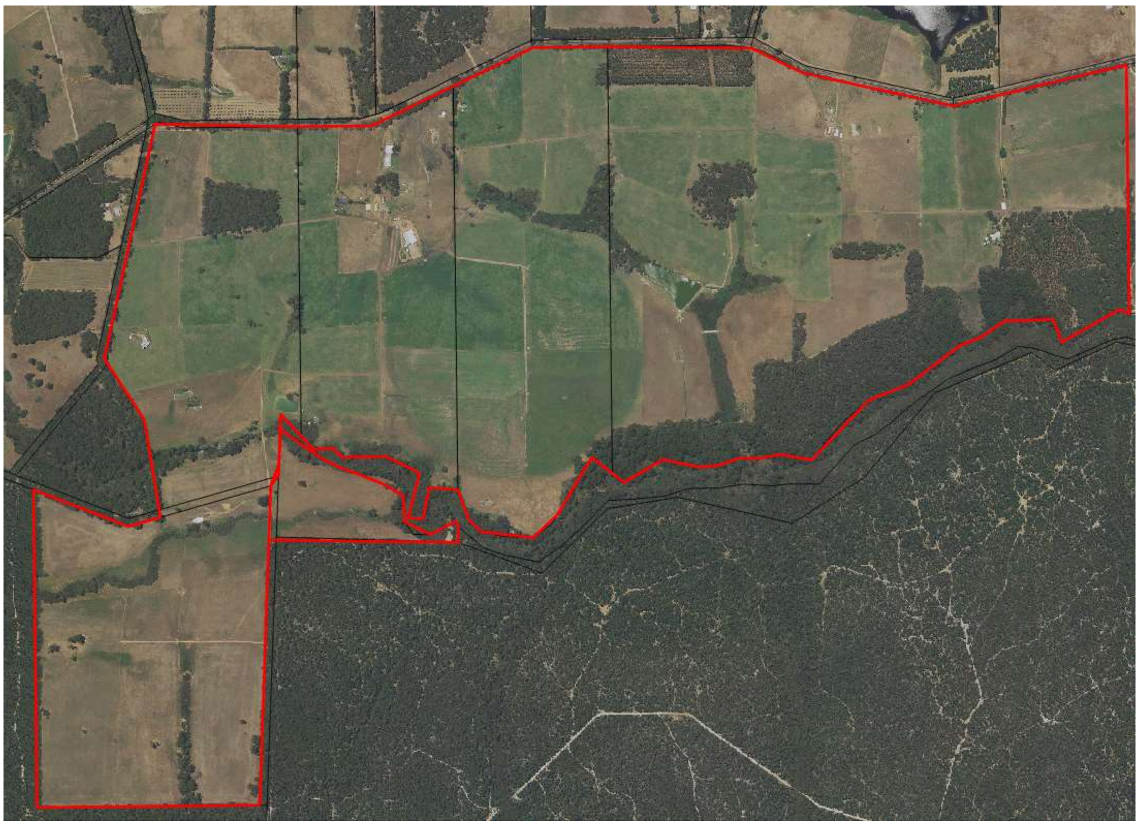
SW HYDROLOGY

Proposed dam development
Lot 1002 Warner Glen Rd, Forest Grove



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Executive Summary

Brad and Steven Noakes (Chapman Brook Pty Ltd) operate a dairy business producing 4 million litres of milk annually. There is currently 125Ha of irrigated pasture that provides feed for dairy cows and beef stock. There is a current shortfall of water to enable all areas of pasture to be irrigated during summer months, meaning certain paddocks and irrigation infrastructure need to be turned off to avoid exceeding the licensed water entitlements.

The existing dam wall is leaking and needs to be stabilised, it also impacts the current irrigation practices by losing water from the dam. However, this dam cannot be removed or repaired until the downstream dam is constructed as the existing dam is critical for irrigating pasture to operate the dairy effectively and to avoid bringing extensive amounts of feed to site.

To obtain sufficient water supplies the client is proposing to construct a new 58,585kL dam and deepen the existing dam increasing its storage capacity from 24,900kL to 38,438kL. Combined these dams will provide up to 97,023KL of stored water. The client is also engaging in leasing/transferring additional groundwater entitlement from a neighbour. These water supplies will enable the farm to maintain irrigation rates and maximise milk production.

The property is zoned as priority agriculture under the current Augusta Margaret River Local Planning Scheme No 21 with dam developments and general agriculture being an approved landuse.

1. Site Details

The client own's Lot 1002, Lot 2765 & Lot 1 Warner Glen Rd, Forest Grove, Lot 2763 Holland Rd, Forest Grove and Lot 2760 on Plan 203074 Forest Grove with a total land area of 328.2699Ha (820.675 acres) of which ~39.55Ha is retained with native vegetation and the remaining 288.7199Ha arable land. Lots 1002, 2765, 1 & 2763 are bordered by private freehold land except for the southern boundaries which contains Unallocated Crown Land where the main channel of the Chapman Brook flows. Lot 2760 is surrounded by Unallocated Crown Land except for the northern and northwestern boundaries which are freehold.

The main channel of the Chapman Brook flows through parts of Lot 2763 and Lot 1 and back floods into Lot 1002 below the dam site during winter. Three minor tributaries originate within Lot 2763, Lot 2765 and Lot 1002, with the latter being the site of an existing dam and the proposed new dam. Another large tributary flows through Lot 2760 and the southern portion of Lot 1002.

Five general land classifications (*Table 1 and Figure 1)* have been allocated to the property with Treeton Slopes being the dominant land unit followed by Treeton Fertile Flats and Treeton Wet Valleys. Vales and Flats and Nillup Flats being the predominant land classification. The watercourse is classed as Blackwood Wet Vales, the Blackwood Deep Sandy Flats are within a small section on the NE corner of Lot 2410 and the Blackwood Fertile Flats on the SW boundary of Lot 2413.

Land unit	Classification	Description
Treeton Slopes	T	Slopes with gradients generally ranging from 2-15% and gravelly duplex (Forest Grove) and pale grey mottled (Mungite) soils. This unit can be subdivided into: T2—Treeton Gentle Slopes; slopes 2-5%,
Treeton Fertile Flats	Tf	Well drained valley flats and floodplains with deep alluvial soils, often red-brown barns (i.e. Marybrook soils).
Treeton Ironstone Slopes	Ti3	Low slopes (gradients ranging from 2-10%) with shallow gravelly sands over laterite.
Treeton Valleys	Tv	Narrow V-shaped drainage depressions.
Treeton Wet Valleys	Tvw	Broad u-shaped drainage depressions with swampy floors.

