AGRICULTURAL BUSINESS PLAN FOR

PORTION 17 OF 232 REDFORD FARM

Prepared for Balderja Farm, Redford

by

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1. INTRODUCTION

1.1 Background

The applicant purchased Portions 12, 15 and 17 of the farm Redford 232, Plettenberg Bay, (collectively known as Balderja Farm), for the development of macadamia nuts and cover crops under drip irrigation. To cultivate a proposed 28ha macadamia orchard under drip irrigation, the mean annual irrigation requirement is approximately 81 000 m^3/a, with a maximum demand reaching up to 116 000m^3/a (Hydrological Report, Confluent). The farm is in the Western Cape, approximately 15km north-east of Plettenberg Bay, within quaternary catchment K60E in the Gourtiz Water Management Area (Figure 1).

The construction of a storage facility for the storage of water to which the properties are and may become entitled, was commenced in 2021, but construction has been ceased (as per CMA directive Dec 2021) pending the outcome of the WULA.

There is an Existing Lawful Water Use (ELU) for the three portions of land purchased by the applicant. This is provided through the Rondebosch River Water Use Association Certificates of Entitlement (16/06/2021), which provides for water use from the furrow system. A proportional allocation of water from the furrow system is provided to the three properties. A total of 31 properties receive water from this furrow system. The applicant owns three portions of land on the furrow system, namely portions 12, 15 and 17 of Redford Farm 232. Furrow allocations to each property are based on a ratio of 1:31 allocated to each landowner. Calculation of the precise volumes of water available through the furrow system are difficult to confirm. Two approaches were used in the Hydrology report. The modelled volumes from the catchment split into 31 totalled 16 972 m^3/a per portion, with a total for all three portions of 50 377 m^3/a. Transmission losses and uncertainty about the volumes of water that bypass the furrow system probably over-estimate this value, and measured flows by a furrow user were as much as 50% lower than this figure. A more likely value proposed in the Hydrology Report is therefore 25 000 m^3/a.

The mean irrigation requirements for the planned 28 ha of macadamias are 81 000 m^3/a, with a maximum demand of 116 000 m^3/a. The dam on Portion 17/232 would be filled from three sources: 1) three furrow allocations (25 000m^3/a); 2) 12 200m^3/a surface water from the catchment; and 3) 69 000m^3/a groundwater from a borehole that was sunk on Portion 17/232. Supply from the three sources should be sufficient to meet the annual irrigation demand of the trees, such that irrigation requirements will be met 95% of the time. Water storage of 70 000 m^3 was calculated to be sufficient storage for the planned hectarage of macadamia nuts to be irrigated (Hydrological Report, Confluent and Dam Engineer Report, Jan Brink).

