a consultant and endorsed by a Site Auditor accredited under the NSW *Contaminated Land Management Act 1997*, as per Section 6;
- Any deficiencies, inconsistencies, errors etc. identified within the EMP should be addressed;
- Any changes to external factors that could impact upon the effectiveness of a system. For example, subsurface works were undertaken by others; drainage/sewer works undertaken by others; and
- Understand this EMP and all that it entails.

3.2 Review and Site Audit Report

Every 12 months the implementation and management of the EMP is to be subject to an independent review by the Site Auditor (up to the completion of the proposed 3 year monitoring period – refer to Section 5). An independent auditor should be appointed by the Centre Management. The auditor should be experienced in ground gas issues.

The auditor is to review the operation of the EMP. The review is to include, as a minimum:

- Inspection of all monitoring records;
- Inspection of all other operational records / documentation required by the EMP;
- Interviews with the Operations Manager and any other staff routinely responsible for operation of the EMP; and
- Site visits to observe monitoring and inspection of key components of the VMS.

At the completion of the three year monitoring programme (refer to Section 5) a Section A Site Audit Report should be prepared by the Site Auditor (if appropriate).

3.3 EMP Review

Any alterations or revisions to the EMP requirements **must** be conducted by a suitably qualified consultant experienced in ground gas issues and independently endorsed by a Site Auditor accredited under the NSW *Contaminated Land Management Act 1997*.

3.4 Documentation

Each maintenance/service action and monitoring event must be recorded. The date, time and description of the works undertaken are to be recorded on a site works sheet and on completion signed by the contractor and counter-signed by the Operations Manager. Any follow up works should also be recorded. Additionally, an Environmental Site Inspection Sheet (ESIS) must be signed by the person undertaking the work (e.g. contractor, staff member), countersigned by the Operations Manager and filed. An example of an ESIS is provided in Appendix C.

This documentation and the bi-annual monitoring reports (as discussed in Section 6) are to be kept with a copy of the EMP.

4. VMS Design Summary

The soil vapour mitigation system for Glenrose Village is based on a combination of the following features which DP considered to be appropriate to mitigate against the potential build-up of soil vapours (VOCs) within the building as per the design objectives in the VMS design report (DP 2015). It is noted that each of the proposed systems adopts a minimum of two safety features (i.e. levels of protection, NSW EPA 2012 *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*). The components of the VMS included the following:

- A 200 mm thick post-tensioned suspended concrete slab;
- A vapour membrane/barrier comprising a Liquid Boot Plus System (VI 20 sheets and Liquid Boot Layer); and
- Passive ventilation of the area below the newly constructed slabs.

The Design features are shown in the following design drawings in Appendix A.

Drawing 1: Carpark Level Pipe Network and Riser Location;

Drawing 2: Basement Pipe Network and Riser Locations;

Drawing 3: Retail Level

Drawing 4: Revised Inlet Design

Drawing 5 Cross Section – Carpark Level

Drawing 6: Design Features – Membrane

Drawing 7: Design Features – Membrane

Drawing 8: Penetrations

More detail on the design features of the VMS are provided in the following sub-sections.

4.1 Concrete Slab

The concrete slab over the VMS is a reinforced 200 mm thick concrete slab which was constructed over the over the membrane in the basement level and ground floor levels in the areas indicated on Drawings 1 and 2, Appendix A. All penetrations were be cast-in during construction or sealed around with the Liquid Boot membrane, post-construction.

The penetrations of the slab were sealed using EmerSeal.

4.2 Membrane

The second form of independent protection is composition membrane comprising a Liquid Boot Plus system which is comprised of the Cetco VI-20™ geomembrane (VI-20) which is a 0.5 mm thick high performance polyethylene-EVOH copolymer geomembrane, in conjunction with a 1.5 mm Cetco Liquid Boot layer (the product information sheet for the VI-20 is provided in Appendix D).

A 2 mm Liquid Boot membrane will be used in place of the Liquid Boot Plus system as required only where it is not practical to install the Liquid Boot Plus.

The membrane was installed over a 300 GSM geofabric. Details 6a and 6b on Drawing 6 present a section of the Liquid Boot Plus and Liquid Boot membranes respectively.

The Liquid Boot Plus System is constructed with a VI-20™ geomembrane that is rolled out on with overlapping seams a minimum of six inches (6”) or 150 mm. The geomembrane is cut around penetrations so that it lays flat on the sub-grade and tight at all inside corners. Penetrations (services, footings, inspection/sampling points) are then treated with VI-20™ Detailing Fabric prior to the application of the 1.5 mm Liquid Boot ® layer, at least 150 mm around the penetration and 150 mm up the penetration. A 1.5 mm thick Liquid Boot Layer is then applied across the entire VI-20 membrane to complete the Liquid Boot Plus System. In areas where significant intrusions a 2 mm Liquid Boot ® membrane was be used in place of Liquid Boot Plus system.

A second geotextile (a 300 GSM geotextile) was placed over the membrane as a further protective measure during construction of the concrete slab.

4.3 Gravel Blanket and Ventilation Pipe

The passively vented gravel blanket comprises a 300 mm thick gravel blanket with a series of 150 mm diameter slotted pipes at 3 m centres with alternating inlet and outlet lines within the areas indicated on Drawings 1 and 2, Appendix A.

The gravel blanket was installed over a 300 GSM geofabric to minimise the potential for fines to infiltrate the gravel blanket from the underlying fill. Edges of each geofabric rolls have a minimum 150 mm overlap with the adjacent

The gravel to be used was 63 mm (maximum size) crushed stone with the detailed specification of the gravel provided in DP (2015). The pipe network design was as follows:

- The network has a pipe spacing of approximately 3 m within the footprint of the VMS (refer to the as-built drawings in Appendix B);
- The pipes were constructed of 150 mm diameter PVC;
- The pipes are alternative inlet and outlet lines (refer to Drawings 1 and 2, Appendix A). The outlet lines were slotted/perforated pipe with a minimum 10% open area and the end of each pipe, which terminates within the gravel blanket (i.e. non-riser locations), was capped. The outlet lines were connected to a common manifold (solid pipe) which will be connected to the riser pipes (R1 to R4);
- The pipes were be solid pipes then slotted to the points indicated on Drawings 1 and 2, Appendix A. The open area in the slotted section of the pipes will be 10%. The inlet lines are connected to a common manifold (solid pipe, but separate to the outlet lines) which is connected to the inlet points (I1 to I5); and
- Additionally, all solid pipes have a minimum 1% gradient fall towards the slotted pipes to mitigate against blockage of the solid pipe from a build-up of condensate. Condensate in this instance would flow towards the perforated pipe and into the surrounding gravel blanket;

The installed pipe network is presented in the as-built drawings in Appendix B.

4.4 Risers, Rotating Cowls and Inlets

The riser pipes were extended to the full height of the roof and fitted with a rotating cowl. An air tight sampling and inspection point was installed in each riser at a height of 1.5 m from the ground level. The riser pipes were 150 mm PVC. The rotating cowls Edmunds, Hurricane Wind Ventilators, model H150 which each have a flow capacity of 93 m^3/hour.

The inlet points (I1 to I5), were constructed of 150 mm PVC blank pipe connected by a inlet pipe manifold system to common inlet points that were extended to a height of 0.3 m above the ground level with a 90 degree bend at the end to prevent rain from entering the system. The Inlets were finished at the ground inside of a 900mm diameter concrete lamp post bases. It is noted that the inlet

at I6 was constructed on 150 PVC pipe finished with at a height of 1.2 m above the ground level and a whirly bird was installed at the top of the pipe (no lamp post base was fitted over the PVC). The whirly bird was fixed in place to prevent rotation but provide protection from the weather.

4.5 Sampling Points

Each riser pipe (R1 to R4) was fitted with an air tight sealed inspection/sampling point to allow vapour samples to be collected and air flow rates to be measured for QA purposes. The sampling and inspection points were installed in the riser pipes to allow easy access (refer to Photo 1 and Drawings 4 and 5, Appendix A).

Photograph 1: Example of Riser Inspection Point

Three sampling points (S1 to S3) were installed within the gravel blanket. The locations of the sampling points are presented in Drawings 1 and 2, Appendix A. The sampling points were fitted with air tight caps and gatic covers to allow access for sampling and inspections. The monitoring points should were constructed using 100 mm diameter Stormwater Drainage SCJ pipe (refer to Photos 2 and Figure 1).

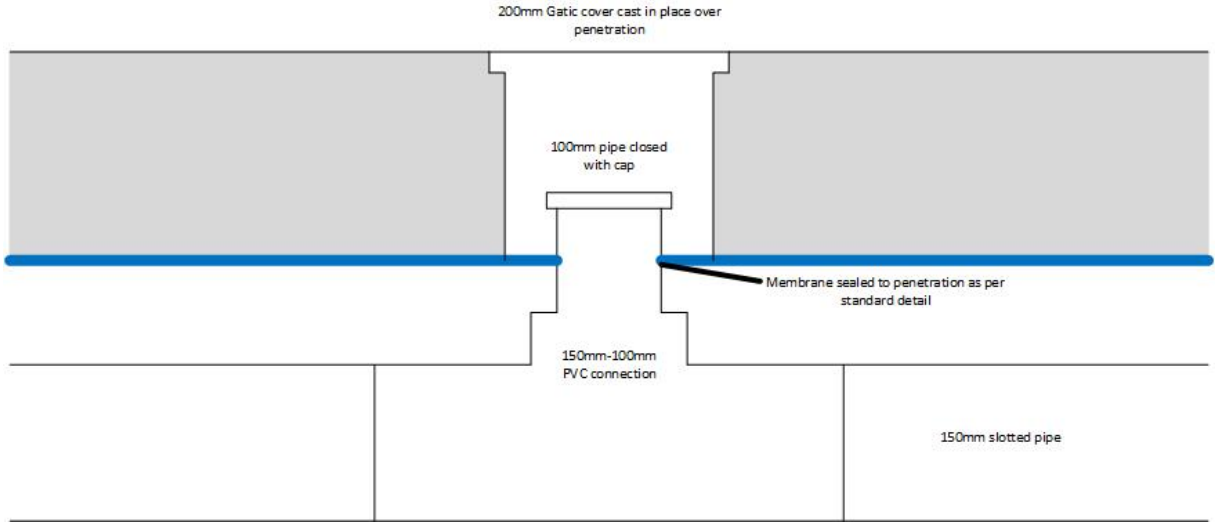


Figure 1: Inspection Point Detail

Photograph 2: Gravel Bed Inspection Point

5. Monitoring Programme

5.1 Testing Regime

A programme of vapour monitoring and indoor air monitoring will be undertaken on a bi-annual basis for a minimum period of three years from the commissioning of the VMS. The purpose of the monitoring programme is to ensure that the VMS is operating effectively and that the primary goal of preventing unacceptably high levels of PCE to enter the breathing environment is prevented.

The monitoring programme includes:

- Vapour level and flow rate monitoring in the gravel blankets at sampling points S1, S2 and S3;
- Vapour level and flow rate monitoring in the riser pipes R1, R2, R3 and R4 at the inspection points on the vertical pipes; and
- Indoor air monitoring in the basement (1 sample location), car park level (2 sample locations) and retail level (2 sample locations). The locations of the indoor air monitoring will be confirmed during the first round of testing in consultation with the Centre Manager.

The locations of the riser sampling points, the gravel sampling points and the indoor air sampling points are presented in Drawings 1, 2 and 3, Appendix A.

Vapour monitoring will be conducted for a period of at least three years at bi-annual intervals per the requirements of Table 1, below.

Table 1: Performance Monitoring

Sampling Point		Monitoring	Rationale
Gravel Blanket Monitoring Points 2 locations in Carpark level (Locations S2 and S3, Drawing 1, Appendix A) 1 location in basement level (Location S1, Drawing 2, Appendix A)		(a) Field Screening of VOC using an FID (b) VOC (TO15) laboratory Grab sample using a Summa Canister (c) Flow rate and general gases using a GA2000/5000 Landfill Gas Analyser	Determine vapour levels in gravel blanket, potential build-up of VOC and flow rates
Risers (at air tight inspection points)	R1 (P1) and R3 (P3)	(a) Field Screening of VOC using an FID (b) VOC (TO15) laboratory grab sample using a Summa Canister (c) Flow rate and general gases using a GA2000/5000 Landfill Gas Analyser	Determine vapour levels in Risers and compare to gravel blanket and flow rates.
	R2 (P2) and R4 (P4)	(a) Field Screening of VOC using an FID (b) Flow rate and general gases using a GA2000/5000 Landfill Gas Analyser	Determine vapour levels in Risers and compare to gravel blanket and flow rates.
Indoor Air Monitoring	Basement Level – 1 location (I1)	(a) Field screening of VOC using a FID (b) Laboratory analysis of VOC levels in Indoor Air using a Summa Canister over a 8 hour period 8	Determine levels of target VOC in indoor air
	Carpark Level – 2 locations. 1 location in Carpark (plant room) (I2) 1 Location in Storage Area (I3)		
	First Floor Retail – 2 locations 1 Location in Woolworths (14) 1 Location in Centre Management (I5)		

In addition to the above the meteorological conditions at the time of monitoring will be measured in the field and obtained from the Bureau of Meteorology. The monitoring programme may be subject to change following the initial monitoring rounds.

The monitoring rounds will be conducted in February and August during low wind conditions, specifically targeting winds speeds within the lowest 10th percentile (so far as is practical).

