Douglas PARTNERS | GROUNDED EXPERTISE

Western Parkland City Authority
Level 2,10 Valentine Avenue
Parramatta, NSW 2150

Project 222630.00
10 April 2024
R.006.Rev0
ECR

Attention: Christine Phan
Email: christine.phan@wpca.sydney

Geotechnical Comment - Response to Design Queries
Proposed Stormwater Infrastructure
215 Badgerys Creek Road, Bradfield NSW

1. Introduction

This report has been prepared as a supplement to our previous reports for the site and to provide responses to specific design queries raised by Stantec, civil designers, for the proposed Regional Stormwater Infrastructure Corridor (RSIC) for the proposed Bradfield City Centre at 215 Badgerys Creek Road, Bradfield. Additional ground water monitoring and surface water sampling has been carried out to supplement previous investigations and assist in addressing the design queries. A description of the additional work undertaken and the response to the various design queries are given within.

2. Background

Douglas Partners Pty Ltd (Douglas) has previously carried out the following investigations for the site:

- "Report on Salinity Investigation, Proposed Urban Development, Bradfield City Centre" (Douglas Project 222630.00.R.004.Rev2) dated 22 January 2024; and

- "Report on Geotechnical Investigation, Stage 2 Civil Works and Regional Stormwater Infrastructure Works, Bradfield City Centre", (Douglas Project 222630.00.R.003.Rev2) dated 19 January 2024

The above two investigations were carried out prior to specific design details being available for the RSIC and as a result, only general geotechnical comments and advice were provided. The test locations within the RSIC were nominated by Douglas Partners without having the proposed site layout and were restricted by access in the water logged areas surrounding the creek.

Stantec, civil designers, have prepared 50% design plans (Stantec Drawing Project No 304000968, Revision 1 dated 29 September 2023) and have provided a list of specific design queries with respect to geotechnical and salinity characteristics of the site.

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3. Supplementary Surface Water Testing

Additional surface water samples were collected for testing of pH and electrical conductivity (EC). The samples were collected from ponded surface water along the Moore Gully alignment on 30 January 2024 following a period of moderate rainfall (locations are shown on Drawing 1, attached). The results of the testing are presented in Table 1.

Table 1: Summary of Testing in Groundwater

Sample	pH	EC (mS/cm)	Salinity (Hazleton and Murphy 2007)
Sample A	6.7	1100	Slightly Saline
Sample B	6.8	1100	Slightly Saline
Sample C	6.6	1100	Slightly Saline
Sample D	7.0	1200	Slightly Saline

The results indicate that the surface water is slightly saline whilst the groundwater testing undertaken as part of the previous investigation was highly saline.

4. Supplementary Groundwater Monitoring

Additional groundwater monitoring was carried out to gather up to date and supplementary groundwater levels to address the design queries. A summary of groundwater observations and measurements within the wells is presented in Table 2. The data from the previous investigation is presented together with the additional measurements taken on 30 January 2024. It is noted that groundwater levels will fluctuate over time in response to climatic variations or anthropogenic influences.

The boreholes drilled as part of the previous field work (August 2023) were to the north of the water logged areas surrounding the Moore Gully water course (refer Drawing 1, attached). The groundwater levels generally match the levels of the low points of Moore Gully in the west and Thompsons Creek in the east.

Table 2: Results of Groundwater Well Monitoring

Bore No.	Date	Groundwater Depth (m bgl)	Groundwater RL (m AHD)
201 Surface RL: 68.1 Well Depth: 5.0 m	24 August 2023	2.1	66.0
	14 September 2023	2.2	65.9
	26 September 2023	2.2	65.9
	30 January 2024	2.1	66.0
203 Surface RL: 64.2 Well Depth 5.0 m	24 August 2023	3.0	61.2
	14 September 2023	2.7	61.5
	26 September 2023	2.7	61.5
	30 January 2024	2.8	61.4
204 Surface RL: 62.3 Well Depth: 5.0 m	24 August 2023	2.8	59.6
	14 September 2023	2.9	59.5
	26 September 2023	2.9	59.4
	30 January 2024	None encountered*	-
206 Surface RL: 59.3 Well Depth: 5.0 m	24 August 2023	1.7	57.7
	14 September 2023	1.8	57.5
	26 September 2023	1.8	57.5
	30 January 2024	1.5	57.8

*Absence of groundwater in Bore 204 on 30 January 2024 is anomalous and not appropriate for design

5. Proposed Development

The proposed RSIC covers the central portion of the site which currently includes Moore Gully, which is an ephemeral creek line. Two small farm dams are along the alignment. Moore Gully flows from west to east along a wide grassy channel and drains into Thompsons Creek to the east. The RSIC will replace the existing natural drainage corridor of Moore Gully and Thompsons Creek. It will comprise a series of linked water quality basins and wetlands to reduce sediment load of stormwater before emptying back into Thompsons Creek to the east. The general site layout is shown in Figure 1.