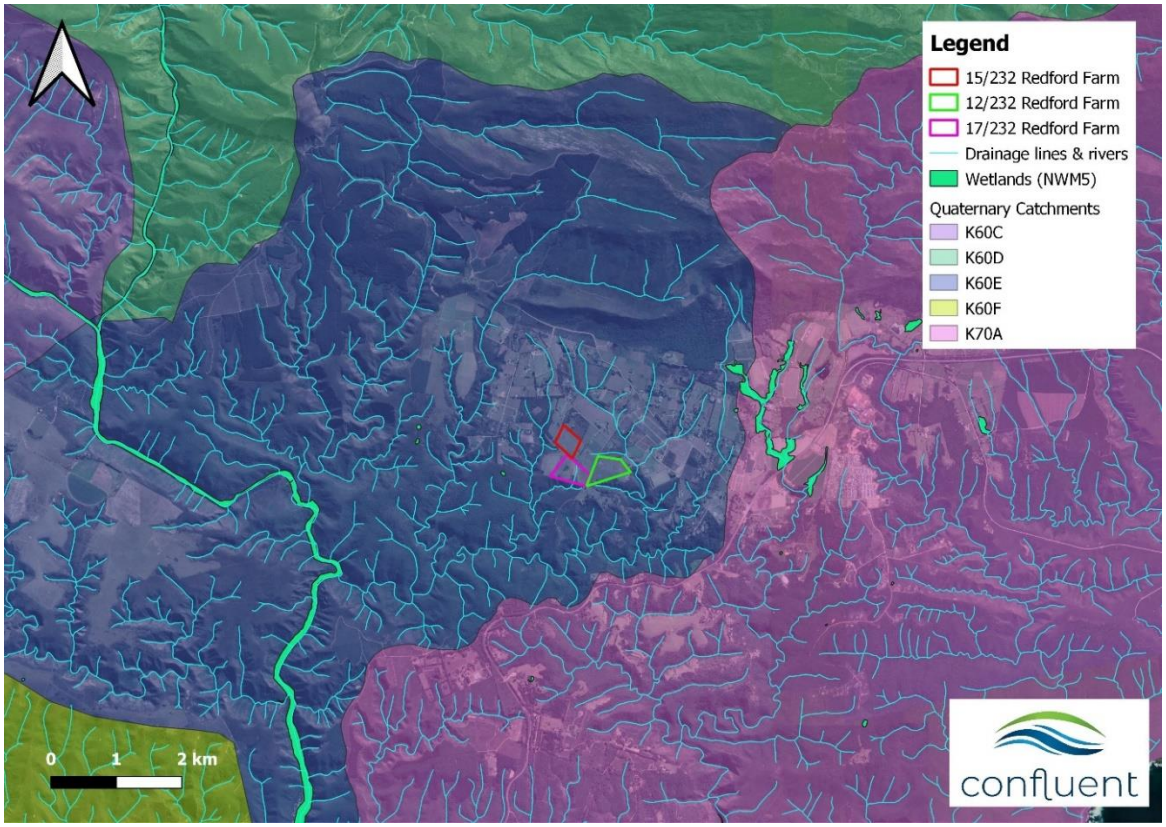


Figure 1: Balderja Farm in relation to quaternary catchments and rivers

1.2 Project Description

The landowner plans to establish 28 ha of macadamia nuts across portions 12, 15 and 17 / 232. All 28 ha have already been ridged and the soil has been prepared for planting of the trees. The orchard blocks will all be established simultaneously, and the orchard layout is provided in Appendix 1. Mulch will be incorporated to the soil surface to ensure reduced evaporation from the soil. The drip irrigation system will be installed in August, and the plan is to plant 8 500 trees towards the end of September. Fortunately, this is timed for the spring rainfall season, but a dependable source of water is required in the long-term given that macadamia orchards cost in the region of R200 000 per hectare to establish.

Irrigation and fertigation will be centrally coordinated from a constructed shed. Irrigation from the proposed dam would be sourced from a combination of 3 furrow allocations (25 000m^3/a), surface runoff from the dam's catchment (12 200m^3/a) and groundwater from the borehole (69 000m^3/a). This provides a total estimated volume of 106 200m^3/a which is sufficient to meet the mean irrigation requirement of 81 000m^3/a but is slightly below the maximum irrigation requirement of 116 000m^3/a. However, the estimated volumes delivered by the furrow allocations may be slightly higher than measured, and if they're between the measured and modelled values then there will be sufficient water to meet the maximum irrigation requirement. A total storage capacity of 70 000 m^3 is optimal for storage of surface water flows in the catchment. The geohydrological study confirmed that 100% of the groundwater demand of 69 000 m^3/a can be supplied from the borehole (DHS, Groundwater Consulting Services).

The orchards will be irrigated by the landowner by means of drip irrigation with computerised, precision technology. This will include probes and weather stations, designed for the sites specifically. The moisture probes will be used for irrigation scheduling purposes. Each block will

have probes to measure the soil moisture contents at 10-15cm depth ensuring that water is used at an optimum. Therefore, irrigation will be planned according to readings as opposed to daily automated schedules, ensuring irrigation is not excessive. Electronic records of irrigation schedules will also be kept, ensuring optimum conservation and water demand management is achieved for the orchards.

