Wetland Design Manual Part C: Technical Design, Construction & Establishment Approach

Manual

December 2020

Melbourne Water makes a vital contribution to the famous Melbourne lifestyle through the supply of high-quality water, reliable sewerage services, integrated drainage and flood management services and by enhancing our waterways and land for greater community use.

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1. Purpose

This part of the manual outlines a design approach for wetlands that reflects the design acceptance process detailed in **Part B.** The manual provides a summary of the design process from concept design through to detailed design. The manual also covers construction, establishment and maintenance considerations.

2. Scope

This document describes the analytical and design tools, and technical resources required by the designer. A description of the technical details of these tools and resources is provided in **Part D** of the manual.

This section includes:

- Concept design
- Functional design
- Detailed design
- Pre-construction
- Construction and establishment

Part C is structured as a series of steps that lead the designer through the design process. Design iterations are often required during the design process, and the designer may be required to review and repeat some design steps until the design meets the required criteria and design intent.

The design approach presented in this Part of the manual assumes a sound understanding of the fundamentals of wetland function, the core outcomes (**Part A1**), the Deemed to Comply design criteria (**Part A2**), the additional design considerations (**Part A3**) and the design acceptance process (**Part B**).

This section should be read in conjunction with the current versions of the following documents:

- Melbourne Water's Building and Works website
- Urban Stormwater: Best Practice Environmental Management Guidelines
- Melbourne Water's MUSIC Tool Guidelines
- WSUD Engineering Procedures: Stormwater

Note: Any variations between this document and the documents listed above are superseded by this manual.

3. Concept Design

The concept design phase is likely to include:

- Authority consultation
- Site visit
- Catchment analysis
- Collaboration between members of design team (e.g. engineering, ecology, landscape)
- MUSIC modelling to estimate performance
- Preliminary estimates of design flow rates to size high flow bypass route width
- Analysis of feature survey or other information to estimate wetland levels and spatial constrains (e.g. existing trees)
- Analysis of flora and fauna survey, geotechnical testing and other relevant site investigations

Note: Where the wetland is located within a Melbourne Water Development Services Scheme, we can provide the designer with advice regarding the wetland objectives and intent. This advice includes highlighting component size requirements, open space and waterway corridor requirements (if applicable), design flows, relevant plans and strategies, Development Services Scheme infrastructure (such as indicative sizes of pipelines and outfall locations) and any available background studies (flora, fauna, cultural heritage, etc.). It can also provide information on the initial developer contribution that is payable to Melbourne Water and the expected estimated costs for reimbursable works if the wetland is required as part of a Development Services Scheme.

Important note: a Development Services Scheme is a catchment masterplan and only has limited information regarding the subject site, topography, asset size and location. A MUSIC model that has been set up for the Development Services Scheme can be provided to the consultant if required. The consultant is responsible for checking the model includes a suitable representation of the catchment and proposed treatment train.

Please refer to the **Concept Design Package** details outlined in **Part B** and the requirements outlined in the **Concept Design Package report** for assistance. The **Concept Design Deemed to Comply checklist** outlines the required conditions that need to be met through the concept design phase.

3.1 MUSIC Modelling

MUSIC modelling is recommended by Melbourne Water and must be undertaken using the most recent version of the software and should be in accordance with the Melbourne Water MUSIC Modelling Guidelines. Where the modelling approach is not in accordance with Melbourne Water's Guidelines, a full justification for the alternative approach must be provided.

The sediment pond must be sized accurately during the functional design stage, however for the concept design stage, the sediment pond can be assumed to be 10% of the macrophyte zone area and have a maximum depth of 1.5 meters.

Where the sediment pond and macrophyte zones have a common Top of Extended Detention (TEDD), a single "wetland" node should be used to represent the system in MUSIC. The Inlet

Pond Volume should represent the volume of the sediment pond's permanent pool above the sediment accumulation zone.

Where the sediment pond's TEDD is higher than the macrophyte zone's TEDD, the sediment pond and macrophyte zone should be modelled using separate nodes in MUSIC (i.e. a "sedimentation basin" node and a "wetland node"). When separate nodes are used, the wetland node's "inlet pond volume" should be set to zero. The sedimentation basin's equivalent pipe diameter or Custom Outflow Relationship must reflect the hydraulic control between the sediment pond and macrophyte zone.