The basins will be up to 5 m deep (typically 2 – 3 m) with embankment batters at grades between 1V:3H and 1V:4H. Water will flow between the various basins and wetlands via pipes embedded within the basin embankments. The basins include lined spillways to manage flood events and a high flow channel will bypass the whole series of basins and wetlands to allow increased flow capacity during periods of higher rainfall.

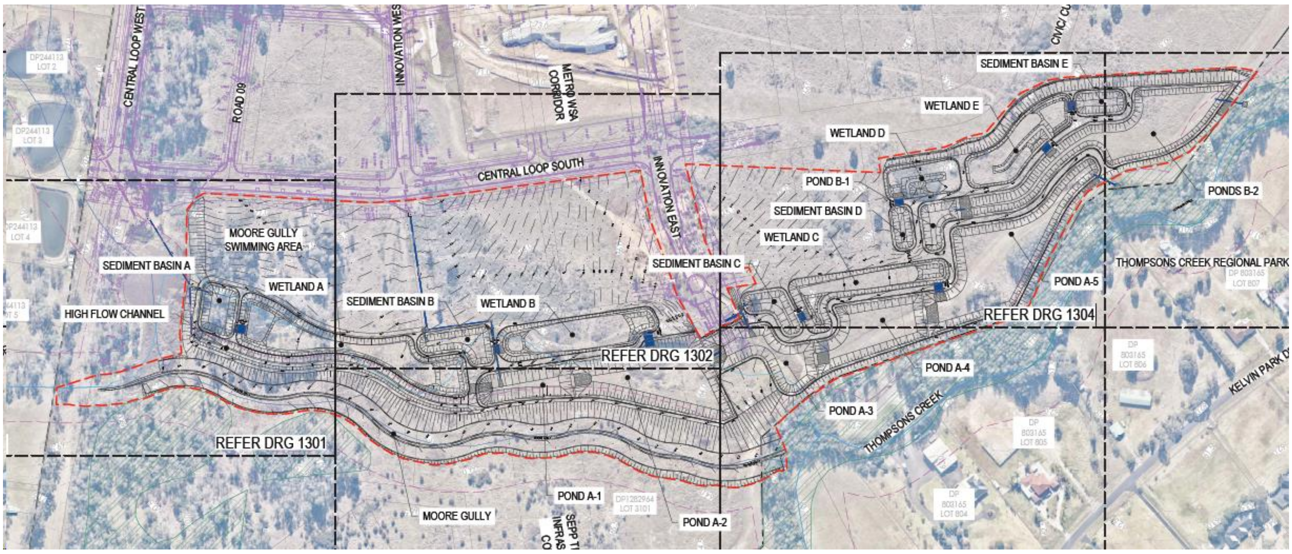


Figure 1: Extract from the 50% design plans showing proposed RSIC layout

A bulk earthworks specification has been provided in the drawing notes which summarised as follows:

- Fill areas should be stripped of topsoil/organic material and test rolled in the presence of a qualified geotechnical engineer;
- Fill material should be placed within 2% of standard optimum moisture content;
- Fill should be compacted in maximum 150 mm loose layer thickness to achieve a Standard Dry Density ratio of at least 98%
- Frequency of compaction testing should be not less than:
  - 1 test per 200 m^3 per 300 mm thick layer of fill;
  - 3 tests per visit;
  - 1 test per 1000 m2 of exposed subgrade;
  - Level 1 testing shall be in accordance with AS3798.

6. Design Queries

The specific design queries forwarded by Stantec are listed and addressed below with reference to the RFI numbers provided to us. Queries relating to the Douglas geotechnical report are prefixed with a "G" and the salinity report with an "S" (eg "G7" is RFI number 7 relating to the geotechnical report). It is noted that the responses must still be considered preliminary and Douglas Partners should be consulted as the design progresses.

6.1 Design Queries for Geotechnical Report

G7: Geotechnical advice required re: the basin embankment construction e.g. clay core between the basins.

A zoned embankment, (ie an embankment that is not homogeneous in composition such as having a clay core or a clay surface to minimise water infiltration whilst the remainder of the embankment is formed from other materials) would typically be used where suitable clayey material is scarce. However, the complexity of the basin and wetlands layout will make it very difficult to construct using zoned embankments.

