Government of Western Australia
Department of Water and Environmental Regulation

Works Approval

Works approval number	W6807/2023/1
Works approval holder	Water Corporation
Registered business address	629 Newcastle Street NEWCASTLE WA 6007
DWER file number	DER2023/000233
Duration	31/08/2023 to 30/08/2028
Date of issue	31/08/2023
Premises details	Toodyay Water Resource Recovery Facility (WRRF) 211 Goomalling-Toodyay Road NUNILE WA 6566 Legal description - Lot 501 on Deposited Plan 33954 Certificate of Title Volume 2536 Folio 30 As defined by the premises map in Schedule 1 and the coordinates in Schedule 2

Prescribed premises category description **(Schedule 1, *Environmental Protection Regulations 1987*)**	**Assessed design capacity**
Category 85: Sewage facility: premises – (a) On which sewage is treated (excluding septic tanks); or (b) From which treated sewage is discharged onto land or into waters.	92 m^3 per day
Assessed activities directly related to the above categories	
Construction of a Vertical Flow (VF) Treatment Wetlands System for wastewater treatment as part of a research and development project trial. The VF wetlands system will be connected to the existing Water Resource Recovery Facility on site.	

This works approval is granted to the works approval holder, subject to the attached conditions, on 31 August 2023, by:

Jarrod Abrahams

Digitally signed by Jarrod Abrahams
Date: 2023.08.31 13:47:41 +08'00'

MANAGER WASTE INDUSTRIES

REGULATORY SERVICES

an officer delegated under section 20 of the *Environmental Protection Act 1986* (WA)

Works approval history

Date	Reference number	Summary of changes
31/08/2023	W6807/2023/1	Works approval granted.

Interpretation

In this works approval:

(a) the words 'including', 'includes' and 'include' in conditions mean "including but not limited to", and similar, as appropriate;

(b) where any word or phrase is given a defined meaning, any other part of speech or other grammatical form of that word or phrase has a corresponding meaning;

(c) where tables are used in a condition, each row in a table constitutes a separate condition;

(d) any reference to an Australian or other standard, guideline, or code of practice in this works approval:

(i) if dated, refers to that particular version; and

(ii) if not dated, refers to the latest version and therefore may be subject to change over time;

(e) unless specified otherwise, any reference to a section of an Act refers to that section of the EP Act; and

(f) unless specified otherwise, all definitions are in accordance with the EP Act.

NOTE: This works approval requires specific conditions to be met but does not provide any implied authorisation for other emissions, discharges, or activities not specified in this works approval.

Works approval conditions

The works approval holder must ensure that the following conditions are complied with:

Construction phase

Construction Environmental Management Plan (CEMP)

1. The works approval holder must submit a Construction Environmental Management Plan (CEMP) to the CEO a minimum of 30 days prior to construction activities commencing.

2. The CEMP specified in condition 1 should include as a minimum:

(a) Details of the potential sources of:

(i) noise emissions; and
(ii) dust emissions;
during the construction works; and

(b) provide mitigation and management measures to reduce and prevent the potential emissions listed under condition 2(a); and

(c) demonstrate how compliance with the *Environmental Protection (Noise) Regulations 1997* will be achieved.

Construction Quality Assurance Plan (CQAP)

3. The works approval holder must submit a Construction Quality Assurance Plan (CQAP) to the CEO a minimum of 30 days prior to construction activities commencing, that provides procedures for identifying non-conformances with the technical specification and the requirements of condition 5 and condition 6.

4. The CQAP required by condition 3, must include as a minimum the following:

(a) descriptions of responsibilities, qualification and obligations for each party involved in the plan and the proposed level of supervision for liner construction and installation;

(b) material testing information, including sampling locations, frequency of testing, test methods, laboratories, accreditations, applicable specifications and quality standards, data evaluation, acceptance and rejection criteria, and contingency measures in the event of a failure;

(c) hold and inspection points for key stages of the work that cannot later be rectified because they will no longer be accessible;

(d) manufacturing quality control including factory tests, certifications and material warranties that meet the minimum requirements listed in Table 10 of Schedule 4;

(e) independent conformance testing that meets the minimum requirements listed in Table 11 of Schedule 5, to verify that the materials supplied comply with the required specifications;

(f) subgrade preparation and liner installation procedures that meet the minimum requirements listed in Table 10 of Schedule 4, including storage to protect from weather and other damage during installation, panel overlaps, welds, jointing and seam orientation in accordance with good practice and the manufacturer's instructions, regular inspections, repairs tested and recorded and any protection from UV light after installation; and

(g) reporting and record keeping requirements.

Infrastructure and equipment

5. The works approval holder must:

(a) construct and/or install the infrastructure and/or equipment;

(b) in accordance with the corresponding design and construction/installation requirements; and

(c) at the corresponding infrastructure location;

as set out in Table 1.

Table 1: Design and construction / installation requirements

	Infrastructure	Design and construction / installation requirements	Infrastructure location
1.	Inlet pipe and screen channel	a) Must be designed and constructed in accordance with the design drawings provided in Schedule 3, Figures 4 and 5.	Within the indicative location for the pilot VF wetlands shown in Schedule 1, Figure 2
2.	Stage 1 dosing siphon tank	a) Must be designed and constructed in accordance with the design drawings provided in Schedule 3, Figure 6. b) Holding tank must have a minimum capacity of 2.45 m^3	
3.	Stage 1 VF Wetlands	The Stage 1 VF wetlands must be designed and constructed to meet the following specifications: a) 3 x cells constructed in accordance with the design drawings provided in Schedule 3, Figures 7 and 8. b) Cells to be separated by a retaining wall panel and post system as shown in Figures 8 and 12. c) Cells must be constructed to the following dimensions: i. depth of 1.2 m ii. width of 5 m iii. length of 10 m d) The base of the wetland cells must be located more than 2 m above the maximum wet season water table. e) Wetland cells formed with 1:1 batter slopes. f) Base of wetland must have 1% fall g) Subgrade and HDPE liner in accordance with condition 6 h) A 200 mm drainage layer of washed gravel (20-40 mm particle size) must cover the drainage pipe along the bottom of each cell. i) Transition layer to be placed on top of the drainage layer and consist of 100 mm smaller washed gravel (5 – 20 mm particle size)	

	Infrastructure	Design and construction / installation requirements	Infrastructure location
		j) Filter layer to be placed on top of the transition layer and to consist of 400 mm of gravel (2 – 8 mm grain size). k) 600 mm x 600 mm concrete splash plates are to be placed on top of the filter layer under feed points; l) An allowance of 400 mm of freeboard is to be provided (200 mm for sludge accumulation and 200 mm for water retention) m) Must be fitted with overflow pipes leading to the existing Storage Dam. n) Vent risers must be fitted with mosquito proof caps.	
4.	Stage 2 dosing siphon tank	a) Must be designed and constructed in accordance with the design drawings provided in Schedule 3, Figure 9. b) Holding tank must have a minimum capacity of 1.32 m^3.	Within the indicative location for the pilot VF wetlands shown in Schedule 1, Figure 2
5.	Stage 2 VF wetlands	The Stage 2 VF wetlands must be designed and constructed to meet the following specifications: a) 2 x cells constructed in accordance with the design drawings provided in Schedule 3, Figures 10 and 11. b) Cells to be separated by a retaining wall panel and post system as shown in Figures 11 and 12. c) Cells must be constructed to the following dimensions: d) depth of 1.1 m e) width of 7 m f) length of 7 m g) Wetland cells formed with 1:1 batters. (internal lined embankment slopes) h) External embankments to have a maximum slope of 1:3 and be covered with mulch or grass seed over reinstated topsoil. i) Base of wetland must have 1% fall. j) Subgrade and HDPE liner to meet the requirements of condition 6. k) A 200 mm drainage layer of washed gravel (20 – 40 mm particle size) must cover the drainage pipe along the bottom of each cell. l) Transition layer to be placed on top of the drainage layer and consist of 200 mm of	

	Infrastructure	Design and construction / installation requirements	Infrastructure location
		smaller gravel (3 – 10 mm grain size). m) Filter layer to be placed on top of the transition layer and consist of 400 mm sand (effective particle size (d10) of 0.25 – 0.4 mm and uniformity coefficient (Uc) of <5 and less than 3% fines). n) An allowance of 300 mm of freeboard is to be provided. o) Must be fitted with overflow pipes leading to the existing Storage Dam. p) Vent risers must be fitted with mosquito proof caps.	
6.	Chambers/tanks: Inlet tank Stage 1 Dosing Siphon tank Stage 1 outlet pits Stage 2 Dosing Siphon tank Stage 2 outlet pits Effluent tank	(a) Chambers/tanks must be either precast concrete or prefabricated Fibreglass Reinforced Plastics (FRP) in accordance with the design drawings in Schedule 3. (b) Must be free from leaks and defects. (c) All tanks must be fitted with overflow pipes leading to the wetland cells or infrastructure as shown by green overflow pathways in Figure 3. (d) Inlet tank to be fitted with a high-level alarm and automatic flow shut-off.	
7.	Pipework	a) U-PVC pipework must be installed in accordance with the design drawings provided in schedule 3. b) Pipes must be examined for faults and cleaned on the inside before they are laid. Any damaged or defected pipe shall be rejected and removed from site. c) All pipe joints must be sealed and the pipeline hydrostatically tested for leaks prior to trench backfill	
8.	Programmable logic controller (PLC) and actuated valves	a) PLC must have time control and manual override for the control of water flows to the wetlands. b) PLC and actuated valves to be battery-solar powered (12 – 24V)	Within the indicative location for the pilot VF wetlands shown in Schedule 1, Figure 2
9.	Security fence	a) 1.2 m high stock fencing and vehicle access gate to be installed around the wetland project area.	Within the prescribed premises boundary shown in Schedule 1, Figure 1
10.	Wetland plants	a) Must be a wetland species native to Western	Within the Stage 1

	Infrastructure	Design and construction / installation requirements	Infrastructure location
		Australia and capable of maintaining porosity through the accumulated sludge and top sediment layer	and Stage 2 wetland cells shown in Schedule 1, Figure 2

6. The works approval holder must:

(a) construct the critical containment infrastructure;

(b) in accordance with the corresponding design and construction requirements; and

(c) at the corresponding infrastructure location;

as set out in Table 2.

Table 2: Critical containment infrastructure design and construction requirements

	Infrastructure	Design and construction requirements	Infrastructure location
1.	HDPE liner and subgrade	As specified in Schedule 4.	Lining the Stage 1 and Stage 2 VF wetland cells as located in Schedule 1, Figure 2.

Emission controls

7. The works approval holder must manage dust generation from construction activities at the premises by wetting down unsealed roads and exposed areas with a water truck.