For the purpose of the concept design phase, it is recommended that the surface areas used in the MUSIC node(s) are assumed to be the area of the wetland at NWL. Alternatively, the Custom Storage Relationship can be used to define the storage volume at a range of depths (although this level of detail is usually not available at the concept design stage).

Important Note: The wetland guidelines now require that a minimum rainfall dataset of 10 years is used to model wetlands in MUSIC.

The following resources will assist in configuring the MUSIC model:

- MUSIC tool guidelines
- MUSIC rainfall templates
- Rainfall distribution map - Melbourne
- MUSIC Auditor
- Wet spells analysis tool

3.2 Hydrologic and Hydraulic Modelling

During the concept design phase, peak design flows are estimated (generally using the Rational Method) to size the high flow bypass channel. The indicative channel dimensions can be estimated using Manning's Equation. Refer to **Part D** of this manual for advice on hydrologic modelling and hydraulic analysis.

4. Functional Design

The functional design phase is likely to include:

- Authority consultation to confirm design requirements and maintenance commitments
- Collaboration between members of the design team (e.g. engineering, ecology, landscape)
- Confirmation of sediment pond and sediment dewatering area configuration
- Refined MUSIC modelling to confirm performance and ensure adequate residence time and inundation patterns
- Confirmation of design flow rates to size hydraulic structures and high flow bypass route
- Three dimensional representation of wetland form to confirm wetland levels and extent relative to any site constraints
- Analysis of water levels and flow velocities relevant to wetland function
- Confirmation of wetland bathymetry and planting design

- A record of design approach and outcomes in a report format
- An estimate of capital costs of proposed works (construction estimate or using Melbourne Waters Standard Refund Rates)

WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005) should be used as the primary reference for the functional design methods. The advice provided in **Part D** of this manual supersedes some of the advice provided in the Engineering Procedures document. In particular:

- The controlled outlet must be sized using the method described in **Part D** rather than the method in the Engineering Procedures
- The velocities must be checked using the method described in **Part D** rather than the method in the Engineering Procedures.

The MUSIC model developed during the functional design stage must reflect the actual stage/storage/discharge relationship of the wetland's extended detention. Where the wetland is within a retarding basin, the MUSIC model must also reflect the stage/storage/discharge relationship of the retarding basin (i.e. when the water level exceeds TEDD). The actual stage/storage/discharge relationships must be represented using MUSIC's Custom Outflow and Storage Relationship function.

Where the sediment pond and macrophyte zone have a common TEDD, a single "wetland" node should be used to represent the system in MUSIC. For the functional design, the Inlet Pond Volume used in the MUSIC model should match the dimensions of the sediment pond shown in the earthworks plan (and sized to meet the conditions in SP3).

Where the sediment pond's TEDD is higher than the macrophyte zone's TEDD, the sediment pond and macrophyte zone should be modelled using separate nodes in MUSIC (i.e. a "sedimentation basin" node and a "wetland" node). When separate nodes are used, the wetland node's "Inlet Pond Volume" should be set to zero. The sedimentation basin node's equivalent pipe diameter must reflect the hydraulic control between the sediment pond and macrophyte zone (this is likely to need to be defined using the custom outflow function). The surface area and extended detention depth should match the dimensions shown on the functional design plans. The permanent pool volume should represent the volume of the sediment pond's permanent pool above the sediment accumulation zone.

Please refer to the **Functional Design Package** details outlined in **Part B** and the requirements outlined in the **Functional Design Package report** for assistance. The **Functional Design Deemed to Comply checklist** outlines the required conditions that need to be met through the functional design phase.

4.1 Worked Example 1 – sizing connection between the sediment pond and macrophyte zone (sediment pond NWL = macrophyte zone NWL)

Scenario: The sediment pond and macrophyte zone NWL is at 20.0 m AHD. The sediment pond and macrophyte zone each have 350 mm extended detention. The connection between the sediment pond and macrophyte zone consists of a wetland inlet weir (length TBC), weir (crest at 20.0 m AHD). A wetland bypass weir (length TBC), weir (crest at 20.35 m AHD) connects the sediment pond to a bypass channel. A 2 m long wetland outlet weir (crest at 20.55 m AHD) is at the downstream end of the macrophyte zone. The wetland is in a retarding basin. The 10 year ARI water level in the retarding basin is estimated to be 21.0 m AHD.