Homogenous embankments will be relatively straight forward to construct however the geotechnical investigation has indicated that the available cut/fill material comprises intermediate and high plasticity clay with a high dispersion potential. High plasticity clay will shrink and crack when dried creating unwanted water pathways. High dispersion potential indicates that the material will disperse easily, even in standing water, leading to high erosion rates and murky water. Therefore, the site clays are not suitable for direct use in embankment construction without stabilisation using lime or gypsum which will reduce the plasticity and dispersibility, thus making them suitable for reuse. Based on the above, consideration should be given to the three options presented below:

- **Option 1 – Stabilisation of the whole embankment.** The whole embankment would be constructed homogenously using stabilised clay fill. This has the benefit of being straight forward to construct but has the downside of requiring a large volume of stabilised material.

- **Option 2 – Stabilisation of the outer layer of the embankments.** Only the outer layer would be stabilised. The treated clay blanket thickness should be at least 1 m (measured perpendicular to the face of the batter slope). The inner portion of the embankment could comprise untreated site won clays. This option has the benefit of requiring less stabilised material and the downside of being harder to construct.

- **Option 3 – Use an artificial liner.** The use of an artificial liner such as bentofix or HDPE would allow the construction of a homogenous embankment using untreated site won material. This option has the benefit of being easier to construct than Option 2 however costs and other limitations of such a liner will need to be discussed with the suppliers.

Where stabilisation is required (Options 1 and 2), stabilisation with 3% gypsum (by dry weight) could be considered as a starting point however additional testing will need to be carried out on treated material to confirm appropriate dispersion and plasticity criteria are met.

Considering the embankments will be constructed using the same material as the foundation material , a typical “keyway” below the centre of the embankment will not be required however the base of the embankment should be tyned to allow appropriate tying in of the first layer of embankment fill.

G14: The report suggested clay liner or impermeable plastic liner to prevent localised raising of the groundwater levels. However, the report also suggested the area consist of clay with low permeability, is the existing clay material a natural liner? Or should we adopt impermeable plastic liner?

The use of a liner (stabilised clay or artificial) is recommended however this should be considered together with the response to previous query (G7). Any of the three options adopted should also be considered to act as a suitable, low-permeability, non-dispersive liner. The natural material is not suitable without stabilisation due to the dispersibility and shrink-swell potential.

G15: The base of the basins need to be above the groundwater table, however the water level fluctuates. Should we use the highest levels in Table 1 to set the minimum basin base levels?

The groundwater levels are determined by the surface water levels in Moore Gully and Thompsons Creek. The Moore Gully surface levels fall from RL67 in the west to RL 64 in the east where Moore Gully discharges into Thompsons Creek. Further east, the levels are determined by Thompsons Creek which falls to RL 59 near the eastern boundary of the site. The measured groundwater levels are all within a metre of the nearest creek surface water levels.

The use of the highest recorded groundwater levels presented in Table 1 for design may not be appropriate as they are isolated measurements of groundwater and have likely not captured maximum or minimum fluctuations. Notwithstanding, an increase of the shallow groundwater levels would result in (or be a result of) flooding of the areas surrounding the creeks.

Critically, the proposed RSIC works will have an effect on the groundwater levels. Additional investigation and detailed groundwater modelling will be required to indicate the effect the RSIC works will have.

If the basins and wetlands are lined and will permanently hold water, it will not be as critical to design the base of the basins/wetlands to be above the groundwater levels. The lining will separate the basin and wetland water from the groundwater and if they remain full of water, hydrostatic pressure from the groundwater will not damage the basin lining. Notwithstanding, if standing ground water levels are above the proposed basin bases, dewatering will be required during excavation and construction.

G17: Please provide recommendation/specification on the clay core and trench in the proposed basin embankment.

Refer to the response to G7 and previous report site preparation recommendations. The general fill placement and testing specification provided in the drawings is considered reasonable however some minor changes could be considered (changes are in **bold** text).

- Compaction: Min 98%, **Max 102%** Standard compaction (change to add a maximum to prevent over compaction)
- Moisture content: **-1%** to +2% of Standard optimum moisture content (change from ±2% to limit placement of dry material);

- Layers could have a maximum loose thickness of **250 mm**; (change to allow placement of thicker layers which are readily compacted by large compaction equipment. Thinner layers may be needed if small compaction equipment is used)

- Testing frequency requirements should include the comment **whichever requires the most tests**

- Testing Frequency requirements should note:

  - One test **per layer** per 1000 m^2; or

  - One test per 200 m^3 distributed evenly **through the full depth and area**; or

  - Or 3 tests **per lot where a lot is a specific material type or days fill.**

With regards to fill materials, the site won material encountered in the previous investigations meets the requirements for unstabilised material and is expected to be suitable for use following stabilisation where or if required. Confirmation testing will be required on stabilised material and any imported material.

