FARM DAM INFILLING ENVIRONMENTAL MANAGEMENT PLAN

MARCH 2021

Tweed Valley Hospital Development
Kingscliff, NSW, 2487

Prepared for Lendlease Building Pty Ltd

BOYDS BAY GROUP ENVIRONMENTAL

Boyds Bay Environmental Services
Suites 9 and 10, 1 Sands Street
Tweed Heads
New South Wales, 2485

P: 07 55365869
F: 07 55366711
boydsbaygroup.com.au

Document Control

Title: Farm Dam Infilling Environmental Management Plan

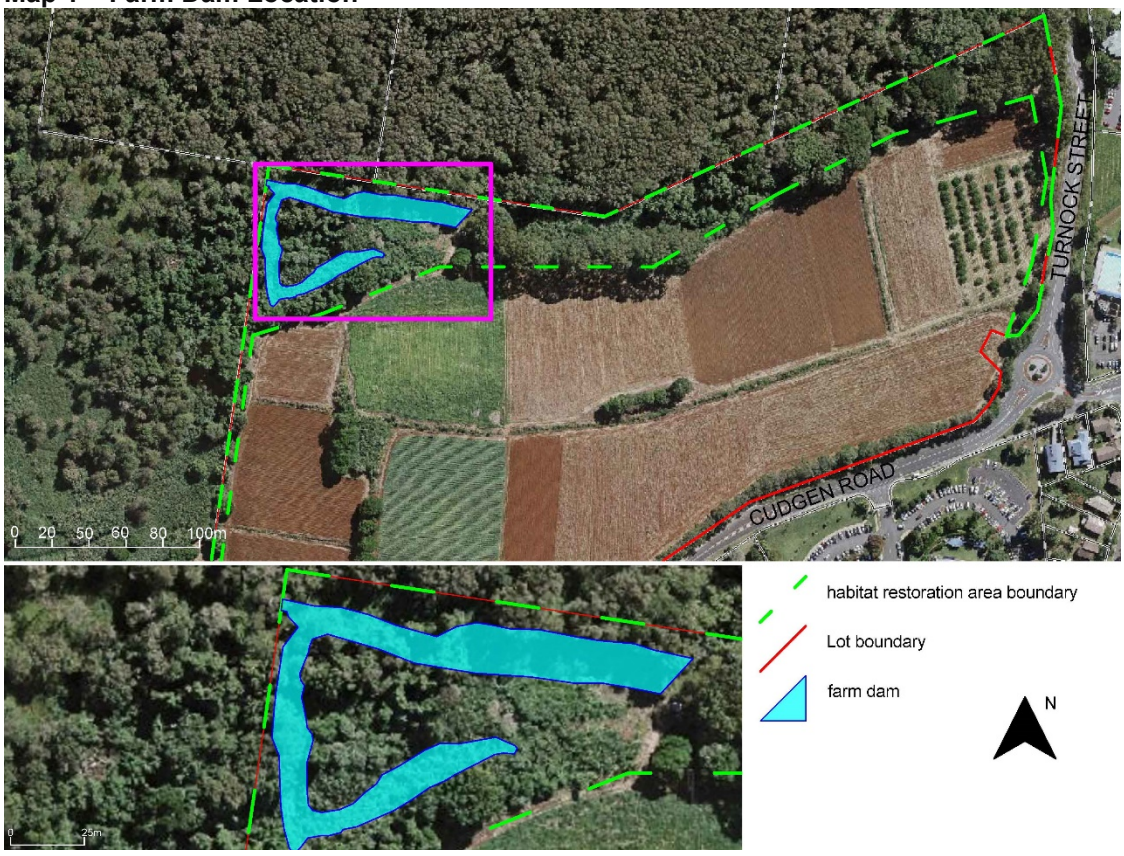
Revision	Date	Authored by	Checked by	Distributed to	Description
Draft	23/02/2021	D. Medvedko	-	G. Lobdell, G. Fraser, M. Birch, G. Lancaster	
1	25/02/2021	D. Medvedko	G. Lobdell, M. Birch, G. Fraser, G. Lancaster	T. Lee, S. Clark	MBO management and defishing methodology revised based on expert comments
2	26/03/2021	D. Medvedko	G. Fraser	G. Lobdell, T. Lee, S. Clark	Revised to incorporate TSA Management and Health Infrastructure comments

Contents

1 Introduction

A farm dam in the north-western portion of Lot 11 DP1246853, outside the Tweed Valley Hospital construction footprint and inside the habitat restoration area, is scheduled for infilling as part of implementing the Stage 2 Biodiversity Management Plan (BMP, Greencap 2020) of the NSW Health Infrastructure Tweed Valley Hospital (TVH) project. Map 1 illustrates dam location within the Lot and outlines the habitat restoration area.

Map 1 – Farm Dam Location[1]



The BMP stipulates the farm dam should be infilled to mitigate the spread of *Salvinia minima* and *Salvinia molesta*. BMP Section 2.3.2.7 provides a general process but does not detail measures to manage Monosulfidic Black Ooze (MBO) on the base of the dam. MBO management measures are not outlined in the BMP because MBO was identified in September 2020 during a preliminary investigation by Boyds Bay Environmental Services (BBES), after the BMP was written. The dam infilling methodology in BMP Section 2.3.2.7 involves slowly filling the dam without dewatering. If this methodology is adhered to, downstream water quality will likely be impacted past acceptable limits because, even if fill is placed into the dam very slowly, it will disturb the MBO which will increase

[1] All maps and figures in this Plan are schematics only.

downstream turbidity and oxidise, leading to gradual acidification and a rapid decrease of dissolved oxygen downstream.[2]

Appropriate MBO management requires a significant amendment to the farm dam infilling methodology that is described in Section 2.3.2.7 of the BMP. This plan proposes a revised dam infilling methodology that adequately manages environmental risks posed by MBO. The revised methodology proposed by this plan is in line with the overarching approach described by the BMP – the infilling process involves aquatic fauna salvage, includes measures to mitigate surface water quality, and includes an infilling operation. The revised methodology consists of the following nine (9) steps:

1. Conduct a threatened frog survey,
2. Install instream sediment controls,
3. Remove floating vegetation on the dam surface,
4. Deploy fyke nets, further classify MBO, and construct an access track,
5. Construct a cofferdam and pump outlet,
6. Dewater while capturing and relocating aquatic fauna,
7. Manage MBO,
8. Infill the dam, and
9. Decommission sediment controls.

Sections 2, 3, and 4 describe the investigation and consultation process that was undertaken to arrive at the revised dam infilling methodology. Key personnel responsible for implementing this plan are presented in Section 5, individual steps of the infilling process are detailed in Section 6. Risk-assessed measures to mitigate environmental harm are described in a series of Environmental Management Plans (EMPs) in Section 8. Section 7 includes the procedures to ensure works are conducted in accordance with the abovementioned Sections and documented. This document is intended to be an addendum to the BMP and will supersede BMP Section 2.3.2.7 upon approval.

[2] As per (Burton 2019) and (Sullivan, et al. 2018), MBO consists of extremely fine particles that resuspend in water upon the slightest disturbance leading to an increase in turbidity, rapid deoxygenation, and slower, subsequent acidification.

2 Preliminary Investigation and Site Visit Summary

Tweed Shire Council Local Environment Plan 2014 Acid Sulfate Soils mapping classifies most of the Lot as a Class 5 acid sulfate soil area suggesting acid sulfate soils are unlikely. However, drainage channels in coastal landscapes tend to accumulate MBO (Burton 2019) so BBES conducted a brief investigation in September 2020 to determine whether MBO is present and to understand dam hydrology and bathymetry.