8. The works approval holder must ensure that:

(a) all reasonable and practicable measures are taken to ensure that no windblown waste escapes from the premises; and

(b) any windblown waste is collected on at least a weekly basis and returned to the premises or otherwise appropriately contained.

9. The works approval holder shall:

(a) Immediately recover, or remove and dispose of, spills of environmentally hazardous materials including fuel, oil, or other hydrocarbons, whether inside or outside an engineered containment system; and

(b) ensure that all material used for the recovery, removal, and/or disposal of environmentally hazardous materials is stored in an impermeable container prior to disposal at an appropriately authorised facility.

Compliance reporting – infrastructure and equipment

10. The works approval holder must within 30 calendar days of an item of infrastructure or equipment required by condition 5 being constructed and/or installed:

(a) undertake an audit of their compliance with the requirements of condition 5; and

(b) prepare and submit to the CEO an Environmental Compliance Report on that compliance.

11. The Environmental Compliance Report required by condition 10, must include as a minimum the following:

(a) certification by a qualified geotechnical, environmental or civil engineer that the items of infrastructure or component(s) thereof, as specified in condition 5, have been constructed in accordance with the relevant requirements specified in condition 5;

(b) as constructed plans and a detailed site plan for each item of infrastructure or component of infrastructure specified in condition 5; and

(c) be signed by a person authorised to represent the works approval holder and contains the printed name and position of that person.

Compliance reporting – critical containment infrastructure

12. The works approval holder must within 30 calendar days of the critical containment structure identified by condition 6 being constructed:

(a) undertake an audit of their compliance with the requirements of condition 6; and

(b) prepare and submit to the CEO a Critical Containment Infrastructure Report on that compliance.

13. The Critical Containment Infrastructure Report required by condition 12 must include as a minimum the following:

(a) certification by a suitably qualified person or accredited testing authority that each item of critical containment infrastructure or component thereof, as specified in condition 6, has been built and installed in accordance with the requirements specified in condition 6;

(b) as constructed plans and a detailed site plan showing the location and dimensions for each item of critical containment infrastructure or component thereof, as specified in condition 6;

(c) photographic evidence of the installation of the infrastructure;

(d) be signed by a person authorised to represent the works approval holder and contains the printed name and position of that person;

(e) a Quality Control/Quality Assurance Certificate from an independent third party that:

(i) is written and certified by a suitably qualified CQA engineer/consultant who has undertaken CQA on the completed works for the compacted subgrade and HDPE liner;

(ii) details the CQA procedures and testing undertaken for the compacted subgrade and HDPE liner;

(iii) confirms the preparation of the subgrade and installation of the HDPE liner have met the minimum requirements contained in Table 10 of Schedule 4 and the relevant requirements of Condition 6;

(iv) confirms the quality control and assurance measures contained in Table 11 of Schedule 5 have been completed and that satisfactory results have been demonstrated;

(v) includes evidence of quality assurance and conformance testing works; and

(vi) certifies that the subgrade and liner are free of fault or defect, built to the design specification and fit for the intended purpose.

Initial operations phase

Commencement

14. The works approval holder may only commence operations for an item of infrastructure identified in condition 5 and condition 6:

(a) where the Critical Containment Infrastructure Report and Environmental Compliance Report have been submitted for that item of infrastructure in accordance with conditions 10 and 12 of this works approval; and

(b) where the CEO has notified the works approval holder that the Critical Containment Infrastructure Report for that item of infrastructure as required by condition 12 meets the requirements of that condition.

Operational requirements and emission limits

15. The works approval holder must ensure that the premises infrastructure and equipment listed in Table 3 and located at the corresponding infrastructure location, is maintained and operated in accordance with the corresponding operational requirement set out in Table 3.

Table 3: Infrastructure and equipment requirements during operation

Infrastructure and equipment		Operational requirements	Infrastructure location
1.	Inlet pipe and screen channel	(a) Must be maintained in good working order.	Within the indicative location for the pilot VF wetlands shown in Schedule 1, Figure 2
2.	Stage 1 siphon dosing tank	(a) Must be maintained in good working order. (b) Operated to intermittently batch feed wastewater at a volume of 1.47 – 2.45 m^3 onto the surface of the wetland cell in operation.	
3.	Stage 1 VF Wetlands 1, 2 and 3	(a) Must not receive more than 10 m^3/day of sewage inflow; (b) A top of embankment freeboard height equal to or greater than 400 mm must be maintained on all wetlands; (c) Operated in a manner which prevents scouring or excessive ponding of the filter beds; (d) Overtopping of the wetlands must not occur; (e) The integrity of all containment infrastructure must be maintained; (f) Wetlands must not breed mosquitoes. (g) Wetland cells with excessive sludge accumulation are to be taken offline and the sludge allowed to dry to ≥ 30% dry solids, before being safely removed and disposed of at a licensed landfill facility by a licensed waste contractor. (h) A minimum 1.5 mm thick HDPE liner with a permeability of less than 2 x 10^{-10} m/s must be maintained at all times;	Within the indicative location for the pilot VF wetlands shown in Schedule 1, Figure 2

Infrastructure and equipment		Operational requirements	Infrastructure location
		(i) Outflow from each wetland must be directed to the Stage 2 dosing siphon tank or to the Effluent Tank and Pump Station.	
4.	Stage 2 dosing siphon tank	(a) Must be maintained in good working order. (b) Operated to intermittently batch feed wastewater at a volume of 0.66 – 1.32 m^3 onto the surface of the wetland cell in operation.	
5.	Stage 2 VF Wetlands 1 and 2	(a) A top of embankment freeboard height equal to or greater than 300 mm must be maintained on all wetlands; (b) Operated in a manner which prevents scouring or excessive ponding of the filter beds; (c) Overtopping of the wetlands must not occur; (d) Wetland cells with excessive sludge accumulation are to be taken offline and the sludge allowed to dry to ≥ 30% dry solids, before being safely removed and disposed of at a licensed landfill facility by a licensed waste contractor. (e) The integrity of all containment infrastructure must be maintained; (f) Wetlands must not breed mosquitoes. (g) A minimum 1.5 mm thick HDPE liner with a permeability of less than 2 x 10^{-10} m/s must be maintained at all times; (h) Outflow from each wetland must be directed to the Effluent Tank and Pump Station, or back to the Stage 2 or Stage 1 dosing tank.	
6.	Chambers/tanks: Inlet tank Stage 1 Dosing Siphon tank Stage 1 outlet pits Stage 2 Dosing Siphon tank Stage 2 outlet pits Effluent tank	(a) Must be maintained in good condition, free of leaks or defects. (b) Overtopping must not occur.	
7.	Pipework	(a) The integrity of the pipework must be maintained.	
8.	PLC and actuated valves	(a) Must be maintained in good working order. (b) Operated to alternate wastewater flows between parallel wetland cells in each stage every 3.5 days, or in accordance with the experimental operational scenario being tested, provided that operation is not detrimental to the requirements set in rows 3 and 5	Within the indicative location for the pilot VF wetlands shown in Schedule 1,

Infrastructure and equipment		Operational requirements	Infrastructure location
		of this table.	Figure 2
9.	Security fence	(a) A 1.2 m high perimeter fence and lockable access gates must be maintained around the boundary of the WWTP.	Within the prescribed premises boundary shown in Schedule 1, Figure 1
10.	Wetland plants	(a) Maintained in healthy condition and free of weed species. (b) Wetland plants must not block inlets, outlets, or wastewater flows. (c) Plant coverage of filter bed to be maintained	Within the Stage 1 and Stage 2 wetland cells shown in Schedule 1, Figure 2

16. The works approval holder must ensure that the emission(s) specified in Table 4, are discharged only from the corresponding discharge point(s) and only at the corresponding discharge point location(s).

Table 4: Authorised discharge points

Emission	Discharge point	Discharge point location
Treated effluent (mixture of wastewater from the existing Water Resource Recovery Facility ponds and treated wastewater from the VF wetlands) discharged to the woodlot onsite	Sprinklers within the woodlot irrigation field	Irrigation field located within the premises boundary as shown in Schedule 1: Maps; Figure 1 (woodlot irrigation areas)

Monitoring

17. The works approval holder must monitor water quality during the initial operations phase in accordance with Table 5 and Table 6 for a period of 24 months from commencement of operations.

Table 5: Water quality monitoring (discharge point)

Monitoring location	Parameter	Frequency	Averaging period	Unit	Method
Flow meter	Volume	Monthly	Cumulative daily	kL/day	N/A
WWTP post filtration and chlorination (453013.89 E; 6511301.20 N) as shown in Schedule 1, Figure 1	*E.Coli*	Monthly	Spot sample	cfu/100mL	AS/NZS 5667.10
	Biochemical Oxygen Demand	Quarterly		mg/L	
	Total Suspended Solids				
	Total Nitrogen				
	Total Phosphorus				
	pH[1]	Monthly	N/A	pH units	

Note 1 – non- NATA *in situ* testing permitted

Table 6: Water quality monitoring (VF wetland cells)

Monitoring location	Parameter	Frequency	Averaging period	Unit	Method
VF Wetlands Effluent Tank as shown in Schedule 1, Figure 1	*E.Coli*	Fortnightly	Spot sample	cfu/100mL	AS/NZS 5667.10
	Biochemical Oxygen Demand			mg/L	
	Total Suspended Solids				
	Total Nitrogen				
	Total Phosphorus				
	pH[1]		N/A	pH units	

Note 1 – non- NATA *in situ* testing permitted

18. The works approval holder must monitor the condition of wetland plants during the initial operations phase for a period of 24 months from the commencement of operation in accordance with Table 7, and record any management actions undertaken to ensure compliance with row 10 of Table 3.

Table 7: Monitoring of wetland plant condition

	Monitoring actions	Frequency
1.	Check for presence of erosion in the filter beds and whether any plants have been tipped over or washed out.	After rain events
2.	Check general plant health	Monthly
3.	Check moisture of wetland media to see whether it is adequate for plant growth.	
4.	Check for presence of weeds	
5.	Calculate wetland plant survival percentage and whether new plants are required to be planted.	Every 3 months
6.	Check plant coverage of filter bed surface	
7.	Check plant need for pruning or harvesting	Every 6 months

Compliance reporting

19. The works approval holder must submit to the CEO a report at the end of the 24-month monitoring period specified in conditions 17 and 18 on the performance of the VF wetland trial during this period.

20. The works approval holder must ensure the report required by condition 19 is submitted within 30 calendar days from the end of the monitoring period specified in conditions 17 and 18, and includes the following:

(a) a summary of the operations, including timeframes and amount of wastewater processed;

(b) a summary of monitoring parameter results obtained during initial operations under condition 17.

(c) a summary of monitoring and management actions undertaken during initial operations under condition 18.

(d) copies of laboratory reports for treated effluent monitoring results recorded in accordance with condition 22.

