PROJECT PLANNERS
RESOURCE MANAGERS
CIVIL & STRUCTURAL ENGINEERS
BUILDING DESIGNERS
ENVIRONMENTAL ENGINEERS

Our Ref: 26065

22 February 2018

ENGINEERING SUBMISSION
FOR
THE SUNDAY PADDOCK LTD
80 CAMERONS ROAD, SEDDON

1. GENERAL

The Sunday Paddock Ltd propose the establishment of 100,000 m^3 of water storage to support the robust supply of irrigation to approximately 116 hectares of cropping and vineyards, which fronts onto both the east and west sides of Camerons Road, 2.3 km west of Seddon. The location of the proposed reservoir, key features of the site and locality are shown on the drawings numbered 26065 sheets C1 -C4 issue 'A', as prepared from survey and detailed design for Resource Consent, Building Consent and construction purposes.

A geotechnical investigation has also been completed as part of the site assessment stage, which included specific reviews of two potential storage areas on the farm.

Mr Ross Davis, Chartered Environmental and Geotechnical Engineer from Davidson Group Ltd has inspected the site and assessed its suitability, including review of experience from a number of other storage projects in the locality. Mr Davis is also up to date with the new 2015 New Zealand Dam Safety Guidelines and a member of the New Zealand Society on Large Dams, the pre-eminent technical group on the topic in this country.

This submission was prepared to accompany an Application for Resource Consent. Note that a Building Consent will also be required. Further documentation will also specify the required standard of drainage and earthworks construction, construction monitoring and commissioning regimes, and ongoing inspection and management requirements.

Davidson Ayson House, 4 Nelson St
P O Box 256, Blenheim 7240, NZ
T: 03-579 2099 / F: 03-578 7028
E: service@DavidsonGroup.co.nz
W: DavidsonGroup.co.nz

Principals
Ross Davis, CPEng, MIPENZ, BE
Stephen Sheat, CPEng, MIPENZ, BE
Leigh McGlynn, CPEng, MIPENZ, BE

2. RESERVOIR FORM, GEOGRAPHY AND GEOLOGY

The attached drawings show the proposed reservoir form, being approximately 680 metres of perimeter with small embankments to the east, north and west sides and the remainder blending into the natural terrace to the south. The earthworks are inside the internal boundary to the immediate north.

The design methodology is to make best use of the available area and achieve the desired storage volume while working in with the existing land features (both above and below ground), making the earthworks as efficient as is practical, and producing regular reservoir form for efficiency of liner installation. The overall depth is as expected for an effective design, and the modest embankments range from 4.0 to 7.2 metres in height.

The footprint does however result in a significant volume of spare topsoil (approximately 2, 400 cubic metres) and excess excavation (in the order of 9, 600 cubic metres) which will need to be placed into fill areas beyond the reservoir. The waste fill areas are identified on the intermediate terrace land to the northeast of the construction site and at the head of a blind gully some 1.2 km to the west. These fill locations will need to be included in the Resource Consent as an additional Land Use activity.

Based on the detailed design, the following statistics are expected (rounded figures):

- Storage volume — 100, 000 cubic metres (xxx, 000 m^3 above lowest ground)
- Total footprint — 3.6 hectares
- Water surface area — 2.4 hectares
- Water depth — 5.6 metres (6.3 metres above lowest ground)
- Embankment height — 4.0 to 7.2 metres
- Freeboard — 0.9 metres
- Crest width — 4.0 metres
- Fill slopes — 1:3 internal, 1:3 external
- Embankment fill — 60, 000 cubic metres
- Liner — 1.5mm HDPE

The crest width and embankment slopes meet or exceed the geometry provided by empirical references. The freeboard provision has been calculated using the detailed design method of Section 13.1.4 of Fell et al. (2015) which comes from USBR Design Standards No. 13 Chapter 6, taking into account the rainstorm flood surcharge as below together with the wind run-up as appropriate for the normal and minimum freeboard cases.

GNS Map 13 (2006) indicates that the general geology is alluvial gravel and sand with minor silt. Our local experience is of simple geology of terraces of variable thickness of fine soils over gravels and mudstone. The site is not subject to specific natural hazards and is elevated well above the Awatere River located to the north. The concealed inactive Hog Swamp fault is approximately 2.3km to the southeast, and the Awatere Fault is some 4.5km to the northwest.

Geotechnical investigation has already been undertaken to identify depths of unsuitable soils to be removed as part of site preparation, establish the significance of any seepages or groundwater that may affect the design and construction, and confirm the selection of fill materials. Samples will be tested for grading and to set compaction requirements. No complex features of the site or design have been identified.

3. WATER FLOWS

The expected input to storage is the pumped river supply at 35 litres per second, dependant on the availability of water relative to threshold river flows. At full rate the proposed reservoir would be filled in 34 days. Surface runoff cannot enter storage.