The investigation consisted of sampling the base of the dam with a hand auger at three locations and gauging water depth and bathymetry with a depth gauge staff. Three samples were collected and sent to Mazlab laboratory for analysis with the reducible chromium sulfur suite. Field parameters (pH, turbidity, and dissolved oxygen) were measured with a Horiba U-52 water quality monitor within the seasonal flowline and farm dam[3]. Map 2 indicates approximate sampling and testing locations.

Map 2 – Sampling and Testing Locations

Note: Samples were collected and field parameters were measured in locations 1, 2, and 3. Field parameters were measured in locations 4 and 5 but no samples were collected at these locations.

A site visit was conducted by Dmitri Medvedko, Environmental Scientist and Matthew Birch, Aquatic Ecologist on 17 February 2020 to refine dam infilling methodology and identify areas for cofferdam and access track construction. Field parameters were measured in locations 2 and 3 and additional measurements were taken in the same locations after disturbing benthic material.

[3] Water testing was undertaken in accordance with (Water Quality Investigation, Department of Environment and Science 2009), sediment testing was undertaken based on the guidance in (Burton 2019).

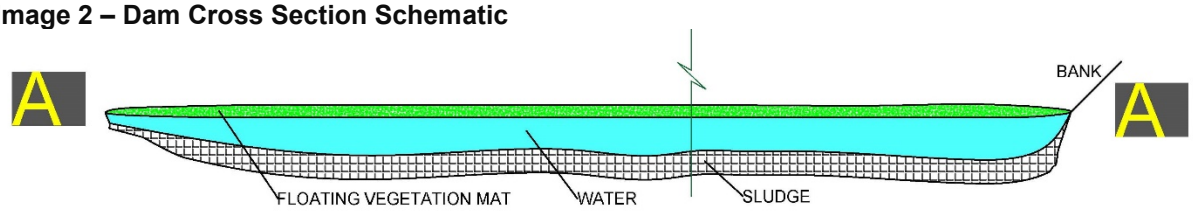
3 Preliminary Investigation and Site Visit Results

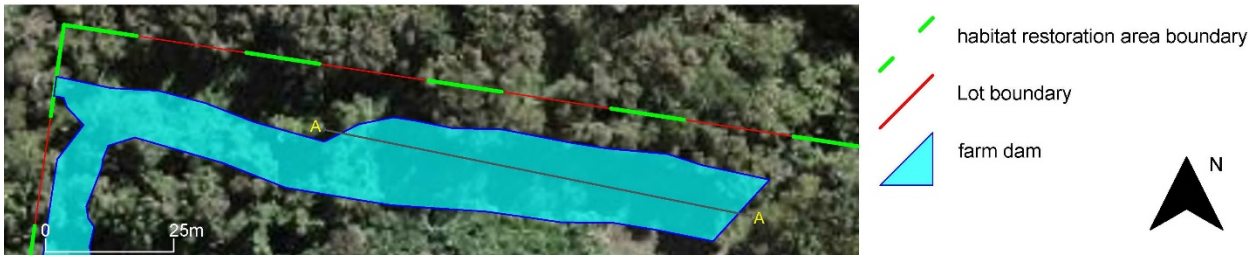
The surface of the dam and the seasonal flowline is infested by *Salvinia spp.* (Salvinia). Most of dam contains a thick floating mat of vegetation consisting of *Salvinia spp.* (Salvinia) and invasive pasture grasses such as *Setaria sphacelata* (Setaria) and *Paspalum mandiocanum* (Broad-leaved paspalum). Image 1, taken from the southern bank of the dam facing sampling location 1 outlines the floating mat of vegetation in black.

Image 1 – Floating Mat of Vegetation in the Dam

The investigation found that water depth varies. The deepest portion is in the east of the dam and is approximately 2m deep. The shallowest portion is approximately 1.5m deep and is in the west. The dam floor consisted of decomposing vegetation and sludge approximately 1m deep. Image 2 provides a cross section of the dam.

Image 2 – Dam Cross Section Schematic





Field measurements (pH, dissolved oxygen, and turbidity) during the preliminary investigation indicated water in the dam is slightly acidic and below the minimum value stipulated by relevant guidelines[4] with pH measurements ranging from 6.2 – 6.3. Water in the dam also had very low dissolved oxygen (DO) with all measured concentrations at or below 1mg/L[5]. Field measurements in the downstream and upstream locations indicated water quality within the flowline is comparable to water quality in the dam, flowline water quality is slightly acidic and dissolved oxygen concentrations are at or below 1mg/L. Turbidity was below the relevant maximum[6] and did not exceed 45NTU.

Laboratory results confirmed the presence of MBO – all samples had relatively high percent sulfur composition and high actual acidity. Sample 3 contained moderate amounts of shells. Shells have a buffering effect[7] so sludge from the area represented by sample 3 is likely to be more acidic than indicated by laboratory results.

Field measurements taken during the site visit were generally consistent with the measurements taken during the initial investigation. After significant rainfall, pH in the flowline and in the dam increased to 7.23 and 7.35 in locations 2 and 3, respectively. Dissolved oxygen concentrations did not exceed 1.5mg/L. Additional measurements during the site visit were taken after moderately disturbing benthic material. After benthic material was disturbed, dissolved oxygen decreased from ~1 to 0.2mg/L and pH remained stable, consistent with the described effect of MBOs on water quality (Burton 2019). Turbidity increased significantly after benthic material was disturbed. Turbidity in location 2 increased from 20.5

[4] (Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Coundil of Australia and New Zealand 2000) stipulates pH should be between 6.5 – 7 in lowland NSW rivers.
[5] (Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Coundil of Australia and New Zealand 2000) stipulates 85% oxygen saturation is the lower limit for a lowland river in NSW which converts to 6mg/L at standard temperature and pressure
[6] (Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Coundil of Australia and New Zealand 2000) stipulates turbidity should be below 50NTU in lowland rivers.
[7] See ASS tip 17: self-neutralising soils (Dear, et al. 2014)

to 128NTU and from 12 to 230NTU in location 3. Laboratory results and field measurements are included in Attachment 1.

The site visit indicated that Vegetation Management Zone (VMZ) 1.4, the area that was cleared of *Pennisetum purpureum* (Barner grass) during the implementation of the Stage 1 Biodiversity Management Plan (Greencap 2019), is not exhibiting significant native recruitment. Dominant re-emerging species include *Pennisetum purpureum* (Barner grass), *Setaria sphacelata* (Setaria), and *Paspalum mandiocanum* (Broad-leaved paspalum). Portions of the VMZ immediately west of the dam contain a vine curtain of *Kennedia rubicunda* (Red Kennedy Pea) and *Macaranga tanarius* (Macaranga) seedlings.

4 Preliminary Investigation and Site Visit Conclusions

Although the preliminary dam investigation and site visit were not sufficient for a detailed classification of benthic material and water quality, results provided sufficient information to conclude that:

1. Dam water quality is comparable with downstream water quality, therefore transferring dam water downstream will not negatively impact downstream water quality.
2. The *Salvinia spp.* infestation of the dam and flowline led to a cycle of deteriorating water quality and MBO formation. *Salvinia spp.* prevents light from entering the water and uses up available dissolved oxygen. Lack of oxygen and rotting vegetation that sinks to the bottom of the dam contributes to the cycle of MBO formation.
3. The dam floor contains MBO which easily resuspends at the slightest disturbance, increases turbidity past relevant thresholds, and further deoxidises water. Therefore, the dam must be segregated from downstream water prior to infilling works so that there are no downstream impacts from MBO.
4. VMZ 1.4 is not exhibiting significant native recruitment. The two native species observed in the VMZ are pioneer species and do not present an increase of ecological values to the area. Therefore, land disturbance prior to reconstruction planting in VMZ 1.4 for the construction of an access track and other activities related to dam infilling will not impact the progress of restoration works.