(e) a summary of the environmental performance of each item of infrastructure or equipment as installed, which at a minimum includes records detailing the:

(i) comparison of the VF wetland system treated effluent monitoring results against the effluent quality targets specified in Schedule 6;

(ii) a comparison of the VF wetland system treated effluent monitoring results against operational monitoring results for the existing WRRF treatment ponds (for monitoring undertaken at the pond outlet – SP Toodyay Overflow Weir Final Effluent – FL S5008000); and

(iii) an assessment of the VF wetland performance against operational requirements in condition 15.

(f) a review of the work approval holder's performance and compliance against the conditions of this works approval; and

(g) where they have not been met, measures proposed to meet the manufacturer's design specification and the conditions of this works approval, together with the timeframes for implementing the proposed measures.

Records and reporting (general)

21. The works approval holder must record the following information in relation to complaints received by the works approval holder (whether received directly from a complainant or forwarded to them by the Department or another party) about any alleged emissions from the premises:

(a) the name and contact details of the complainant, (if provided);

(b) the time and date of the complaint;

(c) the complete details of the complaint and any other concerns or other issues raised; and

(d) the complete details and dates of any action taken by the works approval holder to investigate or respond to any complaint.

22. The works approval holder must maintain accurate and auditable books including the following records, information, reports, and data required by this works approval:

(a) the works conducted in accordance with condition 5;

(b) any maintenance of infrastructure that is performed in the course of complying with condition 15;

(c) monitoring programmes undertaken in accordance with conditions 17 and 18; and

(d) complaints received under condition 21.

23. The books specified under condition 22 must:

(a) be legible;

(b) if amended, be amended in such a way that the original version(s) and any subsequent amendments remain legible and are capable of retrieval;

(c) be retained by the works approval holder for the duration of the works approval; and

(d) be available to be produced to an inspector or the CEO as required.

Definitions

In this works approval, the terms in Table 8 have the meanings defined.

Table 8: Definitions

Term	Definition
ASTM D792	means the ASTM International Standard ASTM D792 Standard Test Methods for Density and Specific Gravity (relative Density) of Plastics by Displacement
ASTM D1004	means the ASTM International Standard ASTM D1004 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D1505	means the ASTM International Standard ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	means the ASTM International Standard ASTM D1603 Standard Test Method for Carbon Black Content in Olefin Plastics
ASTM D4833	means the ASTM International Standard ASTM D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D5397	means the ASTM International Standard ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	means the ASTM International Standard ASTM D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5885	means the ASTM International Standard ASTM D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D5994	means the ASTM International Standard ASTM D5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6693	means the ASTM International Standard ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembrane
ASTM D7466	means the ASTM International Standard ASTM D7466 Standard Test Method for Measuring the Asperity Height of Textured Geomembranes

Term	Definition
ASTM D8117	means the ASTM International Standard ASTM D8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry
EP Regulations	*Environmental Protection Regulations 1987* (WA).
Filter bed	The top filter layer in each wetland cell, consisting of 400 mm of fine gravel in the Stage 1 wetlands in accordance with Figure 7, and 400 mm of sand in the Stage 2 wetlands in accordance with Figure 10.
GRI - GM13 Standard Specification	means the Geosynthetic Research Institute GM13 Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
HDPE	High density polyethylene
initial operations	refers to the operation of the infrastructure and equipment identified under this works approval that is authorised for that purpose, subject to the relevant conditions.
premises	the premises to which this licence applies, as specified at the front of this licence and as shown on the premises map (Figure 1) in Schedule 1 to this works approval.
prescribed premises	has the same meaning given to that term under the EP Act.
suitably qualified civil engineer	means a person who: (a) holds a Bachelor of Engineering recognised by Engineers Australia; and (b) has a minimum of five years of experience working in a supervisory area of civil or structural engineering; or is otherwise approved in writing by the CEO to act in this capacity
suitably qualified CQA engineer/consultant	means a person who: (a) holds a Bachelor of Engineering recognised by Engineers Australia; (b) has a minimum of five years of experience working in a supervisory area of construction quality assurance; and (c) is employed by an independent third-party external to the works approval holder's business and liner installation contractor; or is otherwise approved in writing by the CEO to act in this capacity
waste	has the same meaning given to that term under the EP Act.

Term	Definition
works approval	refers to this document, which evidences the grant of the works approval by the CEO under section 54 of the EP Act, subject to the conditions.
works approval holder	refers to the occupier of the premises being the person to whom this works approval has been granted, as specified at the front of this works approval.

END OF CONDITIONS

Schedule 1: Maps

Premises map

The boundary of the prescribed premises is shown in the map below (Figure 1).

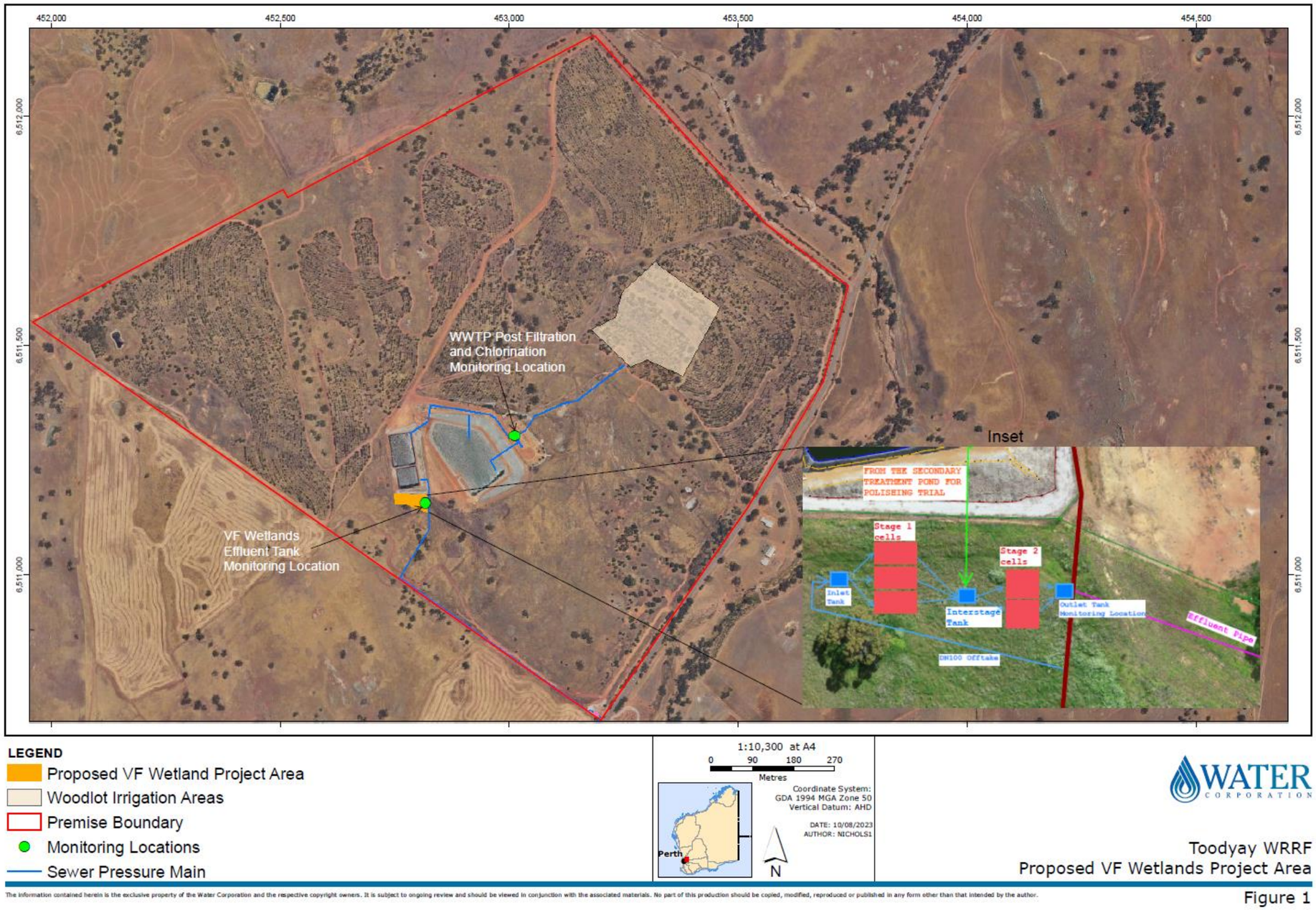


Figure 1: Map of the boundary of the prescribed premises, proposed VF wetland project area, and water quality monitoring locations

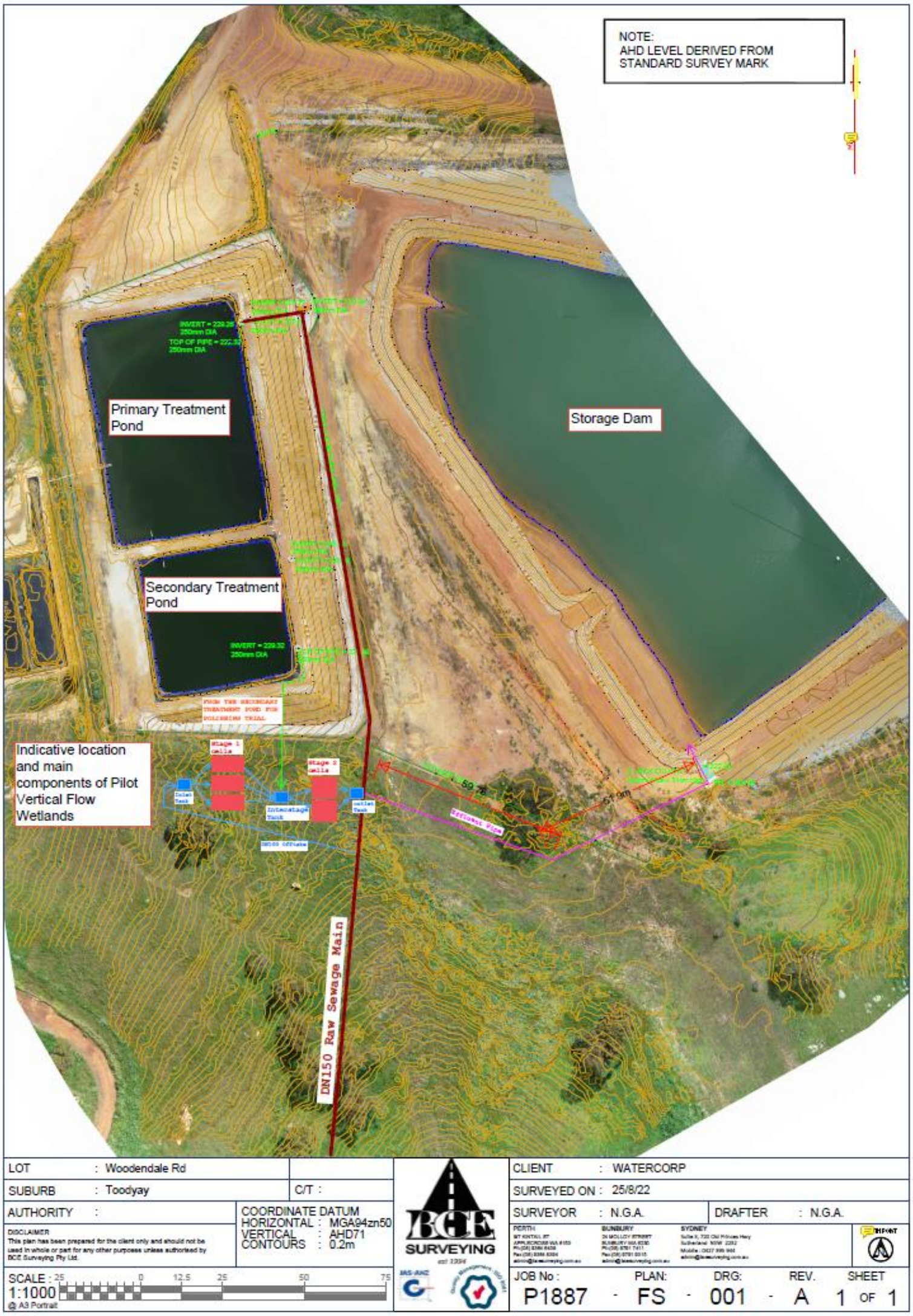


Figure 2: Location of proposed Vertical Flow wetland trial

Schedule 2: Premises boundary

The corners of the premises boundary are the coordinates listed in Table 9.