Bi-annual monitoring reports must be prepared by a suitably qualified environmental consultant and submitted to the Site Auditor for review. Copies of the monitoring reports must be held by the operations manager at the Site Office.

In the event that an exceedance of the indoor air monitoring screening levels occurs the initial response will be to conduct a supplementary round of indoor air monitoring to confirm the initial results.

5.2 Assessment Criteria for Monitoring

5.2.1 Gravel Blanket

The health-based investigation levels (HIL) for commercial sites provided in NEPC (2013) have been adopted as the initial investigation / screening levels for chlorinated hydrocarbons in soil vapour in the gravel blanket and riser pipes. Two sets of screening levels have been adopted. Criteria 1 are the standard Commercial / Industrial HIL in NEPC (2013) which adopts an indoor air attenuation factor of 0.1 which will be adopted in the event that there is known or suspected damage to the Liquid Boot Plus membrane or concrete slab. Criteria 2 will be adopted if the membrane and slab are intact. In this instance the criteria have been increased accordingly by a factor of 10 but still provide an adequate level of safety.

The screening levels for chlorinated hydrocarbons are presented in Table 2.

Table 2: Interim Soil Vapour Health Investigation Levels for Chlorinated Compounds (mg/m^3)

Chemical	Criteria 1	Criteria 2
TCE	0.08	0.8
1,1,1 – TCA	230	2300
PCE	8	80
Cis, 1,2, -DCE	0.3	3
Vinyl chloride (VC)	0.1	1

Note: the above are considered to be screening levels only and an exceedance of the above gravel blanket screening levels will only be considered significant where the indoor air levels of the contaminants of concern exceeds the screening level.

5.2.2 Indoor Air

The adopted screening levels (SL) for indoor air monitoring for PCE, TCE, cis, 1,2-DCE and VC are the airborne concentration indoors associated with threshold (non-carcinogenic) effects.

The screening levels have been calculated using the toxicity reference values consistent with those used to determine soil vapour health investigation levels in Schedule B7 Appendix B of NEPC (2013) using the following formula:

$$SL\ (mg/m^3) = \frac{(TRV_i \times (100\%-BIi)) \times AT_T}{\alpha \times ET_{CI} \times EF \times ED_C}$$

This method of determining the indoor air screening levels was recommended to DP by the NSW EPA for a similar project where the risk from chlorinated solvents in an indoor air commercial environment was in relation to commercial site users (but not workers) in operational dry cleaner premises.

The inputs into the above formula are provided in Table 3.

Table 3: Inputs used to Derived Indoor Air SL

Parameter	Description	Industrial/ Commercial	Unit
TRV_i (TCE)	non-carcinogenic TRV recommended in NEPC (2013) for soil vapour HIL from USEPA (2011)	2.00E-03	mg/m^3
TRV_i (PCE)	TRV recommended in NEPC (2013) for derivation of soil vapour HIL from WHO (2006)	2.00E-01	mg/m^3
TRV_i (cis 1,2 DCE)	TRV recommended in NEPC (2013) for derivation of soil vapour HIL from USEPA (2010)	7.00E-03	mg/m^3
TRV_i (VC)	TRV recommended in NEPC (2013) for inhalation in adults (USEPA IRIS 2012)	4.40E-03	mg/m^3
BI_i	Recommended BI from NEPC (2013) for the derivation of soil vapour HILs. Note for VC and Cis 1,2 DCE, BI is 0	10	%
AT_T	Averaging time for threshold contaminants (hours = ED x 365 days x 24 hours)	262800	hours
α	Soil vapour to indoor air attenuation factor. As samples are indoor air samples no attenuation from soil vapour to indoor air	1	unitless
ET_{CI}	Exposure time indoors	8	hours
EF	Exposure frequency	240	days/year
ED_C	Exposure duration for an adult	30	years

Based on the above the screening levels for the contaminants of concern are as follows:

Table 4: On Site Indoor Air Screening Levels

Contaminant	Screening Level	Units
TCE	8.2E-03	mg/m^3
PCE	8.2E-01	mg/m^3
Cis 1,2 DCE	3.2E-02	mg/m^3
VC	2.0E-02	mg/m^3

Note: If the calculated screening level is below the laboratory detection limits, then the detection limit will be adopted as the screening level

5.3 Visual Inspection of VMS

The basement and car park level concrete slabs form part of the vapour barrier and hence need to be periodically inspected to check their integrity. The integrity of these barriers will generally be compromised where (i) unauthorised penetration has not been appropriately sealed, (ii) sealing of penetrations have not been inspected as required, or (iii) cracking through the full thickness of the slab occurs.

Whilst such inspections can be undertaken by Centre Management as part of daily works, in order to confirm that the slab has been appropriately inspected, formal inspection of the concrete slab should be undertaken in conjunction with the air and vapour monitoring on a bi-annual basis.

Inspections undertaken should be recorded on the ESIS (Appendix C) and counter-signed by the Operations Manager. Any issues that need to be addressed should be recorded along with their rectification. No specific experience or qualifications are required to undertake the visual inspections.

In addition annual inspections of the stormwater pits and CCTV inspections of the stormwater pipes should be conducted by a plumber to confirm that the pipes and joints of the stormwater pipes in the car park level are intact and that they have not become a potential conduit for vapour migration.

5.4 Concrete Slab Inspections

Following the completion of the concrete slab post-tension cracks formed in the concrete slab. Following advice from the structural engineer ADCO allowed the cracks to form over a period of approximately 6 months and once the slab had settled sealed the majority of the cracks using Sikafloor®-160 (product information included in Appendix D . If addition cracks form over time they must be sealed using the same product in accordance with the manufacturer's specifications. Alternative (equivalent or better) products / methods may be considered following consultation with the Environmental Consultant and Site Auditor. An example of the sealed post-tension cracks is presented in Photograph 3.

Photograph 3: Sealed Post Tension Cracks

The slab should be inspected by the Site Manager every 3 months and the Environmental Consultant every six months during the monitoring inspections. If new cracks are identified the cracks should be sealed in accordance with the method with the advice of the structural engineer in Consultation an Environmental Consultant and Site Auditor.

The location of all cracks in the slab should be noted on a site plan to be kept on record with this EMP.

6. In-Ground Work: VMS

6.1 Preparation Works

Before any penetration can be undertaken within the areas defined in Drawings 1 and 2 (the VMS system) a suitably qualified consultant experienced in ground gas issues must be consulted and the proposed works independently endorsed by a Site Auditor.

For any required penetrations through the ground floor concrete slab a works specific work plan must first be prepared and submitted to the Operations Manager for approval. For any other works within these areas of the site where the VMS system was installed (i.e. the PT slab), including construction and/or placement of any obstructions which may significantly impact on air flow movement, a suitably

qualified consultant experienced in ground gas issues must be consulted and the proposed works to prepare an appropriate works plan and VMS system reinstatement plan that is reviewed and endorsed by a Site Auditor.

Advice should be sought regarding the potential exposure of contaminated materials from a suitably qualified consultant during development of the works specific work plans. Appropriate vapour and air monitoring must be determined based on the type and location of the specific works.

6.2 Re-instatement of VMS

The VMS barriers, namely the post tensioned concrete slab, VI20 Liquid Boot Plus membrane and gravel blanket ventilation system restrict the migration of soil vapour from the subsurface into the building. If a barrier is compromised, resultant vapour migration through the breach could pose an unacceptable risk to site users. Common causes include unauthorised penetrations through the slab, unsealed penetrations, and cracking of the slab.

The following procedures are to be followed when the VMS barriers are compromised:

- Report issue to the Operations Manager and record in EMP logbook;
- Immediately address the issue of concern, even if only by undertaking temporary remedial measures. This may involve engaging contractors depending on the nature of the problem;
- Until the issue has been adequately addressed, monitor area for volatile organic compounds, specifically PCE with a flame ionisation detector (FID) and daily eight hour indoor air samples (using Suma Canisters). The concentration of PCE in indoor air must not exceed the screening levels in Table 4;
- For small cracks and/or penetrations (less than 10 mm), repair the affected area by applying gas proof sealants (e.g. Tam-Seal, Emer-Seal) to the concrete slab. For larger cracks seek advice from an appropriately qualified consultant;
- For penetrations/tears in the VI 20 Liquid Boot Plus membrane, this will require engaging an appropriately experienced contractor (e.g. Cetco) to repair it. The membrane is only considered suitable when it is certified by the repairing contractor to be gas proof. Membrane repair should preferably involve the reapplication of VI20 Liquid Boot Plus Membrane;
- If a ventilation pipe is damaged then the ventilation pipe should be replaced. If excessive siltation of the gravel blanket results from the works then the effected gravel should be replaced. Gravel and pipe replacement must meet the requirements of the VMS design (DP *Report on Vapour Mitigation System, Glenrose Shopping Centre, Glen Street, Belrose* prepared for Fabcot Pty Ltd, DP Project 73579.00 dated 22 July 2015 (DP 2015) unless otherwise advised per the following dot point;
- A work method statement must be prepared by a suitably qualified consultant to detail the procedures for re-instating the VI20 Liquid Boot Plus Membrane, gravel and/or pipework prior to the commencement of works and the work method statement be submitted to the Site Auditor for review;
- Temporary measures must be put in place to reduce the potential for exposure to vapour ingress, until permanent measures are implemented. Possible temporary actions include:
    - Temporary ventilation fan blowing in the area;

- Leave door to the room open to increase ventilation;
- Place plastic sheeting over the area and tape down sides of plastic; and
- Apply temporary grouting or sealants which may not be accredited as gas proof, but would act to reduce ingress rates.

- Monitoring is only to cease once the Operations Manager has signed off that works have been completed and the barrier is no longer compromised. The ESIS is provided in Appendix C.

7. Active Ventilation Contingency

In the event that an exceedance of the indoor air monitoring screening levels occurs the initial response will be to conduct a supplementary round of indoor air monitoring to confirm the initial results.

Active ventilation of one of more of the risers may be considered necessary if the levels of PCE in the indoor air samples consistently exceed the adopted indoor air screening levels or if excessive build-up of PCE vapour in the gravel layer occurs. Prior to proceeding with active ventilation measures a site specific risk assessment should be completed to determine if the reported levels of PCE in the atmosphere presents an actual risk to human health.

If the concentrations of PCE build-up in the gravel blanket is due to insufficient flow rates in the gravel blanket this will only be considered to trigger the need for active ventilation, if however, it is considered that there is significant risk of the build-up affecting the indoor air PCE levels, or if it coincides with a exceedance of the indoor air screening criteria then active ventilation will be required.

If an extraction fan is required the contractor is to provide data sheets confirming the extraction fan is intrinsically safe (i.e. will not trigger an explosion). Fan commissioning results are to confirm that the fan has been installed in accordance with relevant industry and Australian standards. A fan commissioning report is to be provided to DP. Further, the output of the fan is to be monitored on three separate occasions over a three month period, post-commissioning to confirm that a minimum air exchange rate required is being achieved. These results are to be provided to DP for review.

Connection of the fans to the ventilation system will be undertaken by an appropriately qualified installer. Once connected, the fans should be turned off to confirm that the system will operate when the fans go off-line. Installation documentation from the installer will be provided confirming that the fans have been appropriately connected into the system.

With respect to the fan specifications, the size and type of fan required for each of the risers would be determined based on areas of influence of each riser. The necessary air exchange will be determined (if required) by measuring (from the passive system) the flow rates in the risers under a range of wind conditions, then it will be determined if additional flow is required to achieve target vapour concentrations in the gravel blanket.

The area and thickness of the as built gravel blanket should be reviewed (based on survey) to confirm the required extraction rate prior to commissioning of the fan. Calculations of the air exchange requirements are to be included in the commissioning report.

8. Long-term Groundwater Monitoring Programme

A long-term groundwater monitoring programme is currently being undertaken by the former owners (Stockland) in accordance with the requirements of Voluntary Management Proposal (VMP), as agreed with the New South Wales Environmental Protection Authority (NSW EPA), VMP No. 20131709.

The long-term monitoring programme includes groundwater monitoring wells within the site, monitoring points 402B & C, 403B, C and 404 B &C (refer to Drawing 9, Appendix A) which are monitoring on a bi-annual basis until at least February 2018.

The listed monitoring well locations need to be maintained for the duration of the monitoring programme and if damaged during site redevelopment works (or otherwise), must be reinstated. A groundwater monitoring well installation plan should be prepared by a suitably qualified environmental consultant prior to reinstatement of the groundwater wells (if required).

Access to the monitoring well locations needs to be made available to the environmental consultant, as required, for the duration of the monitoring programme.

9. Groundwater Remediation Buffer Zone

Based on the outcome of the groundwater monitoring programme, per the requirements of the VMP groundwater remediation contingencies may require to be adopted which would involve works (by the previous owner, Stockland) along the northern site boundary. Groundwater remediation contingency measures may be required under the following circumstances:

- If there is an increasing concentration trend at two or more groundwater monitoring points sustained over two monitoring events (three in total, the initial event and two events showing an increase), the monitoring frequency will be increased to quarterly monitoring;
- If the trend is maintained over a further two monitoring events and confirmed by statistical analysis, additional monitoring points will be added and a reliable relationship between dissolved phase concentrations and soil vapour concentrations will be established; and
- If there is a continued rising trend, the contingency action plan will be initiated, with the urgency of that action dependent upon analysis of the trend, the groundwater-soil vapour concentration relationship and the identified level of risk.

