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Memo

To	Horsham Downs Estate Ltd
From	Constantinos Fokianos
Date	16 June 2026
Job No.	s 9(2)(b)(ii)
Job name	319 Gordonton Road
Subject	Technical Memorandum – Hydrological and Stormwater Assessment for Freshfield Pumpstation Catchment and 319 Gordonton Road

1. Introduction

This technical memorandum presents a preliminary, high-level assessment of stormwater and flood management considerations for the proposed development located at 319 Gordonton Road in Hamilton.

The development site encompasses approximately 54 hectares and is situated within the broader 518-hectare Freshfield Pumpstation catchment—an area typified by low-lying, peat-dominated soils, shallow surface gradients, and reliance on mechanically assisted drainage systems.

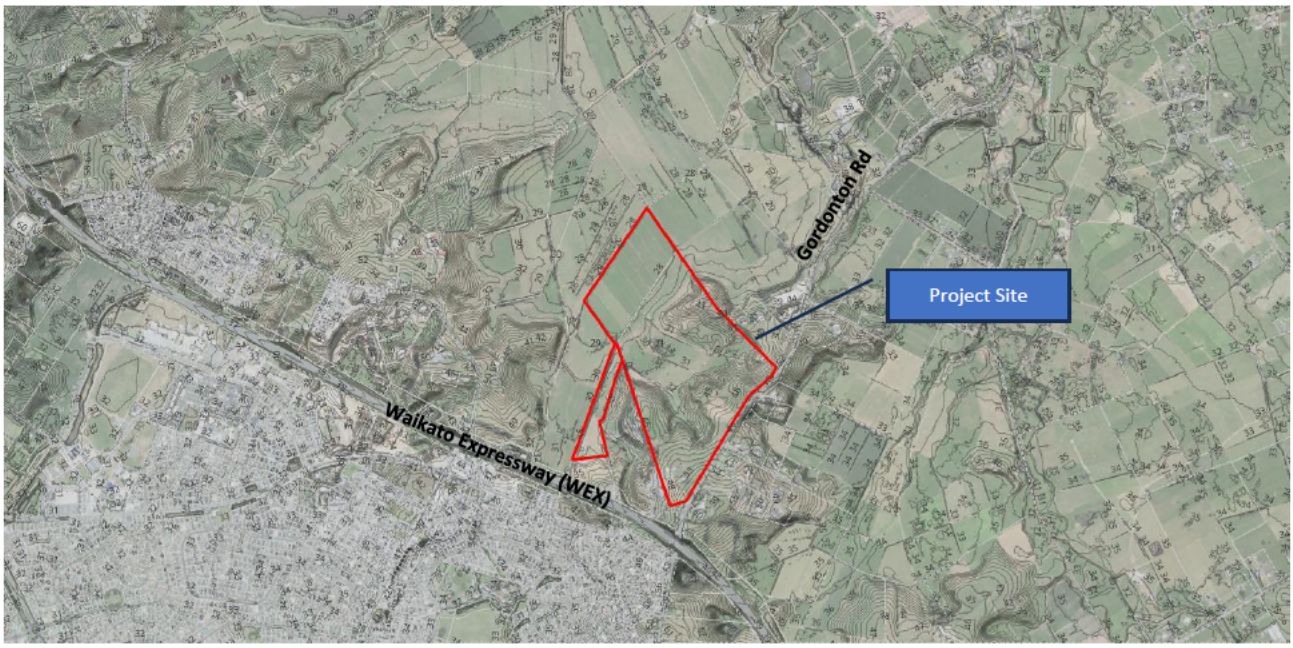


Figure 1. Site locality

This assessment has also been informed by the preliminary geotechnical desktop assessment and groundwater drawdown assessment prepared by CMW Geosciences. These reports identify the site as comprising elevated ridges and lower-lying plains, with the lower areas associated with Piako Subgroup

alluvial deposits including silts, sands, gravels and peat. These findings support the stormwater assessment approach, particularly the need to avoid reliance on widespread infiltration-based disposal and to prioritise surface-based flood storage, controlled conveyance, and treatment infrastructure.

The purpose of this memorandum is to evaluate existing catchment conditions, analyse projected runoff volumes from the development under relevant climate change scenarios, and identify stormwater management requirements necessary for achieving compliance with the Waikato Regional Council's (WRC) regulatory framework.

In particular, the assessment adheres to the performance benchmarks outlined in WRC Technical Reports TR2020/06 and TR2020/07, which address both flood attenuation and water quality management.

- The analysis incorporates results from TUFLOW modelling of the 2-, 10-, and 100-year Average Recurrence Interval (ARI) rainfall events, including the 100-year 24-hour climate-adjusted rainfall event based on the RCP8.5 / +4°C temperature-increase methodology set out in WRC TR25-26. For the 100-year ARI event, this corresponds to a 24-hour rainfall depth of 199 mm, representing a 34.4% increase above the historical 148 mm rainfall depth. The model reflects existing and post-development conditions, including stormwater detention infrastructure, distributed rain tank storage, and operation of the Freshfield Pumpstation at a constant discharge capacity of 2.28 cubic meters per second (m^3/s). It also considers a residual risk scenario where the pump fails. Despite the presence of this infrastructure, the modelled results confirm that without on-site mitigation, floodwater accumulates across larger areas of the site due to same stormwater constraints identified above.
- With on-site mitigation there are no adverse stormwater effects off-site (even in the event of a pump failure), even in a 1% ARI event. The design and location of dwellings on site will also not be impacted by such a flood event as they will be constructed to sit above the flood plain (and freeboard).

This memorandum also considers the design and placement of a wetland/pond system, raised treatment wetland, and additional conveyance elements. It includes scenario testing for pump failure conditions and confirms that post-development flood levels remain lower than under existing conditions, demonstrating that the proposed development can be accommodated without adverse downstream effects.

2. Author Experience, Qualifications and Code of Conduct

This memorandum has been prepared by Constantinos Fokianos, Water Resources Engineer at Bloxam Burnett & Olliver. Constantinos has experience in hydrological and hydraulic modelling, stormwater management design, flood risk assessment, flood storage and attenuation design, climate-change rainfall assessment, and technical reporting for land development and infrastructure projects in New Zealand.

The assessment has been prepared using recognised hydrological and hydraulic modelling methods and with reference to relevant Waikato Regional Council guidance, including TR2020/06, TR2020/07 and TR25-26.

Constantinos confirms that he has read the Environment Court of New Zealand Practice Note 2023, including the Code of Conduct for Expert Witnesses, and agrees to comply with it. He confirms that the opinions expressed in this memorandum are within his area of expertise, except where he states that he is relying on the evidence or advice of others. He also confirms that he has not omitted to consider any material facts known to him that might alter or detract from the opinions expressed.

3. Catchment and Pumpstation Overview

The Project Area falls within the "Freshfield" catchment, which is 518-hectares and is a hydraulically constrained, low-lying landscape located within Horsham Downs. It is almost entirely reliant on mechanical drainage via the Freshfield Pumpstation, owned and managed by Waikato Regional Council, which discharges stormwater into the receiving watercourse downstream through a flood-controlled outlet. The pumpstation represents a critical asset in the region's stormwater infrastructure network.

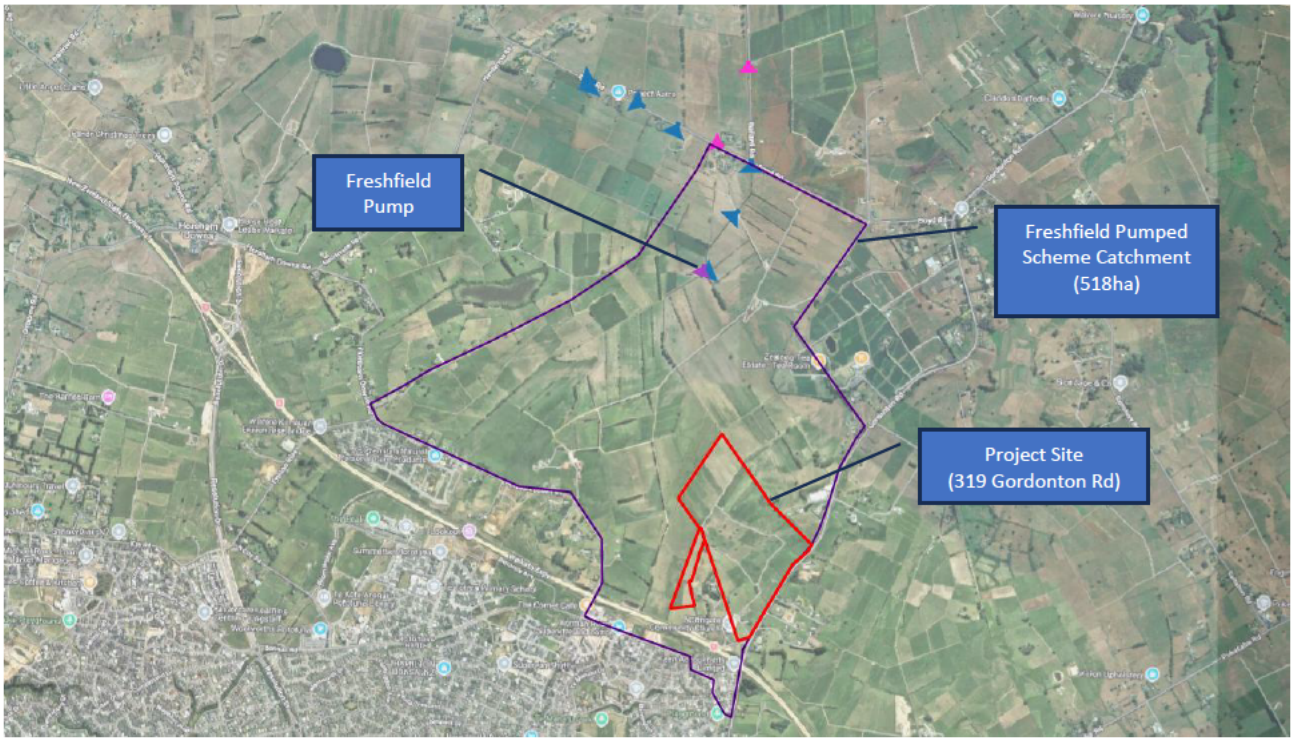


Figure 2. Freshfield Pumped Scheme catchment

As there are no definitive published specifications currently available regarding the Freshfield Pumpstation's operating capacity, assumptions have been made based on the Waikato Regional Council's Regional Asset Management Plan. It is understood that the station is designed to evacuate runoff resulting from 38 mm of rainfall across the entire catchment within a 24-hour period. This corresponds to a volume of 380 m^3 per hectare, and when distributed over 24 hours, results in an equivalent design discharge rate of approximately 4.4 litres per second per hectare (L/s/ha). Scaling this to the full 518-hectare catchment gives a total estimated pumping capacity of around 2.28 cubic metres per second (m^3/s).