Should the dam be approved, work to complete construction of the dam and fully implement any license conditions (e.g. buffers, dam design considerations) would commence immediately.

1.3 Summary of Authorization(s) required in terms of National Water Act.

A summary of water uses that require authorisation in terms of the National Water Act (NWA, Act No. 36 of 1998) is provided in Table 1.

Table 1: Authorisations required for water use in terms of the National Water Act

Water use	Purpose	Capacity/Volume	Property Description	Co-ordinates
Section 21(a) – taking water from a watercourse				
Abstraction of groundwater through Borehole (BH1)	Irrigation	69 000 m^3/a	Portion 17/232	-33.9510;23.4448
Taking of surface water runoff (dam's catchment)	Irrigation	12 200 m^3/a	Portion 17/232	-33.9497;23.44604
Section 21(b) – storing water				
Storage of water in instream Bernardskloof Dam	Irrigation	70 000 m^3	Portion 17/232	-33.9497;23.44604
Section 21 (c) – impeding or diverting the flow of water in a watercourse				
Impeding the flow of water due to a dam	Irrigation	-	Portion 17/232	-33.9505; 23.4458
Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse				
Excavation of soil and removal of vegetation for construction of dam basin and dam wall	Irrigation	-	Portion 17/232	-33.9498; 23.44604

1.4 Dam Safety Risk

The proposed dam has a wall height of 17 m and a volume of 70 000 m^3. Dam Safety Risk is regulated in terms of Chapter 12 of the NWA and the Dam Safety Regulations (GN R.139, February 2012). The Act stipulates that a dam with a wall height of more than 5 m with a volume greater than 50 000 m^3 is classified as a dam with a safety risk (Jan Brink Consulting Engineering, November 2021).

The regulations classify dams in three categories. Should the final wall height of the dam be 17 m, it will most likely be classified as a Category II dam.

2. WATER RESOURCES AND AVAILABILITY

2.1 Existing water resources

The proposed dam will be located on Portion 17/232, and along with Portions 12 and 15 each of the properties receives a furrow allocation through the Rondebosch River Water User Association. It is proposed that furrow allocations from the three properties be stored in the dam on Portion 17/232.

The furrow system was constructed in 1906 and under the NWA the diversion of the water into the furrows is an ELU, as it was in use before 1998 when new legislation came into place. With 31 properties receiving furrow allocations, the proportion of water for each portion is 1:31. The hydrological report (Confluent, 2022) calculated the mean annual allocated volume per property by means of a modelling programme (WRSM Pitman Model), to be approximately 16 792 m^3/a. However, flows measured by a user of the furrow, suggest that actual flows produced by the furrow may be as much as 50% lower than predicted by the model (Hydrological Report, Confluent). If the dam on Portion 17 of Redford Farm 232 will store all three properties allocation, it would amount to an ELU of approximately 25 000 m^3/a. This volume could be increased by ensuring reduced transmission losses through the furrow via infiltration and evaporation.

2.2 New/Additional water resources

The applicant has sunk a borehole to provide water for domestic use as well as to provide sufficient water for irrigation of 28 ha of macadamia nuts. The proposed dam on Portion 17 of Redford Farm 232 would be used to store the borehole water as well as the catchment runoff and furrow allocations from all three properties owned by the applicant (Figure 2).

The proposed dam which has been partially constructed is also a new water resource (Figure 2). The dam is required for storage of water to provide assurance of supply under a range of climatic situations.

Figure 2: Map showing the location of the Dam and borehole on Portion 17 of Farm 232 Redford

3. WATER RESOURCE DEVELOPMENT PLAN

3.1 Water demand analysis

The mean monthly irrigation requirements for 28 hectares of macadamia nuts under drip irrigation are presented in

Table 2. The requirement was compared to the mean monthly volumes that can be supplied from the furrow, the immediate catchment area of the dam and a borehole. The mean annual irrigation requirement is approximately 80 500 m^3/a, with a maximum demand of 116 000 m^3/a during below average rainfall periods (Hydrology Report, Confluent).