Table 1. Tille & Lantzke land classification

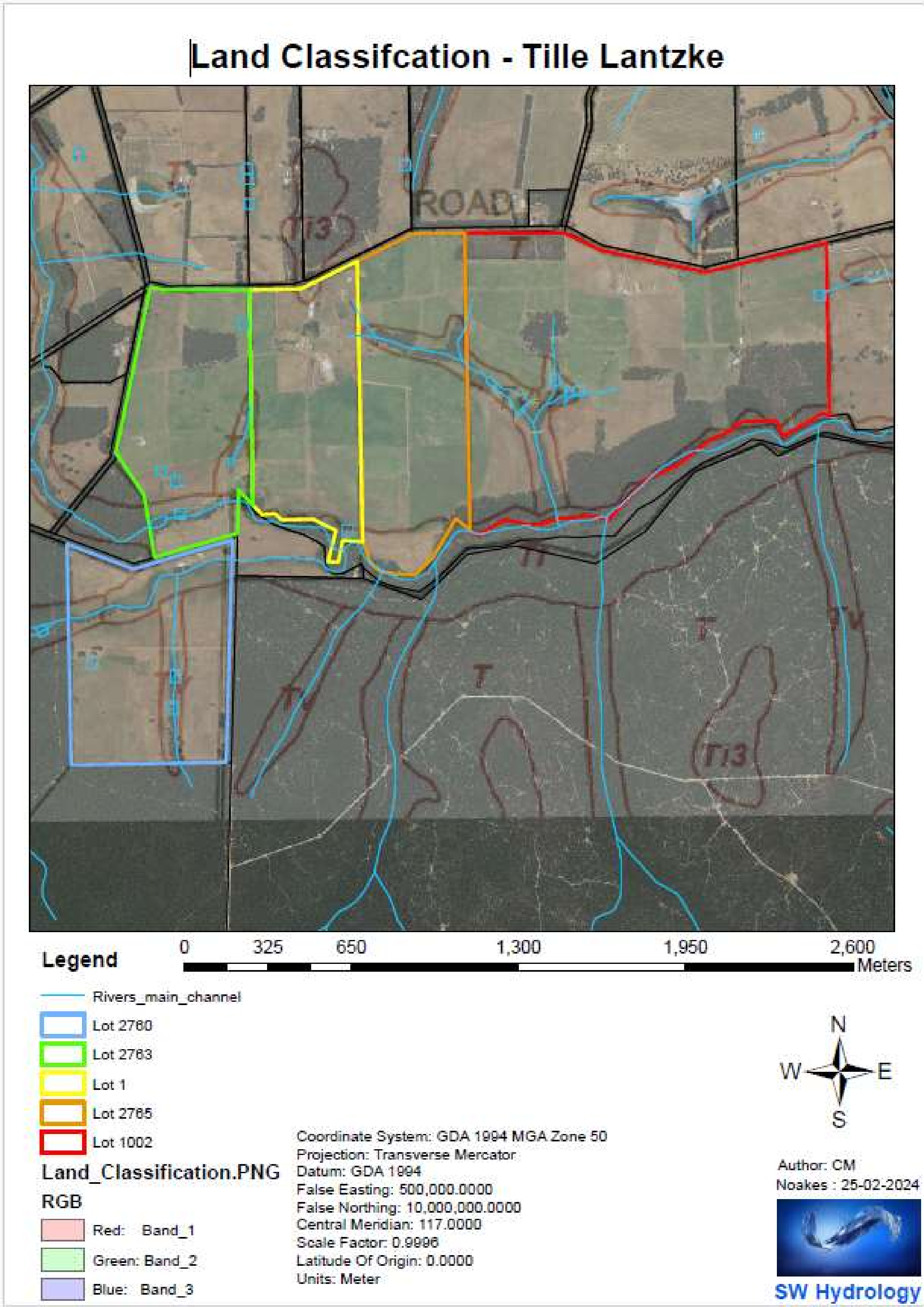


Figure 1. Tille and Lantzke land classification

2. Existing landuse and water supplies

The clients operate a large dairy with 600 milkers producing 4.5 million litres of milk annually, an additional 350 replacement milkers and 150 steers for beef production. The steers are reared on the property before being transferred to other properties to be fattened or sold to market.

There is currently 125Ha of irrigated pasture comprising one 38Ha centre pivot, 38Ha of lateral irrigation, 37Ha of solid set irrigation and 12 Ha of hard hose irrigation.

Irrigation water is sourced from an existing 27,490kL gully wall dam (*Figure* 2) and two groundwater bores licensed under GWL170610 authorising the abstraction of 725,000kL from the Blackwood, Rosa-Beenup, Perth – Lesueur Sandstone South aquifer (*Figure 3*). Once dam supplies have been utilised the bores pump water into the dam which is then fed into the irrigation system. Having the bore water stored in the dam enables higher pump rates for irrigation than can be achieved from the bores themselves. Pumping water into the dam is also useful for enabling back-up storage in-case of pump failure, however, the current storage capacity is insufficient to provide back-up for more than two day's irrigation demand.

The current water supplies and existing irrigation demand for pasture (7,500kL/Ha) results in a water shortfall for the property of 185,010kL (*Table 2*). The water shortfall from existing water supplies requires certain irrigation systems to be turned off during summer months to remain within their licensed entitlement. As a result, the client must buy additional feed, sell, or agist stock. The client is proposing to improve security of water supplies by de-silting and deepening the existing dam and creating a new dam downstream. The existing dam wall is leaking and needs to be replaced or repaired once the new dam is constructed. In addition, the client is entering into a lease agreement with an existing licensee to increase their access to the Lesueur aquifer.

Existing Water Supplies	
Bores (kL)	725,000
Dam (kL)	27,490
Total (kL)	752,490
Water Demand (kL)	937,500
Shortfall (kL)	-185,010