The Freshfield pump subdivision already has a component of urban land protection, as set out In the WRC Land Drainage Management Plan 29 August 2019, see figure 3 below.

Table 10: Waikato Central funding system details

Drainage area/subdivision	Date	Plan Doc	Funding Policy Doc#	Classification category proportion							
				Urban	A	B	C	D	E	F	G
Waitakaruru	1999		527786	1000	100	70	50	20	15	5	0
Manor Park	2001		697857	500	100	70	-	-	50	20	0
Mangaonua	1999		527786	1000	100	70	50	20	15	5	0
Freshfield	2004		869517	1000	100	70	50	20	15	5	0
Freshfield Pump	2004		869517	1000	100	80	50	40	15	5	0
Komakorau	1991		2107377	1000	100	70	50	30	15	5	0
North Mangawara	2002		777186	1000	100	70	50	25	20	5	0
South Mangawara	2002		777186	1000	100	70	50	25	20	6	0
Tauhei	2002		777186	1000	100	70	50	25	20	6	0
Tenfoot	2002		777186	1000	100	70	50	25	20	6	0
Uapoto	2002		777186	1000	100	70	50	25	20	5	0
Rotokauri	1996		490382	1000	100	70	50	25	15	5	0
Ohote Basin	2001		697857	400	100	65	60	-	25	5	0
Ngaruawahia	1996		490382	1000	100	70	50	25	15	5	0
Fencourt	1999		527786	1000	100	70	50	20	15	5	0
Hautapu	1997		2106973	1000	100	70	50	25	15	5	0
Rotomanuka	1976			100	70	29	4	0			
Ohaupo/Ngaroto	2001		697857	1000	100	70	50	25	20	5	0
Greenhill	1968	1520489	1922441		100	90	63				
Hopu Hopu	1966	2174618	2122216		100	66	33	11			0
Kirikiriroa Horsham Downs	1983	2174621	2122216				20	10		2	
Kirikiriroa Komakorau	1983	2174623	2122216				20	10		1	
Koromatua	1974	2174626	2122216		100	66	16				
Matangi (SA)	1988	2174639	2122216		100						
Ngaruawahia North	1990	2174642	2122216		100						
Pukeroro	1969	2174646	2122216		100	66	50				
Puketaha	1993	2174647	2122216	1000	100	70	50	30	15	5	0
Te Kowhai	1969& 1980	2174653 & 2174651	2122216		100	75	37	25	12	6	0

All systems adopted from 1988 have been adopted under the former Rating Powers Act or the LGA 2002. All systems adopted prior to 1988 only include elements of direct benefit and indirect benefits.

Figure 3. Waikato Central Funding System, WRC Land Drainage Management Plan (PS201914).



Figure 4. Freshfield Pump.

This design standard, while historically developed in the context of rural land drainage, has become a baseline reference in stormwater assessments for both rural and peri-urban development. The continued use of the 38 mm depth and 24-hour drainage window reflects an operational performance threshold rather than a consent requirement on the relevant stormwater diversion and discharge consent, yet it remains influential in how new development is evaluated within drained catchments such as Freshfield.

The limited hydraulic gradient across the lower parts of the catchment, combined with reliance on a pumped outlet, means that floodwater recession is strongly controlled by the performance of the pumpstation and downstream drain system. The presence of poorly drained peat and fine-grained soils means that the existing rural land can generate substantial runoff under wet antecedent conditions, particularly during large or prolonged rainfall events. As a result, the hydrological difference between existing pasture and future impervious development is reduced in the largest storm events, although development still requires mitigation for increased runoff volume, reduced initial abstraction, and altered timing of flows. During high intensity or prolonged rainfall events, these characteristics necessitate conservative assumptions in runoff modelling, particularly regarding peak flows, detention storage sizing, and allowable release rates.

Moreover, the condition of the artificial drainage network—including open drains and culverts—plays a pivotal role in the performance of the pumpstation itself. Inadequate maintenance, blockages, or limited gradient within the network can substantially delay the conveyance of runoff to the pumpstation intake, increasing the risk of upstream flooding and extended ponding durations across development areas. For this reason, catchment-scale drainage performance must be considered holistically, not solely as a function of the pump's installed capacity.

As development intensifies within the catchment, cumulative runoff effects become increasingly relevant. Without appropriate on-site controls such as detention basins and time-managed orifices, new impervious surfaces could significantly raise peak inflows to the pumpstation, increasing the risk of backflow, downtime, and service disruption. It is therefore essential that new developments internalise stormwater management to a level that ensures post-development discharge does not exceed pre-development runoff rates and volumes, while remaining compatible with the mechanical limitations of the downstream drainage infrastructure.

The Project Area lies entirely within the effective drainage boundary of the Freshfield Pumpstation. Consequently, all post-development runoff must ultimately be managed to align with the capacity constraints of the pump. The flat terrain and the presence of very poorly draining organic soils throughout the site further elevate the importance of on-site retention and attenuation measures. These must be (and will be) designed to ensure that runoff volumes and peak discharges are appropriately staged and limited to avoid overwhelming the pumpstation.

TUFLOW modelling of the 100-year ARI event, using the WRC TR25-26 RCP8.5 / +4°C climate-adjusted 24-hour rainfall depth of 199 mm, confirms that significant flood inundation occurs in defined parts of the site under existing land use conditions, despite the pump operating at 2.28 m^3/s. Floodwaters back up extensively across the wider upstream catchment, with parts of the site experiencing depths exceeding 1 metre but with low velocity. These flood prone areas are the areas that have been identified for re-contouring and use for stormwater storage. Nevertheless, the existing stormwater ponding patterns reinforce the importance of incorporating flood-compatible layouts and sufficient above-ground storage to prevent adverse effects on surrounding properties.

4. Soil Conditions and Infiltration Characteristics

Understanding the soil, groundwater and landform conditions across both the development site and the wider Freshfield catchment is essential to identifying appropriate stormwater management solutions. This assessment has been informed by S-map data and the preliminary CMW geotechnical assessment. The CMW

assessment identifies a clear distinction between the elevated ridges and the lower-lying plains, with Walton Subgroup materials generally associated with the higher ground and Piako Subgroup alluvial deposits, including silts, sands, gravels and peat, associated with the lower-lying areas.

4.1 Catchment-Wide Soil Characteristics

The catchment is characterised predominantly by peat soils and various loamy and clayey soils with limited drainage. Based on S-map classifications and spatial analysis, approximately 55% of the catchment consists of Airf_7c.2 (deep peat). These soils are highly organic, exhibit extremely low permeability, and remain saturated for prolonged periods.

Approximately 30% of the catchment comprises fine-textured clay loams and silty clays (e.g., Morr_15a.1 and Utuh_31a.2), which have dense subsoils that restrict both vertical and lateral water movement. These soils exacerbate surface ponding and further reduce the capacity for infiltration. The remaining 15% of the catchment contains more moderately drained loams such as Payn_14a.1. These are better structured and more conducive to infiltration, but they are limited in spatial extent and tend to occur only in peripheral areas.

4.2 Site-Specific Soil Characteristics

The soil profile of the site reflects the broader catchment pattern. Approximately 60% of the site is occupied by Airf_7c.2 peat soils. These are characterised by high water retention, low bearing strength, and a high risk of compaction and subsidence. Their permeability is extremely limited, posing challenges for infiltration-based stormwater treatment.

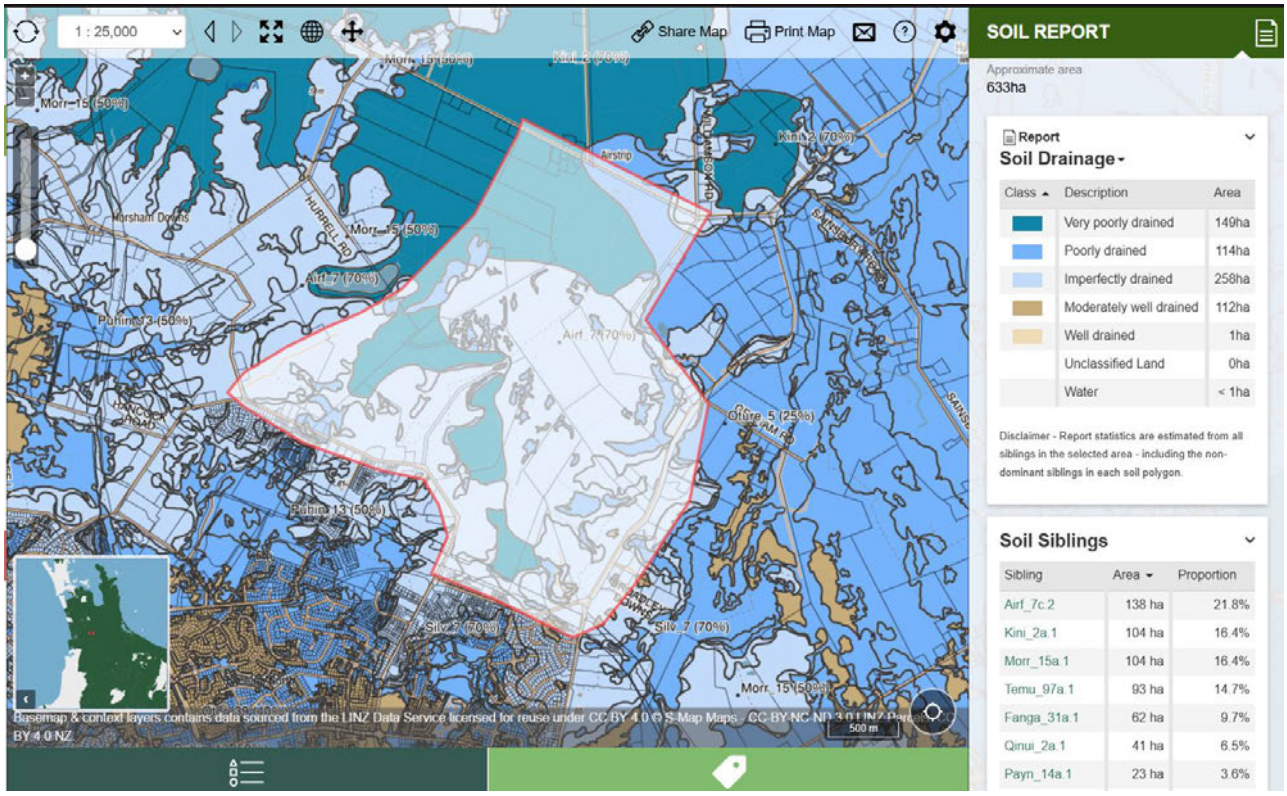


Figure 5. Catchment Soil conditions based on S-Map.