Future irrigation demands were estimated using SAPWAT 4.0, based on the following assumptions:

- Water requirements were estimated for macadamia nuts under drip irrigation;
- The default setting of 75 % was used for water distribution efficiency; and
- Irrigation scheduling was set to take place when readily available water (RAW) reached 70 %.

Table 2: Long-term estimated irrigation requirements for 28 hectares of macadamias

	Irrigation Requirements								Mean Monthly Water Supply (m^3)			
Month	Max	95 %	75 %	Median	25 %	5 %	Min	Average	Furrow Allocation	Runoff from Catchment	Borehole	Total
October	16240	16240	8120	8120	0	0	0	6259	3 275	1 587	5 750	13 888
November	24360	16240	16240	8120	8120	0	0	9304	2 934	1 421	5 750	13 039
December	32480	24360	16240	16240	8120	8120	0	13364	2 058	996	5 750	10 862
January	32480	24360	16240	16240	8120	8120	0	15394	1 410	683	5 750	9 253
February	24360	21518	16240	8120	6090	0	0	9473	1 122	543	5 750	8 573
March	16240	16240	8120	8120	0	0	0	6598	1 388	672	5 750	9 197
April	16240	13398	8120	4060	0	0	0	4568	1 507	730	5 750	9 494
May	18514	12976	10150	7795	4385	763	325	7267	1 876	909	5 750	10 411
June	8120	0	0	0	0	0	0	338	1 853	897	5 750	10 352
July	8120	8120	0	0	0	0	0	1523	1 954	946	5 750	10 604
August	16240	8120	8120	0	0	0	0	3045	2 662	1 289	5 750	12 364
September	16240	16240	8120	0	0	0	0	3383	3 150	1 526	5 750	13 576
Annual	**115953**	**107054**	**91025**	**79088**	**72764**	**58902**	**62600**	**80516**	**25 189**	**12 200**	**69 000**	**106 389**

3.2 Water Source analysis

The average and maximum annual irrigation requirements cannot be met by one water source alone. Combining surface runoff from the dam's catchment area and derived furrow volumes will require supplementary groundwater from the borehole (Hydrological report, Confluent).

According to the geohydrological report the sustainable yield of the borehole drilled for this purpose is 69 000 m^3/annum or 5 875 m^3/month (Stroebel, 2021). The borehole is therefore capable of providing supplementary water required to meet the irrigation requirements of the orchards. Storage of surface water inflows is required to provide assurance of supply during deficit months (Hydrological report, Confluent). Hence the proposal for construction of the dam.

3.2.1 Dam Catchment Area

The catchment area of the dam is approximately 0.14 km^2 with a Mean Annual Runoff of 11.2% (estimate by WRSM/Pitman model for the broader catchment area), generating approximately 12 200 m^3/a from the direct catchment area of the dam (Hydrological Report, Confluent). Mean monthly flows as estimated by the WRSM/Pitman model are presented in

.

Table 3: Mean monthly surface flows from the catchment area of the dam

Month	Surface Runoff from Catchment (m^3)
Oct	1 587
Nov	1 421
Dec	996
Jan	683
Feb	543
Mar	672
Apr	730
May	909
Jun	897
Jul	946
Aug	1 289
Sep	1 526
TOTAL	**12 200**

3.2.2 Furrow

3.2.2.1 Modelled flow volume

Based on analyses presented in the Hyrdology Report (Confluent) the mean annual runoff per furrow allocation is approximately 16 792 m^3/a. The proposed dam on Portion 17/232 Redford Farm would store allocations for the three properties owned by the applicant which would total

approximately 50 377 m^3/a based on calculations (Table 4Table 4). However, this volume does not take transmission losses likely to occur along the length of the furrow system into account.

Table 4: Estimated mean monthly flow volumes diverted out of the Rondebosch River and into the furrow.