Table 9: Premises boundary coordinates (GDA2020)

	Easting	Northing	Zone
1.	451958	6511552	50
2.	452507	6511841	50
3.	452516	6511824	50
4.	453180	6512176	50
5.	453559	6511767	50
6.	453740	6511631	50
7.	453685	6511421	50
8.	453198	6510683	50

Schedule 3: Vertical Flow Wetland Design Drawings

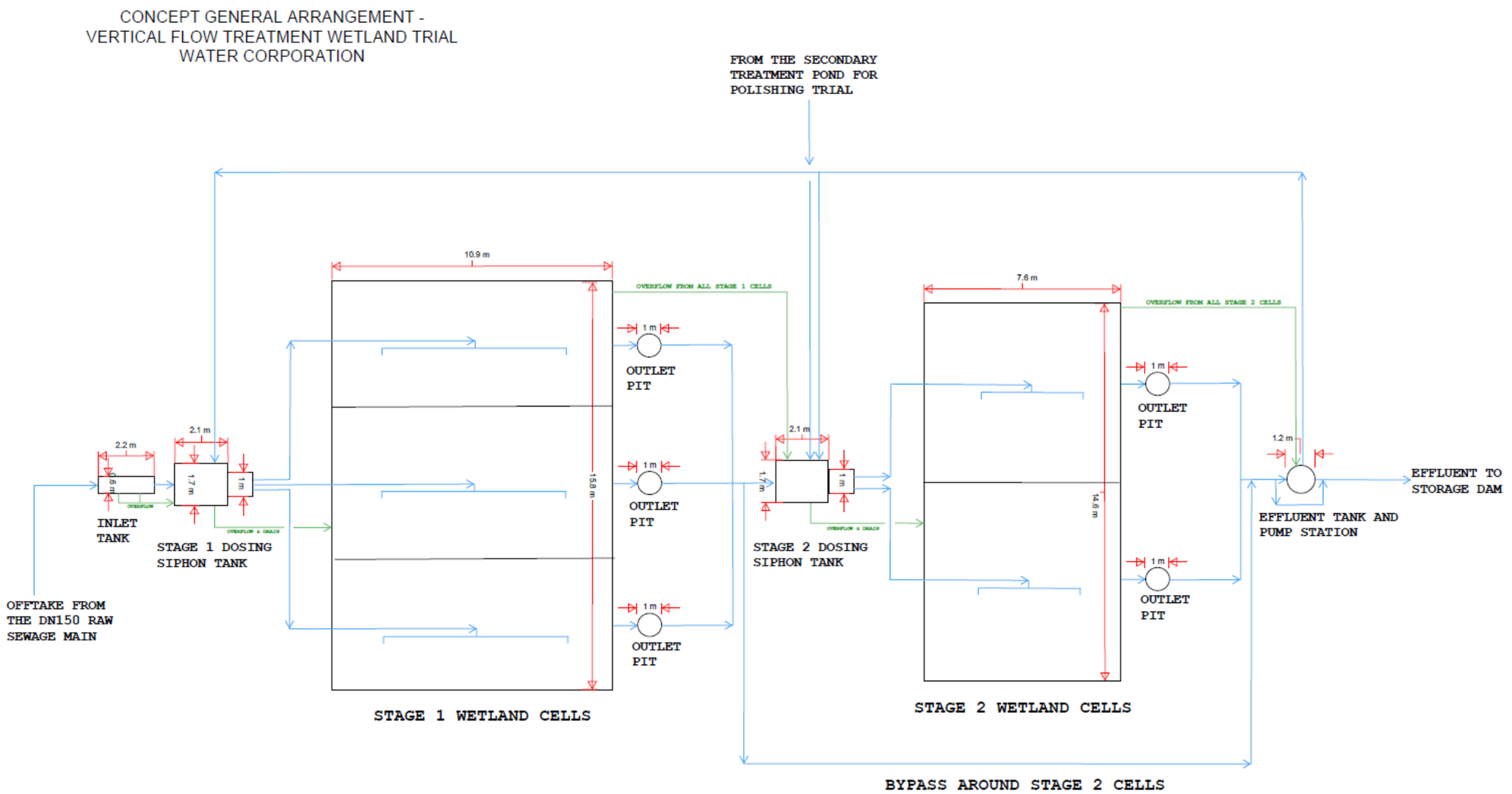


Figure 3: Layout of the Vertical Flow Treatment Wetland Trial

Inlet pipe and screen channel - Section view

600W x 800H x 2200L FRP, poly or concrete (civil to advise) with light weight FRP/grid mesh cover, hinged over screen to allow cleaning. (alternative would be 500W x 700H)

Scale
1:10 in A3

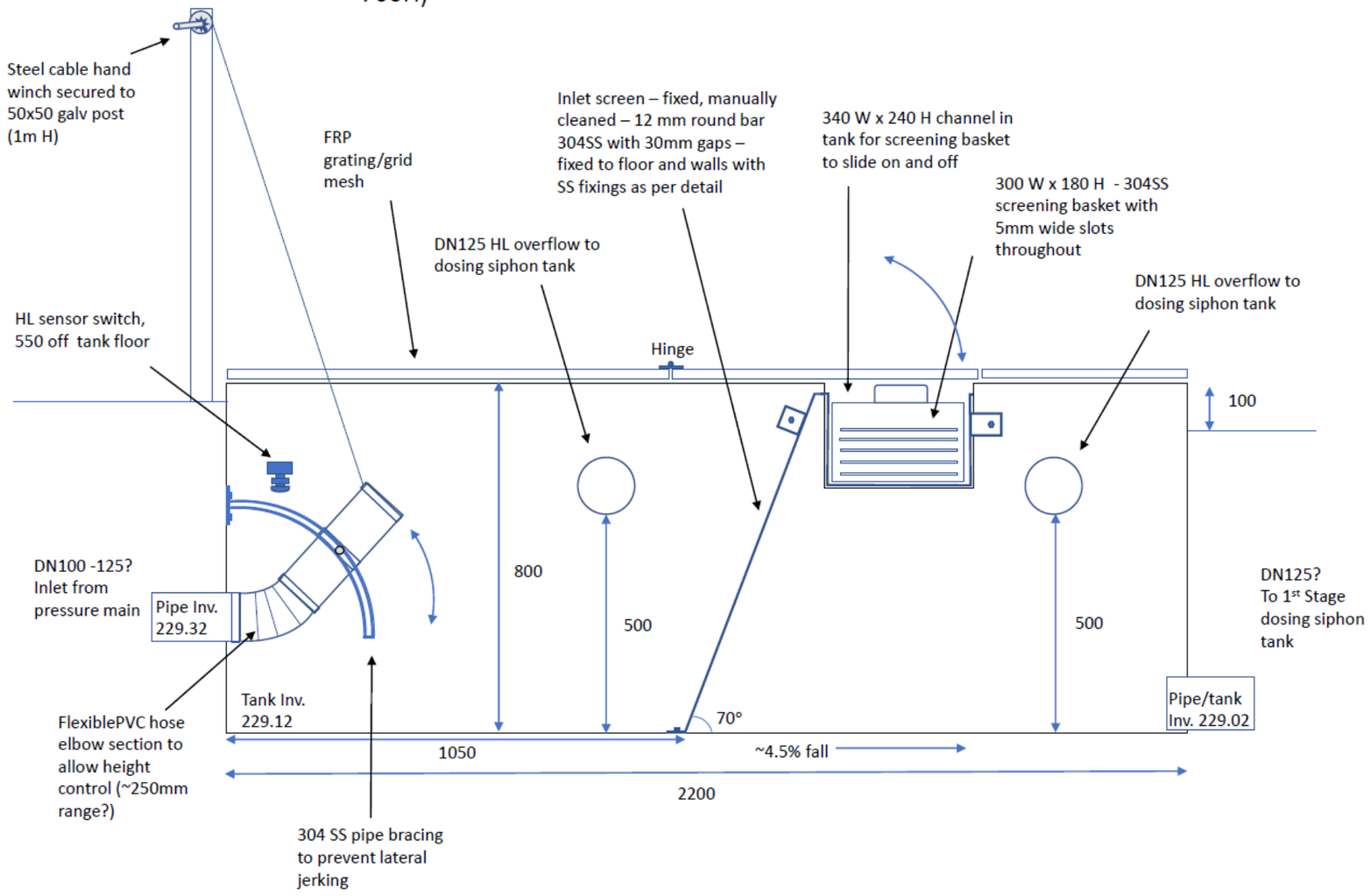


Figure 4: Inlet pipe and screen channel design (section view)