Utuh_31a.2, which makes up roughly 30% of the site, is classified as a silty clay loam with poor drainage characteristics and slowly permeable subsoil conditions. The remaining 10% of the site consists of Payn_14a.1 (silty loam), which has moderately better drainage properties and is the most suitable area on site for potential shallow infiltration systems.

The CMW geotechnical assessment notes that the lower part of the site may include zones of soft and compressible Piako Subgroup soils. This is consistent with the stormwater strategy, as much of the lower-lying/flood-prone area is proposed to be used for stormwater management rather than building platforms. However, it also means that the detailed design of wetlands, ponds, swales and associated embankments will need to consider settlement, batter stability, groundwater conditions, base permeability, and any liner or subsoil drainage requirements.

4.3 Infiltration Implications

While the moderately drained loams offer some opportunity for soakage-based systems, the predominance of saturated, low-permeability soils across both the catchment and site significantly limits the feasibility of widespread infiltration. As such, primary stormwater management should rely on surface detention, vegetated treatment systems, and subsurface drainage infrastructure.

To refine stormwater design strategies, targeted infiltration testing and on-site soil verification are recommended as part of the substantive application process to accurately delineate zones suitable for infiltration enhancement or identify areas where drainage must be managed entirely via above-ground and subsoil conveyance.

These constraints are consistent with the TUFLOW modelling results, which indicate that stormwater retention and surface ponding are likely even under existing conditions. The prevalence of low-permeability soils, shallow drainage gradients and flood-prone landform conditions reinforces the need for conservative infiltration assumptions in the model. The stormwater strategy should therefore continue to rely on engineered treatment, storage and controlled conveyance, rather than widespread infiltration disposal. Any localised soakage or infiltration enhancement should be confirmed by targeted infiltration testing and geotechnical assessment during the substantive application stage.

5. Climate-Adjusted Rainfall and Storm Profiles

Climate change is expected to increase the intensity of extreme rainfall events across New Zealand, with corresponding implications for stormwater management, floodplain storage, and the resilience of new development. For the Project Area, rainfall inputs have therefore been climate-adjusted to reflect the current Waikato Regional Council guidance for climate impact modelling.

The assessment has adopted the Waikato Regional Council Technical Report 2025/26 Climate Change Adaptation Guideline for the Waikato Region (TR25-26). This guideline recommends the use of a temperature-increment approach for hydrological and hydraulic modelling, rather than relying only on scenario-based rainfall outputs from HIRDS. For planning and design purposes, TR25-26 identifies a +4°C temperature increase as the default upper-end scenario for new infrastructure, which is broadly consistent with a high-emissions RCP8.5 / SSP5-8.5 type future climate condition.

On this basis, the stormwater model has adopted the RCP8.5 high-emissions scenario, represented by a +4°C temperature increase. This approach is considered appropriate for the site given the long-term nature of the proposed development, the low-lying and hydraulically constrained Freshfield Pumpstation catchment, and the importance of ensuring that future dwellings, flood storage areas, and stormwater infrastructure remain resilient under severe future rainfall conditions.

5.1 Historical Rainfall Depth

The historical 100-year ARI, 24-hour rainfall depth for the site was obtained from NIWA HIRDS v4. This provides the baseline rainfall depth for the existing climate condition before applying the WRC climate change uplift.

For the project's site, the historical 100-year ARI, 24-hour rainfall depth is 148 mm. This rainfall depth has been used to represent the existing climate condition for the 100-year ARI design storm.

5.2 Climate Change Uplift Methodology

In accordance with WRC TR25-26, the future climate rainfall depth has been calculated by manually applying the recommended rainfall intensity uplift associated with the adopted temperature increase. For a 100-year ARI storm with a 24-hour duration, TR25-26 recommends an increase of 8.6% per 1°C of warming. The adopted +4°C temperature increase therefore results in the following rainfall uplift:

4°C × 8.6% per °C = 34.4%

This uplift has been applied to the historical 100-year, 24-hour rainfall depth of 148 mm, as follows:

148 mm × 1.344 = 198.9 mm.

The resulting climate-adjusted rainfall depth adopted for the stormwater model is therefore:

100-year, 24-hour rainfall depth with climate change = 199 mm.

This represents a 34.4% increase above the historical rainfall depth and has been used as the primary design rainfall input for the climate change scenario.

Scenario	**100-year, 24-hour rainfall depth**
Historical / existing climate	148 mm
RCP8.5 / +4°C climate change scenario	199 mm
Increase above historical	34.4%

5.3 Temporal Storm Distribution

The 24-hour rainfall depth was temporally distributed using the WRC TR2020/06 Type 1 temporal rainfall pattern. This pattern assigns a significant proportion of the total rainfall depth to the central portion of the storm and produces a centrally peaked 24-hour design event that is suitable for stormwater modelling in the Waikato region.

The same temporal distribution was applied to both the historical and climate-adjusted rainfall scenarios. The climate change adjustment was applied to the total 24-hour rainfall depth, with the uplifted rainfall then distributed across the 24-hour storm profile using the adopted WRC temporal pattern.

Table 4-1: Normalised 24 hour design storm[9]

Time (hours:mins)	Time interval (mins)	Normalised rainfall intensity (I/I_{24})
0:00 -	360	0.34
6:00 -	180	0.74
9:00 -	60	0.96
10:00 -	60	1.4
11:00 -	30	2.2
11:30 -	10	3.8
11:40 -	10	4.8
11:50 -	10	8.7
12:00 -	10	16.2
12:10 -	10	5.9
12:20 -	10	4.2
12:30 -	30	2.9
13:00 -	60	1.7
14:00 -	60	1.2
15:00 -	180	0.75
18:00 – 24:00	360	0.40

Figure 5. Rainfall temporal pattern proposed by WRC was used for the stormwater model.

This approach provides consistency between the historical and future climate simulations and ensures that the modelled storm profile reflects both the regional rainfall distribution and the increased rainfall depth expected under the adopted +4°C high-emissions climate change scenario.

5.4 Application to Stormwater Modelling

The climate-adjusted 100-year, 24-hour rainfall depth of 199 mm was applied to the TUFLOW model to assess the performance of the proposed development under future climate conditions. The model considers the constrained hydraulic nature of the Freshfield Pumpstation catchment, including the limited downstream discharge capacity, low catchment gradients, peat-dominated soils, and reliance on mechanically assisted drainage.

The use of the 199 mm rainfall depth provides a conservative basis for assessing flood storage, detention, conveyance, and finished floor level requirements across the Project Area. It also ensures that the proposed development layout and stormwater management strategy are assessed against a rainfall event that is consistent with the latest WRC climate change guidance.

The modelling results therefore provide a suitable basis for testing whether the proposed stormwater management approach can maintain or improve flood performance under both existing and future climate conditions, while avoiding adverse downstream effects within the Freshfield Pumpstation catchment.

6. Initial Abstraction and Runoff Estimation

The determination of initial abstraction (Ia) is essential for understanding when effective runoff begins to occur. It represents the portion of rainfall absorbed through interception, infiltration, and surface depression storage before any surface runoff is generated.

In line with Waikato Regional Council's TR2020/06 guidance, the relationship between the Curve Number (CN) and soil storage potential (S) is used as the basis for calculating initial abstraction. The following formula is applied:

$$S = (1000 / CN - 10) \times 25.4 \text{ mm}$$

$$Ia = 0.05 \times S$$

This relationship, adapted from the USDA NRCS method, has been incorporated in regional design practices to suit New Zealand's hydrological context, including units in millimetres and a reduced initial abstraction coefficient (0.05 instead of the classical 0.2).

For the pre-development condition of the site, a representative Curve Number of 74.2 was estimated. This value reflects a landscape characterised by a combination of drained loamy soils and undisturbed peatlands with restricted stormwater soakage characteristics, particularly in the larger storm events modelled. Applying the above equations yields:

Storage Potential (S): $S = (1000 / 74.2 - 10) \times 25.4 = 88.31$ mm

Initial Abstraction (Ia): $Ia = 0.05 \times 88.31 = 4.42$ mm

In this method, storage potential (S) represents the theoretical capacity of the catchment surface and soil profile to retain rainfall before runoff becomes dominant. A higher S value indicates greater potential for rainfall abstraction and lower runoff response. Initial abstraction (Ia) represents the portion of rainfall that is intercepted, stored in surface depressions, or otherwise retained before effective runoff begins.

For the post-development scenario, site imperviousness increases substantially due to proposed building platforms, roads, and paved surfaces. A CN of 90.2 was adopted based on TR2020/06 recommendations for urban residential development on moderately drained soils with impervious surfaces.

Storage Potential (S): $S = (1000 / 90.2 - 10) \times 25.4 = 27.60$ mm

Initial Abstraction (Ia): $Ia = 0.05 \times 27.60 = 1.38$ mm

The significant reduction in initial abstraction from 4.42 mm (pre-development) to 1.38 mm (post-development impervious) highlights the increased propensity for surface runoff after development, underscoring the need for stormwater treatment and attenuation systems.

Distributed rain tank storage has been included as part of the post-development mitigation approach. This storage is assumed to be provided at lot level and is intended to offset the reduction in initial abstraction associated with increased roof and impervious surfaces. For the current model, the adopted storage allowance is equivalent to 1,800 m^3 across the development, based on 360 rain tanks. This assumption should be confirmed during later design once the final dwelling yield, roof areas, tank sizing and reuse/slow-release configuration are known.

The chosen CN values are consistent with the drainage characteristics derived from S-map data and the TR2020/06 guideline assumptions for soil conditions which have equivalent drainage characteristics to the site. The soil analysis across the site and broader catchment—characterised primarily by poorly drained peat and loamy units such as Airf_7c.2 and Payn_14a.1—indicates low infiltration potential due to high water retention, slow lateral movement, and seasonal saturation. These characteristics support the use of conservative CN values and highlight the importance of accounting for limited infiltration capacity in post-development hydrological planning. This condition aligns with the applied CN values and justifies the conservative runoff assumptions used in the hydrological assessment.

These calculations form a basis for runoff volume estimation under varying storm scenarios, as well as the sizing of stormwater quality and retention infrastructure.

7. Horton's Infiltration Parameters

Horton's infiltration model was applied to simulate time-dependent infiltration losses across the proposed development site. This method is suited for spatially variable soils and enables consistent integration with hydrodynamic models such as TUFLOW.