DP has proposed a set of contingency measures to be adopted including hydraulic containment (Contingency 1), on-site enhanced bioremediation (Contingency 2) and a reactive barrier wall (Contingency 3) in the event that the above conditions are met. These contingencies are detailed in the RAP (Report on Groundwater and Soil Vapour Remediation Action Plan Glenrose Shopping Centre, Glen Street, Belrose dated 24 April 2013) and in Section 3 of the Performance Schedule of the VMP).

In the event that these contingency measures are required a groundwater remediation plan would be prepared that details the specific groundwater remediation requirements.

A three metre remediation contingency buffer zone must be maintained along the northern site boundary to facilitate the groundwater remediation contingency options.

10. Response Procedure Where Unplanned Exposure of Contaminated Material Occurs

Given the potential for PCE contaminated soil and groundwater to remain in the ground in some areas of the site, this section addresses the responses and procedures should such material (e.g. stained or odorous material identified) becomes exposed/observed for any reason:

- Barricade off the area so access to the material is restricted to authorised personnel;
- Cover the material of concern with a heavy duty plastic sheet cover;
- Notify Operations Manager and record incident in the EMP logbook;
- Initiate works promptly to remove exposure pathway to contaminated materials. *Note: Where contaminated materials are to remain in landscaped areas, a minimum 0.5 m of clean overburden is required to truncate the exposure pathway*;
- Formulate a works specific plan to manage the exposed material of concern. This includes immediate cessation of works if being undertaken;
- In the unlikely event that asbestos contaminated material is exposed:
  - If the material requires handling, engage appropriately asbestos licensed contractor to move material; and
  - Where material is to remain permanently on site, this must be covered with either a concrete slab or 0.5 m of clean soil and the location of the material recorded for future reference. Asbestos must not remain exposed to site users following works.
- For other contaminated materials of concern, an appropriately qualified environmental consultant must be engaged to assess the material and provide advice on suitable management options; and
- Once works are completed the Operations Manager must sign off that the works are completed and a record of the sign-off kept with the EMP.

11. Enforcement of EMP

It is noted that it is a requirement of the Contaminated Land Management, Draft guidelines for the NSW Site Auditor Scheme (3rd edition), NSW EPA (2016) that:

a) The EMP has been reviewed by the auditor;

b) The EMP can reasonably be made to be legally enforceable, for example because compliance with it is a requirement of a notice under the CLM Act or of development consent conditions issued by the relevant consent authority. The relevant authority (the EPA or the local authority in these cases, respectively) should be asked their view on the legality of the draft EMP;

c) *There will be appropriate public notification of any restrictions applying to the land to ensure that potential purchasers or other interested individuals are aware of the restrictions, for example appropriate notations on a planning certificate issued under section 149(2) of the Environmental Planning and Assessment Act or a covenant registered on the title to land under s.88B of the Conveyancing Act 1919; and*

d) *There is no off-site migration of contamination from the site which is the subject of the site audit, or where there is off-site migration or its potential, that contamination within the site is managed or monitored so that it does not present an unacceptable risk to either the on-site or off-site environments.*

Therefore the EMP must be reasonably legally enforceable to ensure that it is complied with post construction and over the longer term.

The EMP can be required by Council as a condition of the final Occupation Certificate issued under the Environmental Planning and Assessment Act, 1979. Alternatively a Section 96(1) Application under the Environmental Planning and Assessment Act 1979 to modify the development application and consent to include the EMP in the development approval can be sought (understood to be the preferred approach by Fabcot).

In addition the requirement to enforce the EPM can be subject to public notification under the Section 149 Planning Certificate for the site. Other mechanisms such as a covenant registered on the title to the land under S.88B of the Conveyancing Act, 1919 could also be considered.

DP considers that a condition on the Occupation Certificate or a Section 96(1) modification to the development consent to include the EMP and provision of a Notice on the Planning Certificate are appropriate.

In addition, arrangements for enforcement of the EMP should be referenced in the Owner / Centre Management, management and operations documentation. The site owner should provide a legally binding written undertaking that they will enforce the EMP until final sign-off of the site is achieved.

The client should inform DP and the Site Auditor once the EMP has been appropriately enforced under one or more of the above mechanisms (subject to Auditor agreement) and provide documentation which confirms these arrangements.

12. Conclusion

This EMP provides the requirements for the maintenance and management of the vapour mitigation system at the Site. The EMP also provides the monitoring requirements associated with the performance monitoring of the VMS.

The EMP should be reviewed on an annual basis and upon the completion of the three year monitoring period.

13. Limitations

Douglas Partners (DP) has prepared this report this project at Glen Street, Belrose in accordance with DP's proposal dated 7 April 2014. The work was carried out under contract number 221392. This report is provided for the exclusive use of ADCO Constructions Pty Ltd and Fabcot Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DP's advice is based upon the conditions encountered during this investigation and the information provided by third party sources. The accuracy of the advice provided by DP in this report may be affected by the quality and reliability of the information provided to DP. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Notes About this Report and

VMS Design Drawings

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

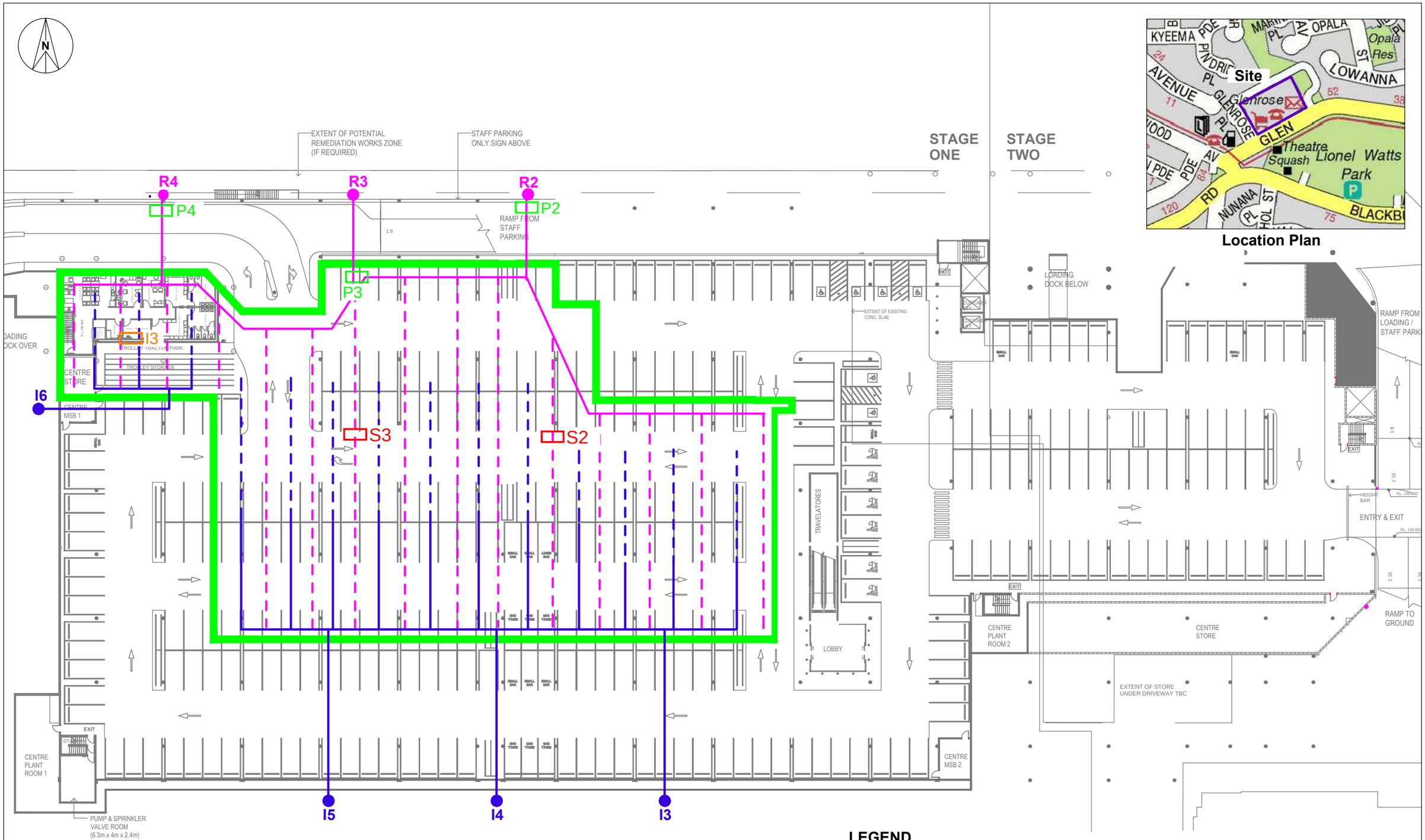
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

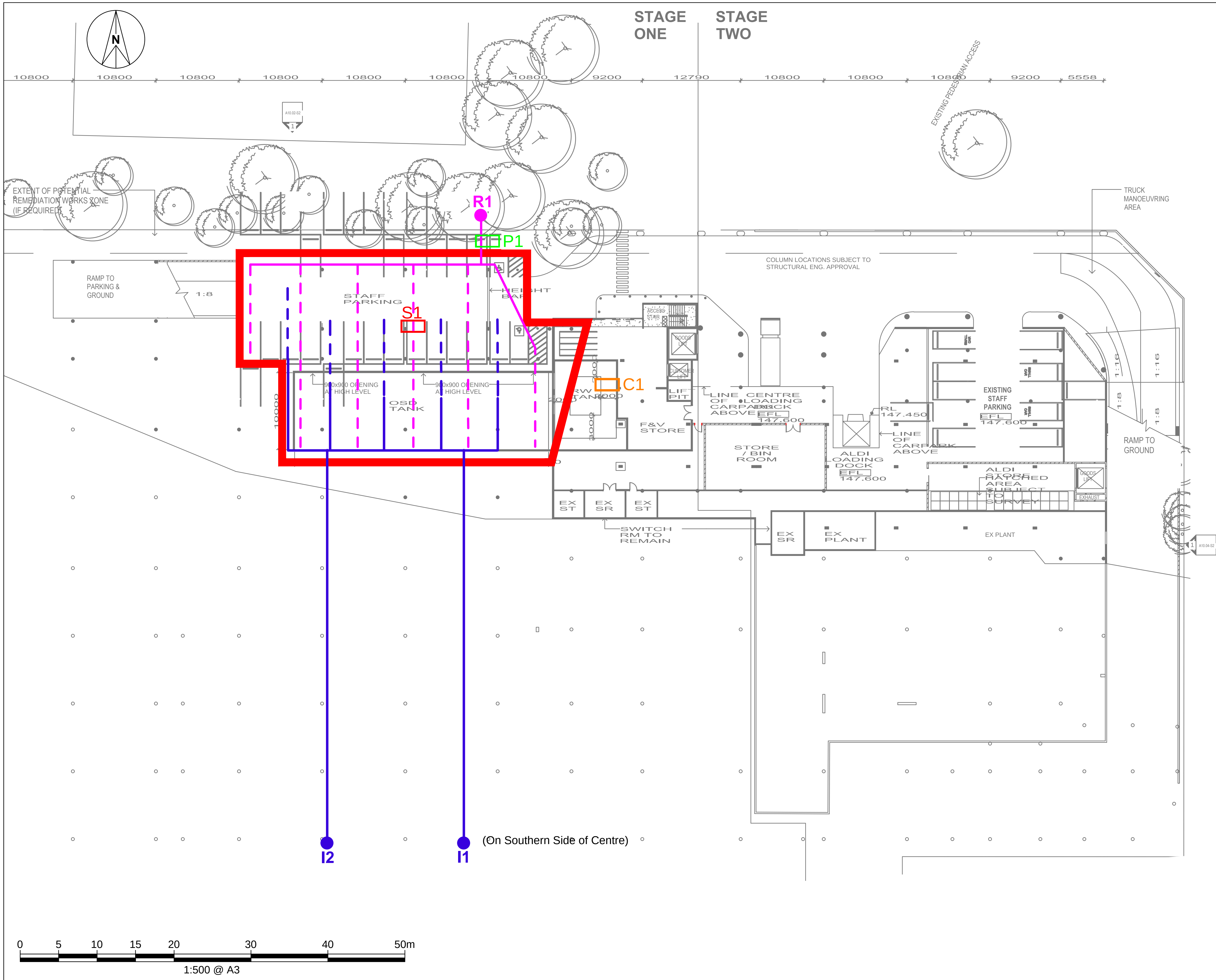
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Carpark Level Pipe Network and Riser Locations-Alternative Option 1** **Vapour Mitigation System** **Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 1
	SCALE: As shown / DATE: 31.10.2016		REVISION: 0