5 Plan Implementation

Boyds Bay Group (BBG) will be implementing the Stage 2 Biodiversity Management Plan and reporting to Lendlease Building Pty Ltd (Lendlease), the principal contractor for the TVH project. Contact details of parties responsible for the implementation of this plan[8] are listed in Table 1.

Table 1 – Contact Details

Role	Name	Contact Information
Project Supervisor	Geoffrey Barrow	geoffrey.barrow@lendlease.com
Project Engineer	Geoffrey Lobdell	0450 095 648
Boyds Bay Group Director	Greg Fraser	0417 023 303
Boyds Bay Group Supervisor	Peter Sherrington	0427 439 752
Environmental Scientist	Dmitri Medvedko	0429 990 089
Aquatic Ecologist	Matthew Birch	0410 470 204
Ecologist	Jono Hooper	0418 779 791
Geotechnical Engineer	Peter Elkington	0407 425 090
Senior Restoration Foreman	Bo Walton	0447 060 069
Restoration Foreman	Matthew Partridge	0428 409 791

All personnel are responsible to adhere with relevant policies and approved plans including but not limited to Lendlease's environmental and safety policies and the environmental and safety policies of Boyds Bay Group. Responsibilities are detailed further in the following sections.

5.1 Project Supervisor

The Project Supervisor is responsible for the overall construction of the Tweed Valley Hospital.

5.2 Project Engineer

The Project engineer is responsible for liaising with BBG personnel and contractors to ensure the best safety and environmental outcomes are achieved throughout the implementation of the BMP.

5.3 Boyds Bay Group Director and Supervisor

Boyds Bay Group Director and Supervisor are responsible for the overall implementation of the BMP in a safe and environmentally friendly way. Their roles include coordinating subcontractors and liaising with Lendlease.

5.4 Environmental Scientist

The Environmental Scientist is responsible for the overall implementation of this plan and the environmental performance of the farm dam infilling. The Environmental Scientist is responsible for

[8] It is understood other personnel such as safety officers and plant operators will be involved in the infilling operation. The personnel listed in Table 1 are personnel responsible for the environmental performance of the dam infilling operation.

implementing the environmental controls listed in Section 8 and for liaising with Lendlease as listed in Section 7.

5.5 Aquatic Ecologist

The Aquatic ecologist is responsible for the aquatic fauna salvage effort and for communicating the results of the salvage to the Environmental Scientist.

5.6 Ecologist

The ecologist is responsible for undertaking the nocturnal frog survey and for communicating the results of the frog survey to the Environmental Scientist.

5.7 Geotechnical Engineer

The geotechnical engineer is responsible for monitoring and advising on cofferdam construction.

5.8 Senior Restoration Foreman and Restoration Foreman

The restoration foremen are responsible for ensuring the ecological performance of the restoration areas nominated by the BMP meet the criteria set by the BMP.

6 Dam Infilling Methodology

Several parties assisted in composing the dam infilling methodology. Matthew Birch, owner of Aquatic Science and Management Pty Ltd, an aquatic ecologist and dewatering specialist with fifteen (15) years of experience, conducted a site visit on 17 February 2021 and assisted in composing the overarching strategy and providing aquatic fauna management measures. Graham Lancaster, manager of the Environmental Analysis Laboratory at Southern Cross University, Lismore, an expert in acid sulfate soil and monosulfidic black ooze classification, testing, and management, provided advise on testing and managing monosulfidic black ooze. Peter Elkington, owner of Pacific Geotech and a geotechnical engineer with over twenty (20) years of experience, assisted with cofferdam design.

Table 2 includes the general timeline of dam infilling. Task 1, the threatened frog survey, is not included because it must be undertaken at least one week before dam infilling so that relevant survey results are incorporated into fauna management measures as described in Section 7.

Table 2 – Infilling Program

Task	Day														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2. *Install instream sediment controls.*															
3. *Remove floating vegetation on the dam surface.*															
4. *Deploy fyke nets, further classify MBO, and construct an access track.*															
5. *Construct a cofferdam and pump outlet.*															
6. *Dewater while capturing and relocating aquatic fauna.*															
7. *Manage MBO*															
8. *Infill the dam and decommission the pump outlet.*															
9. *Decommission sediment controls.*															

Details of the dam infilling process are provided in the following sections.

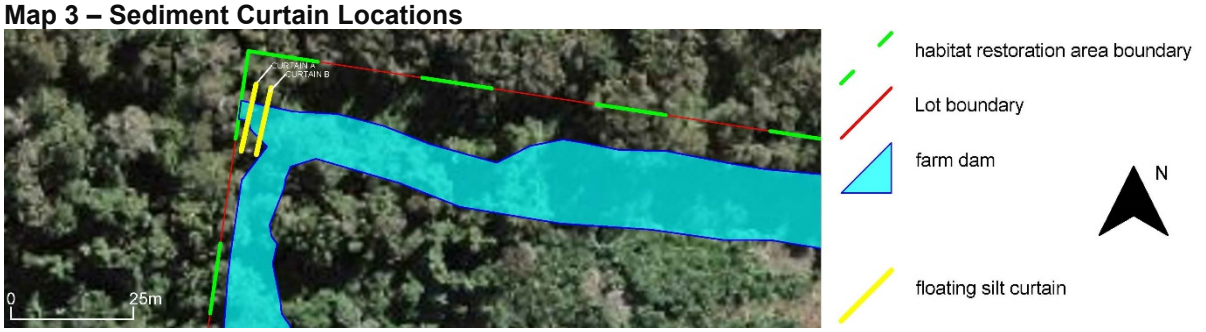
6.1 Conduct a threatened frog survey

A nocturnal frog survey will be conducted on a rainy night to determine the presence of native frogs within and around the dam infilling footprint. Survey results will be documented and implemented in accordance with the procedures described in Section 7.

6.2 Install instream sediment controls

Two floating sediment curtains will be placed in the locations indicated in Map 3.

Map 3 – Sediment Curtain Locations



Sediment curtains will be installed in accordance with the International Erosion and Sediment Control Association (IECA) Australia standard drawings FSC-01, FSC-02, and FSC-03, included in Attachment 2. Curtains will be placed at least 10m apart to accommodate cofferdam construction. If deemed necessary by any of the parties listed in Table 1, curtain B can be removed after successful cofferdam installation. Curtain A will remain in place until decommissioning (Step 9).

6.3 Remove floating vegetation on the dam surface

Once instream sediment controls are installed, floating vegetation will be removed from the dam surface with an excavator bucket. Vegetation that cannot be removed with an excavator bucket will be removed by hand using nets, buckets, and a boat. Removed vegetation can be spread over areas of VMZ 1.4 that are not exhibiting significant native recruitment under the supervision of the restoration foreman as stipulated by Section 7.

6.4 Deploy fyke nets, further classify MBO, and construct an access track.

Once the dam surface is clear of vegetation, several fyke nets (cylindrical fish traps) will be deployed over a series of three nights, or as determined by the aquatic ecologist. A fyke net will be deployed between the sediment curtains to capture any aquatic fauna prior to cofferdam construction. Results of fish trapping will be documented in accordance with Section 7.