The Horton equation is:

$$f(t) = f_1 + (f_o - f_1) \times \exp(-k \times t)$$

Where:
- f(t): infiltration rate at time t (mm/hr)
- f0: initial infiltration rate (mm/hr)
- f_1: final or equilibrium infiltration rate (mm/hr)
- k: decay constant (hr^{-1})

7.1 Assignment of Horton Parameters

Values for f0, f1, and k were selected using EPA SWMM guidelines for partially drained soils and adjusted to reflect the site's low permeability conditions, as identified from S-map sibling data. Conservative assumptions were applied to ensure rainfall losses are not overestimated, consistent with wet season modelling.

Soil Sibling	Area (%)	Soil Type Description	f_o (mm/hr)	f_1 (mm/hr)	k (hr^{-1})
Airf_7c.2	60	Deep peat, saturated	8	0.5	0.3
Utuh_31a.2	30	Silty clay loam, slow drain	15	2	0.6
Payn_14a.1	10	Silty loam, moderately drain	25	4	1.0

The CMW geotechnical assessment does not include site-wide infiltration testing across the low-lying floodplain area. The adopted Horton parameters therefore remain conservative modelling inputs based on S-map soil interpretation, regional drainage characteristics, and the preliminary geotechnical understanding of the site. These parameters should be reviewed following targeted infiltration testing and detailed geotechnical investigations during the substantive application stage.

The infiltration performance of Airf_7c.2 is particularly constrained by persistent saturation and high organic content, while Utuh_31a.2 and Payn_14a.1 reflect low to moderate infiltration behaviour limited by soil texture and drainage class.

These parameters reflect the minimum realistic infiltration capacity under partially drained field conditions, typical of the site throughout much of the year. Given the low equilibrium rates, particularly for the dominant peat soils, runoff is expected to be rapid and substantial following short bursts of rainfall. The reduced decay constants applied further reflect slow recovery of infiltration rates during prolonged or back-to-back rainfall events.

7.2 Modelling Integration

The Horton parameter values were mapped to spatial polygons in the hydrological model based on S-map sibling boundaries. This spatial application enables varying infiltration behaviour to be realistically simulated across the site, improving confidence in volume retention and peak flow attenuation estimates.

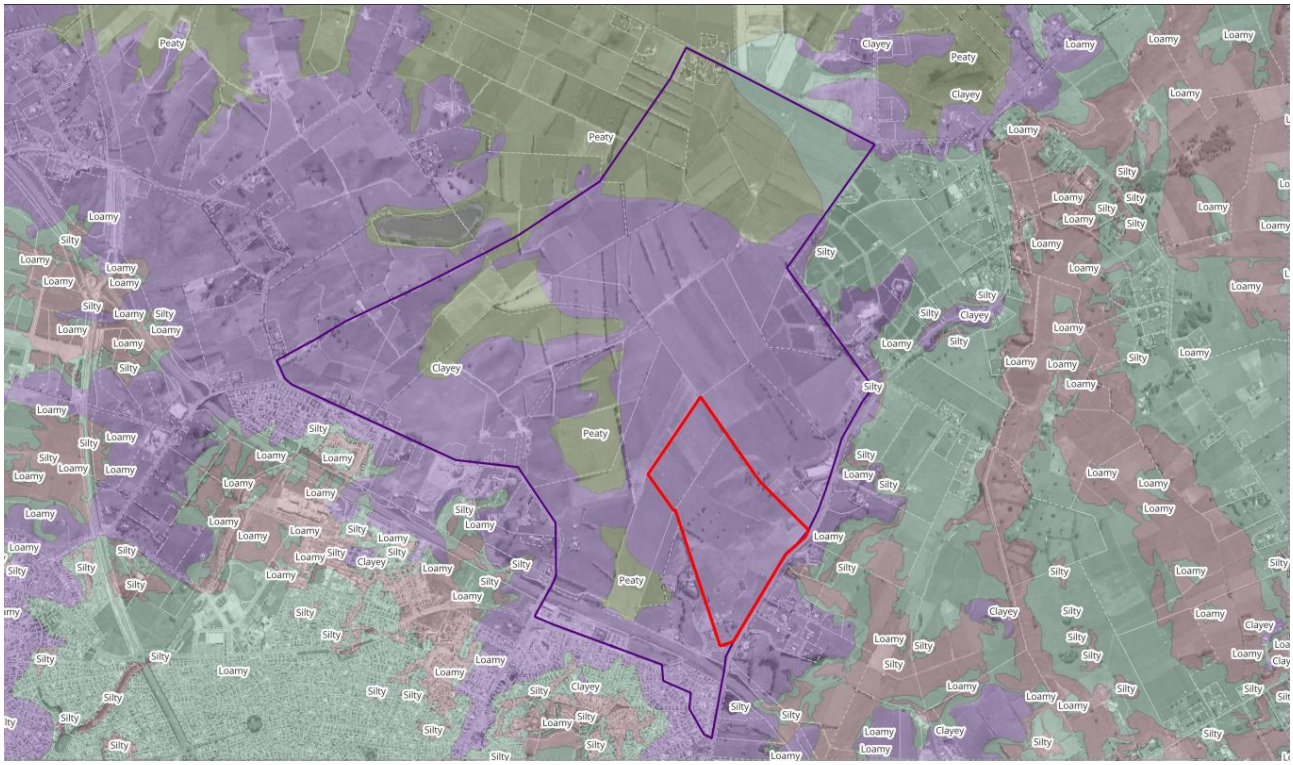


Figure 6. Infiltration layers based on soil textures as modelled in TUFLOW.

The modelling approach is aligned with Waikato Regional Council guidance, which advises the use of conservative infiltration estimates when designing for full development scenarios under wet antecedent

conditions. The conservative values ensure that the system is not under-designed due to optimistic assumptions about infiltration recovery.

Given the dominance of poorly drained soils and the low effective infiltration potential, the stormwater management approach to be implemented as part of the substantive application will incorporate infrastructure focused on surface conveyance and volume retention. Infiltration-based disposal methods may still be viable at small scales (e.g., for disconnected roof catchments over Payn_14a.1 zones) but are unlikely to be appropriate to meet site-wide stormwater treatment requirements.

8. Water Quality Treatment Requirements

The Waikato Regional Infrastructure Technical Specifications (RITS) and Waikato Regional Council's TR2020/07 guidelines establish baseline expectations for stormwater quality treatment. These standards require treatment of runoff from trafficked impervious surfaces to manage contaminant loads and protect downstream receiving environments.

8.1 Water Quality Volume (WQV) Requirement

Under TR2020/07 and RITS, the required treatment volume is defined as the lesser of:

- One-third of the 2-year, 24-hour rainfall depth adjusted for climate change, or
- A maximum fixed depth of 30 mm.

Based on the WRC TR25-26 climate-change uplift methodology, the 2-year, 24-hour rainfall depth for the adopted +4°C climate change scenario is 80.4 mm. Therefore:

WQV depth = min (80.4 / 3, 30)

WQV depth = 26.8 mm

This confirms that the calculated one-third rainfall depth governs, rather than the maximum 30 mm cap.

8.2 Site (54 ha)

Water quality treatment is only required for trafficked impervious areas (e.g. roads, driveways, carparks) and excludes roofs and pervious or landscaped zones. To estimate this area, the following approach was applied:

- Estimated land area required for stormwater and flood management infrastructure (based on TUFLOW modelling and flood extent mapping): 20.1% (10.87 ha)
- Net developable area: 54 ha – 10.87 ha = 43.13ha
- Assumed imperviousness of net developable area: 80%
    - Total impervious area = 0.80 × 43.13 ha = 34.50 ha
    - Trafficked portion (assumed 25% for residential area context): 0.25 × 34.5 ha = 8.63 ha

Required WQV = 8.63 ha × 0.0268 m = 2,312m³

This volume is to be treated through a distributed treatment train, with primary treatment provided as close as practicable to the source of runoff. This will include local raingardens within the road corridors, treatment swales where there are practical opportunities to daylight intercepted runoff, and proprietary sediment removal devices, such as Downstream Defender units or similar approved devices, where spatial, grading, or servicing constraints limit the use of vegetated treatment systems. The proposed wetland will then provide the final stage of treatment and polishing prior to discharge to the downstream drain system.

8.3 Implementation Considerations

Approved stormwater quality devices must achieve a minimum of 75% total suspended solids (TSS) removal and be designed for full treatment of the runoff of a storm of up to 27mm over 24hours (water quality depth). Given the site's low infiltration capacity, it is expected that some systems may require lining or subsoil drainage.

Distributed treatment will improve flexibility and optimise land use by:

- Localising WQV capture near source areas;
- Allowing the central wetland and southwestern swale to manage different subcatchments; and
- Reducing conveyance distances and head losses.

Integrated layout planning must ensure that:

- Runoff is routed through treatment prior to detention;
- Wetland and swale elevations are preserved for hydraulic separation from flood storage zones; and
- Maintenance access is provided across all treatment units.

There are a range of convention stormwater devices and stormwater management techniques to achieve these outcomes. The implementation of these measures with the substantive application will ensure that effects on water quality are mitigated, consistent with Council requirements.

9. Stormwater Attenuation and Flood Management Requirements

The stormwater strategy for the site will address both routine runoff management and flood resilience under extreme rainfall scenarios. Due to the site's flat topography, poor natural drainage, and reliance on the Freshfield Pumpstation, stormwater mitigation will prioritise the preservation of flood storage volumes and avoidance of adverse effects on neighbouring properties.

While the pumpstation provides an indicative outflow constraint of approximately 4.4 L/s/ha, it is not a strict regulatory limit in terms of a consent condition or a regional plan rule. Hydraulic modelling clearly demonstrates that the pumpstation does not prevent extensive ponding across the catchment, including the subject site. Even during relatively frequent storm events, the downstream channel system is unable to convey both the ambient overland flow and the pumped discharge, resulting in hydraulic short-circuiting where water discharged from the pumpstation returns upstream due to downstream backwater effects.

Model results show that the inability of the downstream system to maintain forward conveyance, combined with the site's flat topography and poor drainage capacity, causes prolonged ponding and delayed recession of floodwaters. This highlights that the primary design objective for the site is not peak discharge attenuation, but the preservation of on-site flood storage volumes, particularly during large storm events where the downstream system becomes heavily flow constrained.

9.1 Existing Condition Modelling and Flood Response

TUFLOW modelling of the 2-, 10-, and 100-year ARI rainfall events was undertaken to assess existing flood response across the site. The 100-year ARI event was modelled using the WRC TR25-26 RCP8.5 / +4°C climate-adjusted 24-hour rainfall depth of 199 mm.