Table 2. Existing water supplies and irrigation shortfall

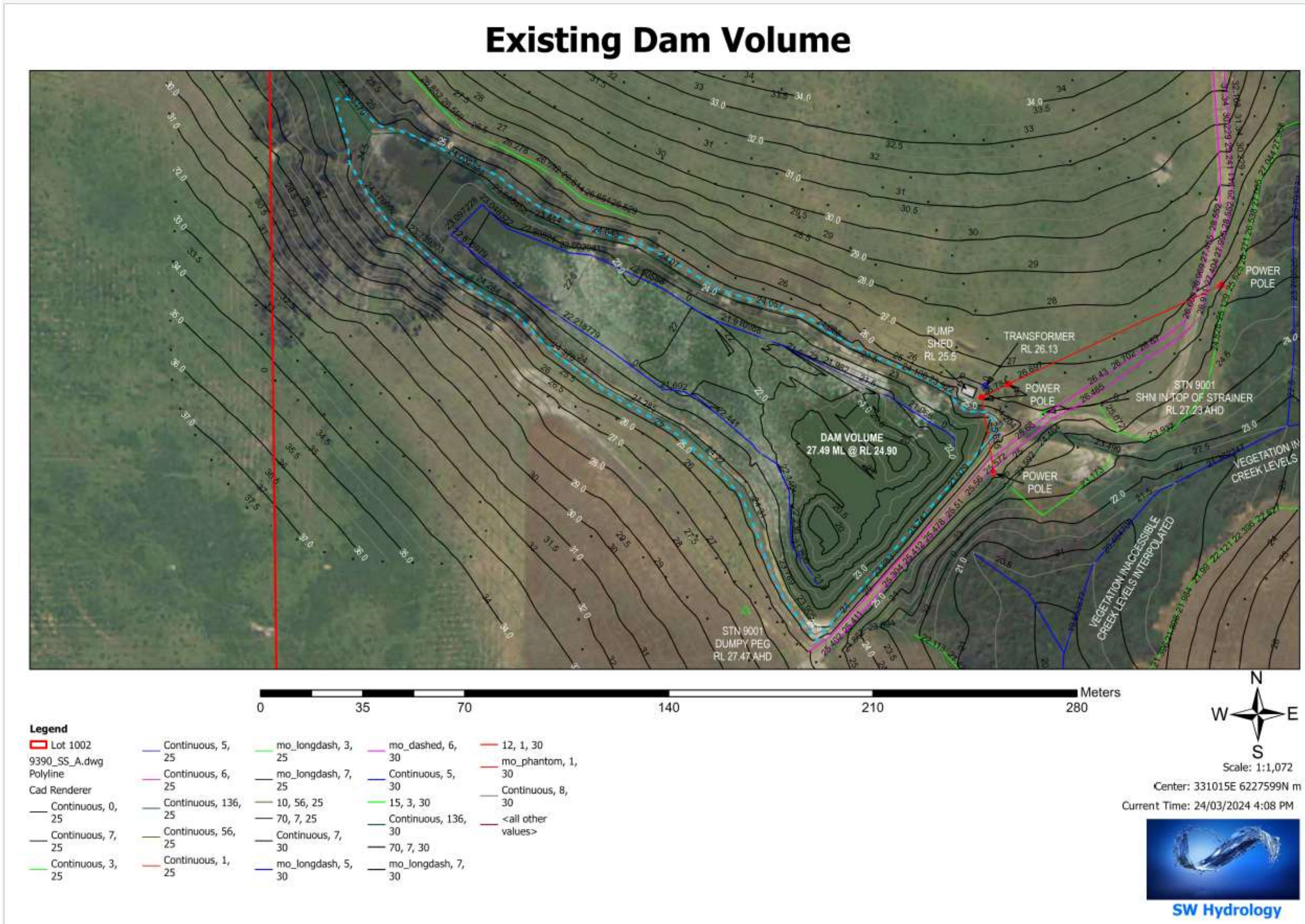


Figure 2. Existing surveyed volume and contours

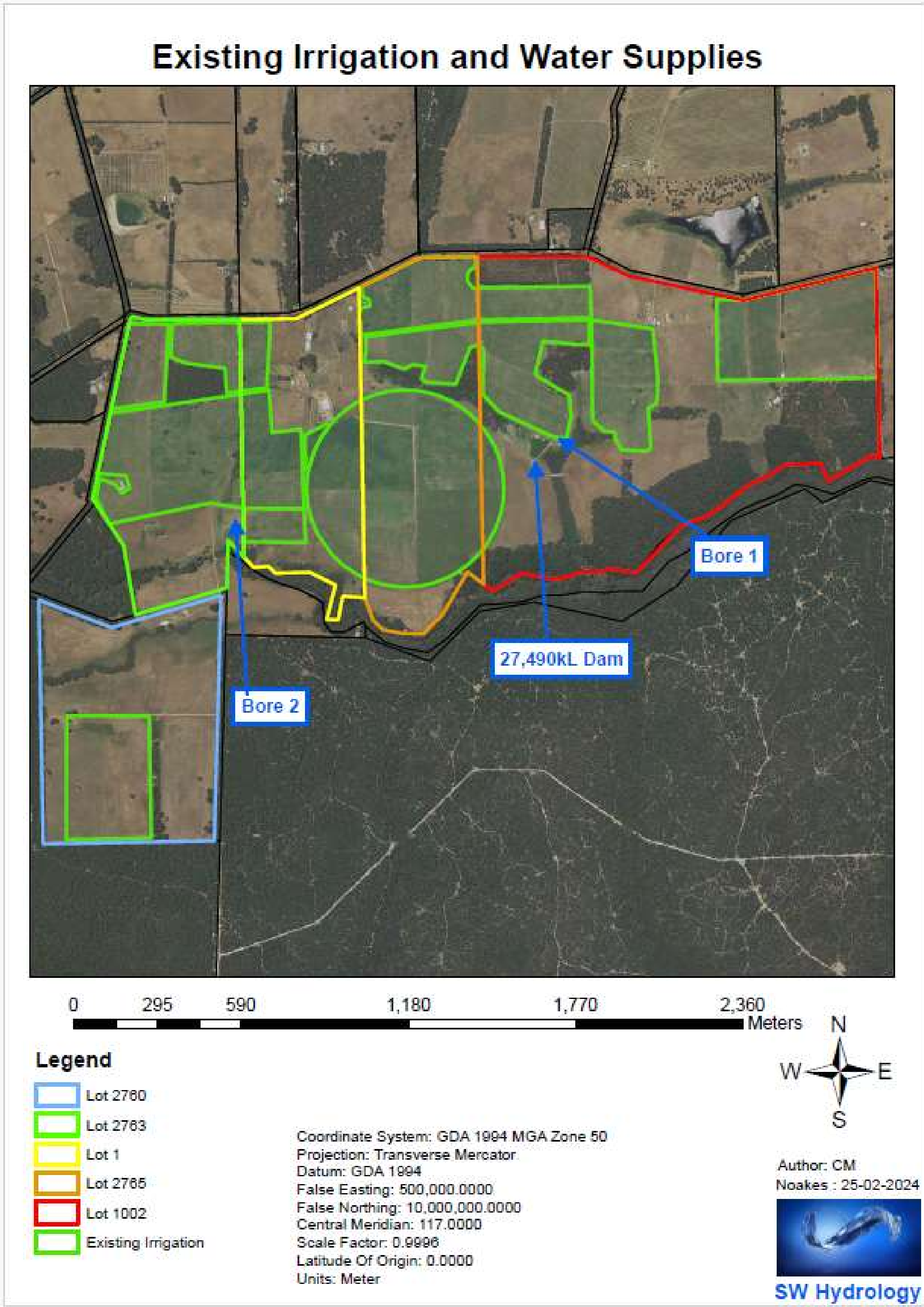


Figure 3. Existing Water Supplies

3. Proposed development and water demand

The client is proposing to slightly increase their irrigated pasture from 125Ha to 130Ha to ensure sufficient feed for their dairy cows and meet their optimum milk production targets. Two new centre pivots are proposed to be installed to improve water efficiency and reduce manual labour costs of moving hard hose irrigators. By maximising year-round pasture production 'on-farm' it minimises the need to buy additional feed from external sources, reducing the cost of production and carbon food miles required to supply additional feed.

The proposed water demand for 130Ha of pasture equates to 975,000kL which exceeds the properties current water supplies (*Table 3* and *Figure 4*). To meet this irrigation demand, the client is proposing to construct a new 58,585kL dam downstream of the existing dam and to deepen and repair the existing dam (*Table 4 and Figure 5*). The client is also in the process of applying for additional groundwater to meet their optimum irrigation demand. If there is no unallocated water remaining within the allocation limit, the client has been discussing leasing water of a neighbour's entitlement. The client already turns off irrigation to certain areas in late-summer early autumn to remain within their groundwater entitlement, obtaining additional water and developing the proposed dam will minimise how much irrigation needs to be turned off, increasing productivity.

Proposed Water Supplies	
Bores (kL)	725,000
Dam (kL)	97,023
Total (kL)	822,023
Water Demand (kL)	975,000
Shortfall (kL)	-152,977

Table 3. Proposed water supplies and irrigation demand

Dam Dimensions - New	
Surface Area (m^2)	17,890
Wall Length	130
Wall Height	7.6
Dam Depth	9
Tailwater	190
Volume (kL)	58,585

Dam Dimensions - Existing	
Surface Area (m^2)	12,517
Wall Length	120
Wall Height	5
Dam Depth	7
Tailwater	260
Volume (kL)	38,438

Table 4. Proposed dam specifications totalling 97,023kL

The proposed 58,585kL dam development allows increased storage to reduce the irrigation shortfall, enable higher pump rates for irrigation and provides a contingency plan to cover any bore pump issues. If a bore has pump related issues, it can take days to weeks to obtain parts or replacement pumps and have them installed. The additional storage enables irrigation to continue until bores have been repaired. The increased storage volume also allows the client to utilise off-peak power by transferring water to the dam during the night when power supply is cheaper.

The full supply level FSL of the proposed dam will be the same elevation as the existing dam FSL of 24.9mAHD. Water from the new dam will then back up to the invert level of the existing dam.

The existing dam is very shallow except for the borrow pit area near the dam wall, the tailwater has been silted up over the past 20 years reducing the dam storage. Deepening this dam will slightly increase its storage volume from 27,490kL to 38,438kL. The existing dam wall is leaking which is further compounding the irrigation shortfall, during construction of the new dam, clay will be used to re-batter the existing downstream wall in the hope of reducing or fixing the leak.

Given the importance of the existing dam for irrigation purposes, the existing dam must remain in place until the new dam is constructed, otherwise all irrigation would stop severely impacting the milk production on the property. Once the downstream dam has been completed a decision will be made whether to retain the existing dam wall or remove it.

By maximising the depth of both the proposed dam and the existing dam it decreases the surface area and helps provide storage depth to decrease water temperature which will help to reduce evaporation losses. The client is very aware of their irrigation shortfall and have investigated floating modules or blankets to minimise evaporation (https://www.awtti.com/armor-ball-aqua/). The hyperlink is an example and not a recommendation/commitment from the client, it purely indicates what options are available to reduce evaporation loss and the clients focus on efficient use of water resources.