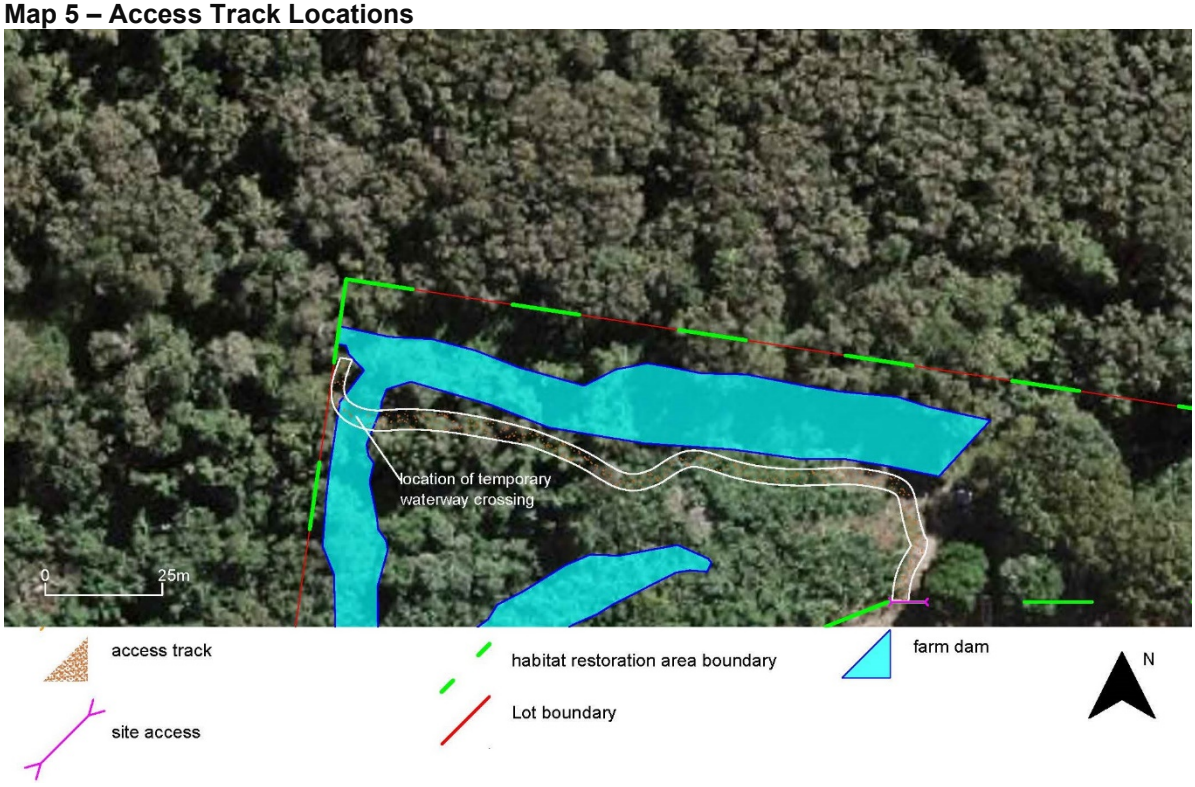
During fyke net deployment, at least four MBO samples will be taken at the approximate locations indicated by Map 4 with at least one sample taken from within the cofferdam alignment. If possible, groundwater depth will be determined from existing investigation results and the groundwater well near the farm dam. Samples will be analysed at a NATA accredited laboratory for acid volatile sulfur and via the reducible chromium sulfur suite. The sample representative of sediment in the cofferdam alignment will be analysed for nutrients and metals in accordance with (Burton 2019).

Map 4 – Additional Sample Locations

MBO sample analysis results and groundwater table height will determine MBO management options, as described in Section 6.7.

During fyke net deployment, an access track will be constructed in the approximate location indicated by Map 5. The site visit concluded that VMZ 1.4 is not exhibiting significant native recruitment and the areas in Map 4 are indicative of locations with significant invasive pasture grass infestation. Access track alignment will be approved by the restoration foreman, in accordance with Section 7. A temporary waterway crossing will be constructed in the location indicated in Map 5 in accordance with the general methodology included in Attachment 3.

Map 5 – Access Track Locations



6.5 Construct a cofferdam and pump outlet

After construction of the access track, a cofferdam will be constructed between sediment curtains A and B. The cofferdam will be constructed in accordance with the methodology provided in correspondence

by the geotechnical engineer included in Attachment 4 and reproduced in italics below. Commentary around the methodology is included in regular font.

It is understood that a stockpile of the natural high plasticity silty clays is available for the construction of the bund. This material is generally suitable for use for a temporary bund provided it is nomically compacted. A nominal bund width of approximately 0.5-1m at the crest and side wall batters in the order of 1-1.5H:1V could be adopted.

Approximately 165m^3 of red clay, typical of the Cudgen soil landscape should be sufficient for dam construction. A Cudgen soil profile report is available in Attachment 5.

The following construction sequence is suggested, subject to confirmation on-site at the time of the works:

1. *The unsuitable material (sludge) on the alignment of the bund should be removed from the base of the dam.*

A maximum of 95m^3 of unsuitable material is expected to be generated during cofferdam construction. Results of MBO testing will determine the best management measure for this material. MBO may be low, medium, or high risk. Low risk MBO is still an environmental hazard but has relatively low levels of Acid Volatile Sulfur (AVS) and therefore can be managed through neutralisation, mixing, or spreading. Medium risk MBO is MBO that has a higher level of acid volatile sulfur and therefore cannot be managed through spreading or mixing but can still be neutralised with aglime[9]. High risk MBO has extremely high AVS levels and cannot be exposed to oxygen without significant risk.

There are three management options depending on the risk rating of the MBO in the cofferdam alignment. Option A involves spreading the unsuitable material over an area that does not have significant ecological value[10] as determined by the bush restoration foreman. Option B is the same as option A except the material will be mixed with lime during transport and placement. Option C involves constructing a treatment area, neutralising, validating the MBO, and incorporating the neutralised and validated material as fill. Table 3 outlines management measures for excavated unsuitable material.

Table 3 - Management of material excavated during cofferdam construction

MBO Risk	Management Options
Low	A
Medium	B
High	C

The process surrounding MBO classification and results communication is outlined in Section 7.

2. *The clay material should be placed into the dam to commence the construction of the bund. The material should be compacted during its placement. This compaction may be achieved through the use of a pin-wheel or other suitable compaction equipment.*