There will be no flood inflows and the only bulk inflow scenario is that of rainfall from a short duration and high intensity storm. For example, data from the NIWA HIRDS V3 system gives a 100 year 10-minute rainfall intensity of 10.9 mm. This extreme rainfall (65 mm/hr) onto 2.4 hectares of lined reservoir area would give an inflow of 650 litres/second for a short period. The proposed spillway - which will fundamentally act as prevention of accidental overfilling - at 2.0 m base width and HDPE lined across the dam wall (and down the downstream shoulder to a discharge to natural ground) will pass such a flow at a surcharge depth of 0.2 metres with minor intrusion into the total freeboard provided.

The position of the overflow spillway was chosen to be in the SW quadrant in the range of prevailing winds to minimise the incidence of stored water being blown over the spillway. With automated control that prevents overfilling, only unusual wind or significant rain will cause any discharge (noting that this is a low rainfall area).

Runoff from the terrace above the reservoir will not enter the storage.

4. DAM BREAK SCENARIO

4.1 Background

The New Zealand Dam Safety Guidelines 2015 and the concept of a Potential Impact Classification (PIC) require assessment of the consequences of a theoretical dam breach without regard to the likelihood of failure. For this project, the potentially relevant cases to consider are piping and overtopping.

We have reviewed the potential implications of a hypothetical dam failure relative to the nature of the dam and the downstream environment. We discuss our judgement on where the dam classification should lie in terms of the NZSOLD Dam Safety Guidelines (2015), and what further process is generated therefrom in the following sections. We note that key elements of the dam safety assessment process require decisions to be made on judgement, particularly in cases such as this where comprehensive dambreak modelling and such complex procedures are not justified for the scale and nature of the situation.

The likelihood of a significant dam safety event is very low and mitigated by a number of factors as discussed below. However, the possibility of failure is required to be considered and as such the potential impact of the release of up to 100,000 cubic metres of water at a flow rate of some cumecs is a scenario.

4.2 Potential Failure Mechanisms

A piping failure could be initiated if there is a substantial leak through the HDPE liner that exceeds the capacity of an under-liner drainage system, or a failure associated with the sealing of the liner or outlet conduit to the interface slab. The effect of this will be reduced by the expected cohesive and granular fill laid within a strict compaction and testing regime, robust detailing and close construction monitoring associated with the outlet conduit, and what effect the robust liner will have on slowing and reducing the extent of breach development.

Further, such a failure can only occur if there is a sustained flow of water driven along a crack or transverse interface in the embankment. The driving head would be the stored water escaping through a compromised point in the liner. In this case, the site is underlain by free draining gravels and sands, and as such leakage flow will take the path of least resistance into the subsoil (noting that a band of free draining material around the perimeter of the base of the liner will be included in the blinding specification). With free drainage of leakage waters to ground, a piping failure cannot occur. The Applicant intends reservoir water level monitoring as part of their new control system, which will have the ability to report unusual falling levels should they occur.

An overtopping failure is not possible with the elevated reservoir and generous spillway capacity. There are also no nearby faults, no landslide hazard, and no adverse ground conditions to add any risk to the proposal.

Study of Section 6.5 of Module 3 of the 2015 NZSOLD Guidelines does not reveal any other considerations requiring attention for this project.

5. HAZARD ASSESSMENT

To date our experience with numerous 'small' dams in the Awatere Valley / Blind River area (and elsewhere in Marlborough) has been of Low PIC except for one instance where the embankment was very close to the main trunk railway line.

A dam failure could occur to the west or north onto the intermediate terrace. Outflows will tend to disperse on the terrace, then drain to the gully to the northwest on the Applicant's property, and then further passing through the Cameron and Starborough properties to the Awatere River some 900 metres distant. The only built development in the flow path is wind machines.

There is an abandoned house near the noted gully inlet and the Applicant proposes a new dwelling nearby to the northwest. We have discussed with them using a slightly elevated floor level as a safety margin against the worst-case scenario (e.g. 500mm above existing ground level).

Table 2.2

With respect to the application of Table 2.2 of the NZSOLD DSG (2015), the judgement point is whether any houses would be impacted to the level of becoming uninhabitable (as there are no critical or nearby major infrastructure issues, no significant environmental factors, and community recovery time is expected to be weeks rather than months). No dwellings would be so affected so long as a free overland flow path is maintained to the head of the aforementioned gully.

Table 3.1

With respect to the application of Table 3.1 of the NZSOLD DSG (2015), firstly we note that there are only minor differences in the PIC outcome between the Minimal and Moderate damage levels. As is appropriate to any community risk-based process, it is the Population At Risk (PAR) and Potential Loss of Life (PLL) that set the scene. We refer to Section 2.8 of Module 2 as follows.

PAR assessment relates to persons exposed to water of more than 0.5m depth. We consider that this is highly unlikely. There could be pump/electrical service people or farm or vineyard workers on that land, but they would readily get to higher ground if surface water became apparent. There could be water level monitoring in the reservoir whose control system can send an alarm to the owner and irrigation contractor if the reservoir level drops abnormally for action to be taken and the downstream property advised.

PLL assessment is described in the Guidelines as "…difficult to estimate…" and "…it is always prudent to adopt a conservative approach.". The Guidelines also indicate that where there are any dwelling(s) that may be destroyed, the potential for fatalities should be considered. Our view is that loss of life may be a remote possibility but is not 'highly likely'.