Design flow estimates are:

Q3month = 1.1m^3/s (note this is wetland design inflow)

Q1year = 2.8m^3/s (note sed pond high flow bypass is to ensure >60% of peak 1year flow is to bypass macrophyte zone (refer Par A2 Figure 5)

Q100 year = 14.8m^3/s (check wetland velocities in 100 year flow to ensure sufficient wetland width)

Wetland inlet weir sizing (IO4, first dot point):

The peak three month flow was determined to be 1.1 m^3/s. The connection must be able to convey 1.1 m^3/s when the water level in the sediment pond is at 20.35 m AHD (i.e. TED) and the water level in the macrophyte zone is at 20 m AHD (i.e. NWL).

The weir equation is used to determine the width of the wetland inflow and bypass weirs:

$$Q = B * C * L * h^{1.5}$$

Where:

Q = flow rate
B = blockage factor (assume no blockage)
C = weir coefficient (assume 1.4)
L = weir length (10 m)
H = head of water above weir (0.35 m)

For the weir length of 10m, the capacity of the weir is therefore estimated to be 2.9m^3/s, which is 160% greater than the required capacity, hence a shorter weir length needs to be adopted. Trial and error – 4m weir adopted as design inlet.

1 year bypass sizing (IO4, second dot point and refer Part A2 IO4 and figure 5):

Bypass Weir Sizing:

STEP 1 Determine design capacity of wetland bypass weir	= 60% of 1yr flows= 1.7m3/s
STEP 2 Determine sed pond 1yr level that will (a) ensure 60% of 1yr flow to be bypassed and (b) 40% of 1yr flows to flow into wetland at TEDD	(b) Is critical in determining 1year level of the sed pond. 40% of 1yr flows= 1.1m^3/s (= 3mth flow) Wetland inlet weir = 4m long (see wetland inlet weir sizing above) Using weir equation above, wetland inlet weir will require head of 0.35m to

	1year pass through flow of 1.1m^3/s. Since wetland is at TEDD, 1yearr sed pond level = wetland TEDD + 0.35m = 20.35+0.35 = 20.70m AHD
STEP 3 Determine length of bypass weir	Base of bypass weir = sed pond TEDD = 20.35M AHD Design capacity of design bypass weir = 1.7m^3/s (see step 1 above) 1yr sed pond level = 20.70m AHD (see step 2 above) Allowable bypass weir head = 20.65- 20.35 = 0.35m Using weir equation, design length of bypass weir = 6m long

Table 1: Bypass Weir Sizing Steps

100 year velocity check (IO4, third dot point):

The peak 100 year flow was determined to be 14.8 m^3/s. When the water level is at 21.0 m AHD, the minimum flow area between the retarding basin inlet and outlet that includes the macrophyte, was determined to be 35 m^2. The velocity through the macrophyte zone is therefore 0.42 m/s which is less than the maximum allowable velocity of 0.5 m/s.

4.2 Worked Example 2 – Sizing connection between the sediment pond and macrophyte zone (sediment pond NWL > macrophyte zone NWL)

Scenario: The sediment pond NWL is at 10.0 m AHD. The macrophyte zone NWL is at 9.5 m AHD. The sediment pond and macrophyte zone each have 350 mm extended detention. The connection between the sediment pond and macrophyte zone consists of a pit (crest at 10.0 m AHD, 0.9 m by 2.9 m) and a horizontal pipe (750 mm, IL 8.5 m AHD). A 15 m long weir (crest at 10.35 m AHD) connects the sediment pond to a bypass channel. The wetland is not in a retarding basin.

3 month capacity check (IO4, first dot point):

The peak three month flow was determined to be 1.1 m^3/s. The connection must be able to convey 1.1 m^3/s when the water level in the sediment pond is at 10.35 m AHD (i.e. TEDD) and the water level in the macrophyte zone is at 9.5 m AHD (i.e. NWL). The capacity of pit and pipe is checked for the following conditions:

- Flow rate controlled by pit acting as a weir
- Flow rate controlled by pit acting as an orifice
- Flow rate controlled by pipe (flowing full)

1. Check capacity of pit acting as a weir (using Melbourne Water grate formula on website)

Grates are required over the pits for safety reasons. During the design, allow for 50% blockage of the upstream grate and 25% blockage of the downstream grate. It may be more economical to construct both grates with equal sized openings.