Month	Furrow	Furrow Allocation per Property (m^3)	Furrow Allocation to Portion 17 of Farm 232 (m^3)
Oct	67 689	2 184	6 551
Nov	60 633	1 956	5 868
Dec	42 533	1 372	4 116
Jan	29 144	940	2 820
Feb	23 189	748	2 244
Mar	28 678	925	2 775
Apr	31 144	1 005	3 014
May	38 767	1 251	3 752
Jun	38 289	1 235	3 705
Jul	40 378	1 303	3 908
Aug	55 022	1 775	5 325
Sep	65 100	2 100	6 300
TOTAL	**520 567**	**16 792**	**50 377**

3.2.2.2 Measured flow volume

Measurements taken by a landowner on the furrow system, indicated a minimum of 6 480m^3 per property per annum for each furrow allocation. This is equal to approximately 20 000m^3/a for the three properties allocated to Balderja. Table 5 indicates the estimated mean monthly flows expected with the WRSM/Pitman model re-calibrated to measured volumes given. This results in an estimated annual volume of 25 000m^3 for all three farm portions.

Table 5: Mean monthly flows estimated from the furrow allocation (calibrated to measured flows).

Month	Furrow Allocation (m^3)
Oct	3 275
Nov	2 934
Dec	2 058
Jan	1 410
Feb	1 122
Mar	1 388
Apr	1 507
May	1 876
Jun	1 853
Jul	1 954
Aug	2 662
Sep	3 150
TOTAL	**25 189**

3.2.3 Furrow catchment area

According to the findings in the hydrological report, the annual flow volumes in the Rondebosch River leading up to the aqueduct (diversion to furrow) are highly variable. These range from just over 200 000 m^3 to 1 800 000 m^3 per year, with a mean annual runoff (MAR) of 540 000 m^3/a.

This represents approximately 11.2% of the mean annual precipitation (MAP). Rain typically falls throughout the year, but runoff results indicate that the majority occurring during spring from August to November. The low flow period is from January to April (Figure 3).

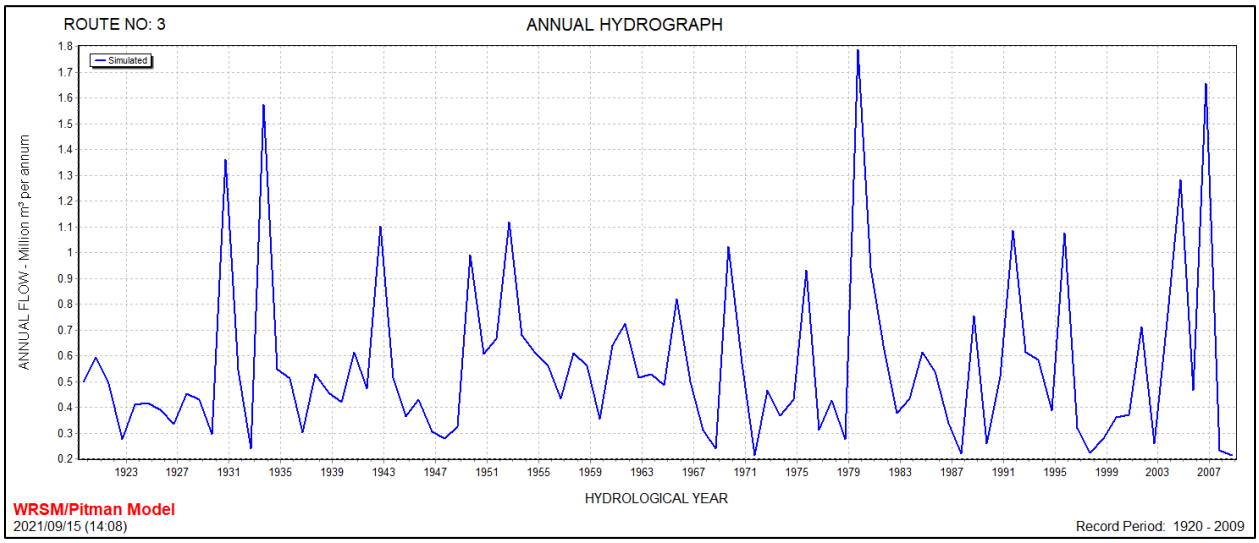


Figure 3: Annual hydrograph of the catchment area of the Rondesbosch furrow.