- Material Description: Clay, sandy / silty clay;

- Plasticity Index: 10% to 30% for stabilised clay, 10% - 50% for unstabilised clay;

- Permeability: < 10^{-9} m/s;

- Emerson Class: Minimum of “4” for stabilised clay, “2” for unstabilised clay;

- Maximum particle size: 50 mm;

- At least 30% fines (material passing 75 micron sieve);

G24: Can ground water levels be interpolated between BH201 and BH203? Noted the levels can be used for preliminary purpose, however, we are proceeding to provide a design package for construction purposes, will there be further advice to confirm the groundwater level we should adopt?"

Refer to G15. Whilst groundwater levels could be interpolated between boreholes, the water levels are determined by the Moore Gully surface water levels so review of adjacent creek levels will be more accurate than interpolation between boreholes. Critically, these are only pre development groundwater levels and the development will likely change the long term groundwater levels.

G26: There will be permanent water in sediment basins, wetlands and the ponds. Will 1V in 3H batter be ok for the slopes below the permanent water levels. Advise the type of material.

Whilst specific stability analysis has not been carried out, 1V in 3H batters prepared in accordance with the specification with up to 2 m of the toe submerged are expected to be appropriate from a global stability standpoint. The materials should be as discussed in responses to G7 and G17.

G27: The report suggests a capping layer to be laid on the backfill, could you please provide specification and depth of the capping layer.

Refer to responses to G7 and G17.

G31: Please provide methodology for the construction of the embankment around the basins.

Methodology will vary depending on the Option (See G7) adopted. The methodology provided in the drawing notes is generally considered appropriate but more detailed methodology specific to the different options is provided below.

Option 1 (Homogenous stabilised clay embankment):

- Strip all organic topsoils and other deleterious materials from the subgrade areas. These materials will not be suitable for reuse as fill. Topsoil or other organic soils can however be stockpiled and used in future landscaped areas;

- Inspect the stripped surfaces to confirm that there is no remaining topsoil or unsuitable material (such as uncontrolled fill or similar) prior to fill placement. Test roll the subgrade with a smooth drum roller of at least 12 tonnes static deadweight capacity. Soft or weak areas should be rectified as directed by the geotechnical consultant;

- Treatment of the stabilised clay embankment fill should be with about 3% (by dry weight) gypsum. Care should be taken to ensure that the gypsum additive is thoroughly mixed through the site won clay fill. Emerson class testing must be undertaken on the gypsum-treated clay soils to confirm that the target dispersion and plasticity criteria have been met.

- The stabilised clay fill should be moisture conditioned to within 1% dry to 2% wet of Standard optimum moisture content and placed in near horizontal layers with a loose thickness of not more than 250 mm.

- The layers should be evenly compacted to achieve a maximum dry density ratio of 98% - 102% relative to Standard compaction.

- Batters should be overfilled and cut back to the design profile to ensure edges are properly compacted.

- All fill placement should be undertaken under Level 1 inspection and testing as described in AS3798 – 2007.

- The batters should be covered with a minimum of 0.3 m of topsoil and appropriately vegetated as soon as practical following construction.

Option 2 (Stabilisation of outer layer of embankments): As above but with unstabilised material used for general embankment construction and stabilised material placed as a blanket at least 1 m thick on the outside of the embankment. The stabilised material could be placed concurrently as the embankment is built up or keyed into the unstabilised embankment after placement.

Option 3 (Artificial liner): As per Option 1 but using unstabilised material and with the artificial liner placed in accordance with the manufacturer's recommendations.

Regardless of the option adopted, the batters should be vegetated to protect against erosion. Suitable vegetation includes grasses and shallow rooted shrubs. Trees are generally not recommended to be planted on embankments due to the following:

- Trees can obscure issues during routine inspections;
- Tree roots can form piping pathways leading to erosion and embankment failure;
- Trees within embankments may be more susceptible to uprooting and overturning which can cause significant damage to the embankments.

Notwithstanding, if the consequence (to life and property) of embankment failure is considered to be low, trees could be planted provided the risks are accepted and appropriately managed. Root systems could be managed through the use of planter boxes and root barriers. Tree types should be carefully selected with minimal lateral root extents. The embankments could also be raised to have a “sacrificial” upper layer which is above spillway levels. Arborists could provide maximum root depths and the sacrificial upper layer specified to be greater than the tree root depths. The planting of any trees will require additional maintenance and inspections.