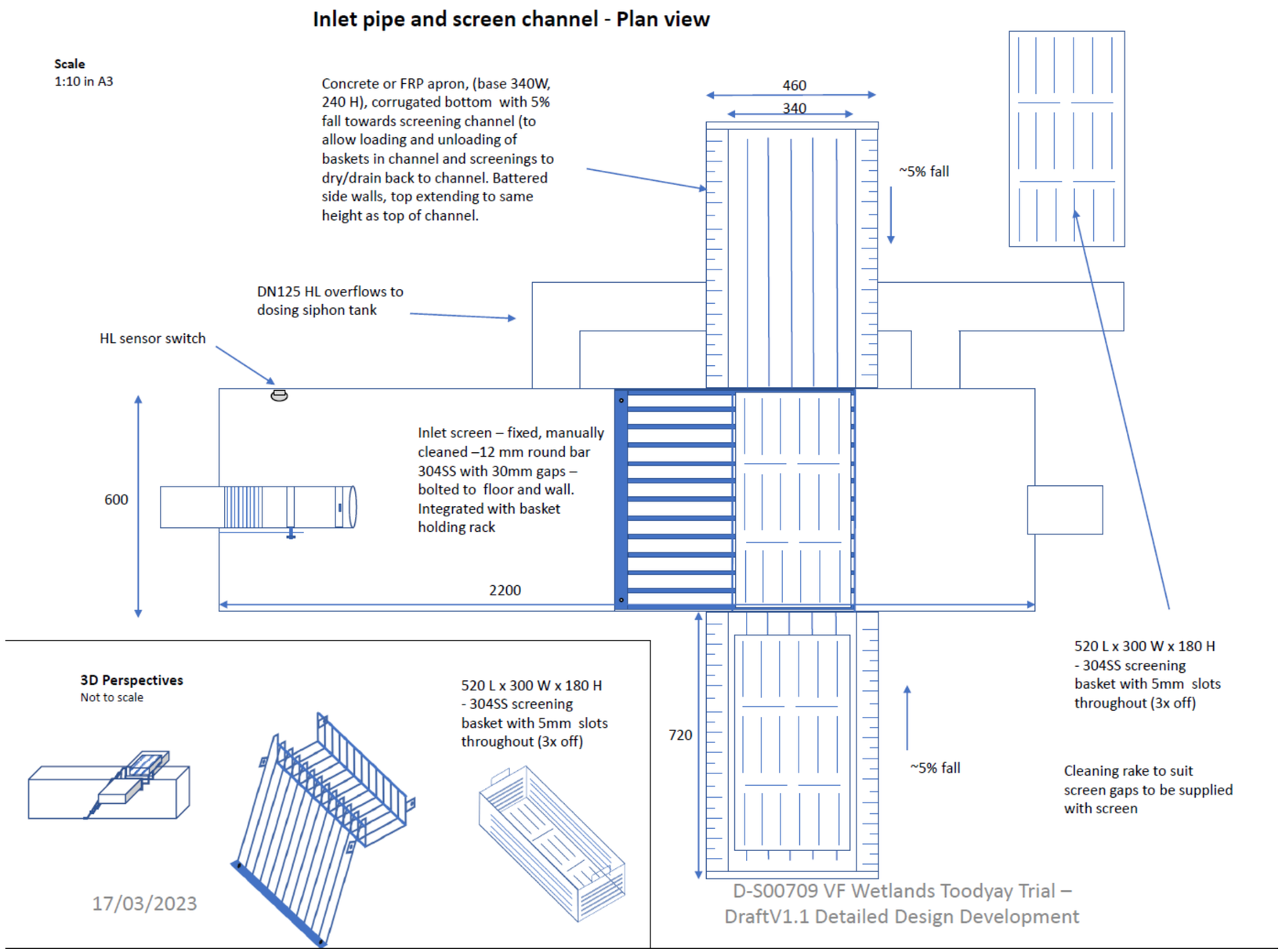


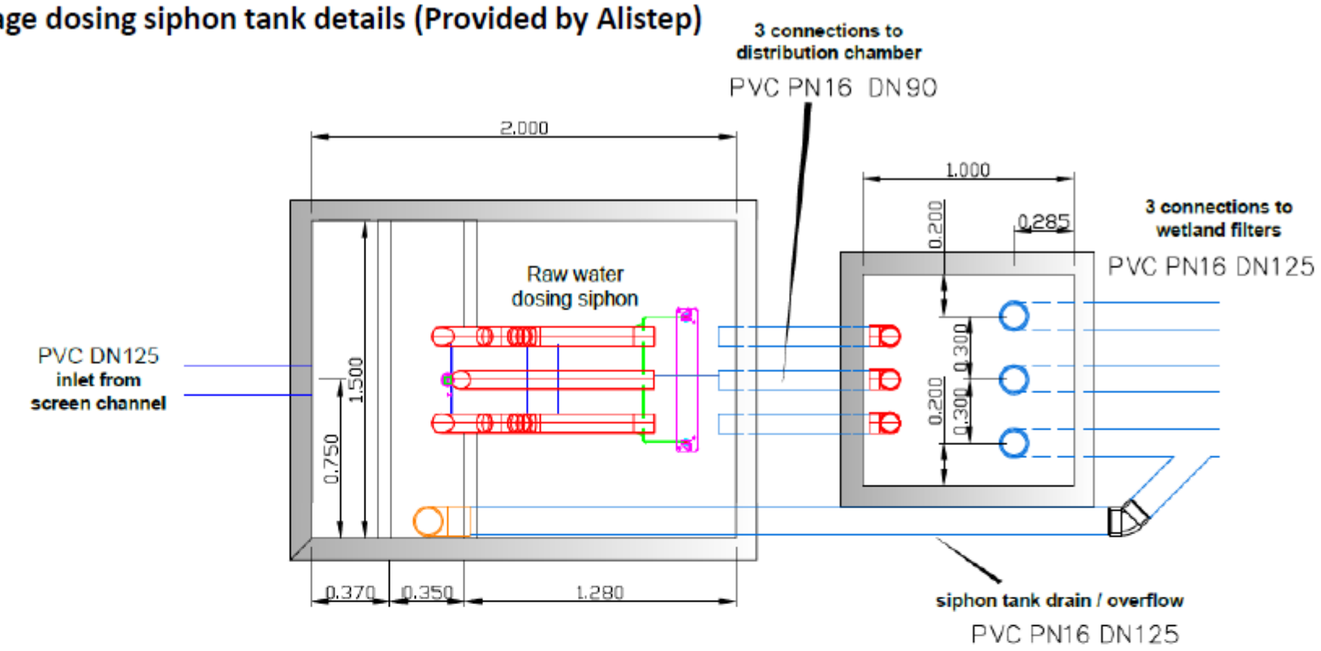
Figure 5: Inlet pipe and screen channel design (plan view)

First Stage dosing siphon tank details (Provided by Alistep)

Scale
1:25 in A3
Measures and heights as shown

Alistep Raw water dosing siphon: Height range 35cm - 85cm (10 cm extension from standard 75cm max). Batch volume range: 1.05 – 2.55kL/batch

Check levels. All mAHD.



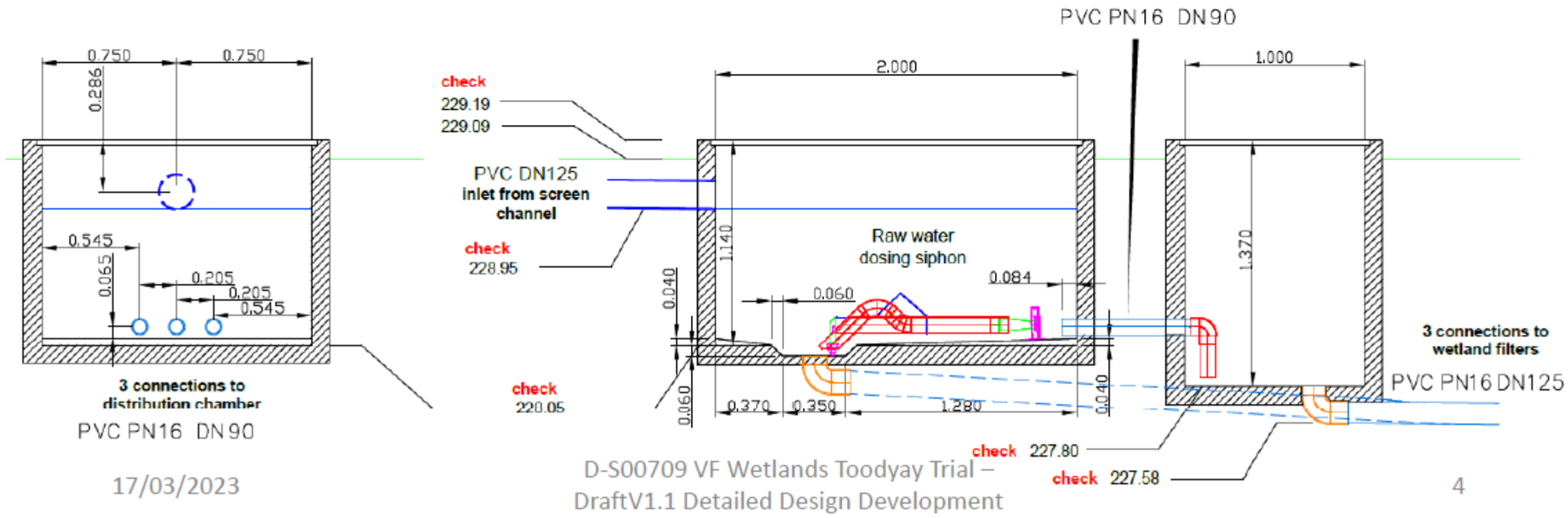
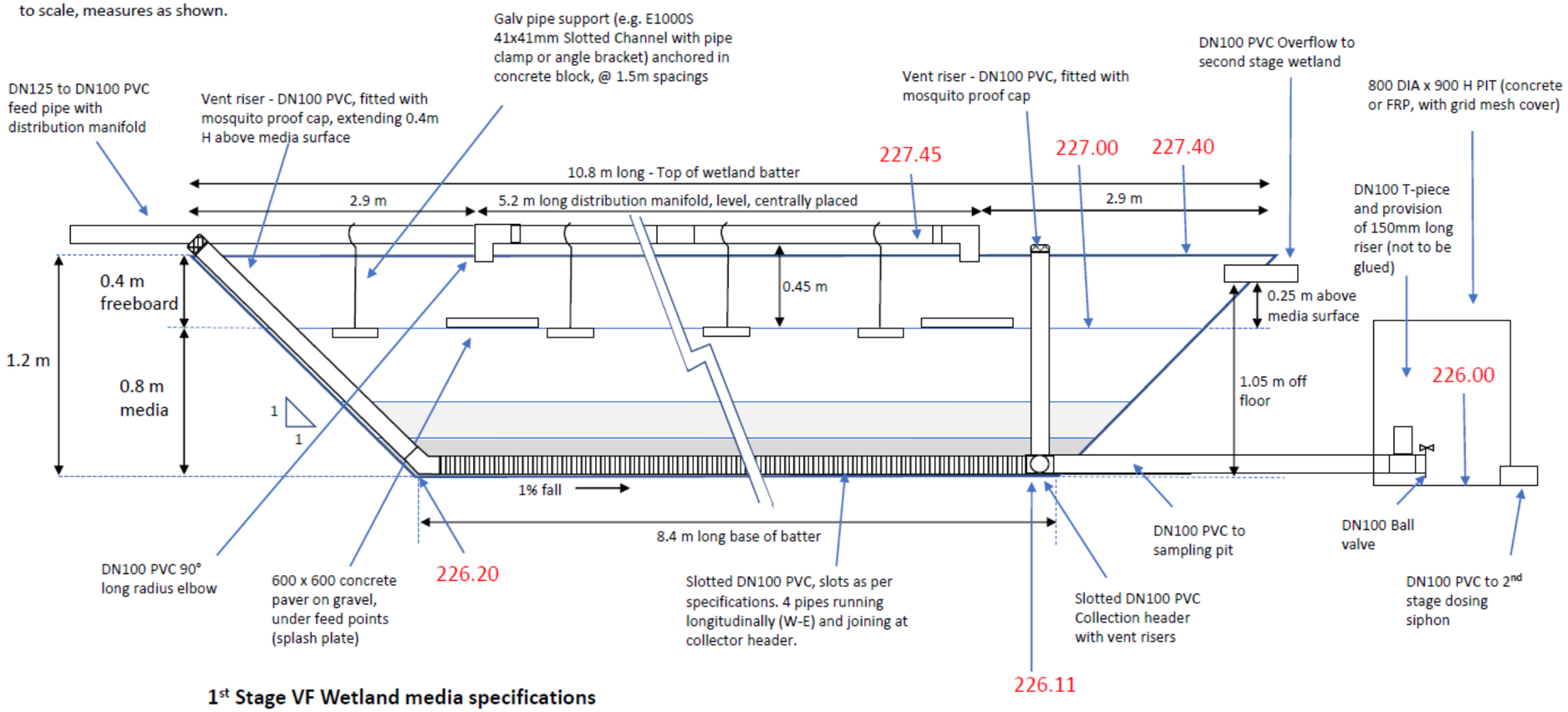