We conclude that the proposed reservoir lies in the Low PIC category.

6. RISK MANAGEMENT

There are several factors that mitigate the potential risk posed by this reservoir. They include

- No overtopping risk
- No catchment inflow
- Water level monitoring
- Ample spillway capacity
- No landslide risk
- Simple dam form
- Simple geology and robust fill materials
- Moderate embankment slopes
- HDPE liner installed and tested by specialist subcontractor
- Provision for emergency drawdown
- Well-qualified and experienced local dam engineer
- Selected earthworks contractor with relevant experience and track record
- Permeable subsoil with free passage of liner leakage
- Resource Consent and Building Consent processes will be undertaken, the latter of which includes specialist regulatory review
- The 2015 NZSOLD Guidelines are being applied together with up-to date references
- Education of the dam owner of inspection and reporting responsibilities
- Regular inspection and review by a suitable professional engineer

7. DAM SAFETY MANAGEMENT

As part of the Building Consent documentation, the Owner will be presented with a self-inspection form to regularly complete as part of their role as primarily responsible for the safe operation and management of their water holding facility. (We also strongly recommend that the existence of the reservoir is recorded in site Health and Safety planning and registered with the Owner's insurer as an asset to be covered for earthquake.)

The Dam Safety Guidelines suggest that technical reviews (Module 5 Section 4.4 - Intermediate Dam Safety Reviews) be undertaken every 1 to 2 years for a Low PIC dam. The structure is simple in form and construction so 2 yearly intervals will be adequate.

8. CONCLUSIONS

The proposed reservoir is a moderate-scale storage in a rural environment. There are no complex site features and the specifics of the locality have been taken into account. There is confidence that an effective, long-lasting facility will result from the input of suitable design, construction and management practices.

The hazard posed to people, infrastructure and the environment has been considered and a Low Potential Impact Classification determined. Seeing this project through and undertaking suitable commissioning and management activities with regard to the requirements of Local Authority approvals and the New Zealand Dam Safety Guidelines will ensure that appropriate practise is adhered to and the interests of all parties are attended to.

9. REFERENCES

Fell, R. et al (2015). *Geotechnical Engineering of Dams, 2nd Edition*. Balkema, Leiden.

Institute of Geological and Nuclear Sciences (2006). *Geological Map 13, Geology of the Kaikoura Area*. MS Rattenbury, DB Townsend and MR Johnston (Compilers).

Marlborough District Council GIS Information.

NZSOLD (2015). *New Zealand Dam Safety Guidelines*.

USBR (2012). *Design Standards No. 13, Embankment Dams, Chapter 6, Freeboard*. US Department of the Interior, US Bureau of Reclamation, Denver, CO.

DAVIDSON GROUP LTD

R W Davis

RWD: DFS

APPENDIX

A1. Photographs

A2. Drawing Number 26065 sheets;

C1 A Locality Plan
C2 A Site plan
C3 A Sections and Filter Drainage Detail
C4 A Details

MARLBOROUGH DISTRICT COUNCIL

ISO 9001:2000
Document Number:
RAF0005-CI987

Name of Applicant The Sunday Paddock Ltd

INFORMATION TO SUPPORT AN APPLICATION For Construction Of Earth Dams (mandatory information)

This additional application form is required to be provided to supplement the Application For A Resource Consent. It is recommended you read the Council's brochures *Guidelines for Applying for a Resource Consent* and *Guidelines for Applying for A Land Use Consent.*
This form does not include any information necessary to support a water permit application that may also be required in association with your application to construct a dam. Further information on water permits is available in the Council's brochure *Guidelines for Applying for a Water Permit.*

Please complete:

Name of water course on which dam is sited (if named) NA

Dam catchment area NA hectares

Type of core material

Type of fill material Clayey Silt and Sandy Gravel

Maximum height of dam above natural ground 7.2 metres

Existing ground conditions (eg. wet, swampy, dry, etc) dry

Commencement date of construction mid 2018

Dam measurement details:

Length of crest 385 metres — Depth of core trench NA metres

Width of crest 4 metres — Width of core trench NA metres

Estimated water storage 100,000 cubic metres

Upstream batter slope 3H:1V

Downstream batter slope 3H:1V

Overflow Spillway:

Bottom width 2.0 metres

Bed slope 3H:1V

Depth of spillway outlet below top of dam 0.9 metres

Spillway batter slope 3H:1V

Is any part of the spillway located on fill material? Yes

Low flow pipe:

Diameter of low flow pipe NA……………………millimetres

Length of dam discharge pipe NA……………………metres

Contractors Name TBA……………………………………………………………

Address ……………………………………………………………Telephone No ……………………

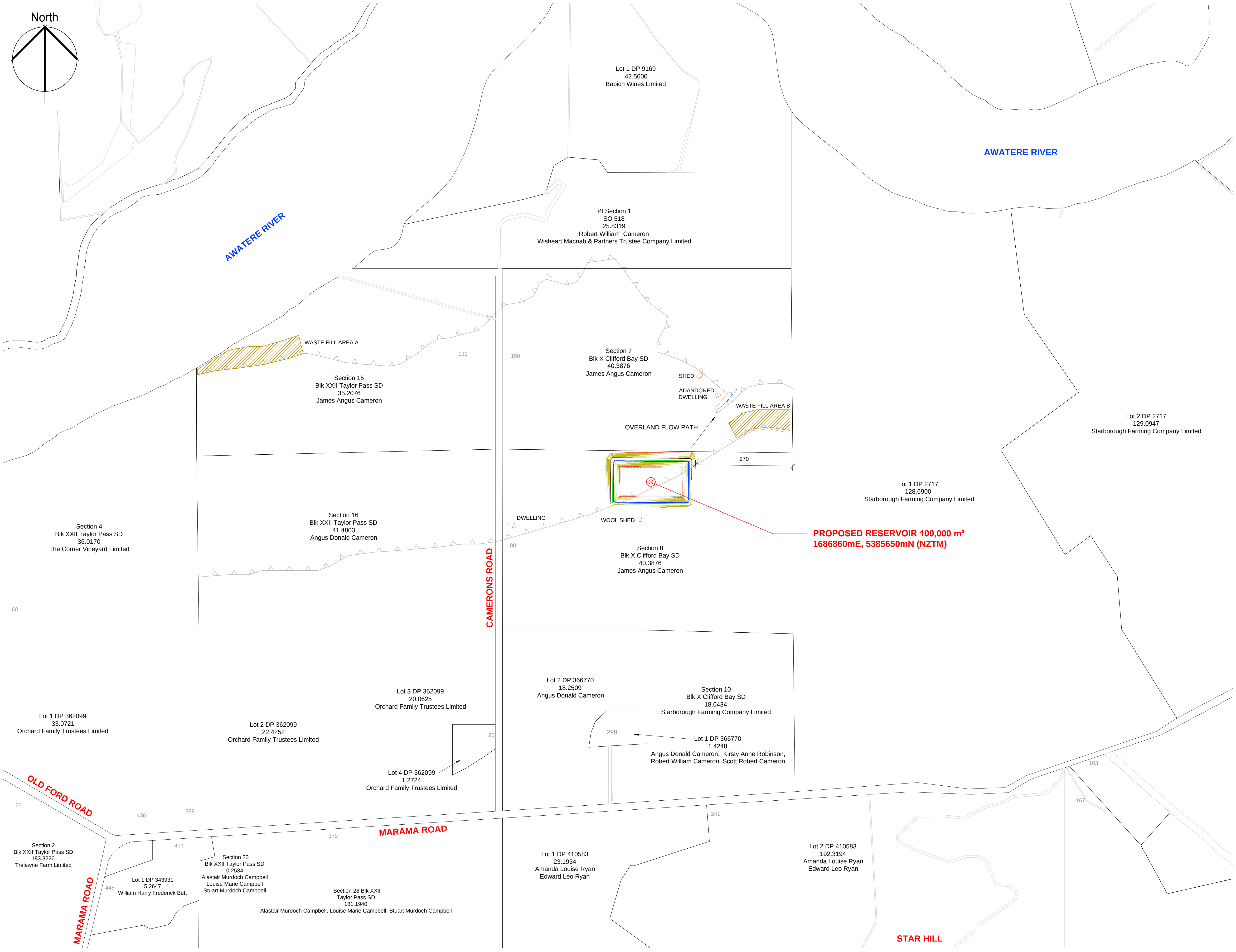
Supervising Engineer's Name Davidson Group Ltd - R W Davis……………………………………………

Address 4 Nelson Street, Blenheim……………………………Telephone No 577 1923……………………

Cross section drawing:

Show particularly the dam batters, core trench and location of any pipes (and associated seepage collars) within the dam. (Supply detailed design and work sheets if appropriate)

Reset form



LOCALITY PLAN
1:5000
1:10000 (A3)

NOTES:

1. SURVEYING UNDERTAKEN BY DAVIDSON GROUP LIMITED FOR ENGINEERING PURPOSES ONLY
2. HEIGHT DATUM NZVD 2016, ORIGIN APUC 93.49m