To size a grated opening the following equation can be used for flow entering a horizontal grate (Ref. Open Channel Hydraulics - Chow, e.q. 12.23).

Q = eCLB (2gE)0.5

where

Q = Required flow through grate (m3/s)

e = Portion of area not taken up by bars (Total Area - Area of Bars)/Total Area

C = Discharge co-efficient (=0.45)

L = Grate Length (m)

B = Grate width (m)

g = 9.8 m/s2

E = Specific Energy = Depth above grate + V2/2g (but V=0) (m)

*50% blockage factor is to be applied separately.

2. Check capacity of pipe (flowing full)

A pipe chart is used for this check. The pipe chart shows the pipe capacity (Q) as a function of the length (L), head (H) and diameter (D). The head for this check is the difference between the upstream (10.35 m AHD) and downstream (9.5 m AHD) water levels (i.e. 0.85 m). The pipe chart indicates that the capacity of the pipe, flowing full, is 1.2 m^3/s, which is greater than the minimum required capacity.

Given that capacity of the pit and pipe are greater than or equal to the three month flow under four flow conditions, the pit and pipe configuration complies with the first dot point of IO4.

1 year bypass check (IO4, second dot point):

Repeat step from worked example 1:

The capacity of pit and pipe is checked for the following conditions:

- Flow rate controlled by pit acting as a weir
- Flow rate controlled by pit acting as an orifice
- Flow rate controlled by pipe (flowing full)

3. Check capacity of pit acting as a weir (using Melbourne Water grate formula on website)

Repeat steps from worked example 1:

4. Check capacity of pipe (flowing full)

A pipe chart is used for this check. The pipe chart shows the pipe capacity (Q) as a function of the length (L), head (H) and diameter (D). The head for this check is the difference between the upstream (10.54 m AHD) and downstream (9.85 m AHD – TED macrophyte zone) water levels (i.e. 0.69 m). The pipe chart indicates that the capacity of the pipe, flowing full, is 1.1 m^3/s, which is equal to the allowable capacity.

100 year velocity check (IO4, third dot point):

The peak 100 year flow was determined to be 14.8 m^3/s. The minimum flow area above the macrophyte zone occurs where the macrophyte zone permanent pool is 0.1 m deep and 20 m wide. The minimum cross sectional flow area when the water level is at TED is therefore 9 m^2 (i.e. 20 m * (EDD+0.1 m)). To achieve a maximum velocity of 0.5 m/s, the maximum allowable 100 year ARI flow through the macrophyte zone is therefore 4.5 m^3/s.

The connection must therefore not convey more than 4.5 m^3/s when the water level in the sediment pond is at the peak 100 year level and the water level in the macrophyte zone is at 9.85 m AHD (i.e. TED). The peak 100 year water level in the sediment pond is a function of the overflow weir length (15 m). The peak 100 year water level is conservatively estimated assuming that 100% of the peak 100 year flow (14.8 m^3/s) passes over the bypass weir. Using the weir equation, 0.79 m of head is required to pass 14.8 m^3/s over a 15 m long weir (assuming no blockage and a weir coefficient of 1.4). A conservative estimate of the peak 100 year flow water level in the sediment pond is therefore 11.14 m AHD (i.e. 10.35 m AHD + 0.79 m).

The capacity of pit and pipe is checked for the following conditions:

- Flow rate controlled by pit acting as a weir
- Flow rate controlled by pit acting as an orifice
- Flow rate controlled by pipe (flowing full)

5. Check capacity of pit acting as a weir (using Melbourne Water grate formula on website)

Repeat steps from worked example 1:

4.3 Worked Example 3 – determining stage – discharge relationship for controlled outlet

Scenario: A macrophyte zone's controlled outlet consists of a 100 mm wide rectangular slot. The macrophyte zone's NWL is 30.0 m AHD and the EDD is 350 mm.