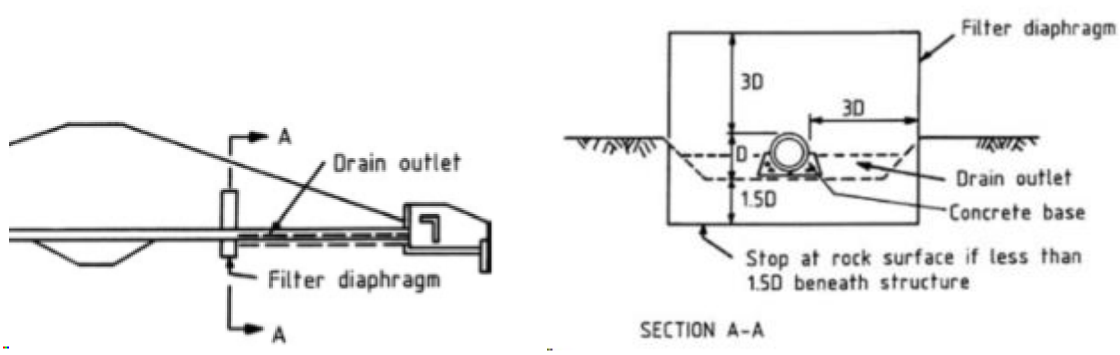
G32: Please provide specifications for the materials to be used for the proposed embankments (i.e. clay core, fill and topsoil)

Refer to response to G17. Topsoil should be non-dispersive (Emerson class of 4 or 5).

G33: There will outlet pipes through the embankments to convey water to the basins and creeks, please provide recommendation on the required treatment along the pipelines.

Pipes within the embankment are not recommended due to the increased risk of piping failure. A recommended design alternative is pipes installed under the foundation with risers on each end. If pipes within the embankment are adopted, the following should be incorporated into the design to reduce the risk of piping around the discharge pipes:

- Concrete encasement of the pipe to facilitate compaction of the clay surrounding the pipe. The sides of the encasement should be sloped not steeper than 1H:8V to facilitate compaction of fill around the pipe;
- Careful placement and compaction of clay material around the pipe. The clay fill should be placed slightly wet of optimum (1 – 2% wet) and not allowed to dry and crack prior to placement of additional embankment fill;
- Use of a filter diaphragm. The filter diaphragm would comprise a vertical “curtain” of sandy gravel material wrapped in a non-woven geofabric which connects to a drain outlet parallel to the pipe which drains into the outlet headwall; (refer Figures 2 and 3)



Figures 2 and 3: Filter diaphragm sections for seepage and piping control around outlet pipe (Fell et al, 2005)

6.2 Design Queries for the Salinity Report

S4: The report suggests further assessment of the impact of the saline groundwater system should be undertaken. What sort of output will be provided in the assessment, will it affect the design of the wetlands/retention ponds? When will this assessment take place, do they need our 80% design documentation?

Additional surface water samples were recently collected to measure surface water salinity following recent rainfall. Further sampling after a prolonged dry period is proposed however the timing of such a period cannot be predicted. Considering the existing highly saline groundwater and the requirements for basin lining from a geotechnical standpoint, it is unlikely that the additional sampling will significantly affect the design of the retention ponds.

S5: The stormwater runoff that stored in the retention pond will be reused for irrigation, therefore, the proposed basins, wetlands will need to be designed to be above the groundwater table, could you please clarify the groundwater levels we should adopt?

Refer G15 and G24

S6: Has DP reviewed the cut/fill plan for the basins? There will be cut to provide storage for the water retention ponds and the wetlands are generally in fill. There will be plantings in the wetland to provide stormwater treatment, will the material be suitable for the construction of the wetland?

The material is suitable for use as general fill and however due to the reactivity and dispersibility, the material should be stabilised (refer G7) to be appropriate for long term exposure to water.

S7: DP recommends a capping layer to be provided for the exposed excavation/filling of sodic soils. What should the depth of capping layer? And How deep should the top soil be? Based on the report, it seems like the construction of wetland and pond will consist of top soil impermeable liner on capping layer, it this correct?

A stabilised capping layer for basin embankments is discussed in G7 and should be 1 m thick. If homogenous stabilised embankments or artificially lined embankments are proposed, a capping layer will not be required. A capping depth of 300 mm of stabilised or non-sodic organic topsoil would be sufficient in general fill (ie not basin or water holding embankments).