REVISION	DATE	BY

THE SUNDAY PADDOCK LIMITED

80 CAMERONS ROAD
SEDDON

STORAGE RESERVOIR

locality plan

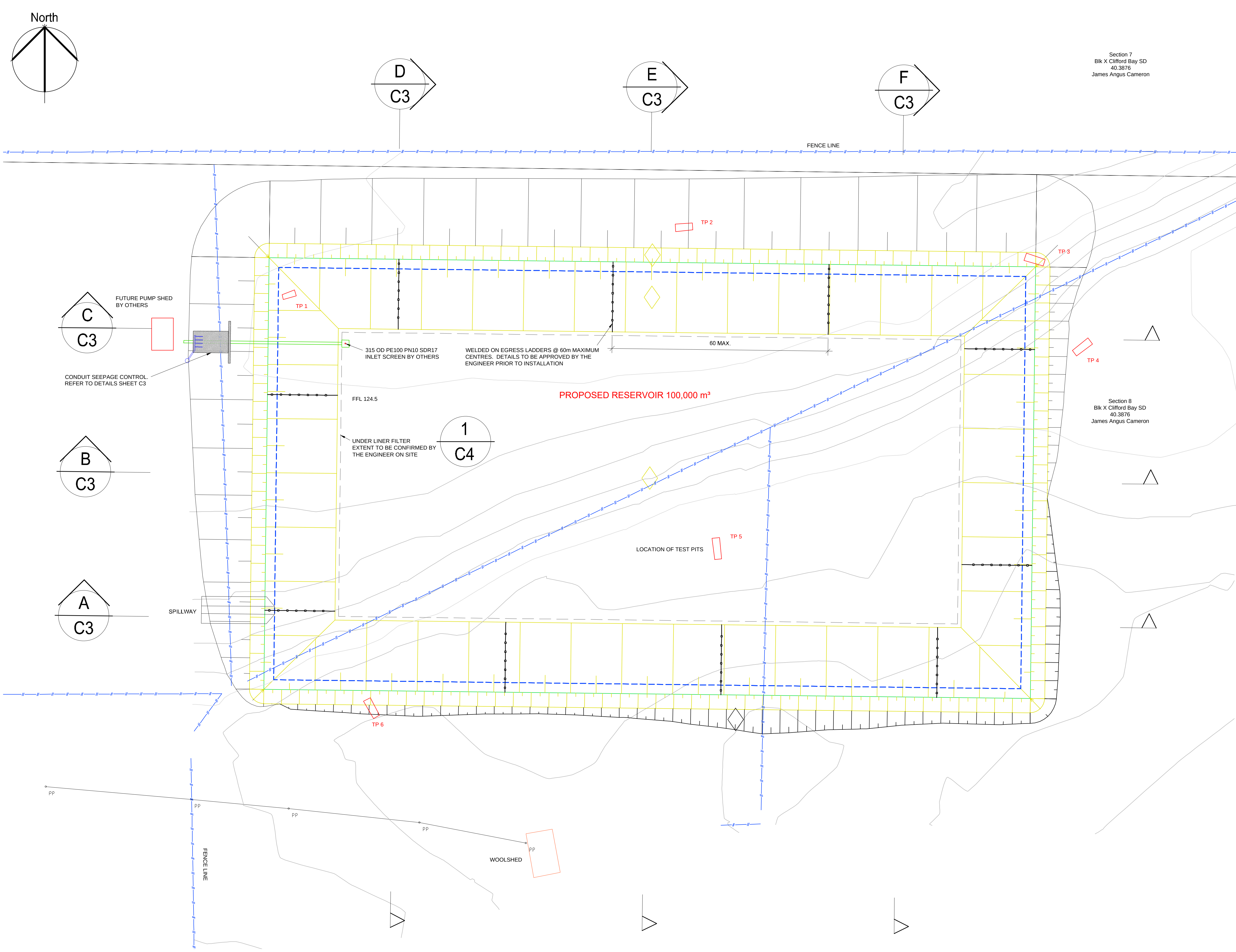
davidson group

PROJECT PLANNERS
RESOURCE MANAGERS
CIVIL & STRUCTURAL ENGINEERS
BUILDING DESIGNERS
ENVIRONMENTAL ENGINEERS

Davidson Ayson House, 4 Nelson St
PO Box 256, Blenheim 7240, NZ
T: 03 579 2099 / F: 03 578 7028
E: service@DavidsonGroup.co.nz
W: DavidsonGroup.co.nz

DESIGNED KJM 02/2018	DRAWING No. 26065	
DRAWN KJM 02/2018		
CHECKED RWD 02/2018		
ORIGINAL SIZE A1	SHEET No. C1	ISSUE A
REF		LB

0mm 100mm



SITE PLAN
1:500
1:1000 (A3)

0mm 100mm

NOTES:

1. SURVEYING UNDERTAKEN BY DAVIDSON GROUP LIMITED FOR ENGINEERING PURPOSES ONLY
2. HEIGHT DATUM NZVD 2016, ORIGIN APUC 93.49m