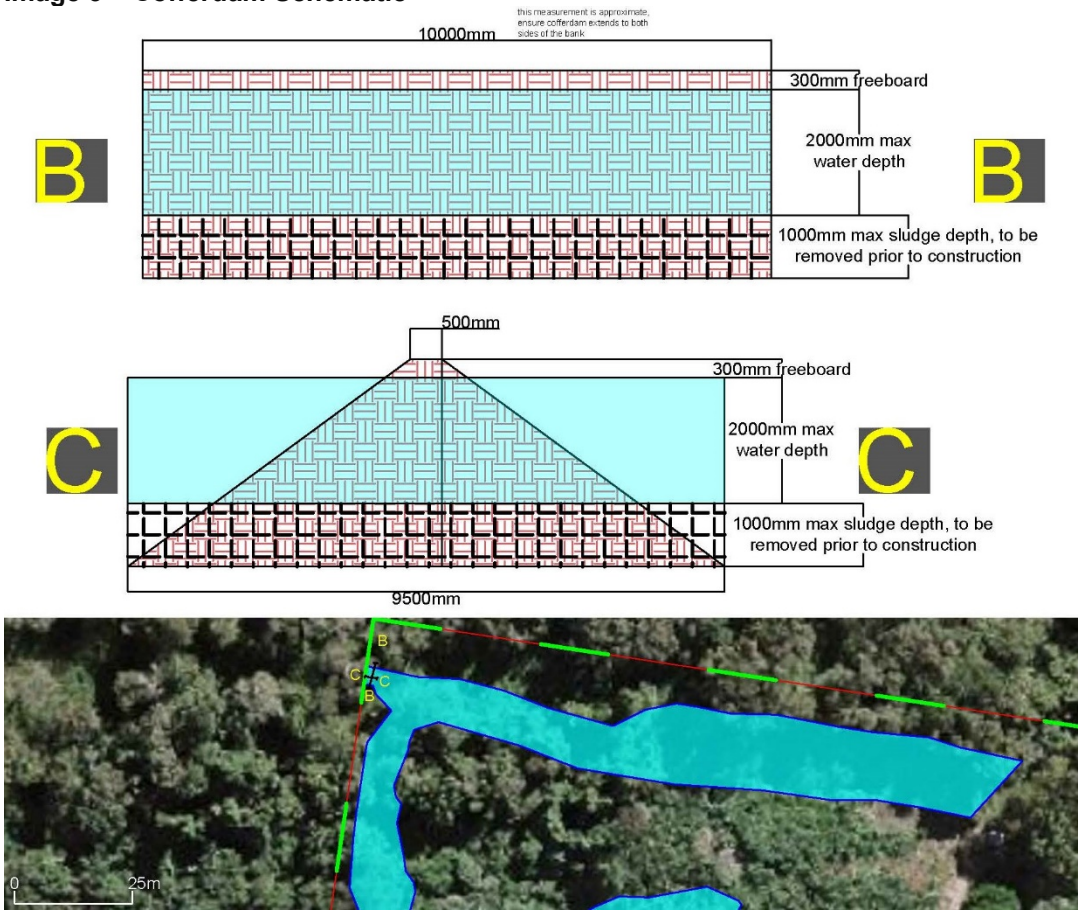
[9] The definition of aglime is in accordance with (Dear, et al. 2014), see ASS tip 11
[10] It is expected unsuitable material will be spread in areas that will be subject to reconstruction planting.

3. *The initial layer of clay should be placed at a maximum thickness in the order of 1m. If the initial layer at this thickness is unable to be compacted, consideration should be given to increasing the dimensions of the bund to allow for the poorly compacted clay material. The extent of the bund width increase will be dependent on the material performance and the degree of compaction that is able to be achieved and should be assessed by Pacific Geotech at the time.*

4. *Following the placement of the bund, confirmation of its suitability should be made by Pacific Geotech prior to the commencement of the dewatering operation.*

The cofferdam should be generally constructed in accordance with the schematic in Image 3.

Image 3 – Cofferdam Schematic



The cofferdam will be constructed under the supervision of Pacific Geotech and amendments to cofferdam construction will be made in accordance with Section 7.

Before, after, or during cofferdam construction, a pump outlet will be constructed. The pump outlet will be a small basin approximately 1-2m off the flowline bank, 1.5m wide by 1.5 long, 0.5m deep, filled with 150-300mm rock, and lined with geomatting or plastic, whichever is available. A chute with rock checks, lined with and geomatting or plastic will be constructed from the small basin to the flowline. The overarching purpose of the pump outlet is to dissipate concentrated flow to prevent erosion and to oxygenate water prior to discharge into the flowline. Amendments to pump outlet design and documentation of pump outlet construction will be made in accordance with Section 7.

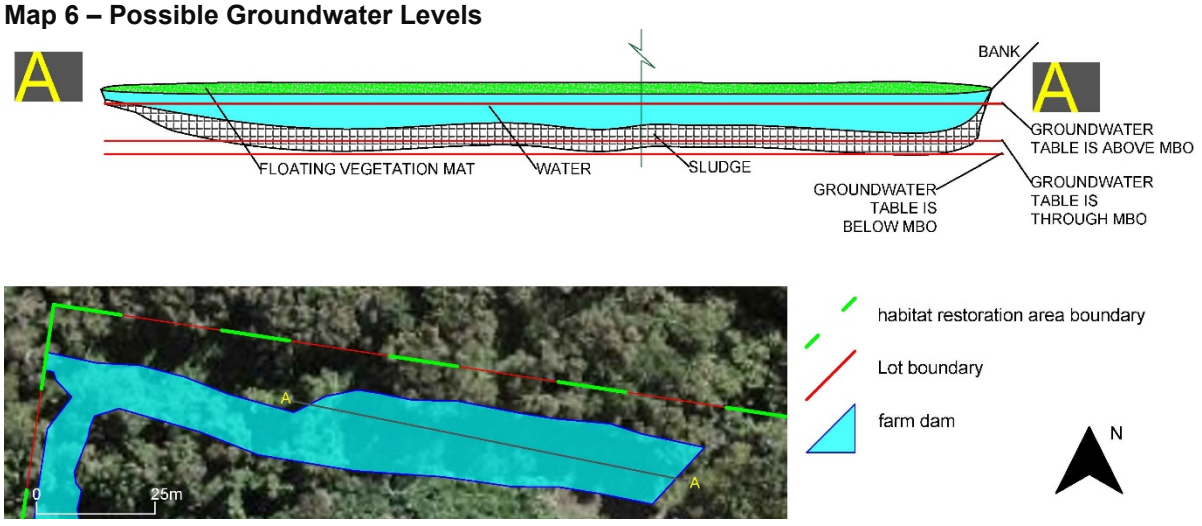
6.6 Dewater while capturing and relocating aquatic fauna,

After the pump outlet and cofferdam are constructed, dewatering will commence. Measures to protect aquatic fauna by stabilising the pump inlet, spill protection measures, and measures to protect surface water quality are described in Section 8. Generally, the pump inlet is expected to move several times throughout dewatering into local low points as water levels subside and local low points become apparent. If appropriate, a sump will be constructed to assist in aquatic fauna relocation, provided the construction of the sump does not have unacceptable consequences to downstream water quality. Aquatic fauna is expected to be captured with a combination of techniques including but not limited to seine nets, electrofishing, and hand nets. Captured aquatic fauna will be relocated to a suitable location as determined by the aquatic ecologist.

6.7 Manage MBO

Results of additional sampling will classify MBO (see Section for 6.5 for definitions of low, medium, and high risk MBOs) and identify the level of the standing groundwater table. The standing groundwater table may be above the level of MBO, thereby providing an anaerobic environment to the MBO after filling, groundwater may be below the MBO, in which case the MBO will be exposed to some oxygen after filling and may acidify groundwater, or the groundwater may be in the middle of the MBO layer in which case parts of the MBO will be in the groundwater while parts will be above after the dam is filled. Map 6 provides a schematic of possible groundwater levels.

Map 6 – Possible Groundwater Levels



There are two management options depending on the results of the investigation. Option A involves dewatering the dam, placing a layer of aglime on top of the MBO, and proceeding with the infilling operation. Option B involves stopping dewatering before high risk MBO is exposed, placing lime into the water that is covering the MBO and proceeding with the infilling operation. Table 4 outlines what combination of results would lead to management options A or B.

Table 4 – MBO Management Options

MBO Risk	Groundwater Level		
	Below	Above	Through
Low	Option A	Option A	Option A
Medium	Option B	Option A	Option A
High	Option B	Option A	Option B

It is considered unlikely that the water table is beneath the level of MBO. Based on literature on MBO formation, the groundwater table is likely above the MBO and Option A, the preferred option, will be chosen. This management measure is consistent with avoidance and strategic reburial strategies described in both (Dear, et al. 2014) and (Sullivan, et al. 2018). Test results vary significantly, a combination of management options may be chosen. Communication and documentation of MBO management options is described in Section 7.

6.8 Infill the dam

After the conclusion of the aquatic fauna salvage effort, the dam will be filled in to meet the surrounding natural ground level, as determined by the bush regeneration foreman. Dam filling does not have to proceed in any specific direction but must be conducted in a way that minimally disturbs MBO. The plant operator and environmental scientist must work together to achieve the best possible filling sequence. A topsoil layer approximately 300mm thick will be spread above the final fill level. It is understood fill will consist of material that is currently stockpiled as part of the TVH development.