S8: The trunk drainage network will consists of concrete pipes greater than 750mm diameter pipes, we noted sulphate resistant cement to be used for those pipes, can we use sulphate resistant material for pipes smaller than 750mm diameter and box culverts? Should the inside of the pipe be lined with PVC layer as risk of saline water draining through the pipes?

The use of sulfate resistant cement or pipe coatings is not applicable to the stormwater corridor portion of the site. (This will apply to portions of the Stage 2A civil site.) Pipes should be designed in accordance with our Salinity report Section 8.3 (K), repeated as follows:

K. Wet cast concrete pipes and currently manufactured spun concrete pipes are understood to have estimated compressive strengths of 50 MPa and 60 – 70 MPa, respectively, in excess of the requirements for mass concrete. Reference to the maximum and minimum test results within the RSIC and to Tables E1 and 3.1 of AS 4058 – 2007 "Precast concrete pipes" indicates that the site falls within the AS 4058 Clay/Stagnant (low sulphate) soil type (chlorides <=20,000 ppm, pH>=4.5 and sulphates <=1,000 ppm) and (in the absence of tidal water flow) falls within the AS 4058 Normal durability environment. Under these conditions, AS 4058-compliant reinforced concrete pipes of general purpose Portland cement, with a minimum cover to reinforcement of 10 mm, are expected to have a design life in excess of 100 years. Any concrete pipes installed within the site should employ AS 4058-compliant steel reinforced pipes of general purpose Portland cement, with minimum cover to reinforcement of 10 mm, or should be fibre reinforced spun concrete.

S9: Further to the question above, is the report suggesting pipes less than 750mm diameter should be encased by a PVC layer? Will Sydney Water accept PVC/PE pipes or FRC pipes?

Not required, refer S8.

S11: Sydney Water wants to reduce the base RL of the ponds to increase the storage depths, hence reduce the footprint of the ponds. Could you please request recommendations from the geotechnical engineer to provide the groundwater levels to be used for the proposed basins?

Refer G15 and G24

7. Conclusions

The primary constraint within the RSIC is the shallow groundwater which is controlled by the adjacent waterways of Moore Gully and Thompsons Creek. The proposed development will have an effect on the ground water levels and further groundwater modelling will be required to determine the influence of the development on the groundwater levels.

The field investigations were carried out before details of the proposed development layout were known. The investigations were preliminary in nature and therefore the responses based on those investigations must also be considered preliminary. Further investigation based on the proposed site layout will be necessary as the design progresses. In particular, detailed groundwater modelling and additional test locations to reduce uncertainty in the subsurface conditions is recommended.

8. References

Fell, et al. (2005). Geotechnical Engineering of Dams. Robin Fell, Patrick MacGregor, David Stapledon & Graeme Bell.

9. Limitations

Douglas Partners (Douglas) has prepared this report for this project at 215 Badgerys Creek Road, Bradfield NSW in accordance with Douglas' proposal dated 14 December 2023 and acceptance received from Alex Nikolic of WPCA. The work was carried out under the WPCA services agreement. This report is provided for the exclusive use of Western Parkland City Authority 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 Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

Douglas' advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully

Douglas Partners Pty Ltd	Reviewed by
	pp.
Eric Riggle	**G W McIntosh / Christopher C Kline**
Engineering Geologist	Principal Consultant Principal

Attachments: About this Report
Laboratory Test Results
Drawing 1: Test Location Plan

About this Report

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.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

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.

continued next page

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.