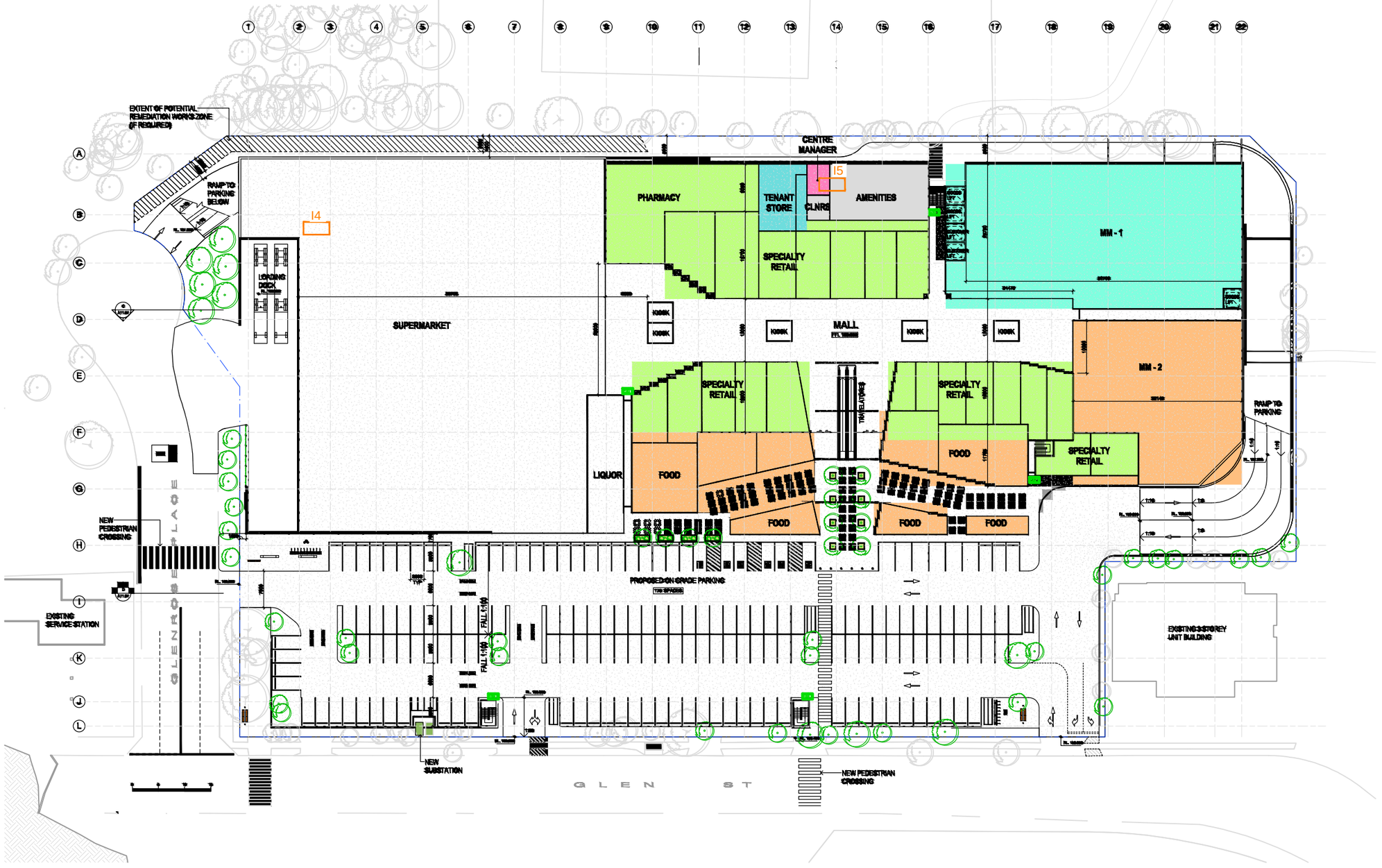


LEGEND

- Solid outled manifold
- Slotted outlet collection pipe
- Solid inlet pipe/ manifold
- Slotted inlet pipe
- R - Riser (at roof level)
- I - Inlet point (300mm from ground)
- Gravel blanket sampling point (S#)
- Indoor air sampling point (I#)
- Riser pipe sampling point (P#)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Fabcot		TITLE: **Basement Pipe Network and Riser Locations-Alternative Option 1**	PROJECT No: 73579.01
OFFICE: Sydney	DRAWN BY: PSCH	**Vapour Mitigation System**	DRAWING No: 2
SCALE: As shown	DATE: 31.10.2016	**Glen Street, Belrose**	REVISION: 0



LEGEND

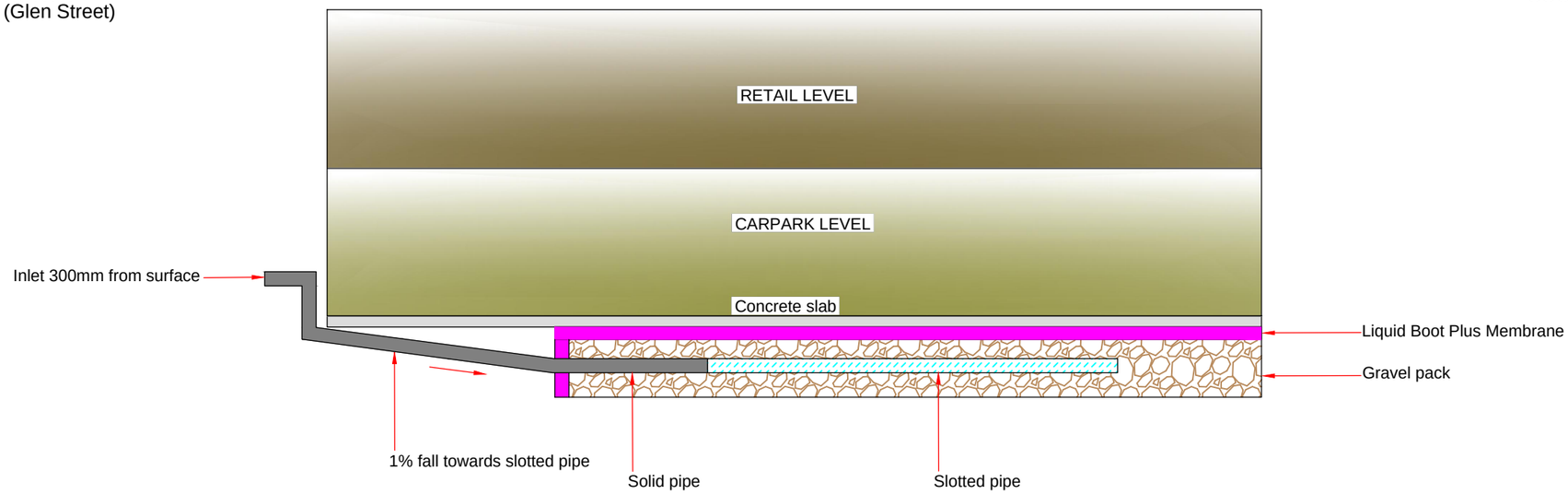
Indoor air sampling point (I#)

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Retail Level Vapour Mitigation System Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 3
	SCALE: As shown / DATE: 31.10.2016		REVISION: 0

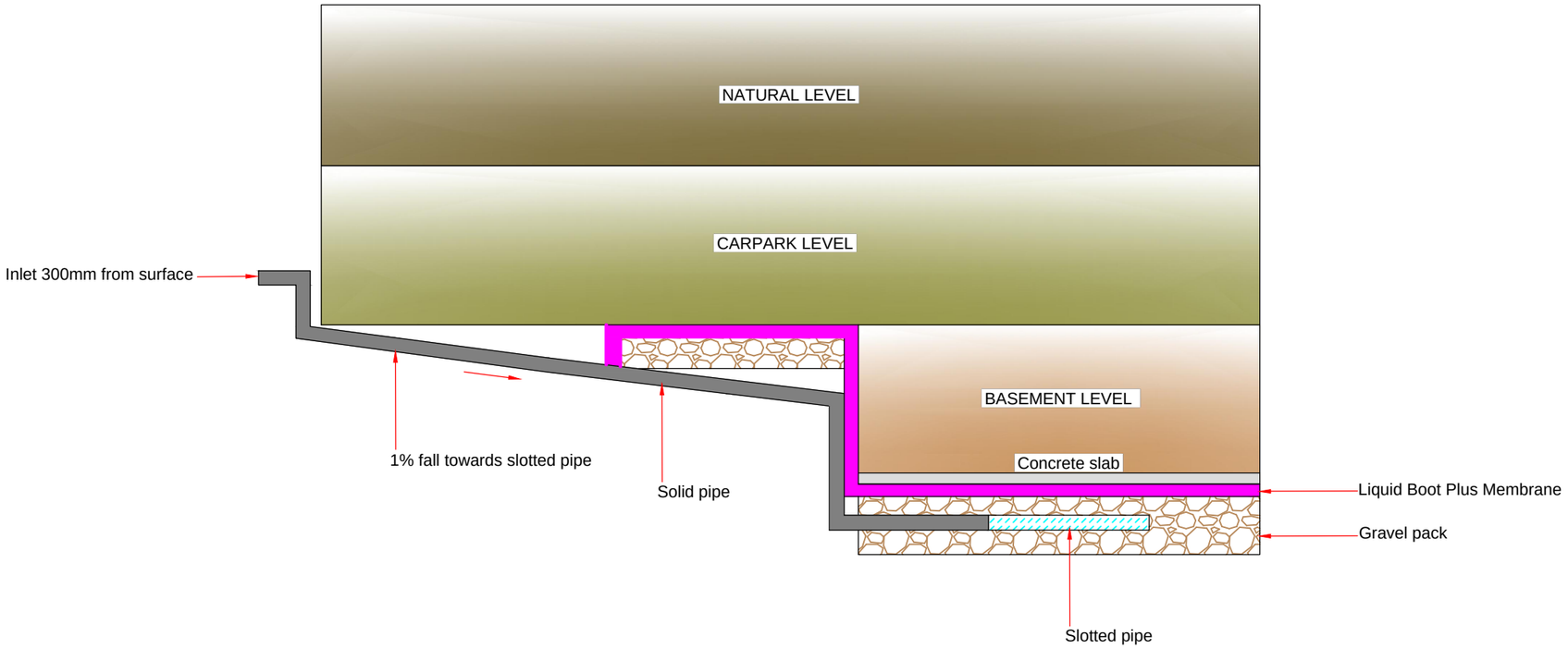
NORTH
(Glen Street)

SOUTH

INLETS I3 TO I6



INLETS I1 AND I2



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Revised Inlet Design** **Vapour Mitigation System** **Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 4
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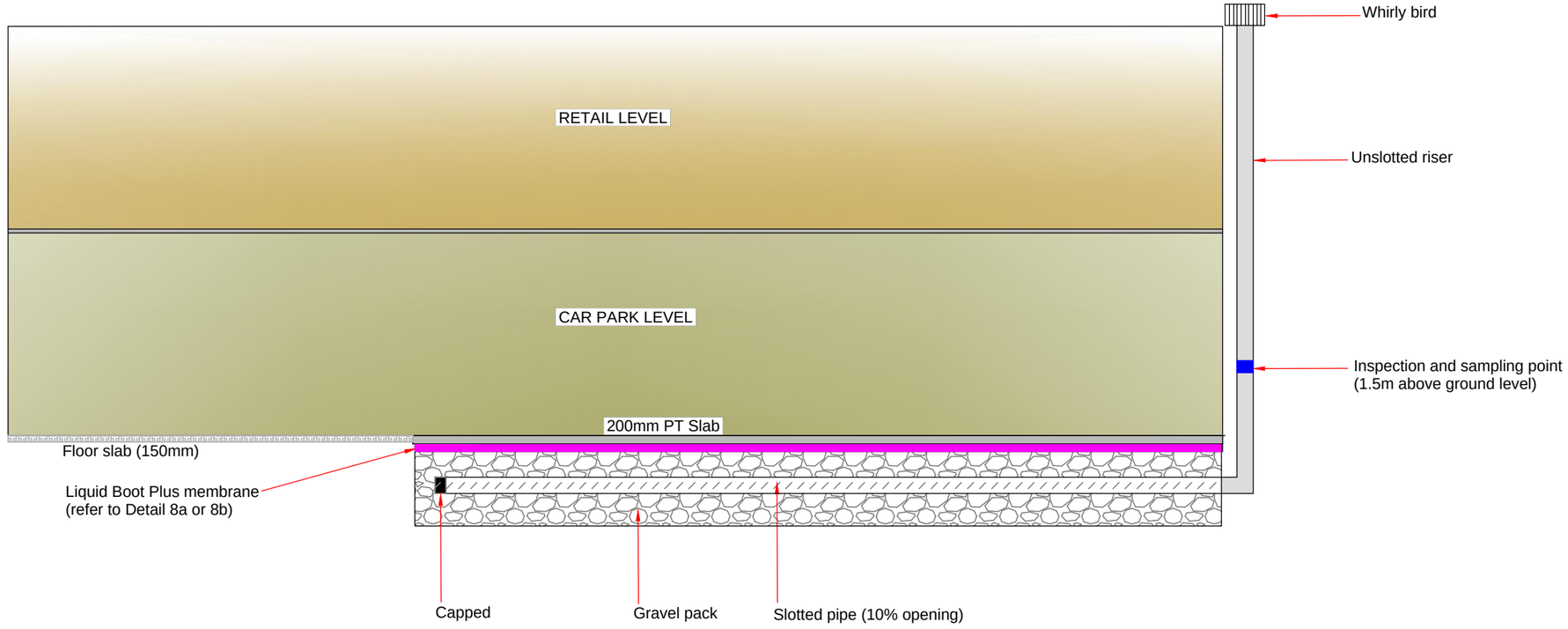
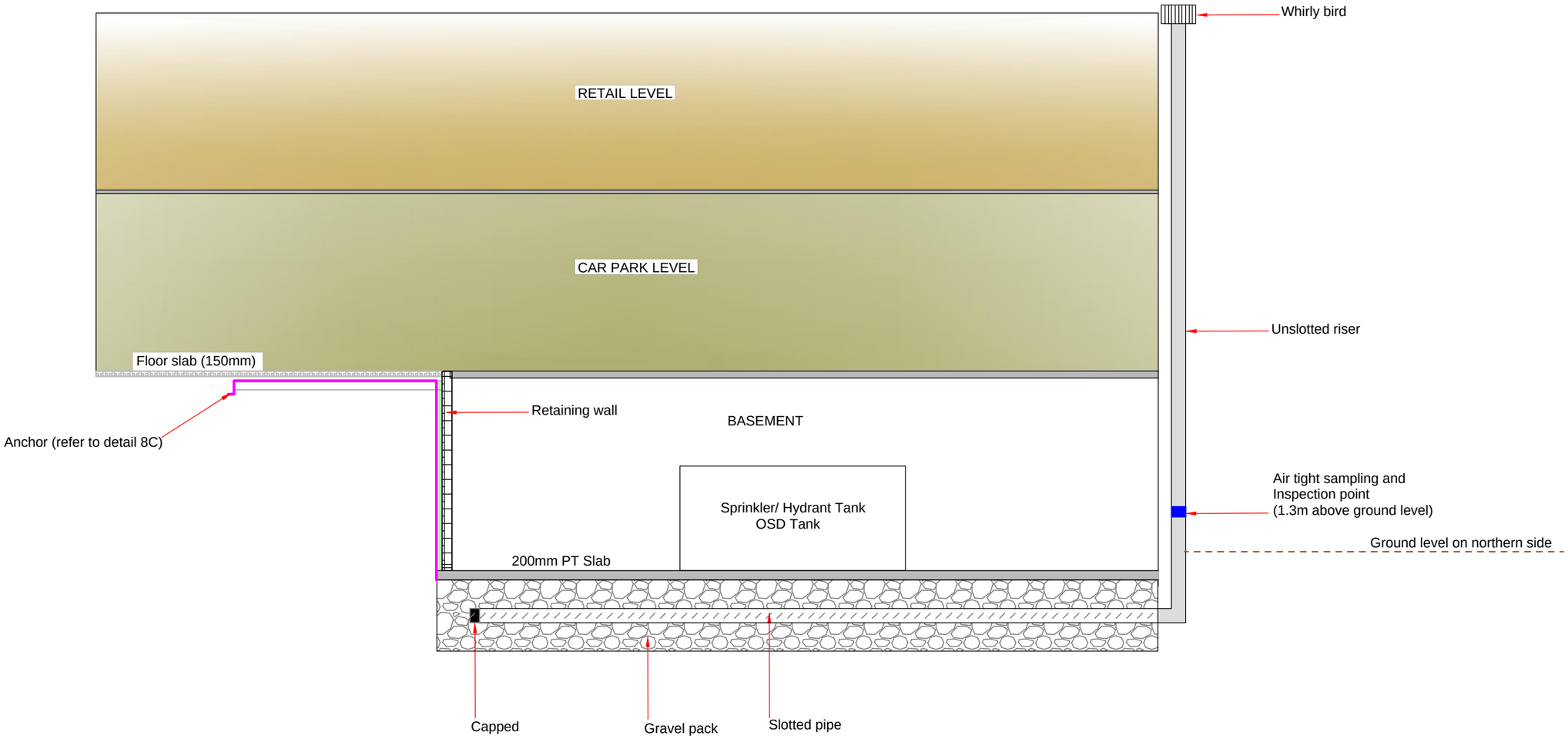