REVISION	DATE	BY

THE SUNDAY PADDOCK LIMITED

80 CAMERONS ROAD SEDDON

STORAGE RESERVOIR

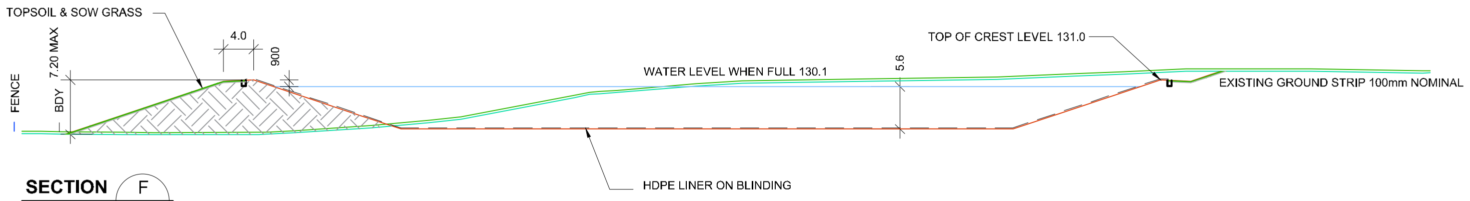
site plan

davidson group

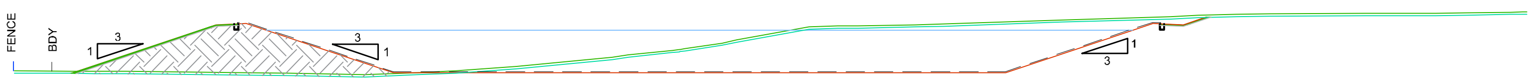
PROJECT PLANNERS
RESOURCE MANAGERS
CIVIL & STRUCTURAL ENGINEERS
BUILDING DESIGNERS
ENVIRONMENTAL ENGINEERS

Davidson Ayson House, 4 Nelson St
PO Box 256, Blenheim 7240, NZ
T: 03 579 2099 / F: 03 578 7028
E: service@DavidsonGroup.co.nz
W: DavidsonGroup.co.nz

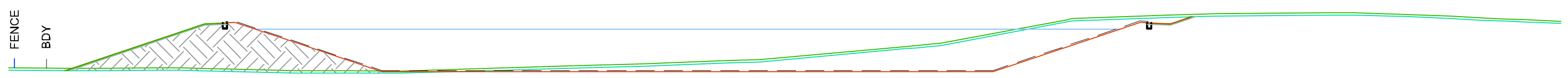
DESIGNED KJM 02/2018	DRAWING No.	
DRAWN KJM 02/2018	26065	
CHECKED RWD 02/2018		
ORIGINAL SIZE	SHEET No.	ISSUE
A1	C2	A
REF		LB



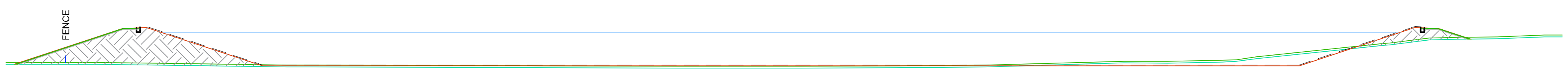
SECTION F
C2
1:500
1:1000 (A3)



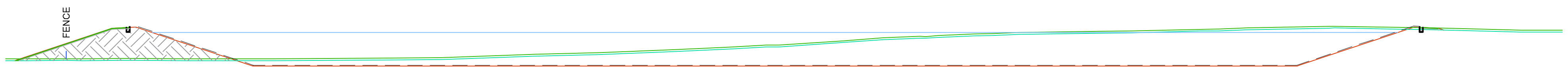
SECTION E
C2
1:500
1:1000 (A3)



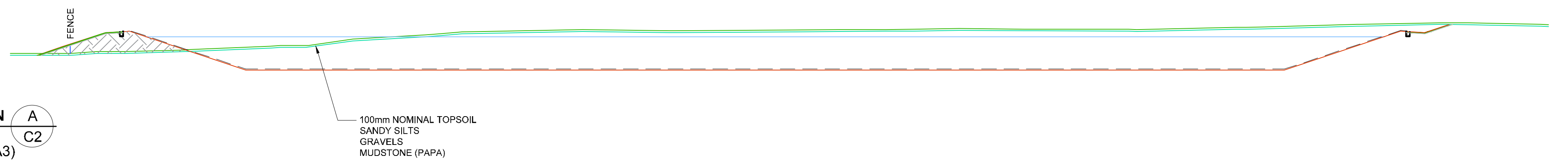
SECTION D
C2
1:500
1:1000 (A3)