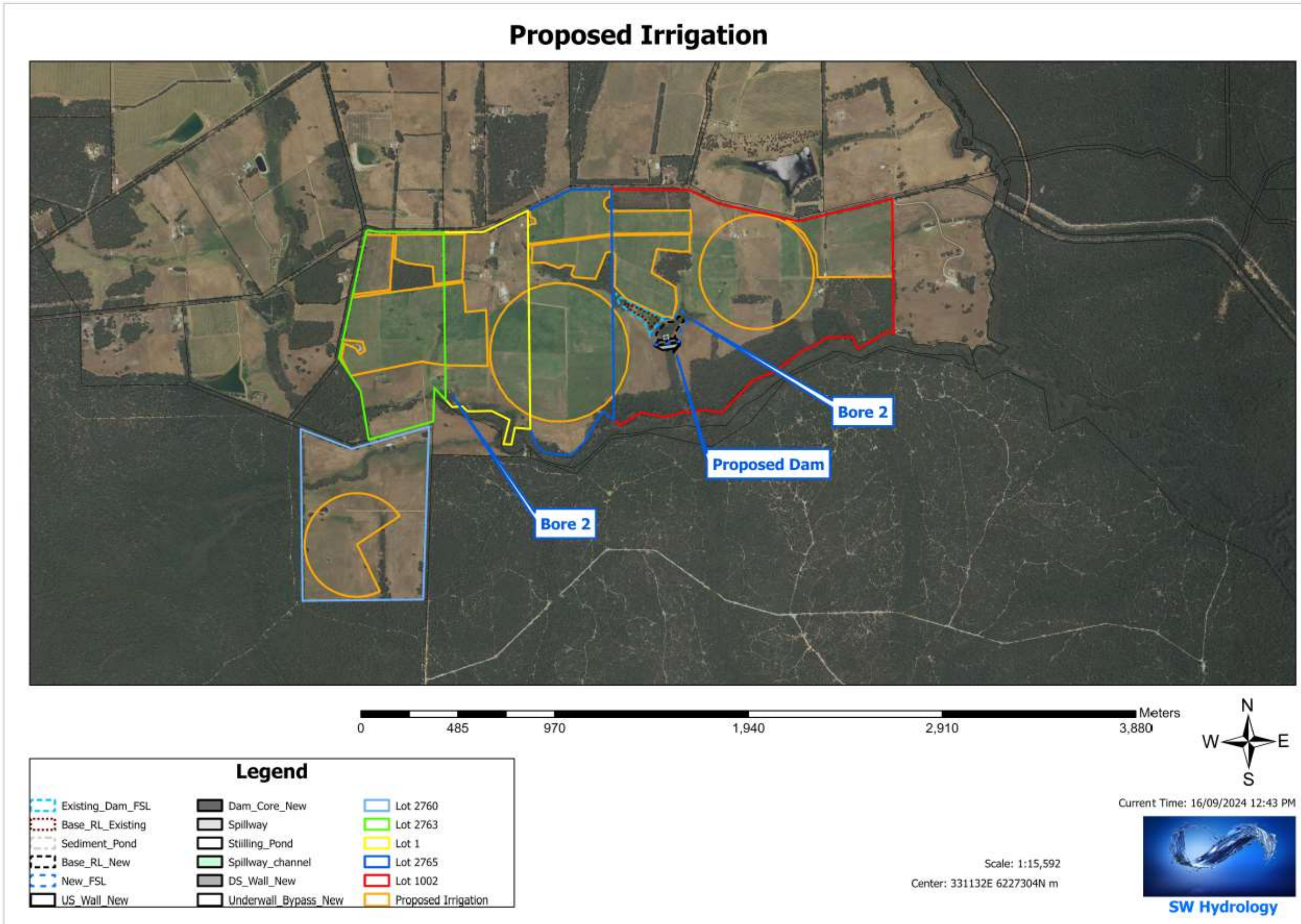


Figure 4. Proposed irrigation areas and water supplies

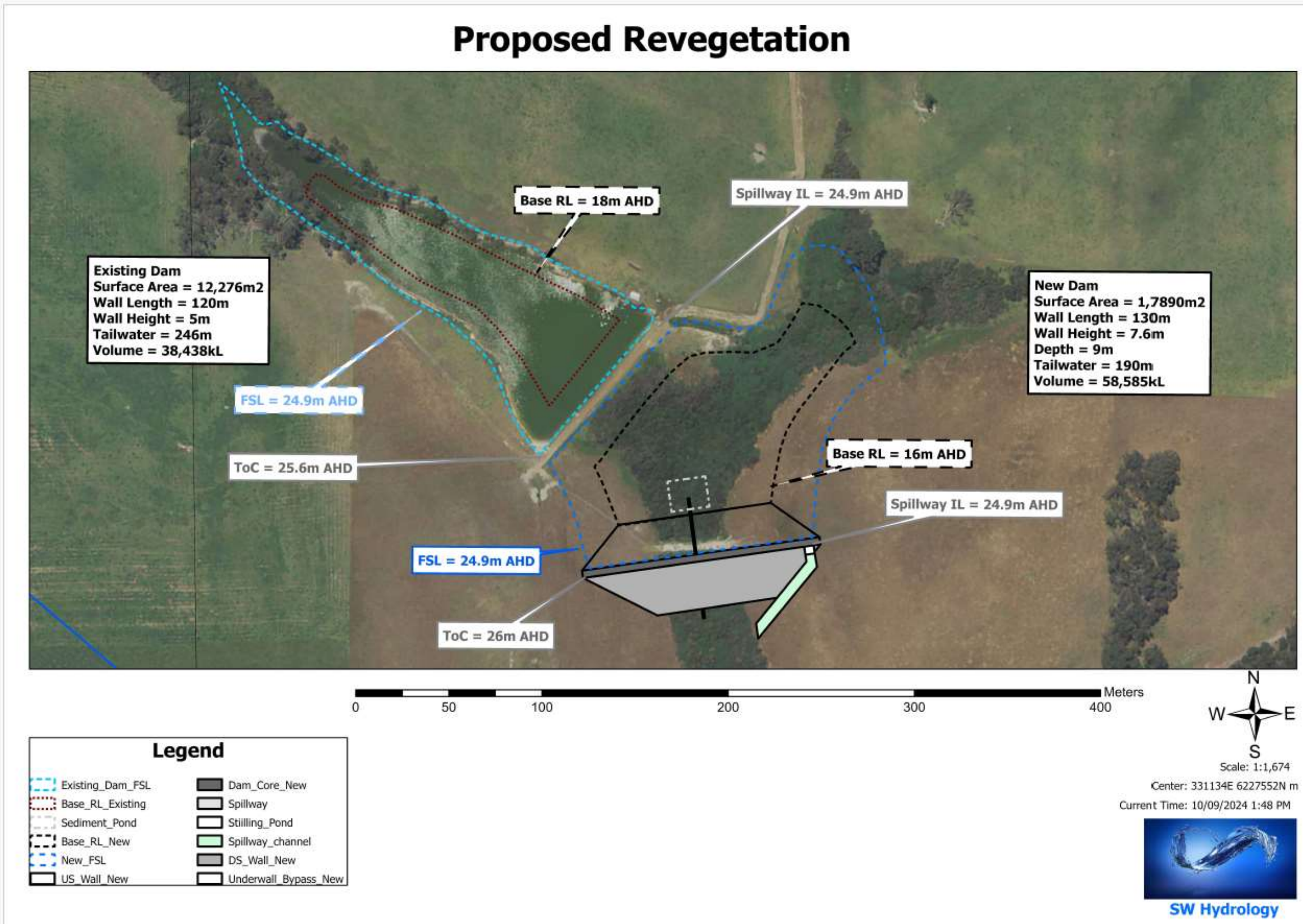


Figure 5. Proposed dam design Lot 1002 Warner Glen Rd

4. Hydrology methodology

The analytical assessment of potential streamflow in this assessment has been determined using 3 separate models. Model 1 was based off derived flows from the Department of Water Forest Grove gauging station (610023) flow data, with modelled flows scaled to the site of the proposed dam and the downstream confluence.