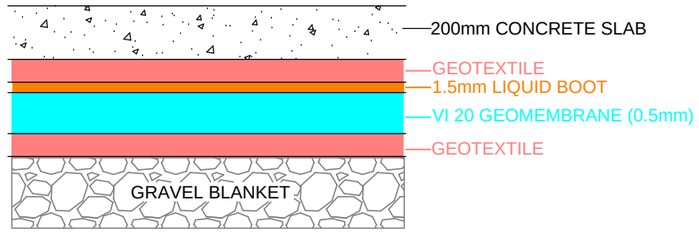
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Fabcot		TITLE: **Cross - Section - Carpark Level**	PROJECT No: 73579.01
OFFICE: Sydney	DRAWN BY: PSCH	**Vapour Mitigation System**	DRAWING No: 5
SCALE: N.T.S.	DATE: 31.10.2016	**Glen Street, Belrose**	REVISION: 0

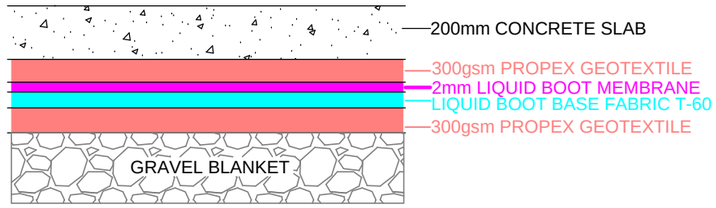


Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Design Features (Membrane)** **Vapour Mitigation System** **Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 6
	SCALE: N.T.S. / DATE: 31.10.2016		REVISION: 0

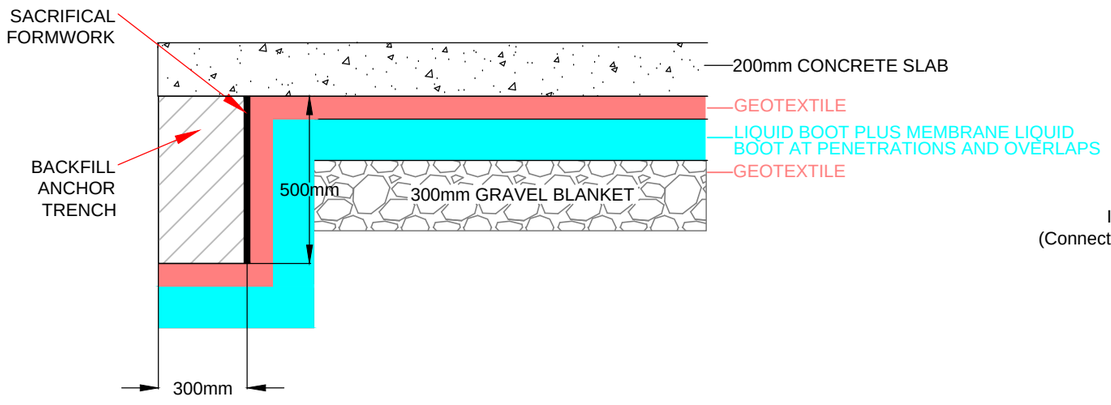
DETAIL 8A: DESIGN OF LIQUID BOOT PLUS



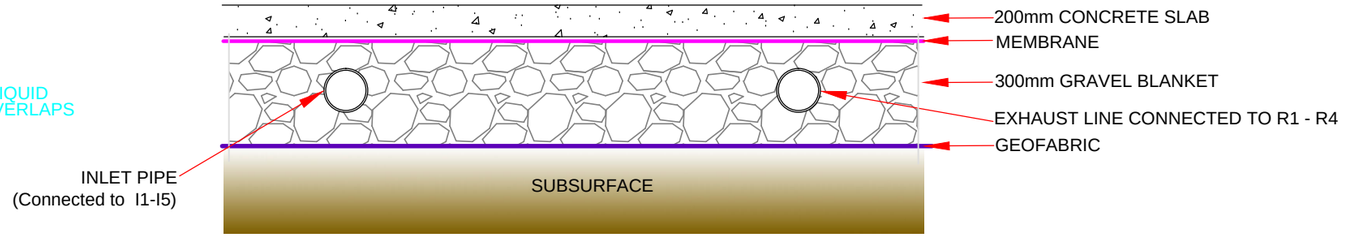
DETAIL 8B: DESIGN OF LIQUID BOOT MEMBRANE (AREAS OF SIGNIFICANT INTRUSIONS)



DETAIL 8C: ANCHOR TRENCH FOR LINER AT EDGE



DETAIL 8D: GRAVEL BLANKET AND MEMBRANE DESIGN



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Design Features (Membrane)** **Vapour Mitigation System** **Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 7
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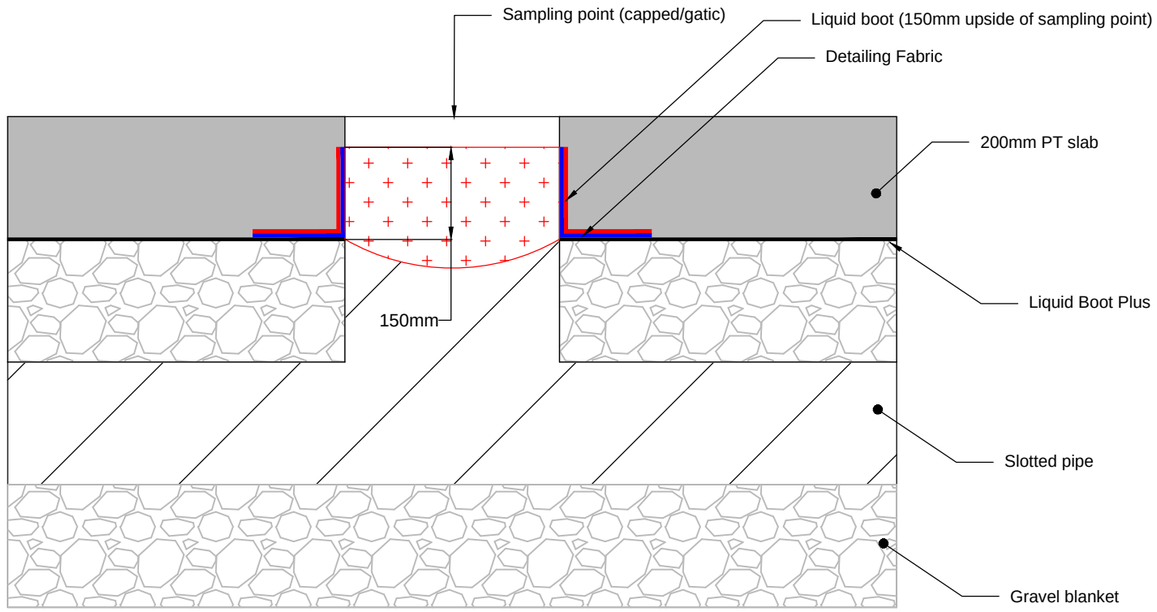
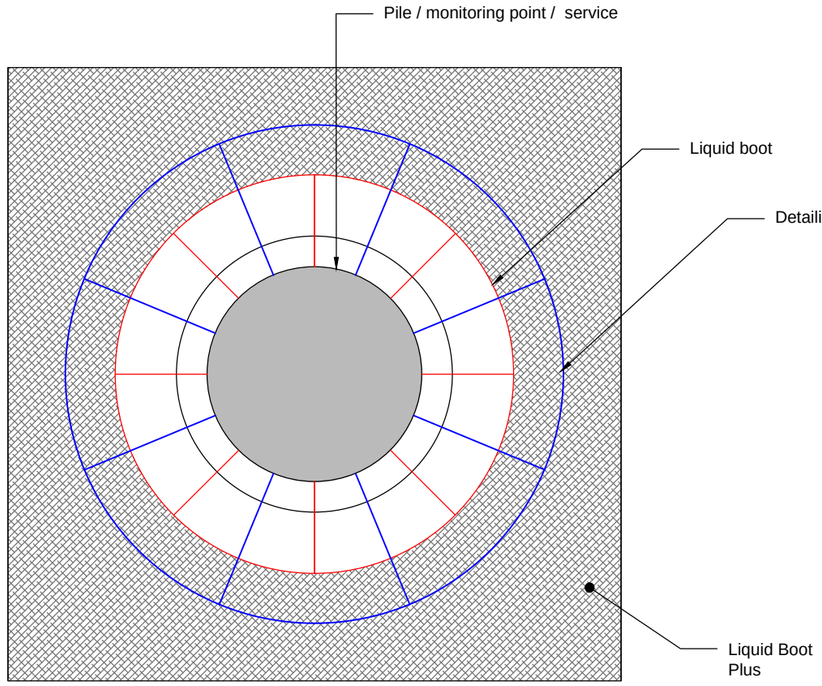
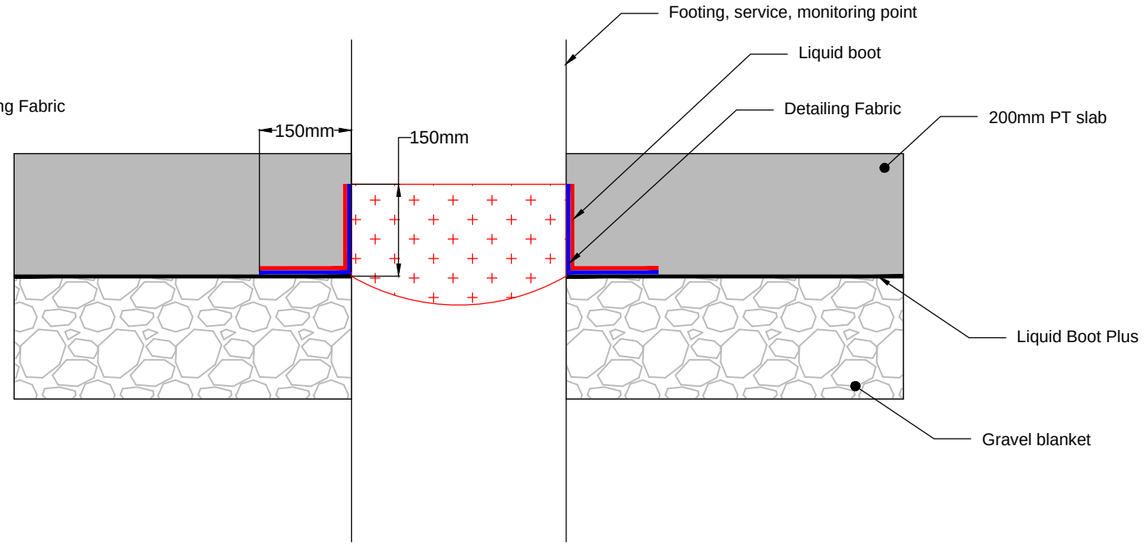