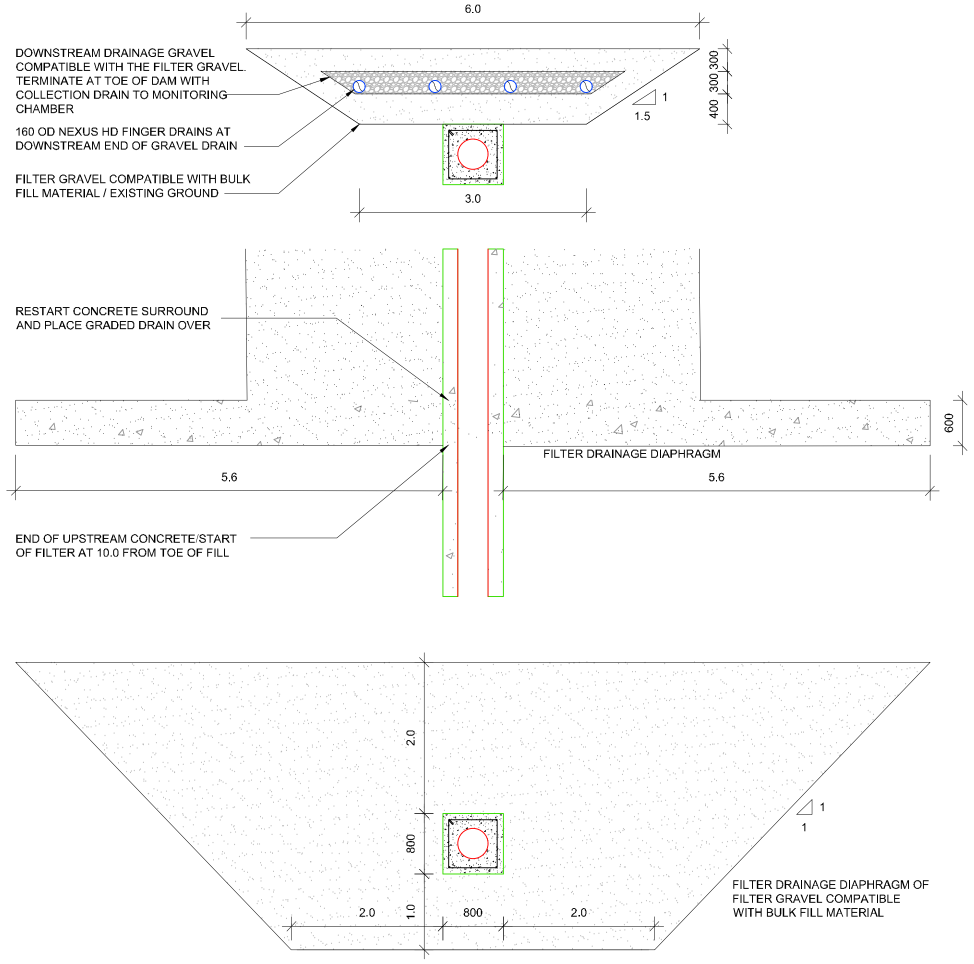
SECTION C
C2
1:500
1:1000 (A3)



SECTION B
C2
1:500
1:1000 (A3)



SECTION A
C2
1:500
1:1000 (A3)



FILTER DRAINAGE DIAPHRAGM
1:50
1:100 (A3)

NOTES:

1. SURVEYING UNDERTAKEN BY DAVIDSON GROUP LIMITED FOR ENGINEERING PURPOSES ONLY
2. HEIGHT DATUM NZVD 2016, ORIGIN APUC 93.49m

REVISION	DATE	BY

THE SUNDAY PADDOCK LIMITED

80 CAMERONS ROAD SEDDON

STORAGE RESERVOIR

sections & filter drainage detail

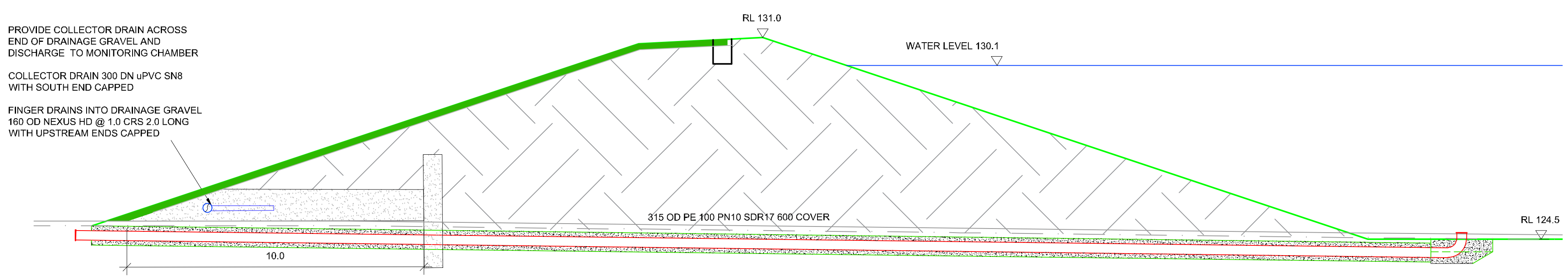
davidson group

PROJECT PLANNERS
RESOURCE MANAGERS
CIVIL & STRUCTURAL ENGINEERS
BUILDING DESIGNERS
ENVIRONMENTAL ENGINEERS

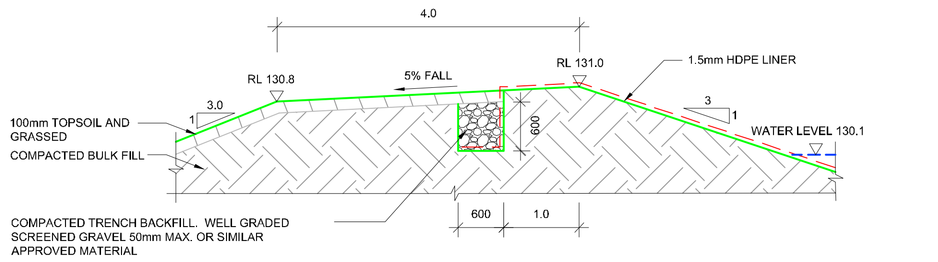
Davidson Ayson House, 4 Nelson St
PO Box 256, Blenheim 7240, NZ
T: 03 579 2099 / F: 03 578 7028
E: service@DavidsonGroup.co.nz
W: DavidsonGroup.co.nz

DESIGNED KJM 02/2018	DRAWING No.		
DRAWN KJM 02/2018	26065		
CHECKED RWD 02/2018			
ORIGINAL SIZE	SHEET No.	ISSUE	
A1	C3	A	
REF		LB	