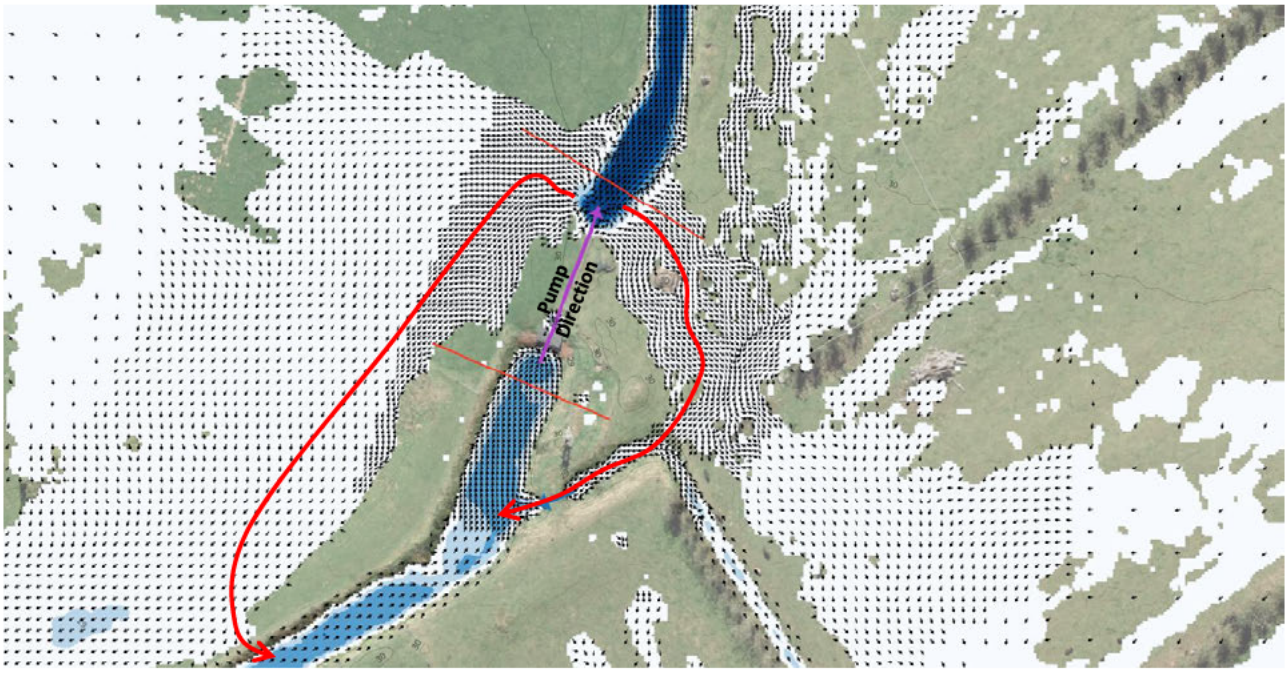


Figure 7. Applying the theoretical capacity of 2.28 m^3/s to the Freshfield pump results in hydraulic short-circuiting, as the downstream drain lacks sufficient capacity to convey this flow without overtopping. Image from the 2-year ARI TUFLOW model.

Under the 100-year ARI event, the maximum flood level across the site reaches 29.484 m. At present, a broad ponded area exceeding 10 hectares forms at the natural low point of the site, as a result of the combined effects of flat topography, poor underlying soil permeability, and downstream hydraulic restrictions. This ponded volume represents a critical component of the effective flood storage within the wider catchment and is accounted for in the model and the proposed stormwater mitigation solutions.

The modelling reinforces that conventional peak flow attenuation measures are of limited value in this context. The mechanical limitations of the pumpstation and the capacity of the downstream channel system impose a hard constraint on discharge rates. The focus of stormwater design is therefore preserving and enhancing the site's flood storage capacity, rather than attempting to control peak outflow.

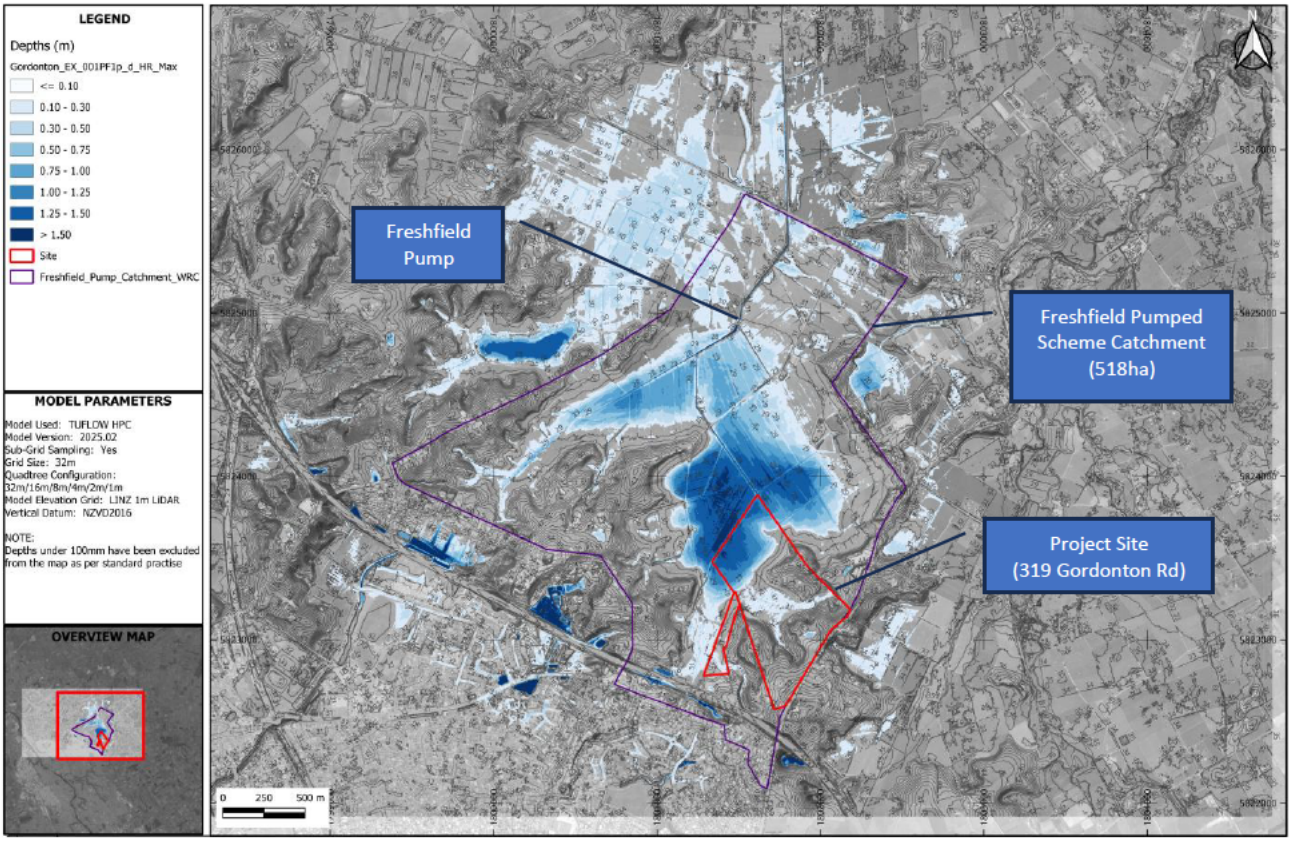


Figure 8. Flood map of the 100-year ARI maximum depths (existing conditions) as modelled in TUFLOW.

9.2 Conceptual Attenuation and Flood Management Design

The proposed development footprint is approximately 54ha. The whole catchment area has been incorporated into the hydrological and hydraulic model for both existing and post-development conditions. A concept-level attenuation and flood management strategy has been developed to ensure that the proposed development maintains hydraulic neutrality even in large flooding events and supports the site's role in providing catchment-wide flood storage. The strategy makes deliberate use of the natural floodplain function of the site and integrates appropriate conveyance and treatment measures to manage runoff from the full development footprint.

The core of the strategy is a flood detention pond/wetland of approximately 10.87 hectares, located within the area of natural inundation identified through existing condition modelling. The pond/wetland preserves the current flood storage capacity of the site while providing sufficient volume to manage runoff from the 54-hectare development footprint. It is designed to function primarily as a flood attenuation and volume compensation facility, with controlled discharge aligned to the operational limitations of the Freshfield Pumpstation so that discharges from the site mirror the current (pre-development) flow rates and patterns.

The CMW geotechnical assessment indicates that the lower flood-prone part of the site may include soft and compressible Piako Subgroup soils. This does not prevent the use of this area for stormwater storage, but it does mean that the detailed design of the pond/wetland will need to consider settlement, embankment stability, excavation depths, batter slopes, groundwater conditions, and construction methodology.

Runoff from the southwest extension of the development will be intercepted and conveyed via a shallow-graded swale along the southwestern boundary. The swale also provides treatment and attenuation, integrating runoff from this subcatchment into the site-wide system without bypassing the main attenuation facilities.



Figure 9. Conceptual layout showing the proposed flood pond/wetland, and the treatment/conveyance swale.

Distributed rain tank storage is proposed at lot level as part of the wider stormwater mitigation strategy. The current modelling assumes a combined storage allowance of 1,800 m³ across the development, based on 360 rain tanks. This storage is intended to reduce early-stage runoff from roof areas, offset part of the reduction in initial abstraction associated with development, and reduce inflows to the treatment and detention system during smaller and more frequent storm events. The final number, size and configuration of rain tanks will need to be confirmed during detailed design once the dwelling yield, roof areas and reuse or slow-release requirements are finalised.

The detention pond/wetland and associated elements have been sized to provide level-for-level volume compensation across the full elevation range of the floodplain. This ensures that the development does not reduce floodplain storage capacity or displace floodwaters to neighbouring areas. The strategy also provides resilience against downstream backwater effects by preserving sufficient on-site storage to accommodate delayed recession of floodwaters during prolonged or back-to-back storm events.