3.2.4 Borehole

The total average annual irrigation requirements cannot be met by surface water volumes derived from the furrow and the immediate catchment area of the dam alone. Supplemental irrigation from a borehole will therefore be required. According to the geohydrological report the sustainable yield of the borehole drilled for this purpose is 69 000 m_3/annum or approximately 5 750 m_3/month (Stroebel, 2021). The borehole is limited by this yield and no more than 5 750 m_3 can be abstracted from the borehole on a monthly basis. The borehole, together with surface flows from the catchment and furrow (total of approximately 106 000 m_3) is therefore capable of providing sufficient water required to meet the mean annual irrigation requirements and up to a 5 % exceedance probability. A summary of the borehole specifications and yields thereof is provide in Table 6.

Table 6: Borehole specifications

Borehole	Depth (m)	Static Water Level (m)	Sustainable Yield (l/h) Pumping 24 hours/day	Volume per day (m^3)	Volume (Mm^3/annum)	Yield (l/s)
DBH1	250	87.03	7 920	190.08	0.069	2.2

All the parameters analysed for the borehole, indicated slightly elevated Iron concentrations, but comply with the SANS241 drinking water limits (Stroebel, 2021).

3.3 Storage demand analysis

A detailed monthly time series water balance was compiled to determine the volume of storage that is required to ensure assurance of supply covering the full range of expected climatic conditions over a 50-year period. The SAPWAT model was used to produce monthly irrigation requirements using weather data (supplied with the model) covering the period from 1950 to 2000 (i.e. a 50-year period; Hydrology Report). The water balance estimated the dam volume at the end of each month whilst accounting for a range of variables explained in Section 4.5 of the Hydrology Report.

Simulations show that a dam storage volume of 70 000 m_3 in combination with an annual borehole abstraction of 69 000 m_3 (i.e. approximately 5 750 m_3 per month), will be sufficient to ensure assurance of supply over the simulation period, even under extreme dry conditions (Figure 4).

Lower dam volumes would result in some months going into an irrigation deficit (Section 4.5 Hydrology Report). While the number of months in deficit is relatively low (e.g. up to 5 % of the months over a 50-year simulation period for a 40 000 m_3 dam), the maximum irrigation deficit for a given month is relatively high (e.g. 48 % and 61 % for a 50 000 m^3 and 40 000 m_3 dam, respectively; Table 7), which presents a risk to high value crops such as macadamia trees. Given the constraints on borehole abstraction, a 70 000 m_3 dam is the only size that would guarantee 100 % assurance of supply over the simulation period (Table 7).