6.9 Decommission sediment controls

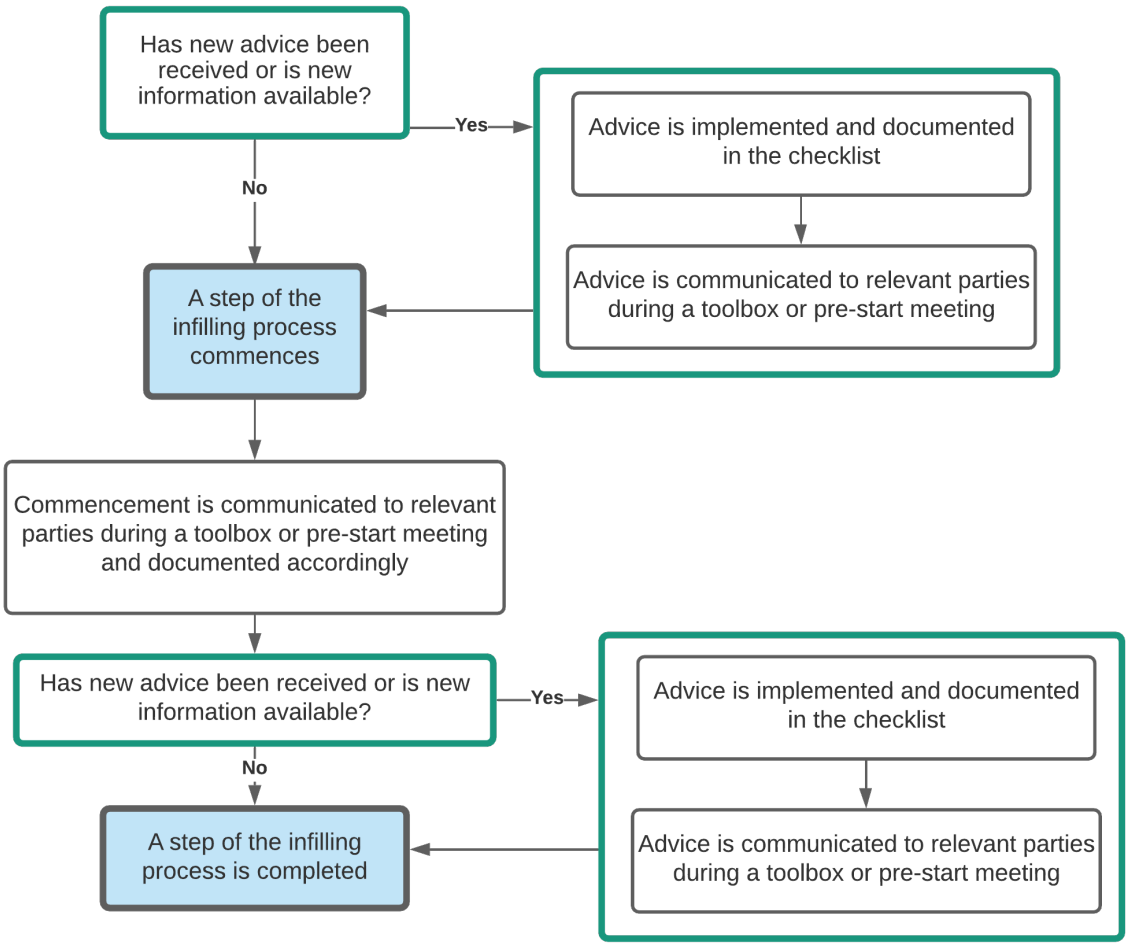
After cessation of dam infill the sediment curtain and pump outlet will be decommissioned. Rock used for the pump outlet may be incorporated into landscaping of VMZ 1.4, including the newly filled dam. Plastic will be disposed as general waste. The access track will be incorporated into restoration planting as per the approved methodology.

7 Adaptive Management Measures and Documentation

Overall progress of dam infilling will be documented with the Dam Infilling Checklist (the Checklist), provided in Attachment 6. The purpose of the Checklist and associated documents is to ensure that advice from relevant parties is considered and communicated to all relevant parties. The threatened frog survey, fyke net trapping, and, most importantly, the MBO investigation will provide information that will determine management options. In the case of MBO management, information gathered during Step 4 (Section 6.4) will allow the selection of the most appropriate MBO management option from the several possibilities that are listed in Section 6.5 and 6.7. The Checklist and associated documents will specify which management option is selected and document the associated decision-making process.

The overarching process of managing and documenting advise and information, including additional relevant information outside the immediate scope of the Checklist, in provided in Flowchart 1.

Flowchart 1 – Managing and documenting advise and information



The Checklist and associated documents listed in the “Reference / Decision tree / Signature” column will be provided to the Project Engineer and / or nominated representative weekly by Friday 5pm AEST.

This package will be known as the Dam Infilling Environmental Progress Submission (the Submission). Most of the associated documents included in the Submission will be pre-start meetings that break down tasks into specific steps and explain the reasoning behind the steps considering information presented in this plan or considering additional information or advise gathered throughout the dam infilling process. Other associated documents may include correspondence from relevant parties such as the geotechnical engineer, laboratory results, and records of toolbox talks. Weekly Submissions will ensure all relevant parties understand the current stage of the dam infilling process.

The Checklist also includes several hold points. Table 5 presents the hold points listed in the Checklist.

Table 5 - Hold Points

Hold Point Number	Hold Point Description	Responsible Party for Hold Point Release
1.	Threatened frog survey results are communicated to the Environmental Scientist and adequate management measures are implemented	Ecologist
2.	Sediment controls are installed	Environmental Scientist
3.	Floating mat of vegetation is placed in an appropriate location	Senior Bush Regeneration Foreman
4.	Access track is constructed in an appropriate location	Senior Bush Regeneration Foreman
5.	MBO management is refined based on results of further MBO classification and results of fyke net trapping. Management measures are presented in a toolbox.	Environmental Scientist
6.	Cofferdam is adequately constructed	Geotechnical Engineer
7.	Dewatering pump outlet is adequately constructed	Environmental Scientist

Failures to document the dam infilling process, including a failure to provide a Submission, will be managed as an incident. Incident management processes are described in the Environmental, Health, and Safety (EHS) Plan (Boyds Bay Group 2021).

8 Environmental Management Plans

Erosion and sediment control, flora and fauna, water quality, monosulfidic black ooze, and contaminated land are the five environmental elements relevant to farm dam infilling. The following sections provide risk-assessed management measures of the various Project-relevant environmental elements. Tables 6, 7 and 8 define impact significance, risk probability categories, and risk levels.