Model 2 inputs utilised local rainfall, topography, soil types, percentage vegetation cover and localised run-off coefficients most relevant to the proposed development site. Analytical modelling of rainfall and streamflow in this model considered flows for the period 1975-2023 based off Alexandra Bridge River rainfall data (Bureau of Meteorology rainfall gauge #9801). Runoff coefficients used conservative figures with 15% of rainfall as runoff for cleared land and 5% for vegetated sections of the catchment. Despite model outputs covering the period 1975-2023, only flows from 2000-2023 have been presented in this report to allow for declining rainfall experienced post 2000.

Model 3 was based off the same inputs as model 2 but applied higher runoff coefficient of 25% rainfall as runoff for cleared land and 8% for vegetated land. The importance of analysing increased runoff coefficients relates to potential drainage lines that can be installed on the property to maximise surface flow and reduce waterlogged sections of the property. It also considers the presence of roaded catchments and years when rainfall is above average.

It should be noted that gauged streamflow data and the modelled streamflow only reflects surface runoff and not groundwater seepage. However, this assessment has also considered potential groundwater recharge and aquifer storage (*Table 5 & 6)* given its relevance in the overall water balance. To determine groundwater recharge conservative rainfall as recharge coefficients of 5% were applied to the catchment area based on existing soil types. Aquifer storage was determined based on annual rainfall, length of the watershed (Thalweg), average width of the watercourse and average depth of the aquifer based on test pit data. Storativity values were applied to the catchment based on existing soil types i.e. 0.05 for clay soils and up to 0.15 for sandy soils. By ensuring recharge is not exceeded it demonstrates aquifer storage will not be impacted, thereby not creating adverse impacts to the resource.

5. Flow Analysis

Proposed Dam Site

The proposed dam site has a catchment area of 1.007km^2 with 0.897km^2 (89.17Ha) cleared arable land and the remaining 0.011 km^2 (11Ha) native vegetation. The modelled flow at the proposed dam site under model 1 ranges between 51,919kL – 243,876kL, while flows in model 2 range between 133,018kL – 233,675kL (*Table 5*).

The discrepancy of flow ranges under these two models for the minimum flow scenario is related to Forest Grove gauging station monitoring flows from a catchment with higher intensity dam development and higher percentage of native vegetation compared to the proposed dam site. These factors affect flows more in low flow years than average and high flow events. Modelled flows in the average and maximum scenarios are more closely aligned.

Modelled Flow - Forest Grove Gauging Station - Alexandra Bridge Rainfall						
Noakes Dam Site						
Model version	*Minimum flow (KL)*	*% reduction*	*Average flow (kL)*	*% reduction*	*Maximum flow (kL)*	*% reduction*
1	51,919	140%	127,496	57.07%	243,876	29.84%
2	133,018	55%	175,044	41.57%	233,675	31.14%
3	188,486	39%	245,951	29.59%	331,117	21.98%

Noakes Dam - Groundwater Recharge - Alexandra Bridge Rainfall							
Minimum (kL)	*% reduction*	*Average (kL)*	*% reduction*	*Maximum (kL)*	*% reduction*	*Aquifer storage (kL)*	*% reduction*
34,601	0.00%	72,241	0.00%	121,570	0.00%	33,075	0.00%

Table 5. Modelled streamflow and groundwater recharge Noakes dam site

The proposed dam and existing deepened dam require up to 72,767kL to refill under maximum irrigation demand, this volume accounts for irrigation water and residual storage demand. This demand equates to utilising 75% of the storage capacity, which is higher than most dam's, where evaporation and residual storage are both considered. Because of the high demand for irrigation the proposed dams would utilise most stored water prior to any significant evaporation loss, then bore water will be pumped into the dams to maintain irrigation supplies. The amount of water required to refill the dam will vary each year depending on the residual storage volume from pumped bore water, and the storage level at the end of the irrigation season.

In the driest year on record the proposed dam could capture all flows from the property catchment under minimum flows in Model 1, 55% under Model 2 and 39% under Model 3. Under an average flow scenario, the proposed dam would capture between 30% - 57% and less than 32% in high flow scenarios. The flow interception is high in the lowest flow scenarios, however, the proposed dam site is located within a minor tributary which is 2.23% of the Forest Grove Catchment. The dam site is located 250m from the main tributary of the Chapman Brook, where impacts from the proposed dam would be unrecognisable. There are also numerous springs and overland flow that discharge below the proposed dam site to maintain flows while the proposed dam is filling.

Potential groundwater interception from the superficial aquifer should be minimal given the dams will be topped up with bore water. The only time this surficial water may be intercepted by the dam, would be if the water level in the dam dropped lower than the static groundwater level. If the dam level is maintained above the static water level it can create groundwater mounding up-stream rather than interception, providing stored water for the upstream vegetation. Modelled groundwater ranges from 38,206kL – 134,233kL with 33,075kL of aquifer storage.

Downstream Confluence

The catchment area at the nearest downstream confluence 250m downstream of the proposed dam has a catchment area of 57.078km^2 of which 38.888km^2 is cleared arable land and the remaining 18.19km^2 is native vegetation. During winter the Chapman River ponds into the client's property 200m downstream of the proposed dam. The take of water from the proposed dam represents only a 3.27% reduction in flows at this confluence during the lowest flow scenario under model 1 and less than 1% under model 2 and 3 (*Table 1*). During average flow modelling there is less than a 1.34% reduction and less than 0.7% in high flow events. Therefore, this dam does not present an adverse risk to the resource, rather the risk of shortfall in storage volume is a risk to the client. This risk has been considered but the benefits of having increased storage outweighs the financial risk of having insufficient water supplies.

Downstream Confluence						
Model version	Minimum flow (KL)	% reduction	Average flow (kL)	% reduction	Maximum flow (kL)	% reduction
1	3,249,408	3.27%	7,951,496	1.34%	15,263,126	0.70%
2	11,327,518	0.94%	14,906,376	0.71%	19,899,291	0.53%
3	16,943,700	0.63%	22,109,411	0.48%	29,765,357	0.36%

Downstream Confluence - Groundwater Recharge - Alexandra Bridge Rainfall							
Minimum (kL)	% reduction	Average (kL)	% reduction	Maximum (kL)	% reduction	Aquifer storage (kL)	% reduction
2,165,539	0.00%	4,521,213	0.00%	7,608,497	0.00%	607,595	0.00%

Table 6. Modelled flows at the downstream confluence from the proposed dam.

6. Sediment control measures and revegetation

The following actions and contingency plans are proposed to prevent sediment export from the property.

Sediment Management During Construction

The proposed dam development will be limited to the months December – May, prior to any modelled overland flow occurring. During dam construction topsoil will be removed and stockpiled outside the full supply level (FSL) so it can be respread around the sides of the dam above FSL to aid in revegetation post dam development.

The existing dam will be retained while the downstream dam is being constructed, therefore any flow events associated with summer thunderstorms and early frontal activity will be captured by this dam, preventing any flows entering the work site. If summer thunderstorms with more than 20mm of rainfall are forecast, hay will be laid around the downstream base of any stockpiled material to prevent sediment mobilisation into the work site.

The proposed dam wall be another containment barrier for any sediment mobilisation downstream.

Dam Designs and Sediment Management Controls

The existing dam has a surface area of 12,517m^2 a design depth of 7m and 260m tailwater. The proposed dam has a surface area of 17,890m^2 with a design depth of 8.9m and 190m tailwater. The designed dam areas, length and depth of the dam will provide sufficient storage capacity to enable sediment that may enter the dam, to drop out of suspension prior to flows leaving the dam. The proposed dam has a spillway stilling pond incorporated into the designs (*Appendix 1. Plan 1 & 1.5*) which provides another control to enable sediment to drop out of suspension before leaving the dam site and reduce flow velocity.

The spillway has been sited to ensure the lowest gradient, thereby, reducing potential velocity. In addition, the grassed and rock pitched spillway will have rock riffles installed within the channel to slow the flow of water. Native reeds and sedges will be planted within the spillway channel to provide additional sediment and nutrient filtration, the stilling pond and rock riffles will oxygenate the water which is beneficial for the downstream environment.