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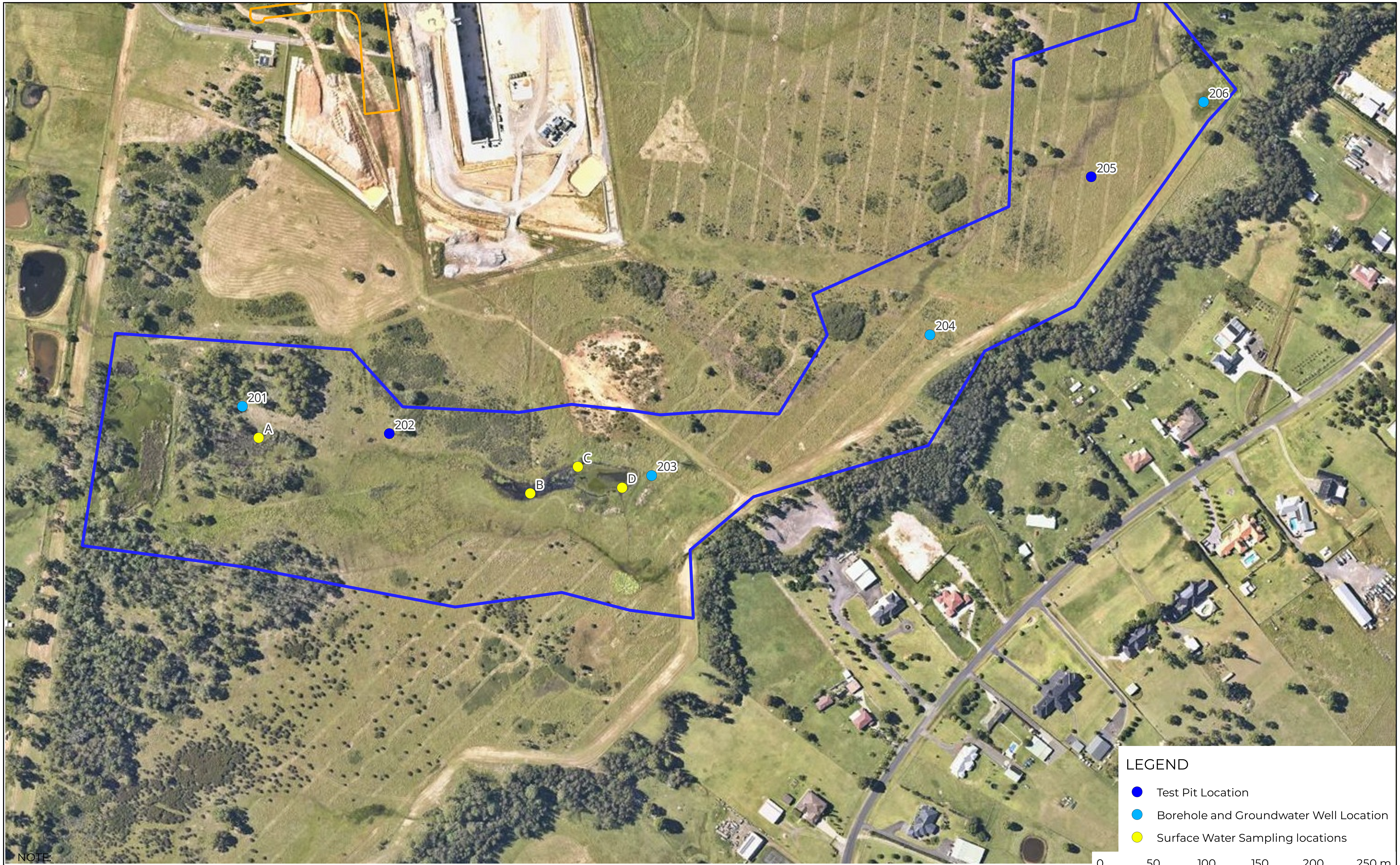
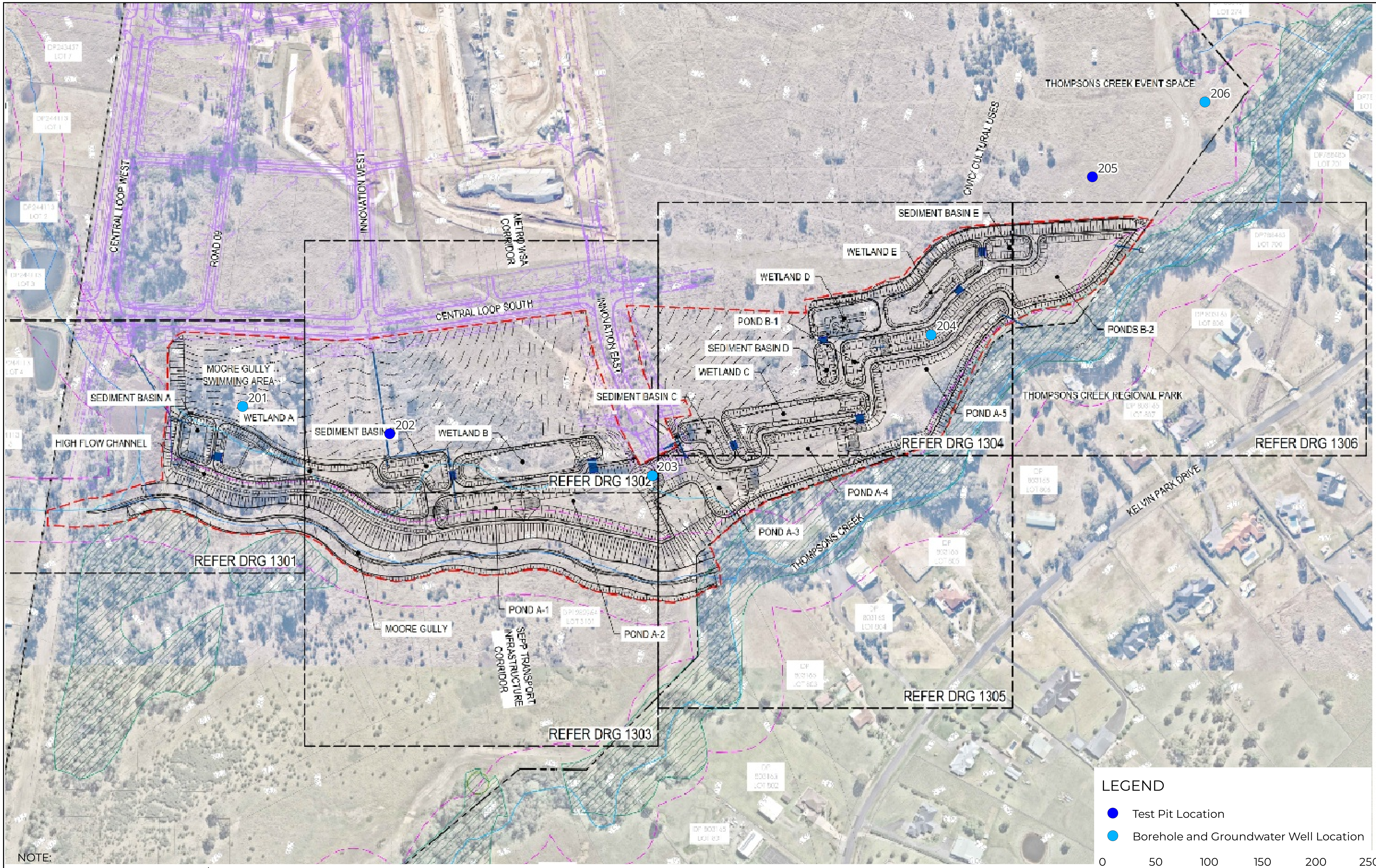