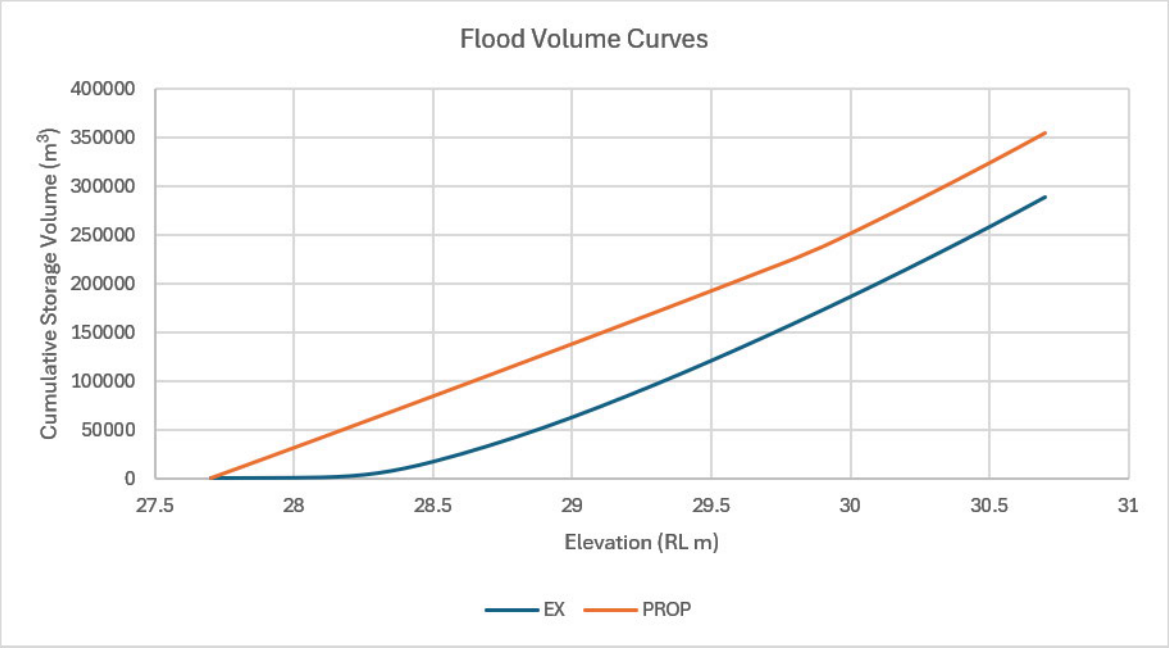


Figure 10. Existing and proposed flood volume curves.

Primary Network, Secondary Flow Paths and Hydrology Mitigation

At detailed design stage, the subdivision will include a primary stormwater pipe network sized in accordance with RITS requirements to convey the 10-year ARI storm event, including appropriate allowance for climate change and potential blockage effects. The primary network will manage frequent and moderate rainfall events and will convey runoff to the proposed treatment, attenuation and flood management system in a controlled manner.

Secondary flow paths will also be incorporated into the site layout to safely convey flows in excess of the primary network capacity, including the 100-year ARI storm event. These secondary flow paths are expected to be provided through a combination of road corridors, engineered overland flow paths, swales, reserve areas and controlled discharge points to the downstream detention wetland/pond. The final alignments and hydraulic grades of these flow paths will need to be confirmed once the detailed road layout, earthworks design, finished platform levels and subcatchment boundaries are developed.

In addition to flood storage and water quality treatment, the stormwater strategy will include hydrology mitigation for small and frequent storm events. This will be achieved through a combination of on-lot rain tank storage, raingardens, treatment swales, retention storage and extended detention within the treatment wetland and associated stormwater management system. These measures are intended to reduce the frequency and rate of small storm discharges, reduce the potential for erosion within receiving drains and streams, and support a more natural hydrological response where practicable.

Opportunities for groundwater recharge will be considered where ground conditions allow. However, given the low-permeability soils, shallow drainage gradients and groundwater constraints identified for the site, the stormwater strategy does not rely on soakage or infiltration as the primary method of stormwater disposal.

9.3 Modelling Results for Proposed Design

The conceptual design was incorporated into the TUFLOW model and tested under the 2-, 10-, and 100-year ARI scenarios. The 100-year ARI results reported below are based on the TR25-26 RCP8.5 / +4°C climate-adjusted rainfall depth of 199 mm. The results confirm that the proposed strategy reduces peak flood levels across the site relative to existing conditions and provides effective volume compensation for the development.

Under the 100-year ARI event with the pumpstation operating, the maximum flood level within the ponded area reduces to 29.426 m, a reduction of 58 mm compared to existing conditions. Under a conservative scenario assuming complete pump failure, the maximum flood level is 29.486 m, 44 mm below the existing 100-year ARI level with pump failure.

These results demonstrate that the proposed development will not increase downstream flood risk and will deliver a measurable improvement in flood storage performance within the whole catchment under both normal conditions as well as during a pump failure incident. The strategy is therefore fully compatible with the mechanical constraints of the pumpstation and the broader hydraulic limitations of the Freshfield catchment.

The implementation of these measures with the substantive application will ensure that effects on water quantity are mitigated, consistent with Council requirements.

9.4 Floor Level Protection

Based on the modelled climate-adjusted 100-year ARI pump failure scenario, the maximum flood level within the detention pond/wetland is 29.486m. A minimum Finished Platform Level (FPL) of 29.986m is recommended for all habitable dwellings across the site, providing 500 mm of freeboard above the maximum modelled flood level. This approach ensures that the development remains resilient to extreme storm events and to any future variations in pumpstation performance or operational reliability. Finished platform levels and earthworks adjacent to the pond/wetland should be coordinated with geotechnical design, particularly where filling is proposed over soft or compressible soils.

The implementation of these measures with the substantive application will ensure that effects of natural hazards are appropriately mitigated consistent with Council requirements and mean that the project is appropriately resilient to flood hazards and the future risk of climate change increasing those hazards.

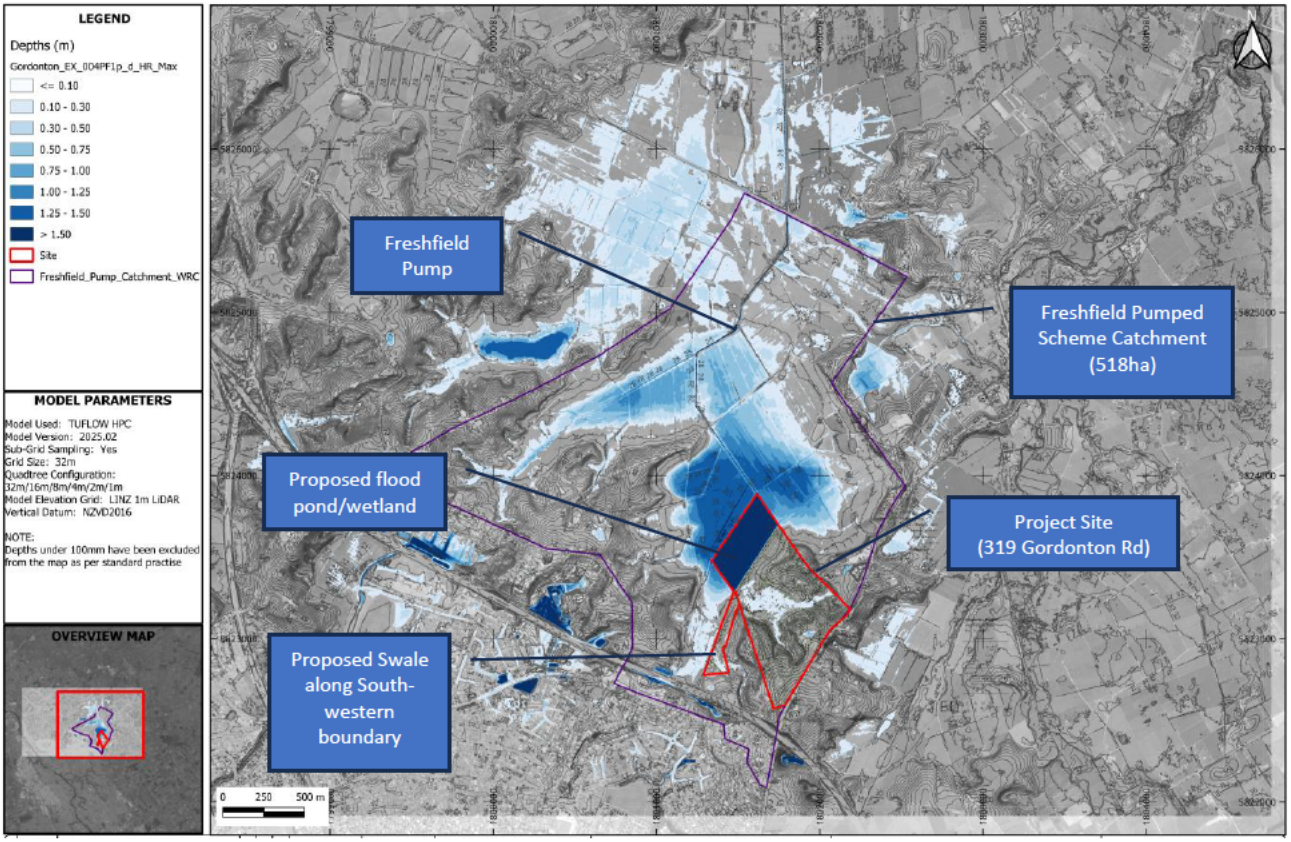


Figure 11. Flood map of the 100-year ARI maximum depths (proposed conditions with pump failure) as modelled in TUFLOW.

9.5 Summary

The attenuation and flood management strategy developed for the site enables the proposed development to proceed without increasing flood risk and while maintaining the site's role in the catchment. The deliberate integration of the site's natural flood storage area, combined with level-for-level volume compensation and appropriate treatment and conveyance elements, ensures consistency with the performance expectations of WRC TR2020/06 and TR2020/07, and with the climate-change rainfall methodology set out in WRC TR25-26.

The modelling confirms that the proposed approach delivers measurable improvements in peak flood levels both on-site and off-site and enhances the resilience of the catchment to large storm events. The strategy provides a robust and technically sound basis for progressing to detailed design and consenting

10. Land Allocation for Stormwater Management

The spatial allocation for stormwater infrastructure is a critical aspect of ensuring that the proposed development achieves regulatory compliance, maintains hydraulic neutrality, and integrates effectively with the wider catchment floodplain. The total development is approximately 54 hectares.

The conceptual flood management strategy has been designed to preserve the effective flood storage capacity of the site while providing sufficient treatment and conveyance capacity to accommodate runoff from the increased impervious area. Key components of the strategy include a flood detention pond, a raised treatment wetland, a conveyance swale for the southwest extension, and distributed rain tank storage.

Approximately 10.87 hectares of the site will be allocated to the flood detention pond, which is located within the existing low-lying area where extensive ponding already occurs under current conditions. This approach makes efficient use of the natural floodplain and minimises the requirement for additional land take.