The proposed dam will have <500mm contour drains established at a 1:100 gradient around the side of the dam footprint (above FSL) to ensure that any hillside runoff is directed to the tailwater section of the dam. Contour drains reduce the risk of hillside runoff creating multiple erosion sites along the dam banks. The above measures are considered best management practice in dam design and dam stability.

All topsoil from within the dam footprint will be stockpiled and used to top-dress the downstream side of the dam wall with the remainder spread along the banks of the dam between high water mark and the natural ground surface. This provides a planting medium for sedges and reeds to stabilise the soils and filter nutrients and sediment, it also maintains the natural seedbank which often has higher success rate than tube stock.

All material removed from the dam footprint will be used to construct the dam wall and re-batter the downstream toe of the existing dam, no excess material will be left outside the dam footprint.

Revegetation Plan

During construction of the proposed dam, *Taxandria linearifolia* will be cleared under clearing permit CPS 9395/1 and stockpiled outside of the dam footprint. Ideally this would be mulched and respread within the revegetation area above FSL. However, embedded and overtaking the *Taxandria* is dense blackberry bushes.

Where possible *Taxandria* will be separated and mulched, although this will likely be too difficult and risk the chance of further spreading blackberries around the property. It is likely that the vegetation will have to be stockpiled and burnt to eliminate/reduce the risk of blackberries regrowing around the dam. Part of CPS9395/1 also relates to some Marri-Jarrah vegetation that does not have the same blackberry problem, this can be mulched and used to spread around the dam for revegetation. The proposed species to be planted and their densities are listed below (*Table 7 and Figure 6*), reeds and sedges will be planted around 1-2m above FSL along the banks of the dam then an 5m wide buffer of shrubs and Jarrah-Marri. No shrubs or deep-rooted species will be planted within 20m of either dam wall to avoid roots compromising wall integrity.

Species	Common Name	Quantity	Width (m)	Height (m)	Cost ($)	Plants/m^2	Location
Juncus pallidus	Pale Rush	205	1	2	$256	1/m^2	Dam Batters
Ficinia nodosa	Knotted Club Rush	205	0.8	1	$256	1/m^2	Dam Batters
Microlaena stipoides	Weeping Grass	205	5	0.2	$718	1/m^2	Dam Batters
Kunzea recurva	Mauve Kunzea	38	1.5	2	$133	1/5m^2	Dam buffer
Myoporum oppositifolium	Twin-Leaf Myoporum	38	1.5	2	$133	1/5m^2	Dam buffer
Kunzea spathulata	NA	38	3	4.5	$133	1/5m^2	Dam buffer
Podocarpus drouynianus	Wild plum	38	4	3	$133	1/5m^2	Dam buffer
Banksia sessilis	Parrot Bush	38	4	6	$133	1/5m^2	Dam buffer
Bossiaea aquifolium	Water Bush	38	1	1	$133	1/5m^2	Dam buffer
Melaleuca huegelii	Chenille Honeymyrtle	38	4	5	$133	1/5m^2	Dam buffer
Taxandria linearafolia	Swamp Peppermint	38	5	8	$133	1/5m^2	Dam buffer
Corymbia calophylla	Marri	18	15	20	$540	1/40m^2	Dam buffer
Eucalyptus marginata	Jarrah	20	25	35	$600	1/40m^3	Dam buffer
Total		957			$3,435		
Tree guards		957			$1,436		
Labour		957			$2,394		
Grand Total					**$7,265**		

Table 7. Proposed species list and planting density

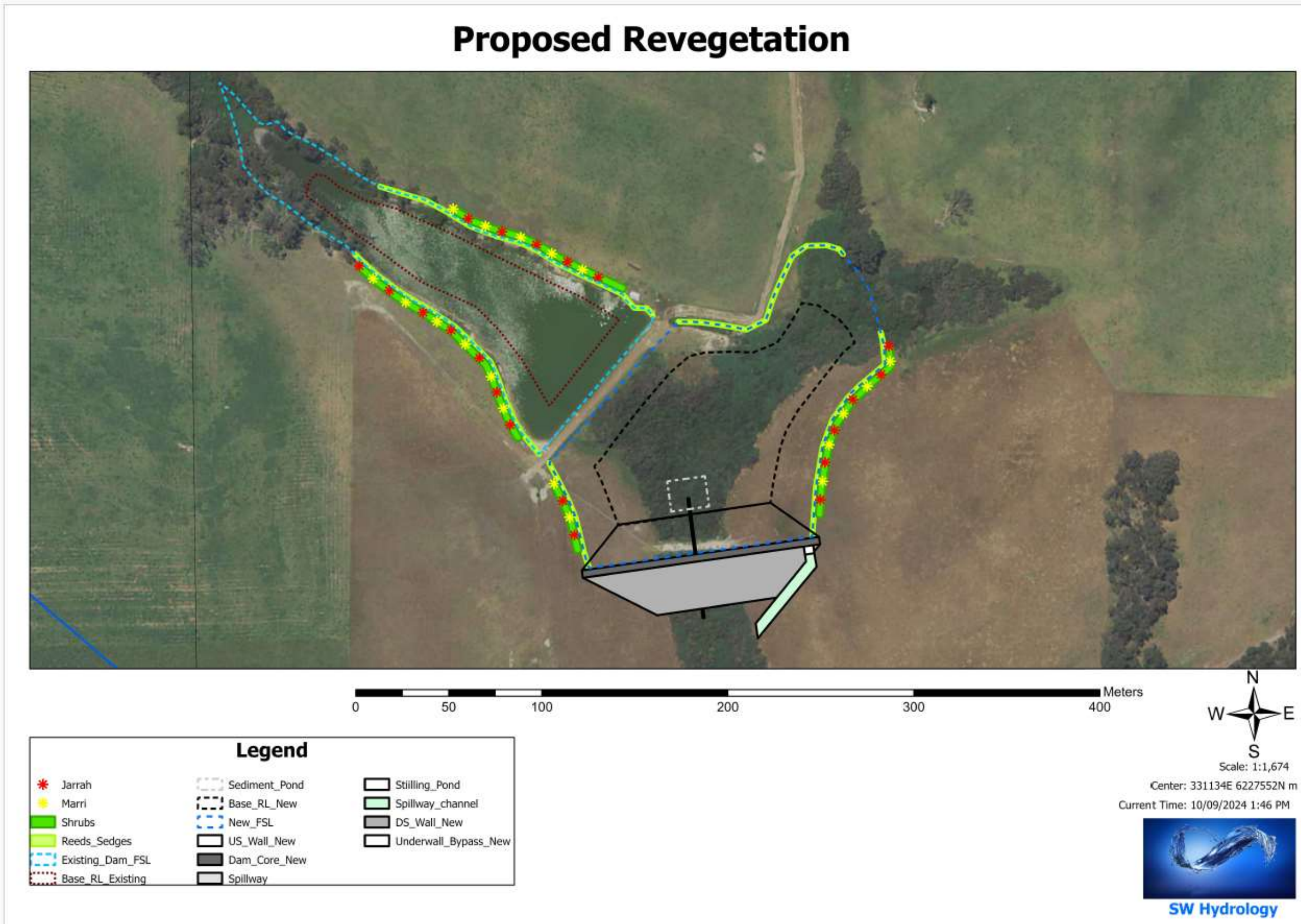


Figure 6. Proposed revegetation around dams

7. Regulatory Approvals

Rights in Water and Irrigation Act 1914

Surface Water

The property is located within the Lower Blackwood, Chapman subarea which currently has water available for allocation under the Whicher areas surface water allocation plan 2009 and the Departments Water Register. This report provides supporting information including detailed dam designs and water balance in support of an application under s17 and s5C of the *Rights in Water and Irrigation Act 1914*.

Environmental Protection Act 1986

Clearing permit

The proposed dams will require a clearing permit under s51E of the Environmental Protection Act 1986. The applicant has an existing application CPS9395/1 which is currently being assessed.