Determining the stage/discharge relationship:

The stage/discharge relationship for the slot is determined using the following equations from Measurement of Small Discharges in Open Channels by Slit Weir (Aydin et al, 2002):

- $Q = C_d*(2/3)*((2*g)^{0.5})*b*h^{1.5}$
- $C_d = 0.562+11.354/Re^{0.5}$

Where:

- Q = discharge (m^3/s)
- C_d = discharge coefficient
- g = gravitational constant = 9.81 m/s^2
- b = slot width = 0.1 m
- h = water depth i.e. stage (up to 0.35 m)
- Re = Reynolds number = V*R/v
- V = velocity = Q/(b*h)
- R = hydraulic radius = (b*h)/(b+2*h)

An iterative approach was used to determine the discharge rate for each stage using the above equations. The stage/discharge relationship is shown in the table below.

Stage (m AHD)	Discharge (m^3/s)
30.0	0.0022
30.05	0.006
30.10	0.011
30.15	0.017
30.20	0.023
30.25	0.03
30.30	0.038
30.35	0.045

Table 2: Stage/Discharge Relationships

4.4 Worked Example 4 - Sediment Pond Sizing Example

A sediment pond is being sized to capture 95% of the coarse particles ≥ 125 μm diameter for a 60 ha catchment. The peak three month ARI flow is 1.4 m^3/s and the peak 100 yr ARI flow is 5 m^3/s. The sediment pond will be 1.5 m deep and has 0.35 m extended detention. It has a turbulence parameter of 1.35 (from Figure 4.3 and Equation 4.2 of WSUD Engineering Procedures Stormwater (Melbourne Water, 2005)).

<u>Step 1: Determine area required to achieve removal efficiency</u>

The sediment removal efficiency is calculated using the modified Fair and Geyer equation:

- $R = 1-(1+(1/n)*(v_s/(Q/A))*(d_e+d_p)/(d_e+d*))^{-n}$

Where:

- R = fraction of target sediment removed = 0.95
- n = turbulence parameter = 1.35
- v_s = settling velocity of 125 μm diameter particle = 0.011 m/s
- Q = peak three month ARI flow rate = 1.4 m^3/s

- A = surface area at normal water level (m^2)
- d_e = extended detention depth (m) = 0.35 m
- d_p = permanent pool depth (m) = 0.5 m to 1.5 m depending on how much sediment has been collected
- d^* = depth below the permanent pool level that is sufficient to retain the target sediment = 0.5 m to 1.0 m depending on how much sediment has been collected

The required sediment basin area is determined for two scenarios:

Sediment basin is empty:

a. d_p =1.5 m
b. d^* = 1.0 m
c. Therefore A = 1,100 m^2
d. Therefore the area at normal water level must be at least 1,100 m^2 to achieve the required removal efficiency when the basin is empty.

Sediment basin is full

a. d_p =0.5 m
b. d^* = 0.5 m
c. Therefore A = 1,700 m^2
d. Therefore the area at normal water level must be at least 1,700 m^2 to achieve the required removal efficiency when the basin is full.

<u>Step 2: Determine volume to achieve clean out frequency</u>

The sediment removal frequency is calculated using the following equation:

- $S_t = C_a * R * L_o * F_r$

Where:

- S_t = volume of storage required between base and 0.5 m below normal water level
- C_a = contributing catchment area = 1.6 ha
- R = fraction of target sediment removed = 0.95
- L_o = sediment loading rate = 1.6 m^3/ha/yr
- Fr = clean out frequency = 3 years

The equation shows that at least 300 m^3 of storage is required between the base and 0.5 m below normal water level to ensure a clean out frequency of 3 years.

<u>Step 3: Determine minimum width to achieve scour velocity</u>

The scour velocity is calculated using the following equation:

- $v_{scour} = Q_{scour}/(d_e * w_{nwl})$

Where:

- v_{scour} = scour velocity threshold =0.5 m/s
- Q_{scour} = peak 100 year ARI flow = 5 m^3/s

- d_e = extended detention depth = 0.35 m
- w_{nwl} = width of sediment pond at normal water level (m)

The equation shows that the sediment pond must be at least 30 m wide at the normal water level to ensure a scour velocity of less than 0.5 m/s.

Definition of d*

The sediment pond sediment removal efficiency is a function of the depth below the permanent pool level that is sufficient to retain the target sediment. This depth is referred to as "d*" and is measured in meters below the permanent pool level. The value of d* used in the removal efficiency equation should be:

- 1.0 m if the base of the sediment pond is at least 1.0 m below the permanent pool level; or
- The depth of the sediment pond if the base if less than 1.0 m below the permanent pool level.