DETAIL 9A: VAPOUR GRAVEL BLANKET MONITORING POINT

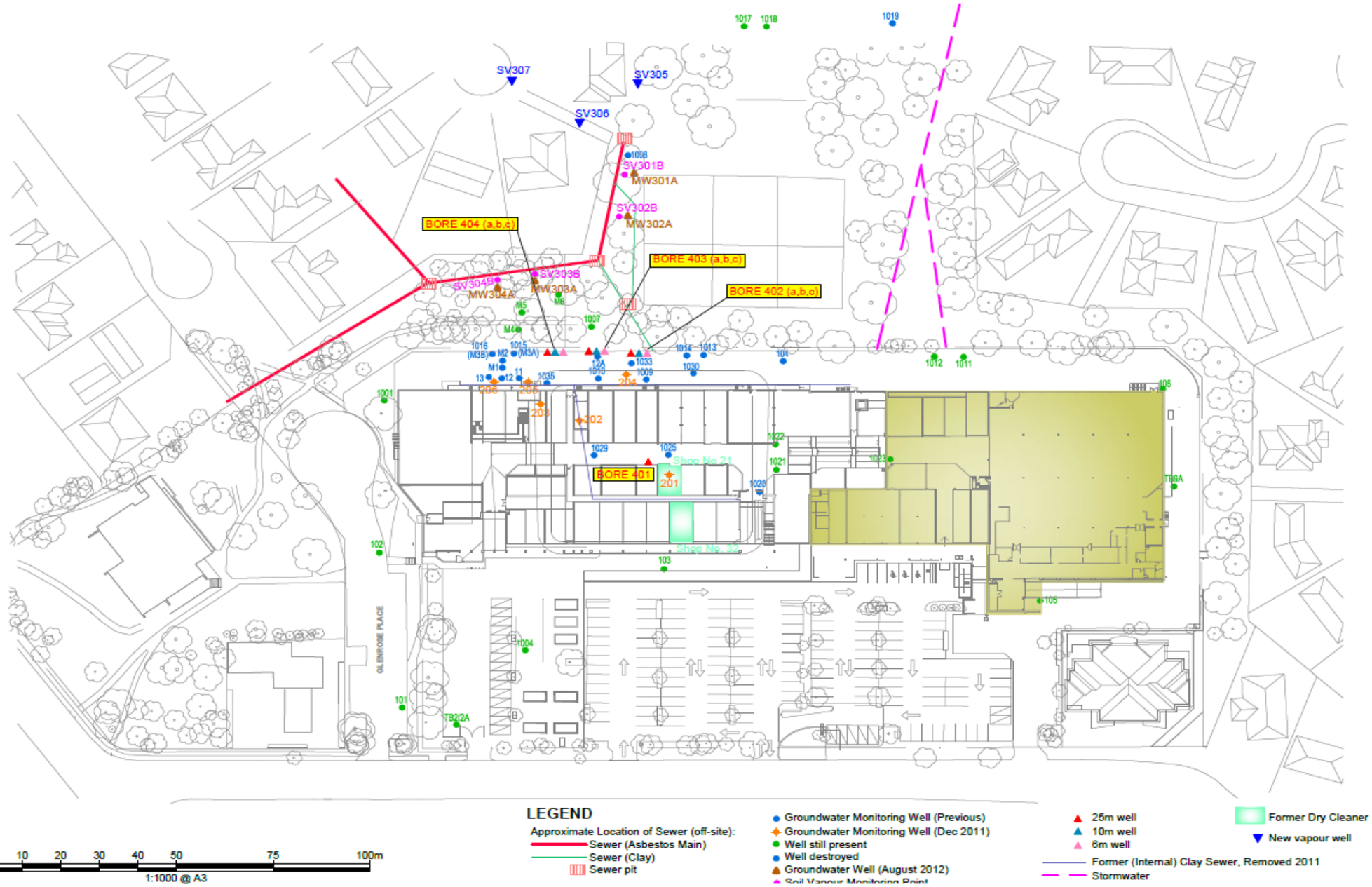


DETAIL 9B: PLAN VIEW APPLICATION OF LINER TO PENETRATIONS (SERVICES, PILES, MONITORING POINTS)



DETAIL 9C: SIDE VIEW DETAIL OF PENETRATION SEALING (SERVICES, PILES, MONITORING POINTS)

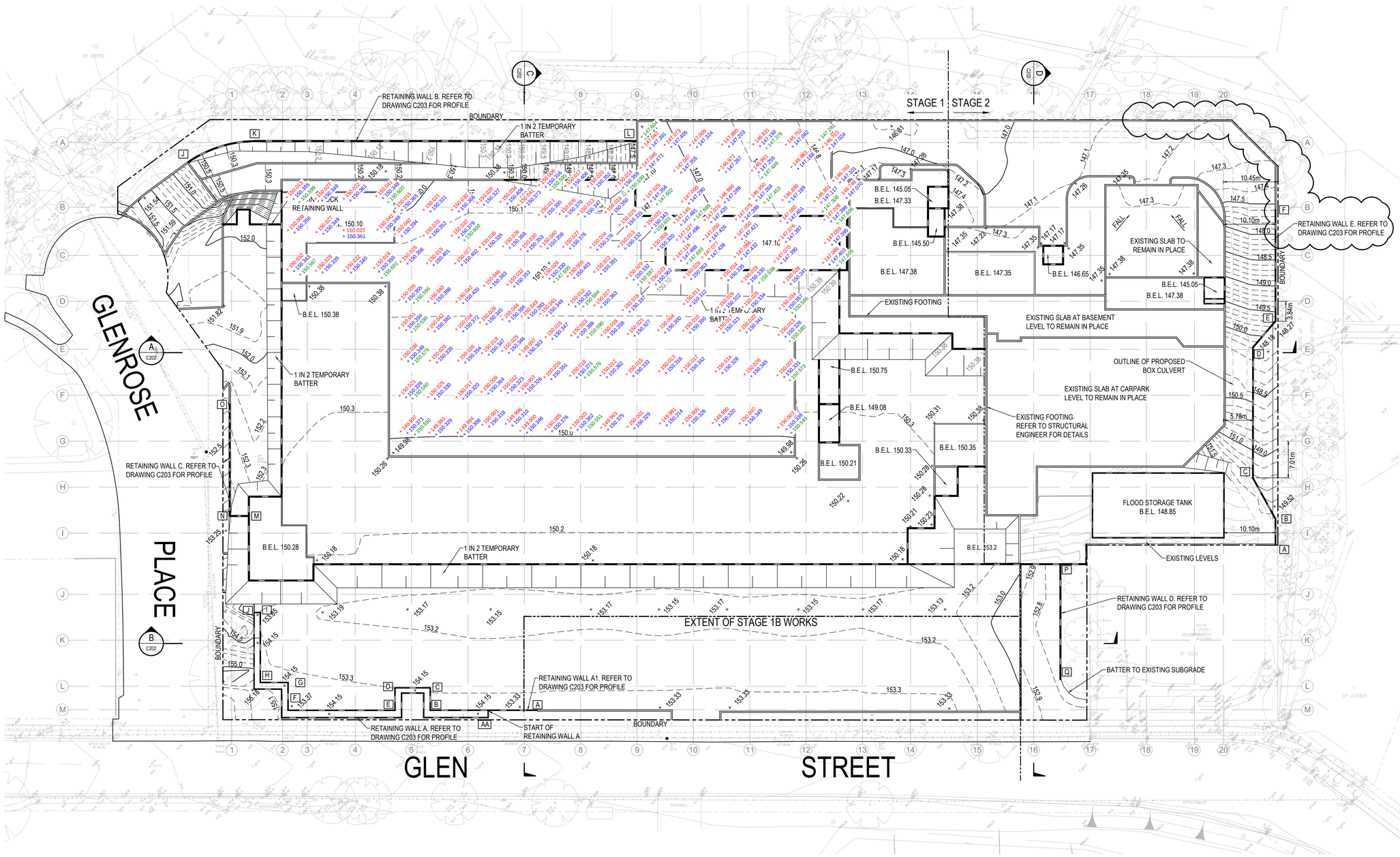
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Fabcot	TITLE: **Penetrations** **Vapour Mitigation System** **Glen Street, Belrose**	PROJECT No: 73579.01
	OFFICE: Sydney DRAWN BY: PSCH		DRAWING No: 8
	SCALE:Not to scale DATE: 31.10.2016		REVISION: 0



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: ADCO Constructions		TITLE: **Groundwater Monitoring Locations**	PROJECT No:	73579.01
	OFFICE: Sydney	DRAWN BY: KDP	**VMS EMP**	Drawing	9
	SCALE: As shown	DATE: 11 Apr 2016	**Glenrose Shopping Centre, Belrose**	REVISION:	A

Appendix B

As Built Drawings



PLAN
SCALE 1:400

LEGEND

RETAINING WALL
REFER TO STRUCTURAL ENGINEER FOR DETAILS

[A] DENOTES RETAINING WALL LOCATION
REFER TO DRAWING C203 FOR DETAILS

NOTE

1, IN VAPOUR MANAGEMENT AREA, DEPTH FROM F.F.L. TO B.E.L. TAKEN TO BE 500mm CONSISTING OF;
- 200mm PT CONCRETE SLAB
- MEMBRANE (NOMINAL THICKNESS)
- 300mm GRAVEL BLANKET

2, SUB-BASE THICKNESS OF 100mm ASSUMED WHERE SLAB ON GROUND HAS BEEN SPECIFIED.

3, REFER TO STRUCTURAL PLANS FOR CONCRETE SLAB AND SUB-BASE SPECIFICATIONS

4, STAGE 1
CUT VOLUME = 6,360m^3
FILL VOLUME = 6,640m^3

5, STAGE 2
CUT VOLUME = 500m^3
FILL VOLUME = 650m^3

6, EARTHWORKS VOLUMES DO NOT INCLUDE EXCAVATION FOR PROPOSED BOX CULVERT (APPROX. 450m^3 OF CUT)

7, EARTHWORKS VOLUMES ARE TAKEN TO EXISTING SITE LEVELS AS PER SURVEY CARRIED OUT BY LTS LOCKLEY REGISTERED SURVEYORS DATED 30.07.13 REFERENCE NUMBER 40058DT

8, DRAWING IS TO BE READ IN CONJUNCTION WITH STRUCTURAL ENGINEER'S PLANS

× 150.003 Excavation as-built level

× 150.336 Top of Gravel as-built level

× 150.600 Top of PT Slab as-built level

WORKS AS EXECUTED
VAPOUR BARRIER
EXCAVATION AND GRAVEL LEVELS

29 SEPTEMBER 2016

ADCO CONSTRUCTIONS PTY LTD.

REVISIONS:

No.	REVISION DESCRIPTION	DRAWN	DATE
5	RETAINING WALL AMENDED	AH	09.02.16
4	RETAINING WALL A & D AMENDED	AH	18.08.15
3	CARPARK GRADING AMENDED	AH	23.07.15
2	LEVELS AMENDED FOR NEW SLAB DEPTH	AH	02.07.15
1	FLOOD STORAGE AMENDED, LABELS ADDED TO WALL 'E'	AH	16.16.15
0	FOR CONSTRUCTION	AH	04.06.15

SCALE BAR
0 10 20 30 40m
SCALE 1:400

van der Meer Consulting
van der meer
LEVEL 3, 39 CHANDOS STREET
ST LEONARDS NSW 2065
Telephone 61-2-9436 0433 Fax 61-2-9436 1370
www.vandermeer.com.au
van der Meer (NSW) Pty Ltd
A.B.N. 56 158 266 301