Figure 6: Stage 1 dosing siphon tank details

Scale
Approx 1:25 in A3
Horizontal lines exagerated, not to scale, measures as shown.

First Stage VF Wetland Cells - Section – longitudinal view (W-E)



1st Stage VF Wetland media specifications (all washed gravel - free of fines):

Substrate	Depth / thickness	Particle size
Top filtration layer:	40 cm	Fine gravel: 2 – 8 mm
Transition layer	20 cm	Medium gravel: 5 – 20 mm
Bottom drainage layer	20 cm	Large gravel: 20 - 40 mm

Slotted DN100 PVC: slot length shall be ⅓ of pipe circumference and width greater than 8 mm, for every 10 cm of drainage pipe length.

Check levels. All mAHD

Figure 7: Stage 1 VF Wetland Cells design

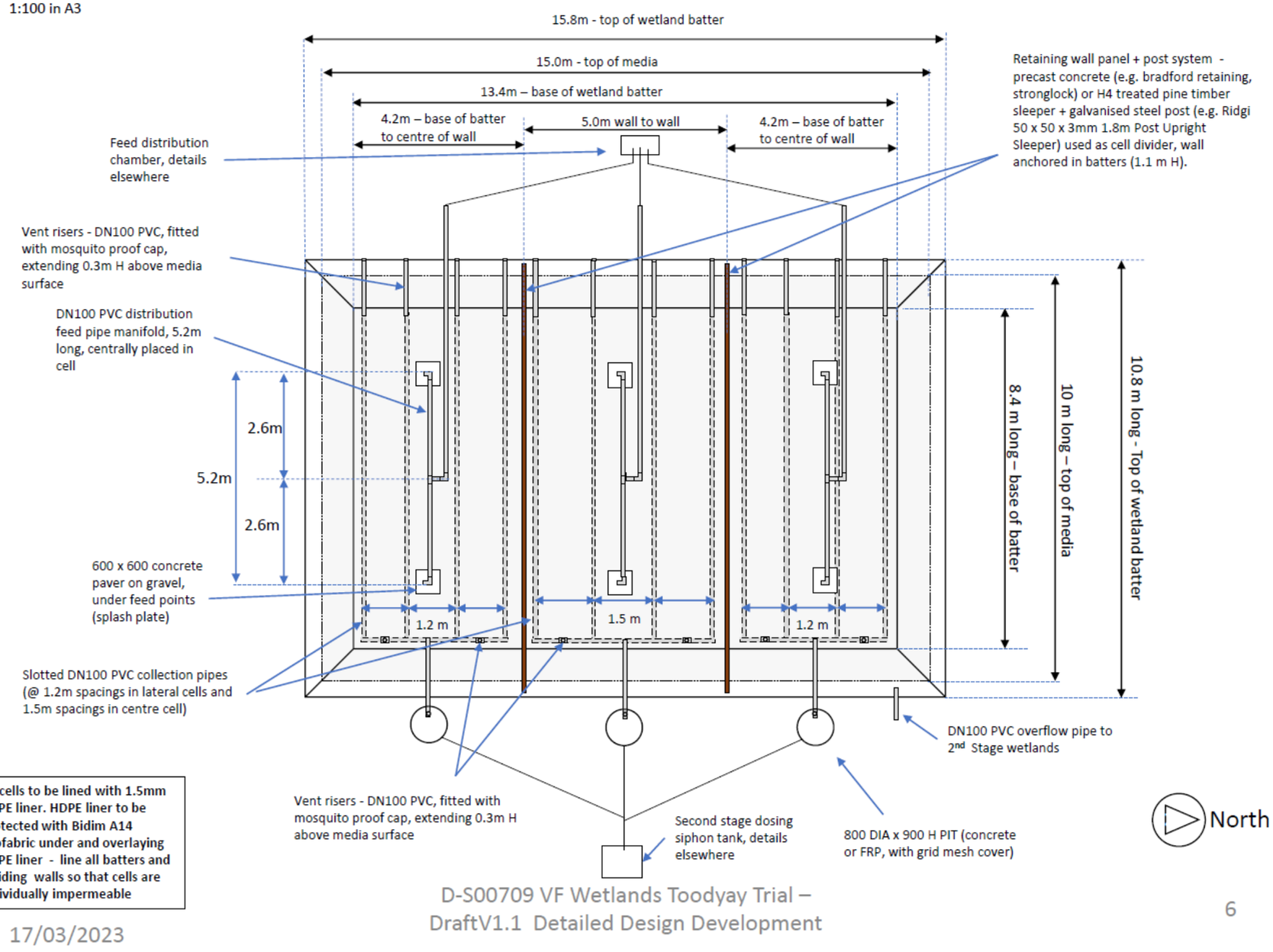


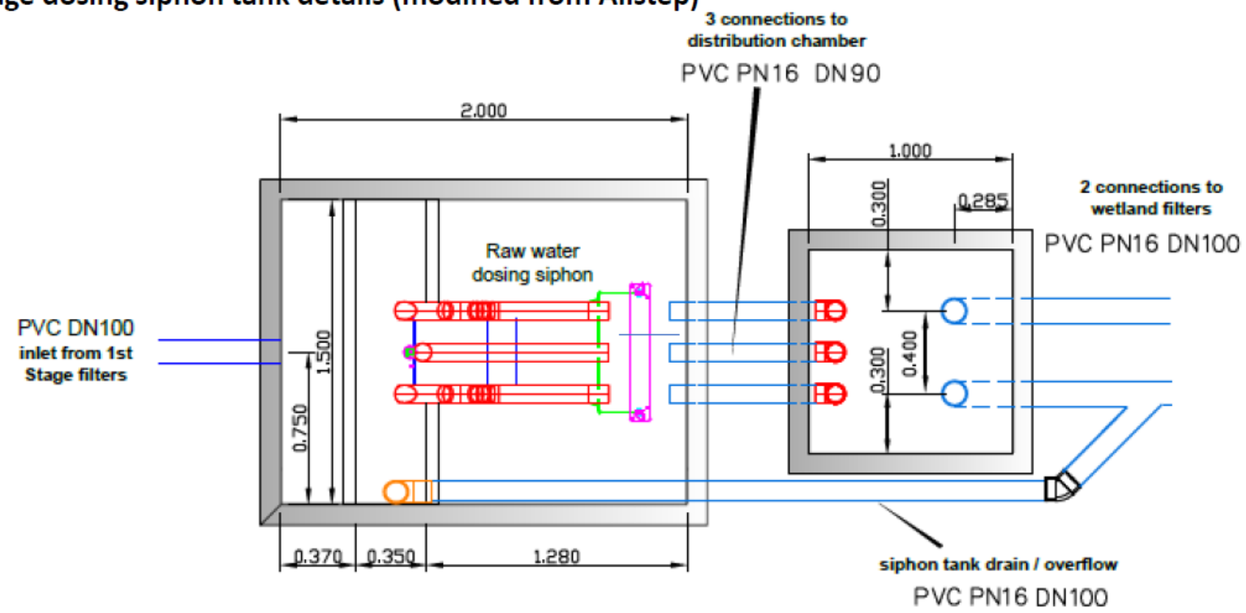
Figure 8: Stage 1 VF Wetland Cells layout

Second Stage dosing siphon tank details (modified from Alistep)

Scale
1:25 in A3
Measures and heights as shown

Alistep Raw water dosing siphon:
Height range 35cm - 75cm
Batch volume Range: 1.05 – 2.25kL/batch