Treatment swales may be incorporated where there are practical opportunities to daylight intercepted runoff, including along the southwestern boundary or other suitable drainage corridors. These swales would provide both conveyance and additional treatment before runoff enters the main pond/wetland system. Where levels, space, or servicing constraints prevent open swale solutions, piped conveyance and proprietary sediment removal devices may be used instead.

Distributed rain tank storage will be implemented as part of the development of the site and will not require additional dedicated land area. The tanks will be integrated into individual lot layouts as part of the overall site-wide attenuation strategy and can be used for non-potable water supply associated with the residential activities.

Additional localised land requirements will be needed for road corridor raingardens, treatment swales where practicable, proprietary sediment removal devices, maintenance access, and conveyance infrastructure. These elements are expected to be integrated into the road reserve, drainage corridors, and open space network as the layout is refined during detailed design.

The primary pipe network is expected to be accommodated within the road reserve and drainage corridors and is not expected to require a separate land allocation beyond the normal civil infrastructure footprint. Secondary flow paths will also be integrated into the road layout, open space network, swales and drainage reserves where practicable. The final layout will need to demonstrate that the 10-year ARI flows can be conveyed by the primary network and that the 100-year ARI flows can be safely routed to the downstream drain/stream network without creating unacceptable flood risk to dwellings, neighbouring properties or critical access routes.

The proposed spatial arrangement supports the technical objectives established through the TUFLOW modelling and provides a strong basis for detailed design. The integration of the flood detention pond/wetland, treatment wetland, swales, road corridor treatment, primary pipe network and secondary flow paths ensures that flood storage, water quality, conveyance and hydrology mitigation objectives can be developed in a manner consistent with WRC TR2020/06, WRC TR2020/07 and RITS.

11. Conclusion and Recommendations

The assessments undertaken confirm that the proposed development at 319 Gordonton Road is feasible from a stormwater and flood management perspective. The site can be developed in a manner that preserves its existing flood storage role, meets relevant regulatory requirements, and maintains hydraulic neutrality across the Freshfield Pumpstation catchment. Compliance with the regulatory requirements for stormwater management and particularly treatment also ensures that the Project can give effect to Te Ture Whaimana o Te Awa o Waikato.

The concept-level stormwater strategy makes deliberate use of the site's natural floodplain, incorporating a flood detention pond, a raised treatment wetland, a conveyance swale, and distributed rain tank storage. The modelling confirms that this approach provides level-for-level volume compensation, achieves measurable reductions in peak flood levels under both normal and pump failure scenarios, and delivers compliance with WRC TR2020/06 and TR2020/07.

The strategy is well aligned with the constraints of the downstream system. The approach focuses appropriately on volume management and floodplain function, rather than conventional peak flow attenuation, recognising the limitations imposed by the pumpstation and the broader hydraulic behaviour of the catchment.

The site's flood management design will require continued refinement through detailed design stages. The following actions are recommended as part of the substantive application process:

- Confirm the primary pipe network sizing in accordance with RITS, including allowance for climate change and potential blockage effects;
- Confirm secondary flow path alignments and finished levels to safely convey the 100-year ARI event to the downstream drain/stream network;
- Apply a minimum freeboard of 500 mm above the modelled 100-year ARI pump failure level for all habitable platforms (addressing residual risk);
- Maintain hydraulic separation of the treatment wetland from the flood storage pond/wetland to preserve treatment performance during large storm events;
- Coordinate with WRC to confirm pumpstation operation assumptions and to ensure consistency with any future pumpstation upgrades;
- Engage with both Waikato District Council and Hamilton City Council;
- Active engagement with mana whenua to reflect cultural values in the design of open water and treatment features.

Subject to these actions, the development can proceed with a high degree of confidence that stormwater and flood management requirements will be met, that the effects of the environment can be appropriately mitigated, and that the proposed approach will contribute positively to the resilience of the wider Freshfield catchment.

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Yours sincerely

Bloxam Burnett & Olliver

Constantinos Fokianos
Water Resource Engineer
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s 9(2)(a)

Jarred Stent
Director
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Appendix A – Flood Maps

LEGEND

Depths (m)

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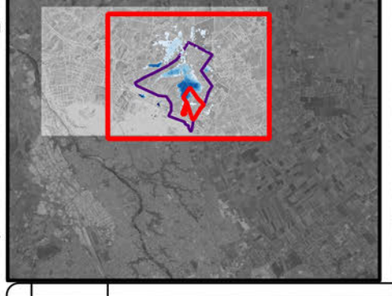
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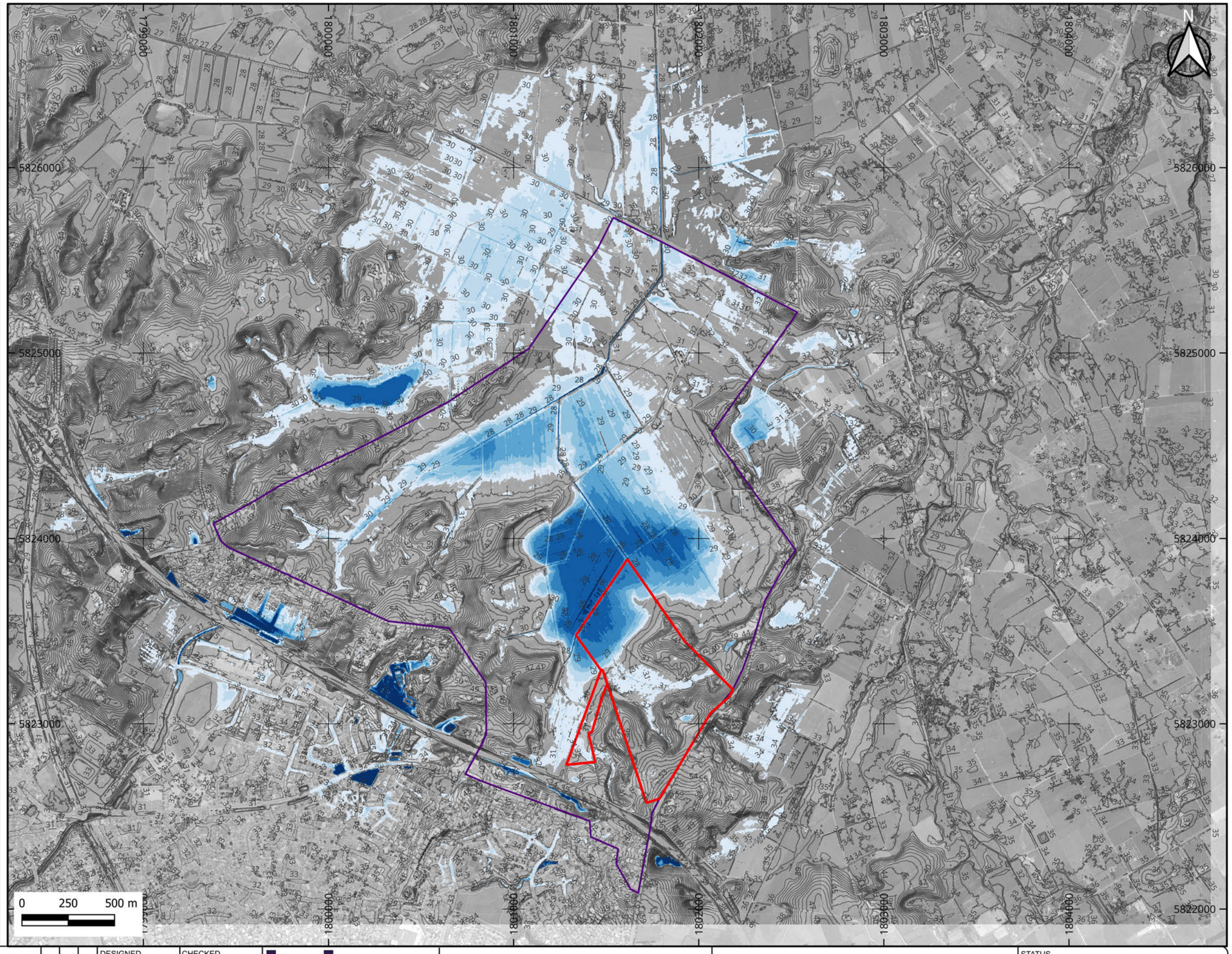
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NOTE:
Depths under 100mm have been excluded from the map as per standard practise

OVERVIEW MAP





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	DATE	ISSUE/REVISION DETAIL	BY	CHK	APPR