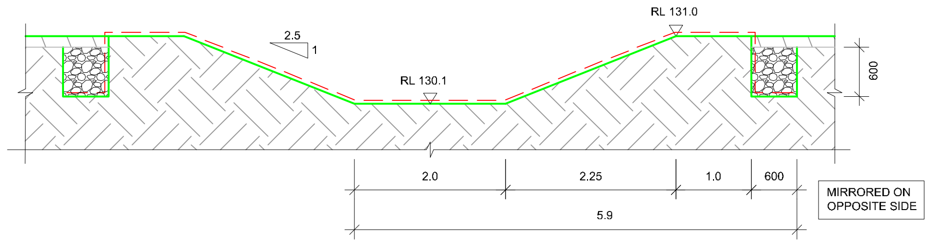
0mm 100mm



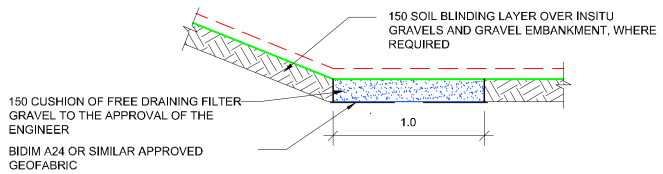
SECTION OUTLET 3 / C2
1:100
1:200 (A3)



LINER KEY TRENCH DETAIL
1:50
1:100 (A3)



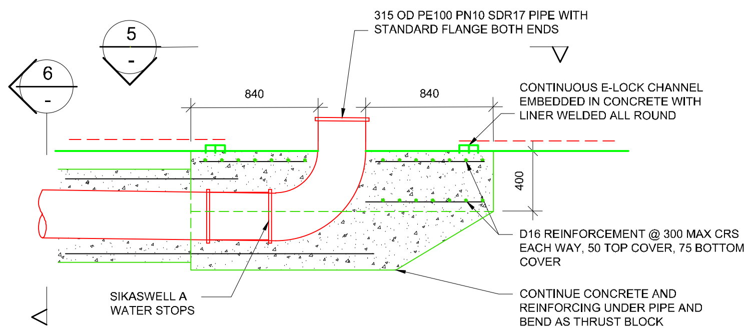
SPILLWAY DETAIL
1:50
1:100 (A3)



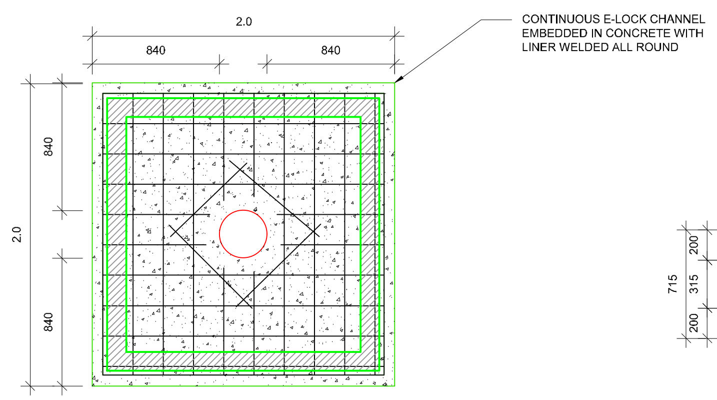
UNDER LINER FILTER DETAIL 1 / C2
1:25
1:50 A3

NOTES:

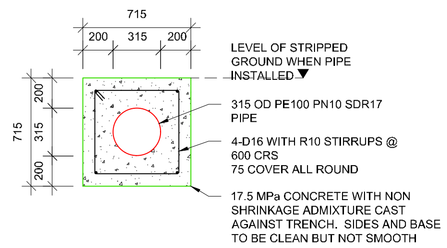
1. SURVEYING UNDERTAKEN BY DAVIDSON GROUP LIMITED FOR ENGINEERING PURPOSES ONLY
2. HEIGHT DATUM NZVD 2016, ORIGIN APUC 93.49m



PIPE DETAIL 4 / -
1:25
1:50 A3



CONCRETE DETAIL 5 / -
1:25
1:50 A3



PIPE DETAIL 6 / -
1:25
1:50 A3

REVISION	DATE	BY

THE SUNDAY PADDOCK LIMITED

80 CAMERONS ROAD SEDDON

STORAGE RESERVOIR

details

davidson group
PROJECT PLANNERS
RESOURCE MANAGERS
CIVIL & STRUCTURAL ENGINEERS
BUILDING DESIGNERS
ENVIRONMENTAL ENGINEERS
Davidson Ayson House, 4 Nelson St
PO Box 256, Blenheim 7240, NZ
T: 03 579 2099 / F: 03 578 7028
E: service@DavidsonGroup.co.nz
W: DavidsonGroup.co.nz

DESIGNED KJM 02/2018
DRAWN KJM 02/2018
CHECKED RWD 02/2018
DRAWING No. 26065
ORIGINAL SIZE A1
SHEET No. C4
ISSUE A
REF
LB

0mm 100mm