Check levels. All mAHD



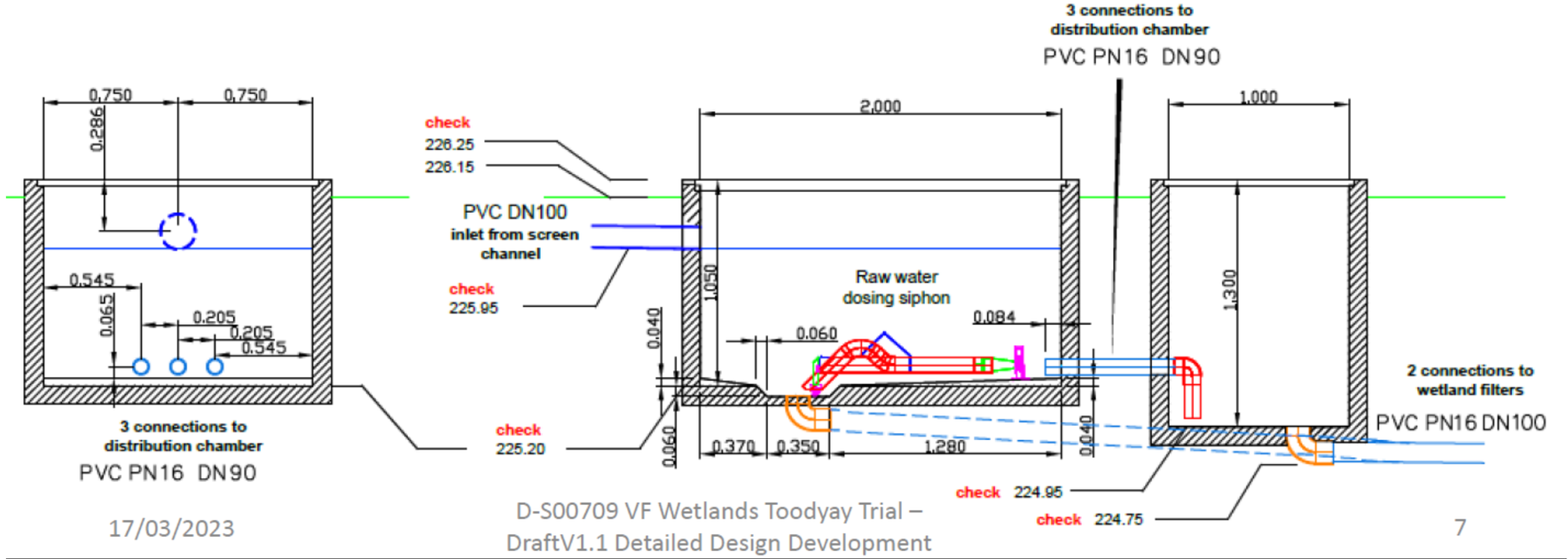
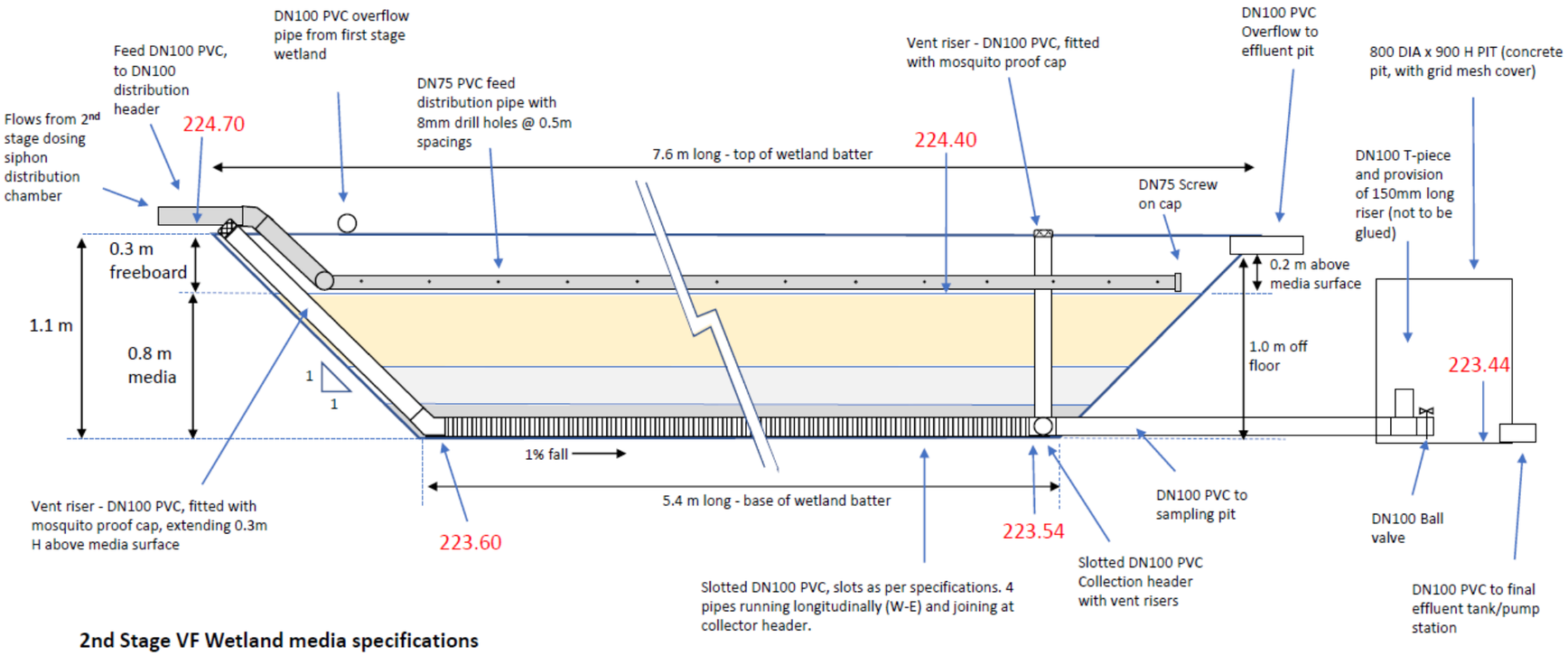


Figure 9: Stage 2 dosing siphon tank details

Scale
Approx 1:25 in A3
Horizontal lines exaggerated - not to scale, measures as shown.

Second Stage VF Wetland Cells - Section – longitudinal view (W-E)



2nd Stage VF Wetland media specifications (all washed gravel and sand - free of fines):

Substrate	Depth / thickness	Particle size
Top filtration layer:	40 cm	Medium Sand 0.25mm <d10 <0.4mm and d60/d10 < 5 and < 3% fines
Transition layer	20 cm	Medium gravel: 3 - 10 mm
Bottom drainage layer	20 cm	Large gravel: 20 - 40 mm

Check levels. All mAHD

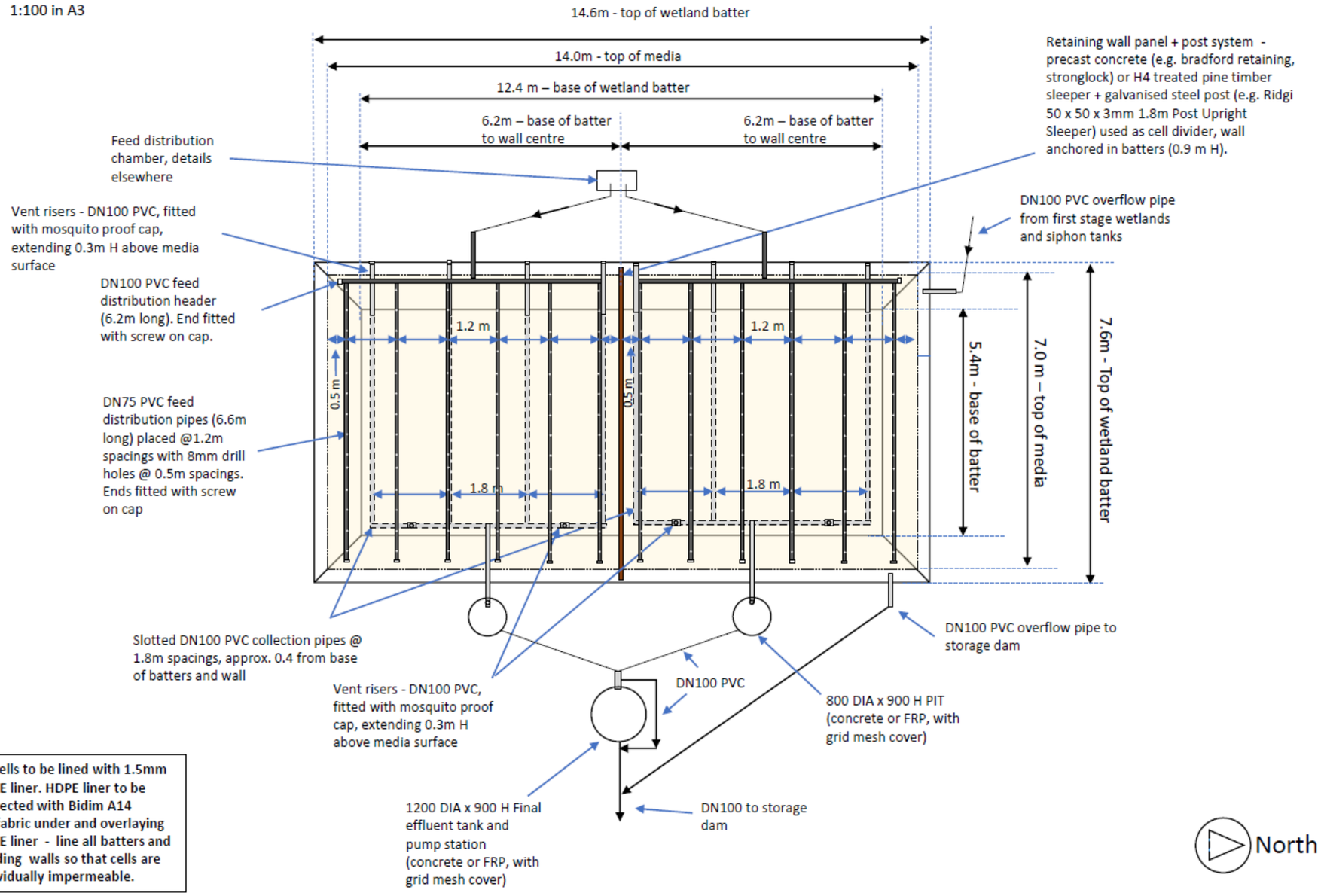
For both the transition and drainage layer, the Terzaghi rule is used (D15/d85 ≤ 4). A permeability criterion is also added: D15/d15 ≥ 4. This rule is used to ensure that the interface between the sand layer and transition layer does not produce a decrease in permeability by reducing the local porosity (migration of sand). Contractor to provide samples and particle size report prior to delivery.

Figure 10: Stage 2 VF Wetland Cells design

Second Stage VF Wetland Cells - Plan view

Scale

1:100 in A3



All cells to be lined with 1.5mm HDPE liner. HDPE liner to be protected with Bidim A14 geofabric under and overlaying HDPE liner - line all batters and dividing walls so that cells are individually impermeable.