NOTE:
1. Drawing projection in GDA2020 / MGA zone 56, adapted from Stantec drawing 304000968-100-C1031 Rev1,
2. Test locations are approximate only

Douglas PARTNERS	CLIENT: Western Parkland City Authority	TITLE: **Test Location Plan**	PROJECT: 222630.00
	OFFICE: Macarthur / DRAWN BY: ECR	**Propsoed Stormwater Infrastructure Corridor**	DRAWING No: 2
	DATE: 08.April.2024	**Bradfield City Centre, 215 Badgerys Creek Road, Bradfield**	REVISION: 0



NOTE:
1. Drawing projection in GDA2020 / MGA zone 56, adapted from Stantec drawing 304000968-100-C1031 Rev1,
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

Douglas PARTNERS

CLIENT: Western Parkland City Authority		TITLE:	**Test Location Plan**
OFFICE: Macarthur	DRAWN BY: ECR		**Propsoed Stormwater Infrastructure Corridor**
	DATE: 06.March.2024		**Bradfield City Centre, 215 Badgerys Creek Road, Bradfield**

N

PROJECT:	222630.00
DRAWING No:	2
REVISION:	0

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CERTIFICATE OF ANALYSIS 342829

Client Details

Client	Douglas Partners Pty Ltd
Attention	Eric Riggle
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**222630.00, Bringelly, Bradfield Centre**
Number of Samples	4 Water
Date samples received	01/02/2024
Date completed instructions received	01/02/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	08/02/2024
Date of Issue	02/02/2024

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Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By
Nancy Zhang, Laboratory Manager

Miscellaneous Inorganics					
Our Reference		342829-1	342829-2	342829-3	342829-4
Your Reference	UNITS	A	B	C	D
Date Sampled		30/01/2024	30/01/2024	30/01/2024	30/01/2024
Type of sample		Water	Water	Water	Water
Date prepared	-	01/02/2024	01/02/2024	01/02/2024	01/02/2024
Date analysed	-	01/02/2024	01/02/2024	01/02/2024	01/02/2024
pH	pH Units	6.7	6.8	6.6	7.0
Electrical Conductivity	µS/cm	1,100	1,100	1,100	1,200

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			01/02/2024	1	01/02/2024	01/02/2024		01/02/2024	[NT]
Date analysed	-			01/02/2024	1	01/02/2024	01/02/2024		01/02/2024	[NT]
pH	pH Units		Inorg-001	[NT]	1	6.7	6.7	0	101	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	1	1100	1100	0	107	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.