As a sediment pond fills with sediment the effective base level will rise which may impact the d* value (refer Figure 1). To estimate the removal efficiency of a 1.5 m deep sediment pond immediately after it has been emptied, a d* value of 1.0 m should be used. To estimate the removal efficiency of the same basin which has accumulated sediment to within 0.5 m of the permanent pool level, a d* value of 0.5 m should be used.

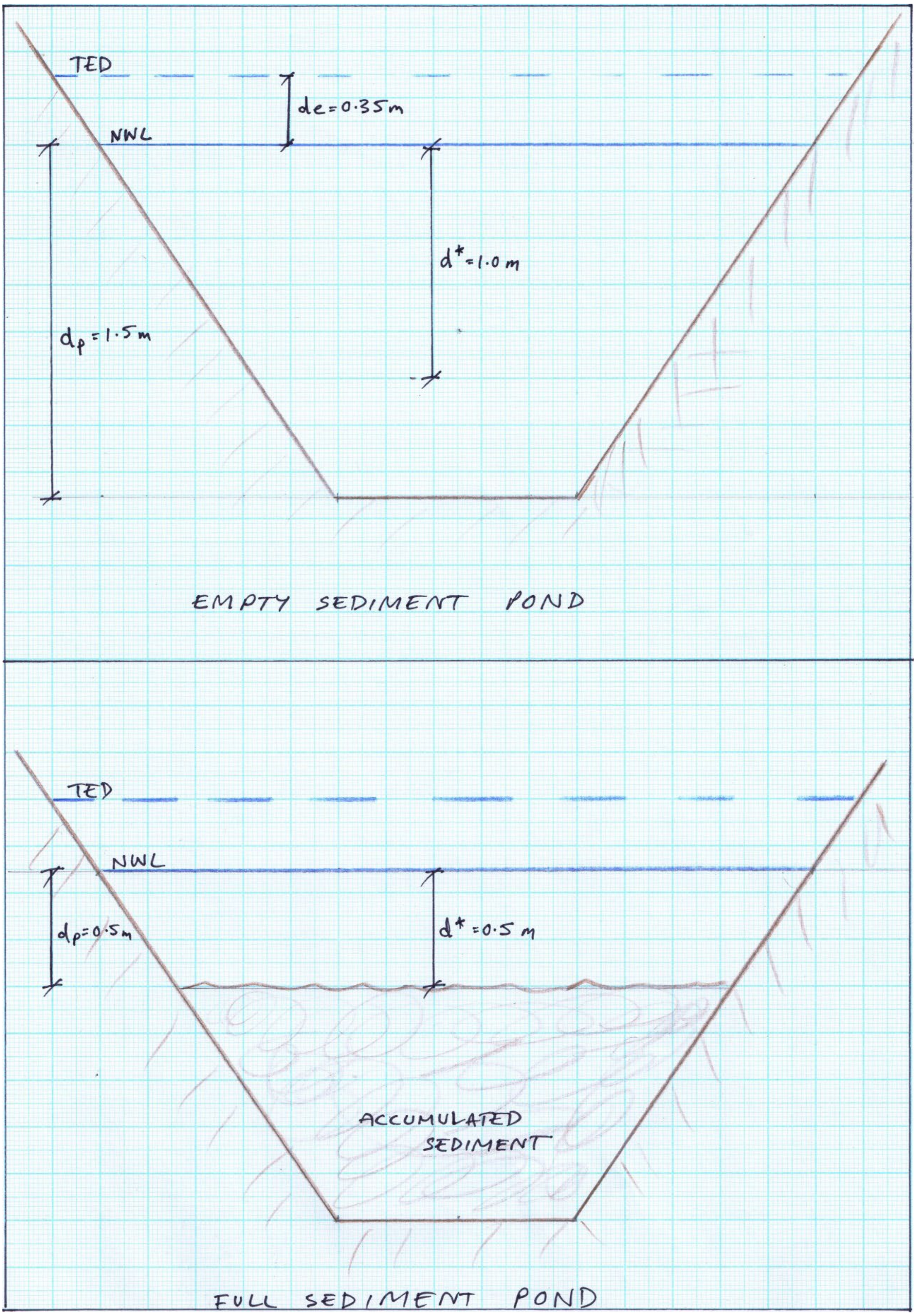

Figure 1: Schematic showing d* for and empty and full sediment pond

5. Detailed dDsign

Our Business Improvement team will review the submitted detailed design plans and provide feedback. We are also available to answer any questions that you may have about your design. Please give yourself plenty of time to achieve final acceptance of your design from Melbourne Water. Our Design of works website provides key lead times in the design acceptance process:

- Design of works
- Planning and Building website
- Standard drawings

Please refer to the **Detailed Design Package** details outlined in **Part B** and the requirements outlined in the **Detailed Design Package report** for assistance. The **Detailed Design Deemed to Comply checklist** outlines the required conditions that need to be met through the detailed design phase.

6. Pre-Construction

The key to successful construction and establishment is undertaking detailed planning. Pre-construction planning will involve the:

- Preparation of tender documents (that form the basis for reimbursement)
- Development of a Site Environmental Management Plan,
- Engagement of a contractor
- Submission of pre-construction Certification Checklist and Statement.

Melbourne Water advises clients to wait for confirmation of the reimbursement amount before commencing construction work. Please refer to **Part B** for further information about the design acceptance process.

The primary reference for the pre-construction phase is the Melbourne Water Planning and Building website:

- Building and Works website
- Permit to Work
- Tendering of works
- Construction of works

7. Construction and Establishment

The integrity of good wetland design can be jeopardised by poor construction and establishment, leading to reduced wetland performance and impacts on the long term sustainability of the wetland system. Similarly, poor understanding of the operational and maintenance activities required at the site can impact the performance of a wetland.

7.1 Construction Planning

Wetlands are most vulnerable during the construction phase of developments, when large amounts of sediment are likely to enter wetland. It is important to consider how the wetland will be protected during the construction phase. This may involve staged construction and establishment of the wetland, whereby the macrophyte zone of the wetland is protected (kept offline) during the construction phase. A second option may be to construct the wetland but leave the macrophyte zone acting as a sediment pond during the construction phase. Under this scenario, sediments that have accumulated within the macrophyte zone during the construction phase will need to be removed prior to establishing the wetland vegetation.

The timing of catchment development relative to the timing of wetland construction will influence the wetland's water level regime. Developed catchments generate a lot more runoff than undeveloped ones. If a wetland is constructed before the majority of the contributing catchment is developed, the wetland will initially receive less water than under ultimate conditions. The impact of this interim flow regime on wetland vegetation should be considered.

7.2 Construction Phase

To ensure good translation of the detailed design into on-ground works, clear communication of the design intent to the site contractors and regular inspections are required. Hold points for inspections need to be clearly written into tender documents. This may be required to be submitted as part of the detailed design documentation.

The construction works must be undertaken in accordance with relevant Melbourne Water Standard Drawings and Example Construction Specifications. The site superintendent is responsible for ensuring that the contractor who constructs the works meets all of Melbourne Water's required outcomes. Non-compliance with Melbourne Water's requirements will require that rectification works be undertaken. All construction based rectification costs will be borne by the developer and/or contractor. Please refer to Melbourne Water's Construction of Works conditions on our website for more information.

Contractors are required to have Site Environmental Awareness Training (SEAT) accreditation and an approved site environmental management plan in place before works commence. The site environmental management plan should identify the environmental risks for the site, their likelihood and consequence, along with environmental protection measures which are proposed to manage this risk. See Melbourne Water's Site Management Standards for more information.

Site Environmental Awareness Training (Green card)

A Site Environmental Awareness Training (SEAT) course is available to all Contractors that are involved with the construction of Melbourne Water's waterway and wetland assets. This is a full day course run by Statewide River & Stream Management out of Holmesglen TAFE, and covers topics relating to legislation and obligations, EPA enforcement and penalties, principles of erosion management and treatment measures.

A Melbourne Water green card containing photo identification will be issued to all people who have completed the training course. All contractors will be required to have a current SEAT prior to Melbourne Water issuing a Permit to Work.

Construction and Establishment Guidelines

The Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2009) provides information and resources that inform best practice wetland construction and establishment. The guidelines provide civil and landscape specifications, step by step construction procedures, checklists and sign off forms for certification and compliance during the construction phase.