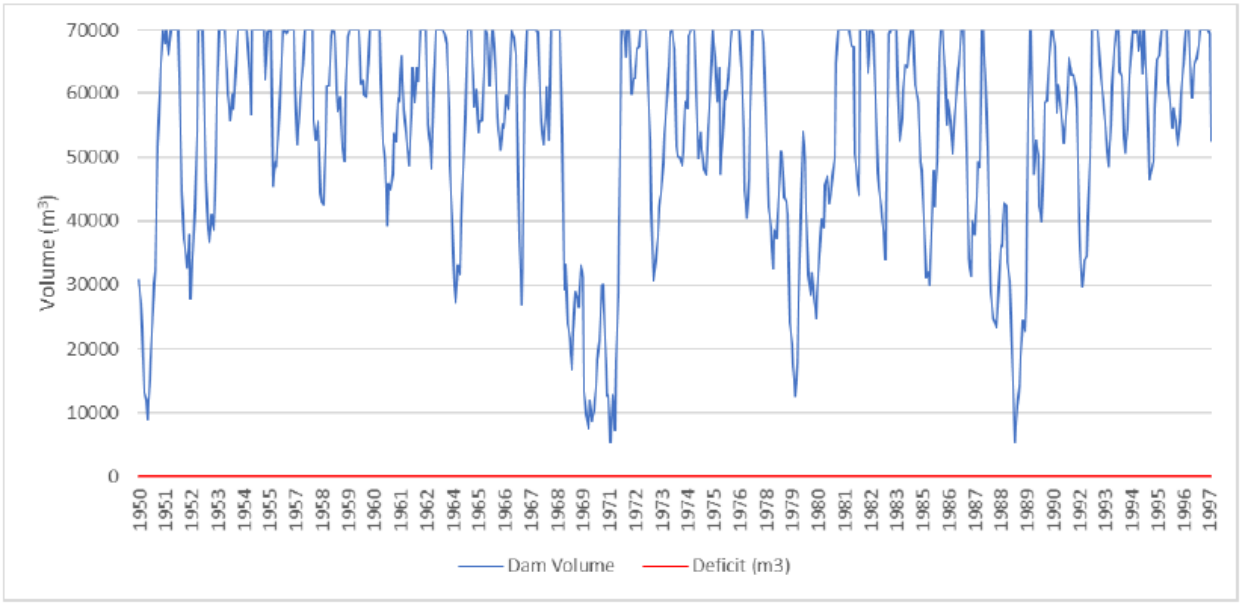


Figure 4: 50-year simulation with a dam volume of 70 000 m^3 and borehole abstraction of 5 750 m^3 per month

Table 7: Summary of irrigation deficit for different dam sizes

Dam Size	No. of Deficit Months	No. of Deficit Months (% of total)	Average Monthly Deficit (% of irrigation demand)	Maximum Monthly Deficit (% of irrigation demand)
40 000	28	4.9	17	61
50 000	8	1.4	22	48
60 000	3	0.5	10	22
70 000	0	0	0	0

3.4 Water distribution plan

Water from the dam catchment, the three furrow allocations and the borehole will be stored in the proposed dam on Portion 17 of Redford Farm 232. The water will be used to irrigate the 28 ha of macadamia trees (Appendix 1, orchard layout). See Figure 2 for the location of the dam and borehole. The irrigation and fertigation pumphouse is located on Portion 12/232 as indicated in Appendix 2. The approximate route of furrows transferring water into the dam is also indicated in Appendix 2.

4. WATER DEMAND MANAGEMENT

Water from the dam catchment area as well the ELU from the three furrow allocations will be stored in the dam. Supplementary water pumped from the borehole will be monitored with a flow meter and stored in the dam.

Low flow drip irrigation systems will be used, and irrigation schedules will be informed by soil moisture probes and weather stations. In this way water use is measured and monitored with precision, computerised technology. This ensures that irrigation is done according to readings as opposed to daily automated schedules to ensure unnecessary water is not used for irrigation (Agrimotion, 2021).

Cover crops will be established, and mulching used in the orchards to prevent soil erosion and water losses through evaporation. The cover crops help to keep the soil moist in the orchards and help reduce the need to irrigate.

Significant sections of the furrow have been piped to reduce transmission losses through infiltration and evaporation.

5. WATER RESOURCE PROTECTION

The dam volume will be closely monitored by the landowner. The installation of flow meters will ensure that abstraction volumes remain within allocated allowances and automated irrigation schedules will be kept on a software programme for record keeping and monitoring purposes.

A 10 m riparian buffer revegetated with indigenous plants will be established according to specifications in the Aquatic Specialist report around the proposed dam measured from the high-water mark. This will reduce the potential impact of sedimentation and agricultural chemicals on water quality in the dam.