CLIENT
ADCO CONSTRUCTIONS P/L
7-9 WEST STREET
NORTH SYDNEY, NSW 2060

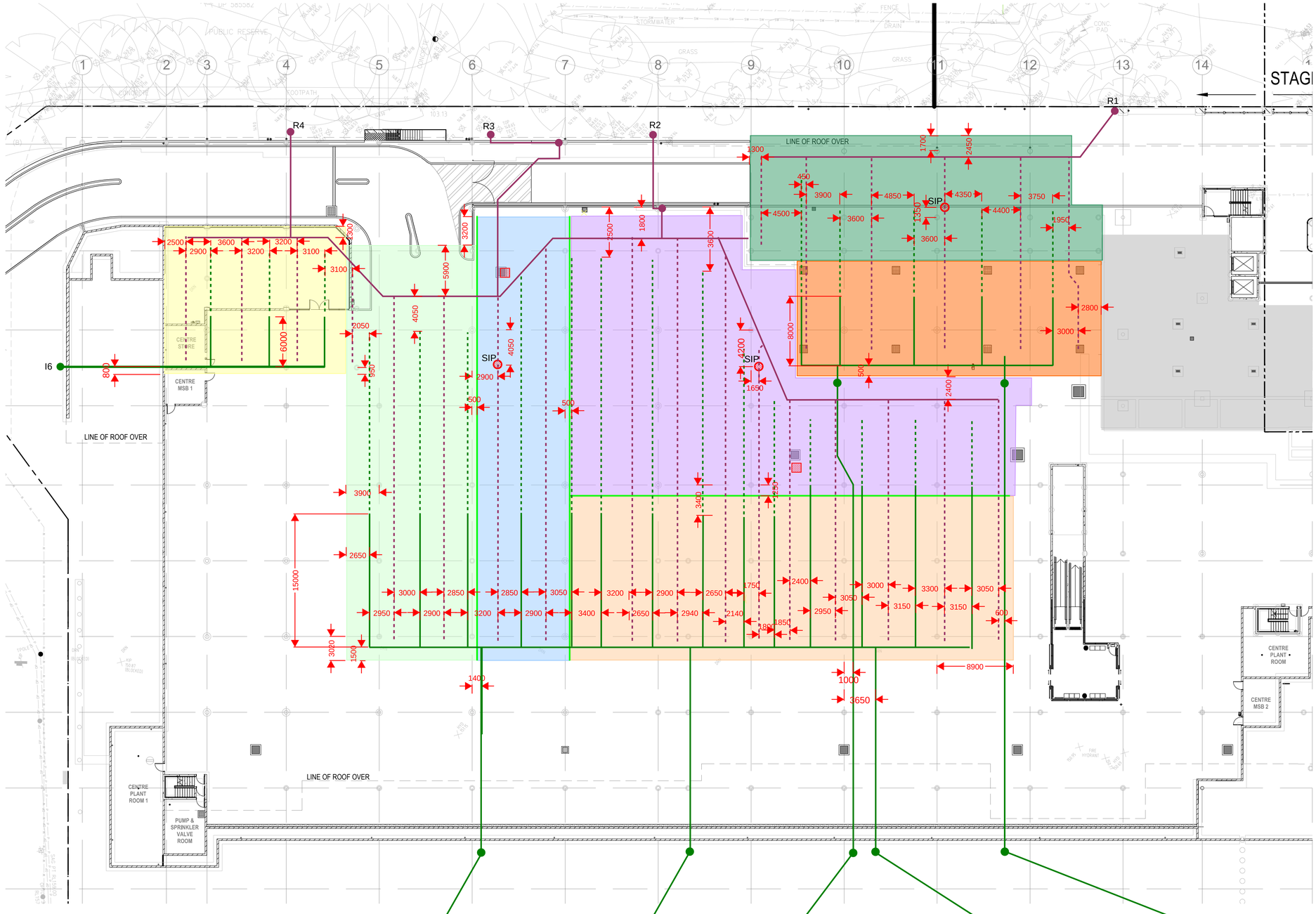
ARCHITECT
BN ARCHITECTURE
82 ALEXANDER STREET, CROWS NEST, NSW 2065

PROJECT TITLE
GLENROSE VILLAGE
56-58 GLEN STREET
BELROSE NSW 2085

DRAWING TITLE
BULK EARTHWORKS PLAN

DRAWING STATUS
FOR CONSTRUCTION

PROJECT LEADER	DESIGNER	SIGNATURE	
RJB	AH		
DRAFTSPERSON	SCALE	DATE	SHEET SIZE
AH	AS SHOWN	FEB 2015	A1
JOB No.		DRAWING No.	REVISION
SY141-088		C201	5



PLAN
SCALE 1:250

LEGEND

- ANCHORED LINER BASEMENT LEVEL
- ANCHORED LINER CARPARK LEVEL
- 150Ø SLOTTED INLET PIPE
- 150Ø SOLID INLET PIPE/MANIFOLD
- 150Ø SLOTTED OUTLET COLLECTION PIPE
- 150Ø SOLID OUTLET PIPE/MANIFOLD
- SEALED INSPECTION POINT
- I — INLET POINT 300mm FROM GROUND
- R — RISER

NOTE

1. PIPE NETWORK BASED ON A PASSIVE SYSTEM WITH FLEXIBILITY TO CONVERT TO ACTIVE POST CONSTRUCTION
2. VAPOUR MANAGEMENT SYSTEM DESIGN AND DETAILS FROM DOUGLAS PARTNERS REPORT ON VAPOUR MITIGATION SYSTEM , JUNE 2014
3. REFER TO C431 FOR VAPOUR MITIGATION DETAILS
4. VAPOUR MITIGATION SYSTEM TO BE INSTALLED BY AN APPROPRIATELY QUALIFIED INSTALLER TRAINED IN THE APPLICATION OF LIQUID BOOT MEMBRANES
5. PIPES AT 3.0m CENTRES APPROXIMATELY
6. SOLID INLET PIPES GRADED AT 1.% TO SLOTTED INLET PIPES

- P3
- P4A
- P4B
- P4C
- P4D
- OSD TANK
- OSD CAR PARK
- SEALED INSPECTION POINT

WORKS AS EXECUTED
VAPOUR BARRIER
VENTING NETWORK

7 OCTOBER 2016

ADCO CONSTRUCTIONS PTY LTD.

Appendix C

Environment Site Inspection Sheet

Glenrose Village, Glen Street, Belrose, EMP - Environmental Site Inspection Sheet

Date:

Time:

Works Undertaken by:

Location of Works Being Udertaken:

Works Category Undertaken (circle):

Monitoring- Routine, Other (specify) ……

Servicing- Services, Rotating Cowls, Other (specify) ……

Maintenance- Services, Rotating Cowls, Other (specify) ……

Inspection- Concrete Slabs, Concrete Slab Seals, Ventilation Inlets/Outlets, Stormwater Pits on Carpark Level Rotating Cowls, Other (specify)……

Work Not Stated Above (specify)……

Summary of Works Undertaken:

Are there any issues that still require attention?

Rectification Works (if required)

Contractor Signature:

Contractor Name:

Operations Manager Signature:

Operations Manager Name:

Appendix D

Membrane Product Sheets and

Concrete Sealant Information

LIQUID BOOT®

SPRAY-APPLIED GAS VAPOR BARRIER

PRODUCT DESCRIPTION

Liquid Boot® is specially formulated for use as a:

- Gas Vapor Barrier
- Damp Proofing Membrane

Damp proofing membrane is intended to provide a barrier to water in non-hydrostatic incidental water conditions. Liquid Boot® has been specially designed as an impermeable vapor membrane/barrier for projects that are situated on sites with volatiles, gases or contaminants in the soil. Liquid Boot® is manufactured to meet or exceed the minimum average values listed in the chart below.

BENEFITS

- Spray application provides excellent sealing of penetrations
- Seamless, monolithic membrane means no mechanical fastening required
- Protection from methane gas, VOCs, chlorinated solvents and other contaminates
- Also protects against water vapor

INSTALLATION

Protect all adjacent areas not to receive gas vapor barrier. Ambient temperature shall be within manufacturer's specifications. All plumbing, electrical, mechanical and structural items to be under or passing through the gas vapor barrier shall be secured in their proper positions and appropriately protected prior to membrane application. Gas vapor barrier shall be installed before placement of reinforcing steel. Expansion joints must be filled with a conventional waterproof expansion joint material. Surface preparation shall be per manufacturer's specification. A minimum thickness of 60 dry mils, unless specified otherwise.

AVAILABILITY

Shipping is available from two convenient plant locations:

- CETCO, 1001 S Linwood Ave, Santa Ana, CA
- CETCO, 218 NE Industrial Park Rd, Cartersville, GA

Contact your local technical sales manager at:
714-384-0111 or 800-527-9948

PHYSICAL PROPERTIES

PROPERTIES	TEST METHOD	VALUE
Hydrogen Sulfide Gas Permeability	ASTM D1434	None Detected
Chemical Resistance: VOCs, BTEXs (tested at 20,000 ppm)	ASTM D543	Less than 1% weight change
Sodium Sulfate (2% water solution)	ASTM D543, D412, D1434	Less than 1% weight change
Acid Exposure (10% H2SO4 for 90 days)	ASTM D543	Less than 1% weight change
Radon Permeability	Tested by US Dept. of Energy	Ø permeability to Radon (222 Rn)
Chromate Exposure (10% Chromium6+ salt for 31 days)	ASTM E96	Less than 1% weight change
Air Infiltration	ASTM E283-91	0 cfm/sq. ft.
*Bonded Seam Strength Tests	ASTM D6392	Passed
*Micro Organism Resistance (Soil Burial)	ASTM D4068-88	Passed
*Methane Permeability	ASTM 1434-82	Passed
*Oil Resistance Test:	ASTM D543-87	Passed
*Heat Aging:	ASTM D4068-88	Passed
*Dead Load Seam Strength	City of Los Angeles	Passed
*Environmental Stress-Cracking	ASTM D1693-78	Passed
PCE Diffusion Coefficient	Tested at 6,000 mg/m3	2.74×10^{-14} m^2/sec
TCE Diffusion Coefficient	Tested at 20,000 mg/m3	8.04×10^{-14} m^2/sec
Benzene Diffusion Test	Tested at 43,000 ppm	2.90×10^{-11} m^2/day

* Required Tests for membranes in the City of Los Angeles Methane Zone

PROPERTIES cont'd	TEST METHOD	VALUE
Soil Burial	ASTM E154-88	Passed
Water Penetration Rate	ASTM D2434	$<7.75 \times 10^{-9}$ cm/sec
Water Vapor Permeability	ASTM E96	0.24 perms
Water Vapor Transmission	ASTM E96	0.10 grains/h-ft^2
Toxicity Test	22 CCR 66696	Passed
Potable Water Containment	ANSI/NSF 61	NSF Certified for tanks >300,000 gal
Coefficient of Friction (with geotextile both sides)	ASTM D5321	0.72
Cold Bend Test	ASTM D146	Passed. Ø cracking at -25°F
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. Ø spalling or disbondment
Accelerated Weathering and Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Hydrostatic Head Resistance	ASTM D751	Tested to 138 feet or 60 psi
Elongation	ASTM D412	1,332% Ø reinforcement, 90% recovery
Elongation w/8 oz. non-woven geotextile both sides	ASTM D751	100% (same as geotextile tested separately)
Tensile Strength	ASTM D412	58 psi without reinforcement
Tensile Strength w/8 oz. non-woven geotextile both sides	ASTM D751	196 psi (same as geotextile tested separately)
Tensile Bond Strength to Concrete	ASTM D413	2,556 lbs/ft^2 uplift force
Puncture Resistance w/8 oz. non-woven geotextile both sides	ASTM D4833	286 lbs. (travel of probe = 0.756 in)
Flame Spread	ASTM E108	Class A with top coat (comparable to UL790)
Electric Volume Resistivity	ASTM D257	1.91×10^{10} ohms-cm

LIMITED WARRANTY

CETCO warrants its products to be free of defects. This warranty only applies when the product is applied by Approved Applicators trained by CETCO. As factors which affect the result obtained from this product, including weather, equipment, construction, work-manship and other variables are all beyond CETCO's control, we warrant only that the material herein conforms to our product specifications. Under this warranty we will replace at no charge any product proved to be defective within 12 months of manufacture, provided it has been applied in accordance with our written directions for uses we recommend as suitable for this product. This warranty is in lieu of any and all other warranties expressed or implied (including any implied warranty of merchantability or fitness for a particular use), and the Manufacturer shall have no further liability of any kind including liability for consequential or incidental damages resulting from any defects or any delays caused by replacement or otherwise. This warranty shall become valid only when the product has been paid for in full.

PACKAGING

- 55 Gallon Drum
- 275 Gallon Tote

LIMITATIONS

- Do not allow materials to freeze in containers.
- Store Liquid Boot® at site in strict compliance with manufacturer's instructions.
- When applying material below 45°F, contact your local technical sales manager.

EQUIPMENT Contact CETCO for complete equipment specifications

- COMPRESSOR: Minimum output of 155-185 cubic feet per minute (CFM)
- PUMPS: For "A" drum, an air-powered piston pump of 4:1 ratio (suggested model: Graco, 4:1 Bulldog). For "B" drum, an air-powered diaphragm pump (0 -100 psi)
- HOSES: For "A" drum, ½" wire hose with a solvent resistant core (for diesel cleaning flush), hose rated for 500 psi minimum. For "B" drum, a 3/8" fluid hose rated at only 300 psi may be used.
- SPRAY WAND: Only the spray wand sold by CETCO is approved for the application of Liquid Boot®.
- SPRAY TIPS: Replacement tips can be purchased separately from CETCO.

800.527.9948 Fax 847.577.5566 For the most up-to-date product information, please visit our website, www.cetco.com.

TECHNICAL DATA

VI-20™ GEOMEMBRANE

HIGH-PERFORMANCE GAS VAPOR BARRIER

DESCRIPTION

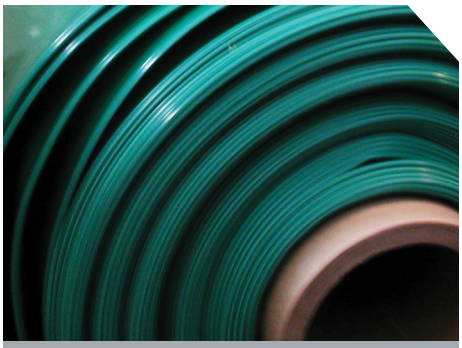
VI-20™ is a 7-layer co-extruded EVOH geomembrane made using high quality virgin-grade polyethylene and barrier resins that provide unmatched impact strength as well as superior resistance to VOC vapor transmission. EVOH technology serves as a highly resilient underslab and vertical wall barrier designed to restrict methane, radon and other harmful chemicals. Applications for EVOH originated in the manufacturing of automotive fuel systems to control emissions of hydrocarbons, whose use was mandated by the US EPA and the CA Air Resources Board (CARB) to reduce VOC emissions.