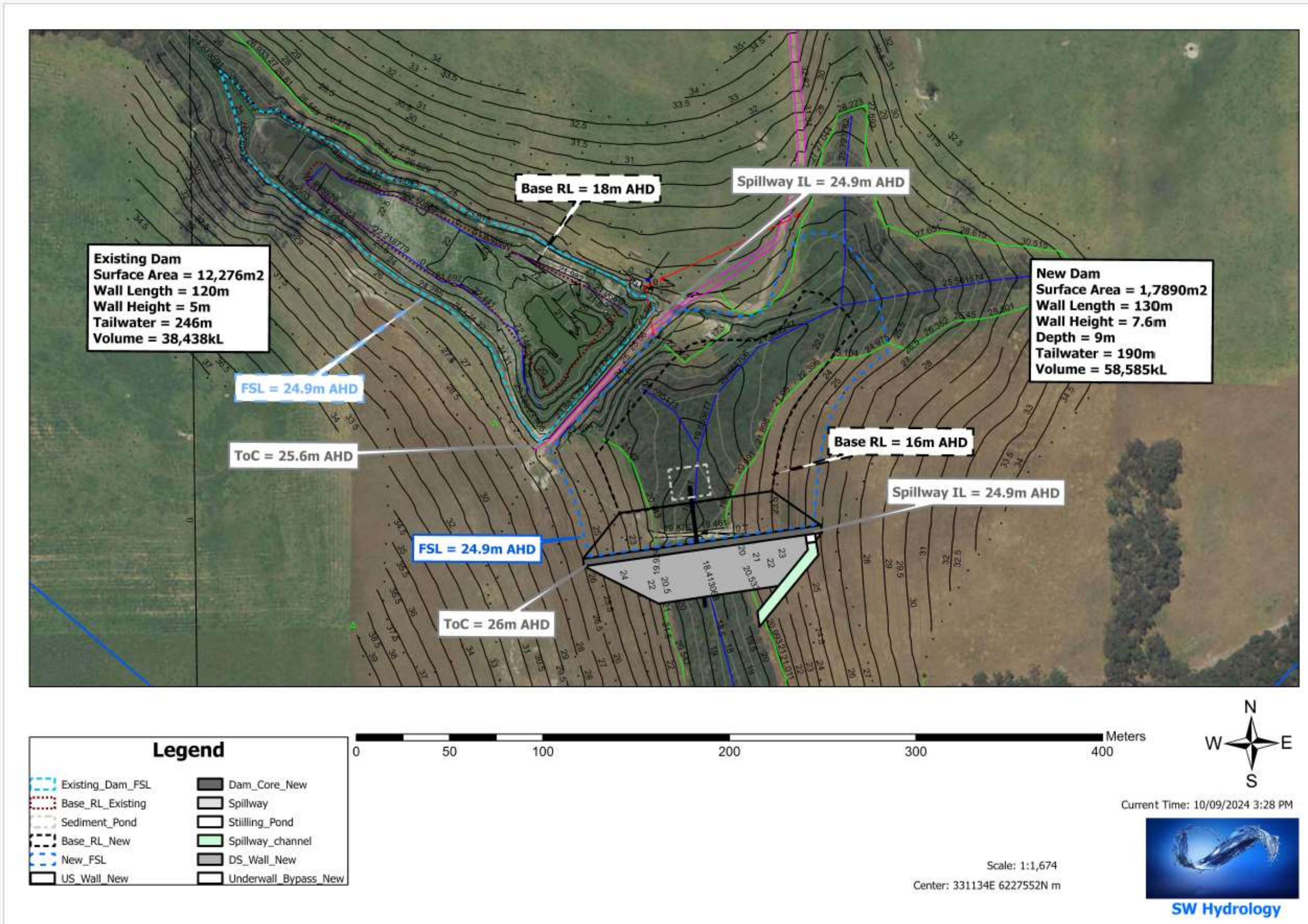
Shire of Augusta Margaret River Town Planning Scheme 21

According to the Shire of Augusta Margaret River Local Planning Scheme No. 1 (LPS), Gazetted 24 September 2010, Updated April 2019, the property is zoned as Priority Agriculture. The proposed landuse is consistent with land use zoning, an application for development approval for the dam has been submitted for approval.

Summary

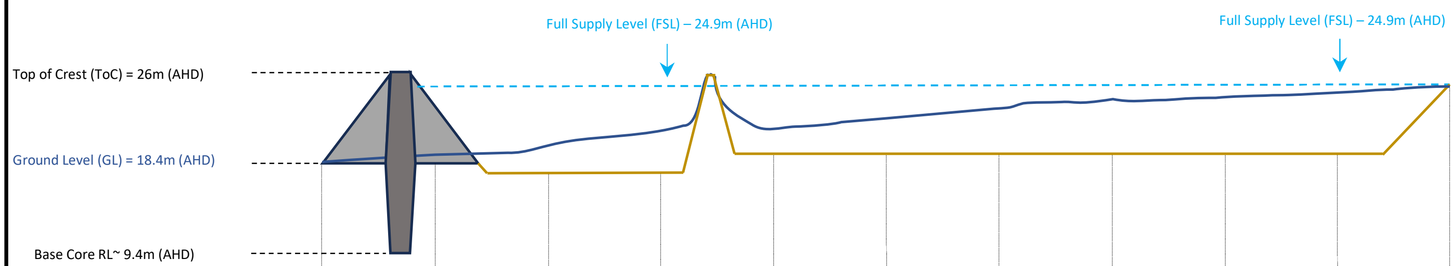
The proposed development is critical in maintaining the commercial viability of the property to meet their irrigation demands. The existing dam is leaking and does not have sufficient storage capacity to ensure against any pump failures in the bores. If the bores have any issues the existing dam only provides 2 days back-up supply. This is a significant risk to their operations and without suitable dam storage the client's dairy operations are at risk. The proposed dam development, repair and deepening of the existing dam will not have any adverse impacts to the downstream flow. The proposed dam development is planned to commence in December 2024 and be completed by 30 May 2025.

Appendix 1. Detailed Dam Designs



Plan 1. Detailed Dam designs and specifications

SW HYDROLOGY

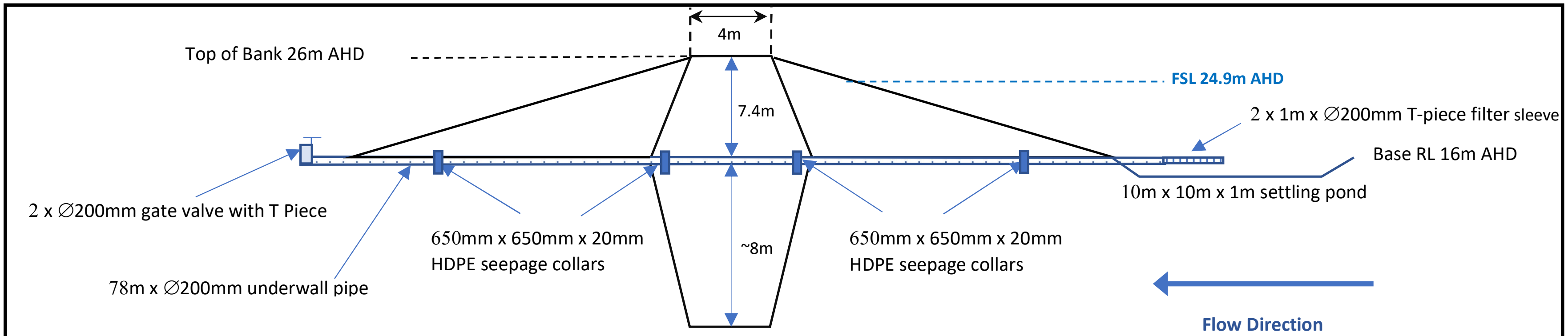


Existing ground level m (AHD)	18.4	19	20	21	21.2	21.5	22	22.5	23.1	24.5	24.9
Design ground level m (AHD)	18.4	16	16	16	18	18	18	18	18	18	24.9
Chainage (m)	0	40	80	120	160	200	240	280	320	360	400