The Construction and Establishment Guidelines can be downloaded from the Water by Design website: Bioretention technical design guideline

To avoid invasive plants and animals being introduced to wetlands during construction and establishment, equipment should be washed down before being used on site and the suppliers of aquatic plants must demonstrate that their stock is free of pest fish and unwanted aquatic weeds.

For both safety and security, Construction sites must be isolated from the public and this is typically achieved using temporary safety and security fencing that complies with a range of Australian Standards. Melbourne Water has developed a risk assessment for safety and security fencing on construction sites and this must be completed for both civil and planting works.

- Risk assessment for safety and security fencing on construction sites

7.3 Establishment Phase

Successful plant establishment is fundamental to long term wetland function. It is important to ensure that conditions are provided during establishment that maximise plant growth, including water level control by having the sidewinding penstock valve within the twin chamber outfall pit fully open for the 1st 12 months of the planting establishment period.

Important note: The control of the water level in the macrophyte zone is critical to the establishment of the macrophyte planting. The wetlands water level should be controlled by having the sidewinding penstock valve within the twin chamber outfall pit fully open for the 1st 12 months of the planting establishment period. It can then be gradually closed to the design width over the remaining 12 months of the planting defects period.

The rapid establishment of vegetation cover within the macrophyte zone enables the wetland vegetation to cope with waterbird grazing pressure and weed invasion; and reduces the level of maintenance required during the establishment phase (first two years prior to hand over).

Plant substitutions should not be made without written approval from Melbourne Water. Macrophyte species tolerance to water depth and inundation are not the same, and replacement species must be suitable for the proposed planting depth and inundation regime. All plant substitutions should be clearly marked on the as-constructed drawings.

The macrophyte planting should be undertaken in the wetland system during the spring-summer months (September to March) to ensure a higher success rate of plant survival and establishment. If a developer and site superintendent decide to plant the wetland outside of these months, then this will be done at their own risk and cost. Ephemeral batter vegetation can be generally planted all year round and this can assist with the staging of landscape planting works.

Figure 2: An example of a densely planted wetland with good water level control during the early establishment phase.

Macrophyte planting stock should be well developed, healthy and have a well-developed root system (Figure 2). All seedlings must be hardened off prior to delivery to the wetland site and be at least 300 mm high.

Figure 3: An example of well-developed and healthy macrophyte planting.

The following requirements should be followed to assist vegetation growth during the wetland establishment phase:

- Maintain water levels at normal water level (do not engage the extended detention depth) during the first year of operation or the first growing season;
- The outlet should be controlled via a twin chamber outfall pit containing a side winding penstock and gate valve providing flexibility to gradually implement the ultimate extended detention depth of the wetland system from no extended detention depth in the 1st 12 months of planting establishment to reaching the full design extended detention only after the 2 years and 3 months establishment period; and
- Netting of some macrophytes species (such as *Triglochin procerum*) to avoid damage by birds. Appropriate contractor details are to be provided on site so that in the event of birds becoming caught in the netting, the appropriate people can be contacted.

The endorsed maintenance agreement between Melbourne Water and Council plus the operational plan must be implemented prior to achieving the end of defects period for the wetland.

Clean out of the sediment pond of a wetland is required to be undertaken immediately prior to civil works hand over. Please refer to Melbourne Water's project finalisation page on the Planning and Building website for further information on defect liability periods and for other construction and establishment phase information.

- Construction of works
- Provision of notice
- Working on live assets
- Indemnity and insurance
- Signage
- Certification at the end of construction
- Certificate of completion

The Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010) is a recommended references for the Construction and Establishment phase stage for a wetland.

Quick reference and standards for construction and establishment

- Risk assessment for temporary safety and security fencing on construction sites
- Water levels must be maintained at normal water level during the first year of operation
- Some macrophyte species must be netted to avoid damage by birds
- Sediment ponds must be cleaned out immediately prior to hand over
- Plant suppliers must ensure and demonstrate that their plant stock is free of pests and weeds
- Signage should be installed as the last component of the wetland system just prior to handover to Melbourne Water

8. Document History

Date	Reviewed/ Actioned By	Version	Action
December 2020	Senior Asset Practitioner – Water Quality	2	Updated template and links