Table 6 – Impact Significance and Definitions

Impact Significance	Definition
Very High	These impacts are considered critical to the decision-making process. They tend to be permanent, or irreversible, or otherwise long term, and/or can occur over large-scale areas. Environmental receptors are extremely sensitive, and the impacts are of national significance.
High	These impacts are likely to be of importance in the decision-making process. They tend to be permanent, or otherwise long to medium term, and/or can even occur over large or medium scale areas. Environmental receptors are high to moderately sensitive, and/or the impacts are of state significance.
Moderate	These impacts are relevant to decision making, particularly for determination of environmental management requirements. These impacts tend to range from long to short term, and/or occur over medium scale areas or focused within a localised area. Environmental receptors are moderately sensitive, and/or the impacts are of regional or local significance.
Minor	These impacts are recognisable, but acceptable within the decision-making process. They are still important in the determination of environmental management requirements. These impacts tend to be short term, or temporary and at the local scale.
Negligible	Minimal change to the existing situation, this could include for example impacts which are beneath levels of detection, impacts that are within the normal bounds of variation, or impacts that are within the margin of forecasting error.
Beneficial	The project results in an improvement in the baseline situation, for example, improved downstream water quality

Table 7 – Likelihood of Impacts and Risk Probability Categories

Likelihood of Impacts	Risk Probability Categories
Highly Unlikely	May occur only in exceptional circumstances – can be assumed not to occur during period of the project (Probability <10%)
Unlikely	Event is unlikely to occur, but it is possible during period of the project (Probability 10 – 30%)
Possible	Event could occur during period of the project (Probability 30 – 70%)
Likely	Event likely to occur once or more during period of the project (Probability 70 – 90%)
Almost Certain	Very likely to occur because of the proposed project construction and/or operations; could occur multiple times during relevant impacting period (Probability >90%)

Table 8 – Risk Levels

			Impact Significance (consequence)				
			1 Negligible	2 Minor	3 Moderate	4 High	5 Very High
Likelihood	A	Highly Unlikely	Very low	Very low	Low	Low	Medium
	B	Unlikely	Very low	Low	Low	Medium	Medium
	C	Possible	Low	Low	Medium	Medium	High
	D	Likely	Low	Medium	Medium	High	Very High
	E	Almost Certain	Low	Medium	High	High	Very High

Inspections, documentation, and management of non-conformances and incidents will be conducted in accordance with the process described in the EHS Plan (Boyds Bay Group 2021).

8.1 Erosion and Sediment Control

Erosion and sediment control is relevant during cofferdam construction and during dewatering. The Project objective in relation to erosion and sediment control is to implement best practice sediment and erosion control measures throughout. Project performance indicators are:

- No release of sediment from site, and
- No evidence of uncontrolled erosion.

Map 3 indicates the location of sediment curtains, Section 6.5 describes outlet construction, and Attachment 2 contains sediment curtain specifications. Table 9 contains risk-assessed erosion and sediment management measures.

Table 9 – Erosion and Sediment Control Risk Assessment

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
Access Track and Cofferdam construction	Sediment deposition in waterways, environmentally sensitive areas, or in public areas adjacent to the Site	E3 HIGH	Establishment and maintenance of erosion and sediment controls as per Section 6.2, Attachment 2, and Attachment 3. Measurement of water quality as described in Section 8.3 The Environmental Scientist is to visually inspect the floating sediment curtain daily and record any contingency measures, if any, in the Checklist as additional information.	Throughout the project	B3 LOW	BBG Supervisor and Environmental Scientist	Checklist and associated documents
Dewatering	Scouring at the outlet leads to erosion and deposition of sediment into waterways	D2 MEDIUM	The outlet will be installed as described in Section 6.5 and documented in accordance with Section 7.	During installation of the dewatering system and throughout dewatering	B2 LOW	BBG Supervisor, Environmental Scientist, and	Checklist and associated documents

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
			Water quality will be monitored as described in Section 8.3. The outlet will be monitored during commencement and throughout the dewatering operation to ensure it is functioning properly. Dewatering will cease and the outlet will be reconfigured if scouring occurs.			Aquatic Ecologist	
	Deposition of sediment in the waterway occurs because sediment is sucked through the inlet.	E3 HIGH	The dewatering pump inlet will be placed on a float so that the inlet does not touch the bottom. The inlet will be configured as described in Section 8.2 to further mitigate any potential for the inlet to touch the bottom and suck in sediment. The inlet will be monitored during commencement and throughout the dewatering operation to ensure the inlet does not touch the bottom.	During installation of the dewatering system and throughout dewatering	B3 LOW	BBG Supervisor, Environmental Scientist, and Aquatic Ecologist	Checklist and associated documents

8.2 Flora and Fauna

The Project objective in relation to flora and fauna is to appropriately manage construction activities to minimise impact on flora and fauna. Project performance indicators are:

- No harm to native fauna,
- No harm to threatened species or communities, and
- As little harm to native aquatic fauna as possible.

The project is not expected to impact any significant vegetation. The access track will be constructed on previously disturbed areas that are currently dominated by invasive grasses. Vegetation that will be removed from the dam and the unsuitable material that will be generated during cofferdam construction will be placed in areas that have been previously disturbed as well. Dam infilling works are not expected to impact vegetation on the northern side of the farm dam. Table 10 contains risk-assessed flora and fauna management measures.

Table 10 – Flora and Fauna Risk Assessment

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
All	Native frogs are impacted with dam infilling	C3 MEDIUM	An ecologist conducts a frog survey and provides the environmental scientist with survey results and relevant management measures. Management measures are implemented in accordance with Section 7	Before project commencement	A3 LOW	Ecologist, Environmental Scientist	Survey report, Checklist and associated documents
Access track construction	Valuable regenerating native bushland is harmed	C3 MEDIUM	The alignment of the access track is in general accordance with the location described in Map 5. The restoration foreman supervises access track construction to ensure no valuable regenerating bushland is harmed.	During access track construction	A3 LOW	Environmental Scientist	Checklist and associated documents.
Cofferdam construction	Native aquatic fauna is harmed	C3 MEDIUM	Fyke nets trap native fauna within the alignment. If the area exhibits a significant abundance of native aquatic fauna, seine nets or electrofishing is used to capture aquatic fauna within the cofferdam alignment. Water quality will be monitored in the dam during cofferdam construction to ensure dissolved oxygen levels are comparable to baseline conditions. Cofferdam construction will cease if the aquatic ecologist	Before and during cofferdam construction	A3 LOW	Aquatic Ecologist, Environmental Scientist	Aquatic Fauna Salvage Report, Checklist and associated documents

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
			determines water quality measurements have decreased past acceptable limits.				
	Valuable regenerating native bushland is harmed during placement of unsuitable material	C3 MEDIUM	The restoration foreman supervises placement of the spoil to ensure the spoil is placed in areas with no native vegetation.	During cofferdam construction	B3 LOW	Environmental Scientist, Restoration foreman, Plant Operator	Checklist and associated documents
	Unsuitable material harms native bushland	D3 MEDIUM	The results of the investigation (see Section 6.4 for details of the investigation) determine the management measures for the material (see Section 6.5 for material management options).	During cofferdam construction	A3 LOW	Environmental Scientist, Plant Operator	Checklist and associated documents
Removal of floating vegetation mat	Valuable regenerating native bushland is harmed during placement of floating vegetation	C3 MEDIUM	The restoration foreman supervises placement of floating vegetation to ensure the vegetation is placed in areas with no significant native vegetation.	During vegetation removal	A3 LOW	Environmental Scientist, Restoration Foreman, Plant Operator	Checklist and associated documents
Dewatering	Native Aquatic fauna is harmed by passing through the dewatering system	E3 HIGH	A fish gate is installed at the pump inlet. A fish gate is a device that prevents fish from entering the pump inlet while allowing water to pass through. The pump inlet is monitored throughout dewatering to ensure the fish gate is functioning properly.	During dewatering system installation and throughout dewatering	B3 LOW	Aquatic ecologist, Environmental Scientist	Aquatic Fauna Salvage Report, Checklist and associated documents
	Native Aquatic fauna perishes due to poor water quality in the dam.	E3 HIGH	An aquatic fauna salvage effort captures and relocates most native aquatic fauna before water quality deteriorates	During dewatering	B3 LOW	Aquatic ecologist, Environmental Scientist	Aquatic Fauna Salvage Report, Checklist and associated documents

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
	Native aquatic fauna perishes due to poor water quality downstream	E3 HIGH	The outlet and inlet are monitored throughout the dewatering process to ensure no erosion occurs and to ensure no sediment from the base of the dam is transferred downstream. If erosion or transfer of sediment from the base of the dam becomes apparent, the dewatering operation will cease and the dewatering setup will be reconfigured accordingly. Water quality is monitored in accordance with Section 8.3	During dewatering	B3 LOW	Aquatic ecologist, Environmental Scientist	Aquatic Fauna Salvage Report, Checklist and associated documents
Dam infill	Native aquatic fauna perishes due to loss of habitat	E3 HIGH	An aquatic fauna salvage effort captures and relocates most native aquatic fauna into acceptable habitat.	During dewatering	B3 LOW	Aquatic ecologist, Environmental Scientist	Aquatic Fauna Salvage Report, Checklist and associated documents

8.3 Water Quality

The Project objective in relation to water quality is to have no long- or short-term impacts to ground or downstream surface water. Project performance indicators are:

- No deterioration of downstream water quality,
- No spills, and
- No deterioration of groundwater quality.