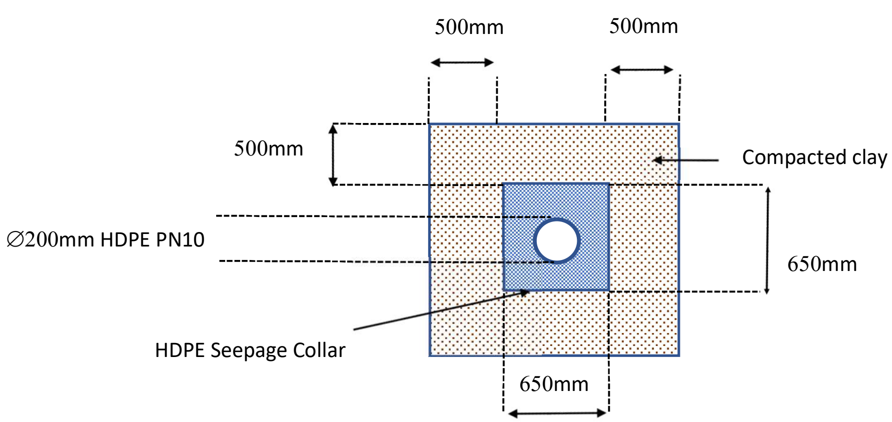
Plan 1.1
Proposed Dam – Cross Section

SW Hydrology
Drawn by: CM
Date: 27-08-2024

SW HYDROLOGY



Plan 1.3.1. Underwall bypass and scour valve



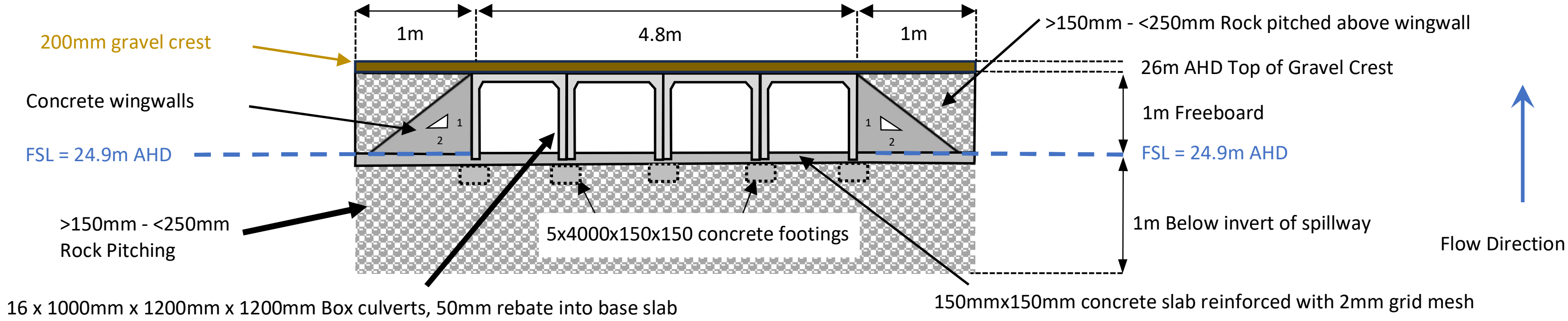
Plan 1.3.2. HDPE seepage collars

Plan 1.3

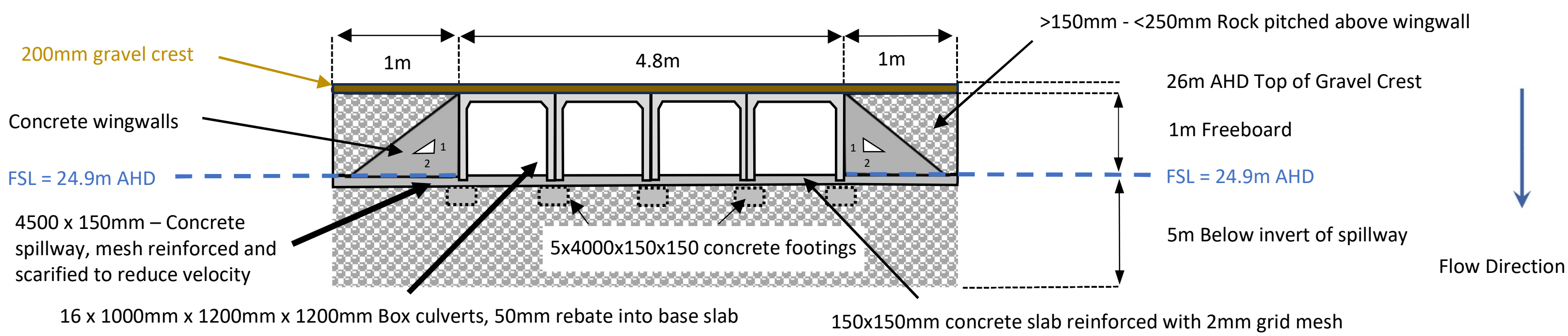
Proposed Dam – Underwall bypass design

SW Hydrology
Drawn by: CM
Date: 27-08-2024

SW HYDROLOGY



Plan 1.4.1. Spillway inflow – cross section

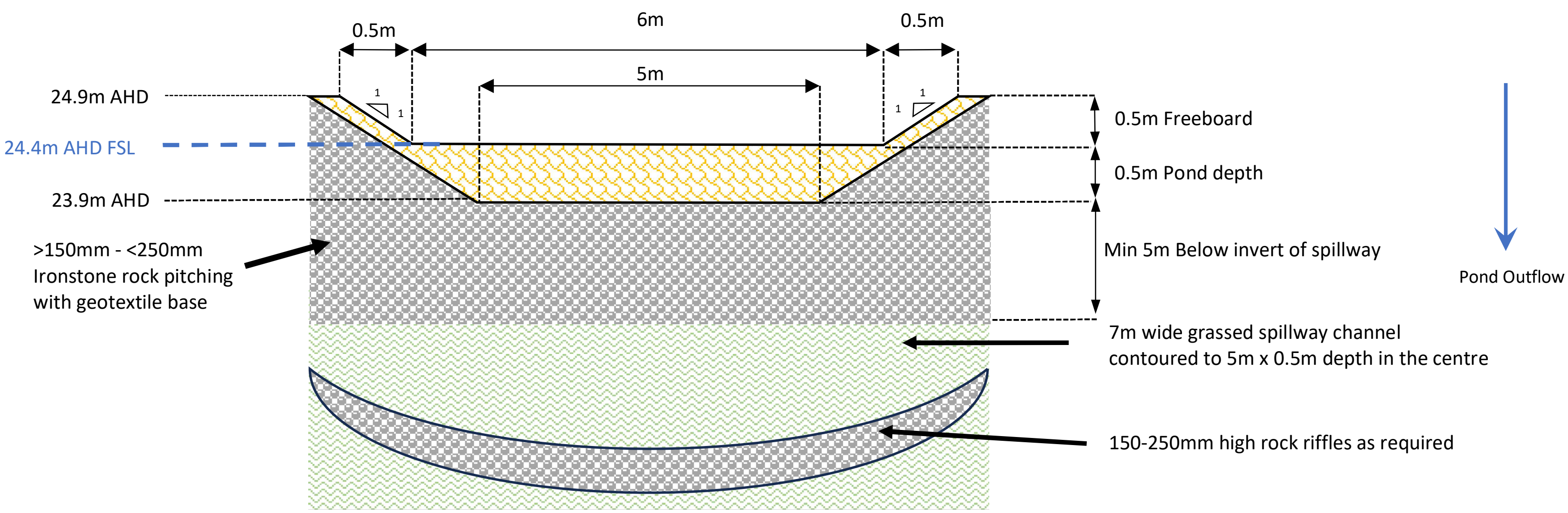


Plan 1.4.2. Spillway outflow – cross section

Plan 1.4
Proposed Dam - Spillway design

SW Hydrology
Drawn by: CM
Date: 27-08-2024

SW HYDROLOGY



Plan 1.5.1. Spillway and stilling pond – cross section

Plan 1.5 ***Proposed Dam – spillway channel design***	SW Hydrology Drawn by: CM Date: 27-08-2024