Figure 11: Stage 2 VF Wetland Cells layout

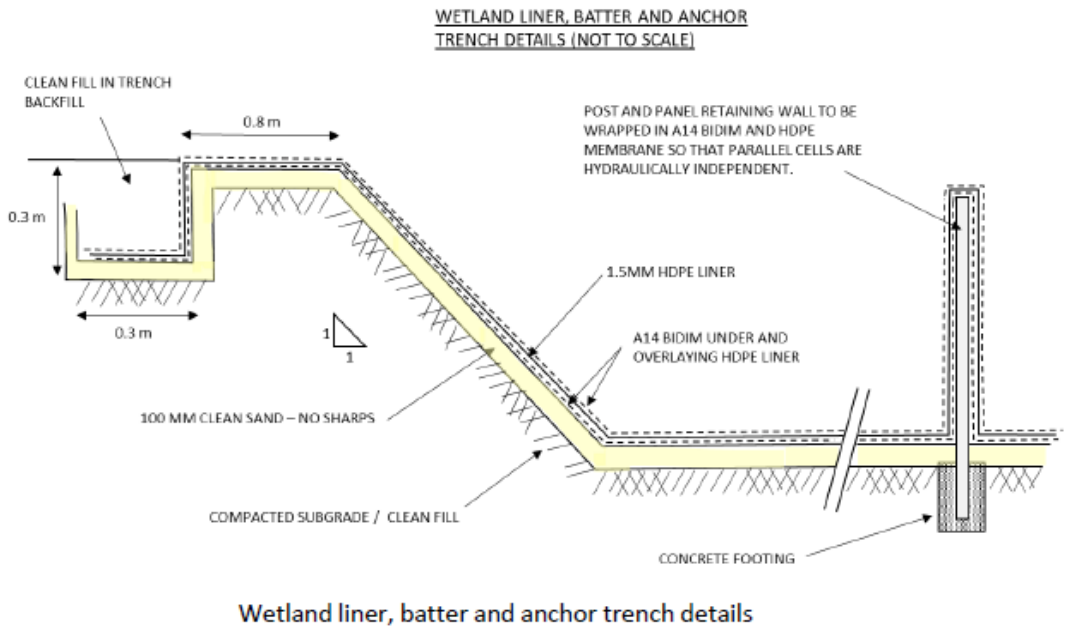
Schedule 4: Liner installation requirements

In accordance with condition 6, the items and corresponding requirements described in Table 10 and depicted in Figure 12, are required to be met and/or completed for the installation of the HDPE liner material in all VF wetlands.

Table 10: Minimum requirements for installation of wetland HDPE liners

Item		Requirements
1.	Wetland cell base and embankment subgrade preparation	Prior to installation of the HDPE liner, the works approval holder must; (a) Clear, strip and separately stockpile vegetation and topsoil. All earthworks fill for the wetland cells are to be sourced from the site, with the cut volume from the wetland floor being used to construct the new embankments. (b) Construct embankments in a series of lifts with each lift being placed and compacted. (c) Subgrade under the wetland floor and embankments shall be compacted to 95% of Maximum Dry Density (MDD), firm and unyielding. Subgrade shall be prepared free from any sharp materials, protruding edges, stones, construction debris, abrupt elevation changes, voids, cracks, and free from standing water. (d) Cover the compacted subgrade with a 100 mm thick layer of clean fill sand. (e) Place Geotextile Bidin A14 (or similar approved) over the clean fill sand as an underlay for the HDPE liner as shown in Figure 12. (f) The geotextile must be installed to overlay the subgrade so that it remains in direct contact with the subgrade, with sufficient slack given to ensure that low areas in the subgrade are not bridged by the geotextile.
2.	HDPE liner and geotextile underlay and overlay installation	(a) The HDPE liner is to be 1.5 mm thick to achieve a permeability of less than $2x10^{-10}$ m/s. (b) The entire surface area of each roll must be inspected by the suitably qualified CQA engineer/consultant prior to works commencing or during unrolling/installation, to ensure that there are no tears, punctures, abrasions, indentations, cracks, thin spots or other faults in the material; (c) Installation and seaming must be undertaken by installers with extensive experience in seaming the same type of HDPE liner being installed and using the same seaming procedures to be used on site. They must hold a current independent certification for seaming and installation to a recognised industry standard (national or international). (d) The method used to unroll or deploy the panels must not score, scratch or crimp the geomembrane; (e) The liner must not be installed during rainfall, high winds or in the presence of standing water. (f) Panel overlap zones must be no less than 125 mm and orientated so the overlap is in the down sloping direction and across the wetland base; (g) Panels installed on pond embankments must be fixed in anchor trenches; (h) Panels must be free of holes, blisters, blemishes, striations, bubble, roughness, contaminants and permanently attached raw materials; and (i) The installation must be undertaken in accordance with any additional minimum requirements specified by the manufacturer. (j) A layer of Geotextile Bidin A14 (or similar approved) to be installed on top of the HDPE liner as shown in Figure 12.

Item		Requirements
3.	Anchor trenches	(a) Must be set back at least 0.8 m from the top edge of the pond embankment; and (b) Must be backfilled with clean fill while liner materials are in the relaxed state, in full contact with subgrade and without wrinkles or folds.
4.	Welding methods	(a) Only thermal welding methods shall be used; (b) Welding of all main joints between adjacent panels must be conducted using dual-track fusion welding; (c) Extrusion welding must only be conducted for repair work or around pipeline penetrations; and (d) Extrusion welding must be undertaken using material that has the same resin type and physical properties of the HDPE.
5.	Inspection and repair	Following installation of the HDPE liner, the works approval holder must; (a) identify any damage to the HDPE by inspecting the surface of the liner for rips, tears and displaced panels; (b) conduct appropriate repairs to any damage identified through the inspection; and (c) document the results of the inspection, and if required, any repairs done to the liner.



Wetland liner, batter and anchor trench details

Figure 12: Wetland liner, batter and anchor trench details

Schedule 5: Liner quality control and quality assurance requirements

The items and corresponding requirements described in Table 11 are the minimum quality control and assurance activitites that must be undertaken for the installation of the HDPE liner material in all wetland cells.

Table 11: Minimum requirements for quality control and assurance for wetland HDPE liner installation

<table>
<tr><th colspan="2">Item</th><th>Requirements</th></tr>
<tr><td>1.</td><td>Manufacturer Quality Control and Assurance</td><td>(a) HDPE panel rolls must be supplied, tested and certified by the manufacturer in accordance with the GRI - GM13 Standard Specification to confirm that the following material properties meet the requirements of the relevant specification for the HDPE liner:
(i) Thickness, asperity height and formulated density;
(ii) Tensile properties;
(iii) Tear, puncture and stress crack resistance;
(iv) Carbon black content and dispersion;
(v) Oxidative Induction Time;
(vi) Oven aging at 85^{0}C; and
(vii) Ultra-violet resistance; and
(b) A statement on the origin of the resin used in the HDPE, its identification (type and lot number), its production date and the maximum amount of recycled polymer material added to the raw resin must be provided by the manufacturer.</td></tr>
<tr><td>2.</td><td>Conformance testing after shipment</td><td>(a) The works approval holder must undertake conformance testing of HDPE liner material prior to installation of the liner and following delivery of the HDPE liner rolls to the premises, for the properties listed below, using the corresponding test method and testing frequencies listed below.
<table>
<tr><th>Property</th><th>Test method</th><th>Testing frequency</th></tr>
<tr><td>Thickness</td><td>ASTM D5994</td><td>Each roll</td></tr>
<tr><td>Asperity Height</td><td>ASTM D7466</td><td>Two samples</td></tr>
<tr><td>Density</td><td>ASTM D1505 or ASTM D792</td><td rowspan="7">One per 5,000 m^2 or every five rolls delivered to the premises, whichever is the higher number of tests</td></tr>
<tr><td>Tensile properties in each direction
- strength at break
- strength at yield
- elongation at break
- elongation at yield</td><td>ASTM D6693 type IV</td></tr>
<tr><td>Puncture resistance</td><td>ASTM D4833</td></tr>
<tr><td>Tear resistance</td><td>ASTM D1004</td></tr>
<tr><td>Carbon black content</td><td>ASTM D1603</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th colspan="2">Item</th><th>Requirements</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Carbon black dispersion</td><td>ASTM D5596</td><td></td></tr>
<tr><td>Stress crack resistance</td><td>ASTM D5397</td><td rowspan="3">One sample every 10,000 m^2, resin type or manufacturing run</td></tr>
<tr><td>Standard Oxidative Induction Time</td><td>ASTM D8117</td></tr>
<tr><td>High pressure Oxidative Induction Time</td><td>ASTM D5885</td></tr>
</table>
</td></tr>
<tr><td>3.</td><td>Start-up test welds</td><td>
(a) The works approval holder must ensure that start-up test welds are undertaken using the trial weld seams listed below, at the corresponding frequency and tested using the corresponding test method listed below.
<table>
<tr><th>Trial weld seam</th><th>Frequency</th><th>Test method</th></tr>
<tr><td>Trial weld seam with a minimum continuous seam length of 1.0 m and width of 300 mm</td><td>Daily at the start of works, whenever the welding equipment is shut-off for more than 1 hour and after significant changes in weather conditions</td><td>Four 25 mm wide samples cut using a calibrated die cutter from a, tested for shear and peel strength using a calibrated hand tensiometer to determine whether the test welds have passed or failed</td></tr>
<tr><td>Trial weld seam with a minimum continuous seam length of 1.5 m and width of 300 mm</td><td>Whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced.</td><td>Four 25 mm wide samples cut using a calibrated die cutter from a, tested for shear and peel strength using a calibrated hand tensiometer to determine whether the test welds have passed or failed</td></tr>
</table>
</td></tr>
<tr><td>4.</td><td>Destructive weld testing</td><td>
(a) The works approval holder must undertake destructive weld testing for the property listed below, using the corresponding test method and testing frequencies listed below.
<table>
<tr><th>Property</th><th>Test method</th><th>Testing frequency</th></tr>
<tr><td rowspan="2">Weld seam peel and shear strength</td><td>ASTM D6392 conducted onsite using a calibrated tensiometer</td><td>Every weld</td></tr>
<tr><td>ASTM D6392 conducted offsite at a NATA accredited laboratory</td><td>Every 150 m for fusion welds and every 120 m for extrusion welds</td></tr>
</table>
</td></tr>
<tr><td>5.</td><td>Non-destructive weld testing</td><td>
(a) The works approval holder must undertake non-destructive weld testing for the properties listed below, using the corresponding test method and testing frequencies listed below.
<table>
<tr><th>Property</th><th>Test method</th><th>Testing frequency</th></tr>
<tr><td rowspan="2">Continuity of field seams</td><td>ASTM D5820 air pressure test</td><td rowspan="2">All seams over full length</td></tr>
<tr><td>ASTM D5641 vacuum box test</td></tr>
<tr><td rowspan="2">Weld quality</td><td>Visual observation of a consistent ‘squeeze out’ on the weld edge indicating that the correct temperature and pressure were used during installation</td><td>All fusion welded seams over full length</td></tr>
<tr><td>Visual observation of the weld appearance being smooth, uniform and free of streaks and lumps, in addition to having no obvious scoring, notches or deep scratches introduced by surface grinding</td><td>All extrusion welded seams over full length</td></tr>
</table>
</td></tr>
</table>

Schedule 6: Target for treated effluent quality from the two-stage French VF wetland system

Table 12: Treated effluent quality targets

Parameter	Target
Biochemical oxygen demand (BOD)	<30 mg/L
Total Suspended Solids (TSS)	<30 mg/L
pH	6.0 – 9.0
E.coli	<10,000 cfu/100 mL
Total Nitrogen (TN)	<35 mg/L
Total Kjeldahl Nitrogen (TKN)	<15 mg/L
Total Phosphorus (TP)	No target (10-25% removal expected)
Sludge quality	No target (>20% total solids expected)