DESIGNED | CHECKED
DRAWN | APPROVED

Horsham Downs Estate Ltd

HORSHAM DOWNS ESTATE

100-YEAR ARI RCP8.5 DESIGN STORM
MAXIMUM FLOOD DEPTHS
CURRENT CONDITIONS
NORMAL PUMP CONDITIONS

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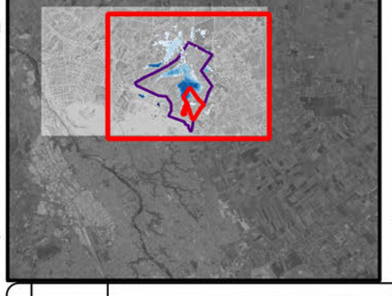
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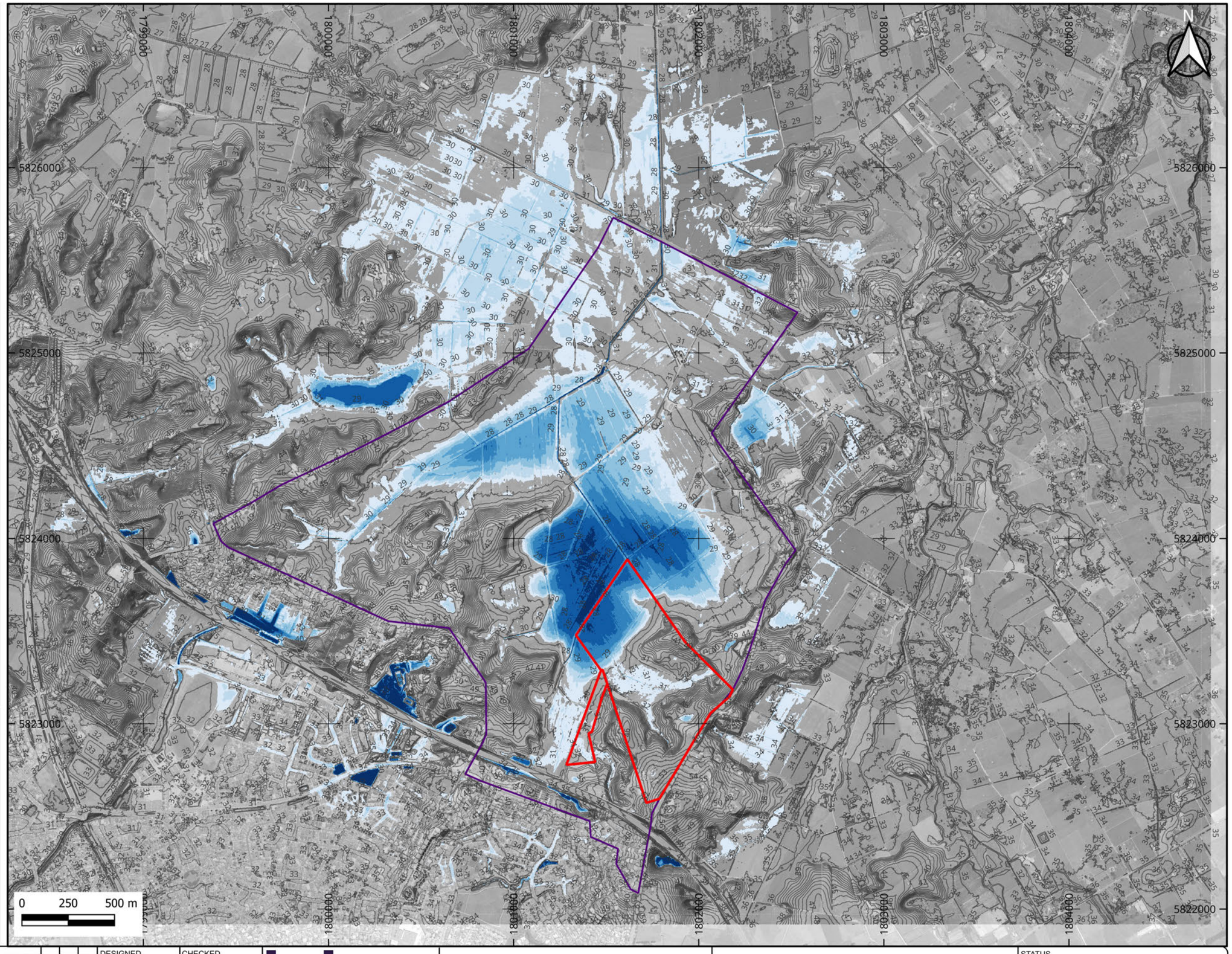
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NOTE:
Depths under 100mm have been excluded from the map as per standard practise

OVERVIEW MAP





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Horsham Downs Estate Ltd

HORSHAM DOWNS ESTATE

100-YEAR ARI RCP8.5 DESIGN STORM
MAXIMUM FLOOD DEPTHS
CURRENT CONDITIONS
PUMP FAILURE CONDITIONS

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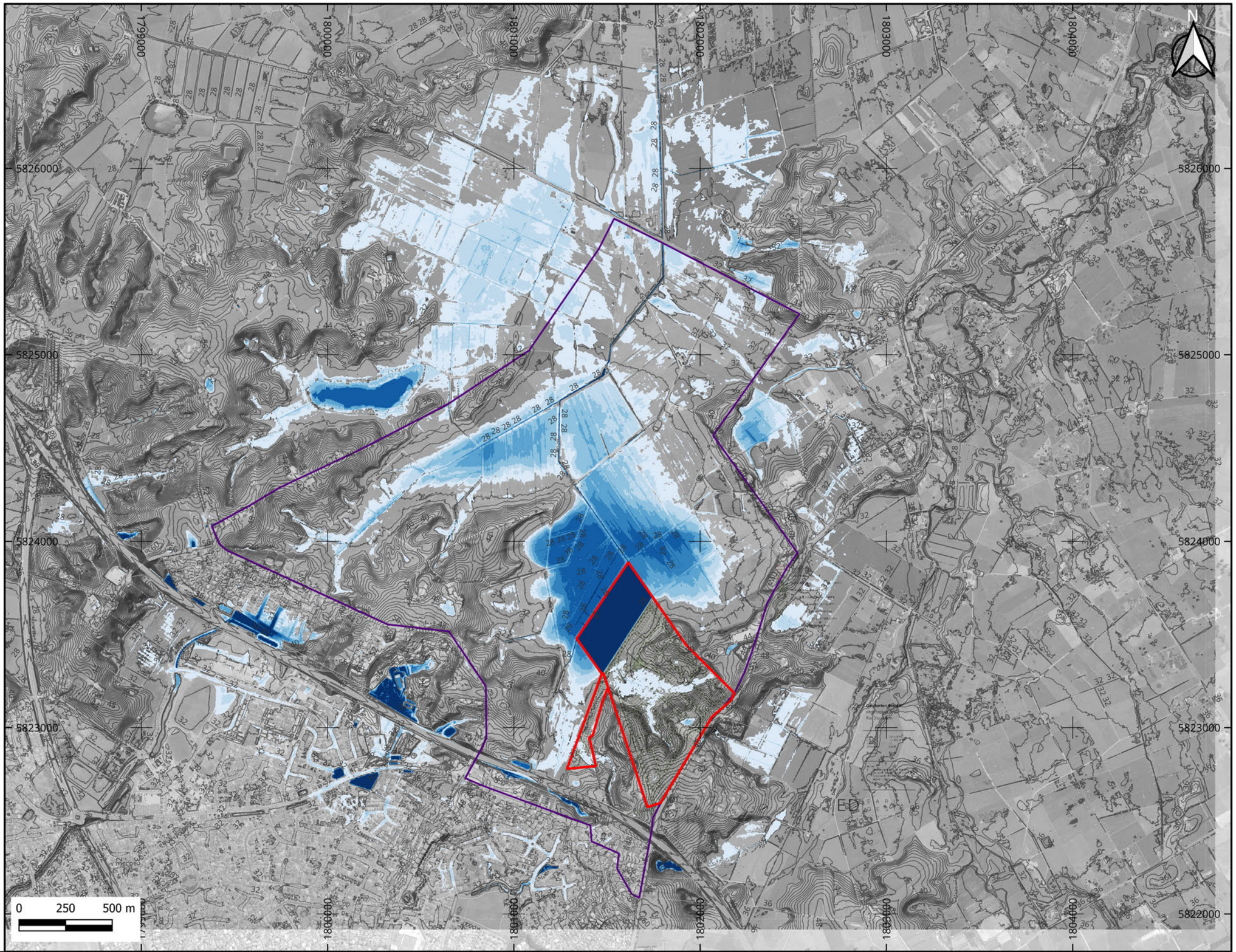
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NOTE:
Depths under 100mm have been excluded from the map as per standard practise

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Horsham Downs Estate Ltd

HORSHAM DOWNS ESTATE

100-YEAR ARI RCP8.5 DESIGN STORM
MAXIMUM FLOOD DEPTHS
PROPOSED CONDITIONS
NORMAL PUMP CONDITIONS

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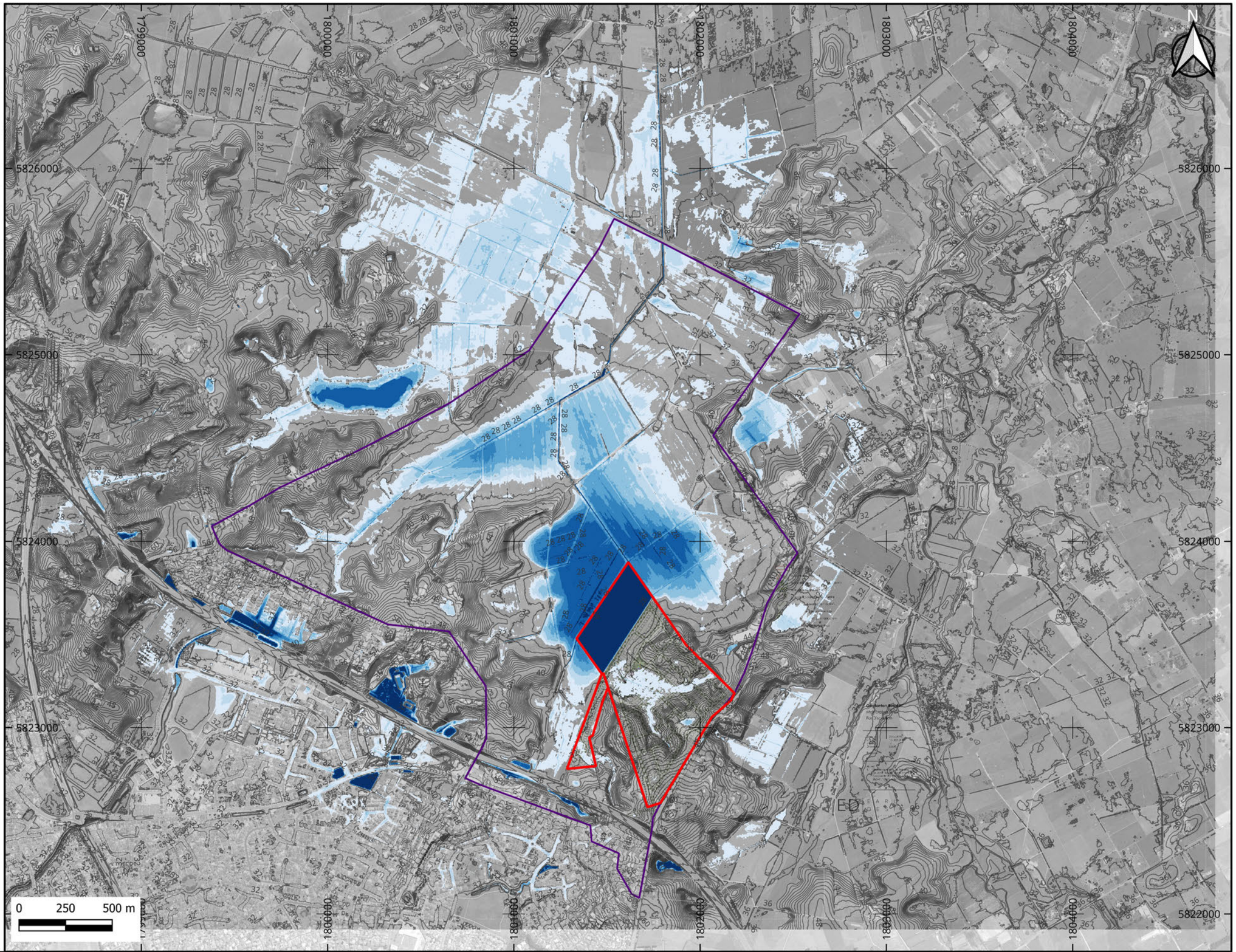
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NOTE:
Depths under 100mm have been excluded from the map as per standard practise

OVERVIEW MAP





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