APPLICATION

VI-20™ is a 20-mil, high performance poly-ethylene-EVOH copolymer geomembrane, specially designed for use as a VOC barrier when used in conjunction with Liquid Boot® spray-applied gas vapor membrane to minimize gas vapor and nuisance water (non-hydrostatic conditions) migration into buildings. VI-20™ is ideal for applications with chlorinated solvents, BTEX and other PAHs.

BENEFITS

- Polyethylene layers provide excellent chemical resistance and physical properties
- EVOH barrier technology provides superior protection against diffusion of chemicals when compared to typical HDPE geomembranes
- Manufactured at ISO 9001:2008 certified plant



EVOH technology provided in VI-20™ geomembrane has been shown to have VOC diffusion coefficients 20 times lower than an 80 mil HDPE geomembrane.

PACKAGING

VI-20™ Geomembrane is available in the following packaging option:

- 10 ft. x 150 ft. Rolls

INSTALLATION

For use as a component of the Liquid Boot® Plus system, VI-20™ geomembrane is rolled out on prepared sub-grade, overlapping seams a minimum of six inches (6"). The geomembrane is cut around penetrations so that it lays flat on the sub-grade and tight at all inside corners. A thin (20 mil) tack coat of Liquid Boot® ("A" side without catalyst) is sprayed within the seam overlap. Once the VI-20™ geomembrane is installed, penetrations are then treated with VI-20™ Detailing Fabric prior to installation of the Liquid Boot® spray-applied gas vapor membrane and UltraShield™ G-1000 protection course.

VI-20™ CHEMICAL & PHYSICAL PROPERTIES		
CHEMICAL PROPERTY	**TEST METHOD**	**RESULT**
Benzene Diffusion Coefficient	EPA Method 8260	4.5 x 10-15 m^2/s
Ethylbenzene Diffusion Coefficient	EPA Method 8260	4.0 x 10-15 m^2/s
m&p-Xylenes Diffusion Coefficient	EPA Method 8260	3.7 x 10-15 m^2/s
Methane Permeability	ASTM 1434	< 5 x 10-10 $m^2/d \cdot atm$
o-Xylene Diffusion Coefficient	EPA Method 8260	3.7 x 10-15 m^2/s
Radon Diffusion Coefficient	EPA Method 8260	2.5 x 10-14 m^2/s
Toluene Diffusion Coefficient	EPA Method 8260	4.2 x 10-15 m^2/s

PHYSICAL PROPERTY	**TEST METHOD**	**RESULT**
Membrane Composite Thickness	ASTM D5199	20 mil
Puncture Resistacne	ASTM D1709	2,600 g
Tensile Strength	ASTM E154 Section. 9	58 lbs
Water Vapor Transmission	ASTM E154 & E96	.0025 US Perms

2870 Forbs Avenue, Hoffman Estates, IL 60192
800.527.9948 | http://remediation.cetco.com

REV: 2/12

Construction

Sikafloor®-160

2-part solvent free epoxy primer & binder, modular Sikafloor® system

Product Description	Sikafloor®-160 is a two part, low viscosity epoxy resin. "Total solid epoxy composition acc. to the test method Deutsche Bauchemie e.V. (German Association for construction chemicals)"
Uses	■ For priming concrete substrates, cement screeds and epoxy mortars ■ For normal to strongly absorbent surfaces ■ Primer for all Sika Epoxy floorings ■ Binder for levelling mortars and mortar screeds
Characteristics / Advantages	■ Solvent Free ■ Available in bulk quantities ■ Low viscosity ■ Good penetration ability ■ High bond strength ■ Easy application ■ Short waiting times ■ Multi-purpose

Product Data

Form

Appearance /Colours	Resin - part A:	transparent, liquid		
	Hardener - part B:	transparent, liquid		
Packaging	*Pre-proportioned 5.5 kg kit:*		*Pre-proportioned 11.1 kg kit:*	
	Part A Part B	3.55 kg 2 kg	Part A: Part B	7.1 kg 4 kg
	Bulk packaging:			
	Part A: Part B	20kg and 200kg 20kg and 200kg		
Yield	**5.55 kg kit:** **11.10 kg kit**	**5.1 litres approx.** **10.2 litres approx.**		
Mix Ratio	Part A : Part B =	(by mass) 1.8:1 (by volume) 1.6:1		
Consumption (as primer)	**2-3 m^2/litre for porous and high profile substrates and 5-6 m^2/litre for low profile and dense substrates**			

Storage

Storage Conditions/ Shelf-Life	24 months from date of production if stored properly in original, unopened and undamaged sealed packaging, in dry conditions at temperatures between +5°C and 30ºC.

Technical Data

Chemical Base	Epoxy	
Density	Part A: ~ 1.10 kg/l Part B: ~ 1.02 kg/l Mixed Resin: ~ 1.1 kg/l All density values at +23°C	(DIN EN ISO 2811-1)
Solid Content	~ 100% (by volume) / ~ 100% (by weight)	

Mechanical / Physical Properties

Compressive Strength	Mortar: ~ 95 N/mm² (7 days / +23°C / 50% r.h.)	(EN 196-1)
Bond Strength	> 1.5 N/mm^2 (failure in concrete)	(EN 4624)
Shore D Hardness	83 (7days / +23°C / 50% r.h.)	(DIN 53505)

System Information

System Structure

Primer:
Low/medium porosity concrete: 1 x Sikafloor®-160
High porosity concrete: 2 x Sikafloor®-160

Levelling mortar fine (surface roughness < 1 mm):
Primer: 1 x Sikafloor®-160
Levelling mortar: 1 x Sikafloor®-160 + Sikfloor® Fillers + Sikadur®-513

Levelling mortar medium (surface roughness up to 2 mm):
Primer: 1 x Sikafloor®-160
Levelling mortar: 1 x Sikafloor®-160 + Sikfloor® Fillers + Sikadur®-513

Mortar Screed (15 - 20 mm layer thickness) / Repair Mortar:
Primer: 1 x Sikafloor®-160
Bonding bridge: 1 x Sikafloor®-160
Screed: 1 x Sikafloor®-160 + Sikadur®-506

Application Details

Consumption / Dosage

Coating System	Product	Consumption
Primer	Sikafloor®-160	2-3 m^2/litre or 5-6 m²/litre for dense surfaces
Levelling mortar fine (surface roughness < 1 mm)	1 pbw Sikafloor®-160 + 0.5 pbw Sikfloor® Fillers + 0.015 pbw Sikadur®-513	1.4 kg/m²/mm
Levelling mortar medium (surface roughness up to 2 mm)	1 pbw Sikafloor®-160 + 1 pbw Sikfloor® Fillers + 0.015 pbw Sikadur®-513	1.6 kg/m²/mm
Bonding Bridge	Sikafloor®-160	2-3 m^2/litre or 5-6 m²/litre for dense surfaces
Mortar Screed (15 - 20 mm layer thickness) / Repair Mortar	1 pbw Sikafloor-160 + 10 pbw Sikadur®-506	2.2 kg/m²/mm

These figures are theoretical and do not allow for any additional material due to surface porosity, surface profile ,variations in level or wastage etc.

Substrate Quality

Concrete substrates must be sound and of sufficient compressive strength (minimum 25 N/mm^2) with a minimum pull off strength of 1.5 N/mm^2.

The substrate must be clean, dry and free of all contaminants such as dirt, oil, grease, coatings and surface treatments, etc.

If in doubt, apply a test area first.

Substrate Preparation

Concrete substrates must be prepared mechanically using abrasive blast cleaning or scarifying equipment to remove cement laitance and achieve an open textured surface.

Substrates heavily impregnated with oil must be cleaned by torching or other methods. To check that all traces of oil have been completely removed, sprinkle a few drops of water over the surface. If all the water is quickly absorbed, the surface is sufficiently oil and grease free. If water forms into globules that remain on the surface, further thorough treatment of the substrate is necessary.

Weak concrete must be removed and surface defects such as blowholes and voids must be fully exposed.

Repairs to the substrate, filling of blowholes/voids and surface levelling must be carried out using appropriate products from the Sikafloor®, SikaDur® and SikaGard® range of materials.

The concrete or screed substrate has to be primed or levelled in order to achieve an even surface.

High spots must be removed by e.g. grinding.

All dust, loose and friable material must be completely removed from all surfaces before application of the product, preferably by brush and/or vacuum.

Application Conditions / Limitations

Substrate Temperature

+10°C min. / +30°C max.

Ambient Temperature

+10°C min. / +30°C max.

Substrate Moisture Content

< 4% pbw moisture content.

Test method: Sika®-Tramex meter, CM - measurement or Oven-dry-method.

No rising moisture according to ASTM (Polyethylene-sheet).

Relative Air Humidity

80% r.h. max.

Dew Point

Beware of condensation! The substrate and uncured floor must be at least 3°C above dew point to reduce the risk of condensation or blooming on the floor finish. Note: Low temperatures and high humidity conditions increase the probability of blooming.

Application Instructions

Mixing Time

Prior to mixing, stir part A mechanically. When all of part B has been added to part A, mix continuously for 3 minutes until a uniform mix has been achieved.

When parts A and B have been mixed, add the quartz sand and if required the Sikadur®-513 and mix for a further 2 minutes until a uniform mix has been achieved.

To ensure thorough mixing pour materials into another container and mix again to achieve a consistent mix.

Over mixing must be avoided to minimise air entrainment.

Mixing Tools

Sikafloor®-160 must be thoroughly mixed using a low speed electric stirrer (300 - 400 rpm) or other suitable equipment.

For the preparation of mortars use a forced action mixer of rotating pan, paddle or trough type. Free fall mixers should not be used.

Application Method / Tools

Prior to application, confirm substrate moisture content, r.h. and dew point.

If > 4% pbw moisture content, Sikafloor® EpoCem® may be applied as a T.M.B. (temporary moisture barrier) system.

Primer:
Make sure that a continuous, pore free coat covers the substrate. If necessary, apply two priming coats. Apply Sikafloor®-160 by brush, roller or squeegee.

Levelling mortar:
Rough surfaces need to be levelled first. Apply the levelling mortar by squeegee/trowel to the required thickness.

Bonding bridge:
Apply Sikafloor®-160 by brush, roller or squeegee.

Mortar screed / repair mortar:
Apply the mortar screed evenly on the still “tacky” bonding bridge, using levelling battens and screed rails as necessary. After a short waiting time compact and smoothen the mortar with a trowel or Teflon coated power float (usually 20 - 90 rpm).

Cleaning of Tools

Clean all tools and application equipment with Thinner C immediately after use. Hardened and/or cured material can only be removed mechanically.

Potlife

Temperature	Time
+10°C	~ 50 minutes
+20°C	~ 25 minutes
+30°C	~ 15 minutes

Waiting Time / Overcoating

Before applying solvent free products on Sikafloor®-160 allow:

Substrate temperature	Minimum	Maximum
+10°C	24 hours	4 days
+20°C	12 hours	2 days
+30°C	6 hours	1 day

Before applying solvent containing products on Sikafloor®-160 allow:

Substrate temperature	Minimum	Maximum
+10°C	36 hours	3 days
+20°C	20 hours	2 days
+30°C	10 hours	1 day

Times are approximate and will be affected by changing ambient conditions particularly temperature and relative humidity.

Notes on Application / Limitations

Do not apply Sikafloor®-160 on substrates with rising moisture.

Freshly applied Sikafloor®-160 should be protected from damp, condensation and water for at least 24 hours.

Avoid puddles on the surface with the primer.

Sikafloor®-160 mortar screed is not suitable for frequent or permanent contact with water unless sealed.

Practical trials should be carried out for mortar mixes to assess suitable aggregate grain size distribution.

For external applications, apply on a falling temperature. If applied during rising temperatures “pin holing” may occur from rising air.

Construction joints require pre-treatment. Treat as follows:

- Static Cracks: prefill and level with SikaDur® or Sikafloor® epoxy resin
- Dynamic cracks: to be assessed and if necessary apply a stripe coat of elastomeric material or design as a movement joint

The incorrect assessment and treatment of cracks may lead to a reduced service life and reflective cracking.

Under certain conditions, underfloor heating or high ambient temperatures combined with high point loading, may lead to imprints in the resin.

If heating is required do not use gas, oil, paraffin or other fossil fuel heaters, these produce large quantities of both CO_2 and H_2O water vapour, which may adversely affect the finish. For heating use only electric powered warm air blower systems.

Curing Details

Applied Product ready for use

Temperature	Foot traffic	Light traffic	Full cure
+10°C	~ 24 hours	~ 4 days	~ 10 days
+20°C	~ 12 hours	~ 2 days	~ 7 days
+30°C	~ 6 hours	~ 1 days	~ 5 days

Note: Times are approximate and will be effected by changing ambient conditions.

Value Base

All technical data stated in this Product Data Sheet are based on laboratory tests. Actual measured data may vary due to circumstances beyond our control.

Health and Safety Information

For information and advice on the safe handling, storage and disposal of chemical products, users shall refer to the most recent Material Safety Data Sheet containing physical, ecological, toxicological and other safety-related data.

Legal Notes

The information, and, in particular, the recommendations relating to the application and end-use of Sika's products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions. In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The proprietary rights of third parties must be observed. All orders are accepted subject of our terms and conditions of sale. Users should always refer to the most recent issue of the Australian version of the Technical Data Sheet for the product concerned, copies of which will be supplied on request.

PLEASE CONSULT OUR TECHNICAL DEPARTMENT FOR FURTHER INFORMATION.

Construction

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