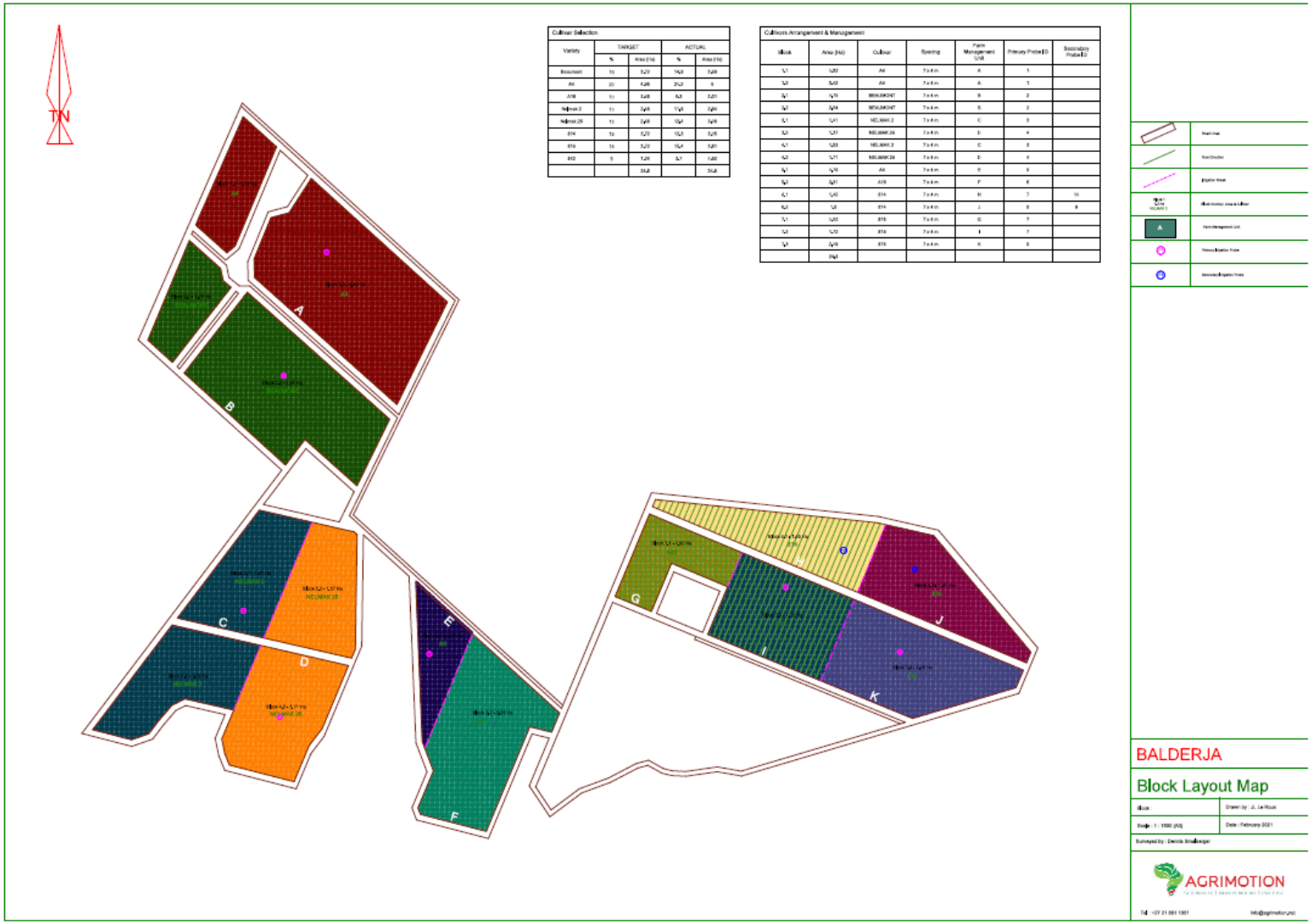
6. REFERENCES

Agribook Digital (2022). Everything you need to know about farming in South Africa.

Agrimotion (2021). Orchard Development Report for Macadamia Nuts, Balderja.

7. APPENDICES

Appendix 1: Proposed orchard layout (Agrimotion New Orchard Development)



Appendix 2: Proposed irrigation layout