Table 11 contains risk-assessed water quality management measures.

Table 11 – Water Quality Risk Assessment

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
Access Track and Cofferdam construction	Downstream water quality is negatively impacted by cofferdam construction	C3 MEDIUM	Establishment and maintenance of erosion and sediment controls as per Section 6.2, Attachment 2, and Attachment 3. Baseline water quality measurements will be taken in location 4, downstream of the dam, prior to cofferdam construction. Water quality will be monitored in location 4 during cofferdam construction. If pH, dissolved oxygen, or turbidity changes at location 4 by 10% of the baseline and if that change is outside relevant guidelines[11], cofferdam construction will cease until water quality reverts to baseline conditions or meets relevant guidelines. In other words, baseline water quality is quite poor and if baseline downstream measurements are outside the relevant guidelines and change by 10% during cofferdam construction but the 10% change brings the parameters within the guidelines, cofferdam construction will continue. For example, if baseline dissolved oxygen is at 1.0mg/L and cofferdam construction begins and dissolved oxygen increases to 2 then 6.5mg/L, cofferdam construction will continue because, even though dissolved oxygen concentrations increased by more than 10%, this increase is an improvement of water quality.	During cofferdam construction	B3 LOW	Environmental Scientist, Plant Operator	Checklist and associated documents

[11] See (Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Coundil of Australia and New Zealand 2000) and footnotes 3 – 5.

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
	The cofferdam fails, releasing sediment and, possibly, other contaminants into the waterway	C4 MEDIUM	The cofferdam is constructed in accordance with Section 6.5, construction is monitored by a geotechnical engineer. The cofferdam is visually inspected and relevant inspection results are noted in the checklist as additional information, signs of dam failure are communicated to the geotechnical engineer immediately and rectified based on the geotechnical engineer's advise as soon as possible.	During and after cofferdam construction	A4 LOW	Environmental Scientist, Geotechnical Engineer, Plant Operator	Checklist and associated documents
Dewatering	Downstream water quality is impacted by dewatering	C3 MEDIUM	The pump outlet will be constructed in accordance with Section 6.4. The pump inlet will be suspended from the base of the dam via a float or similar and will be equipped with a fish gate in accordance with Section 8.2. Performance of the outlet and inlet will be monitored throughout dewatering. Dewatering will cease and the inlet and / or outlet will be reconfigured if the outlet begins exhibiting signs of erosion and if the inlet begins to suck in sediment. Discharge water quality will be monitored and will meet the following criteria: pH 6 – 7.5 Turbidity: <50NTU DO: >1mg/L These criteria are considered appropriate because they reflect baseline water quality in the flowline.	During dewatering system installation and throughout dewatering	B3 LOW	Environmental Scientist	Checklist and associated documents

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
			Dewatering will cease and the dewatering setup will be reconfigured if discharge water quality does not match the criteria.				
All	A spill (fuel, hydraulic oil, or similar) enters surface water	C4 MEDIUM	Refueling will not occur within 20m of the dam or flowline. The pump will be placed on an impermeable plastic liner and bunded with sandbags so that, in the event a spill occurs, all fluid is captured within the liner. Spills are managed in accordance with Section 8.5	Throughout works	A4 LOW	Environmental scientist, Plant Operator	Checklist and associated documents

8.4 Monosulfidic Black Ooze

The Project objective in relation to monosulfidic black ooze is to have no long-term acidification of monosulfidic black ooze and no significant, permanent decrease in dissolved oxygen. Project performance indicators are:

- No release of monosulfidic black ooze into waterways, and
- No uncontrolled acidification of monosulfidic black ooze.

Table 12 contains risk-assessed monosulfidic black ooze management measures.

Table 12 – MBO Management Risk Assessment

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
Cofferdam construction	MBO acidifies surrounding environment	C3 MEDIUM	An investigation classifies MBO and a management option is chosen in accordance with Section 6.5	Before and during	B3 LOW	Environmental Scientist, Plant Operator	Checklist and associated documentation

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
			Option A – investigation determines the thickness at which MBO is to be spread so that the increase in soil pH or nutrients does not affect the performance of planted stock. Option B – same as Option A and the investigation determines the quantity of aglime that needs to be incorporated into the MBO prior or during placement. Validation samples are taken at the rate stipulated by (Dear, et al. 2014) Option C – a treatment area is constructed in accordance with (Dear, et al. 2014), MBO is treated and validated in the treatment area prior to being incorporated into dam fill.	cofferdam construction			
Dewatering	MBO acidifies the groundwater table	C3 MEDIUM	An investigation classifies MBO and a management option is chosen in accordance with Section 6.7 Option A – Investigation results determine the layer of aglime that should be placed on exposed MBO and the MBO layer is capped with fill. Option B – dewatering ceases before any MBO is exposed and saturated MBO is capped with fill	Before and during cofferdam construction	B3 LOW	Environmental Scientist, Plant Operator	Checklist and associated documentation

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
MBO Treatment	Aglime alkalizes waterway or surrounding area	C3 MEDIUM	Only the required amount of aglime is brought to site, it is stored in bulk bags in a dry area that does not flood and covered with a waterproof covering in the event rainfall is forecast. MBO is treated in accordance with laboratory results.		B3 LOW	BBG Supervisor, Environmental Scientist	Checklist and associated documentation

8.5 Contaminated Land and Unexpected Finds

The Project objective in relation to contaminated land is to have no contaminated land and to appropriately managed unexpected finds and areas of contamination. Project performance indicators are:

- No spills, and
- Appropriate management of unexpected finds.

Table 13 contains risk-assessed monosulfidic black ooze management measures.

Table 13 – Contaminated Land and Unexpected Finds Risk Assessment

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
All	Unexpected finds – culturally significant items or remains are impacted	C3 MEDIUM	Only personnel who have been inducted into the TVH Development Project are allowed to work on site. All works cease if an unexpected find is uncovered and the Environmental Scientist contact the Project Engineer immediately.	Throughout works	B3 LOW	Environmental Scientist, Project Engineer	Incident report

Project Activity	Potential Impacts	Pre-control risk	Mitigation Measure	Timing	Post-Control Risk	Responsible Person	Records
	Land or water is contaminated because of a spill greater than 1L	C3 MEDIUM	No refueling is to occur within 20m of the dam or the flowline. The pump is bunded in accordance with Section 8.3 All land that has been impacted by a spill is remediated and disposed of in accordance with relevant regulations.	Throughout works	B3 LOW	Environmental Scientist, Project Engineer	Incident report

9 References

Australian and New Zealand Environment and Conservation Council; Agriculture and Resource Management Coundil of Australia and New Zealand. 2000. *Australian and New Zealand guidelines for fresh and marine water quality.* guidelines, National Water Quality Management Strategy.

Boyds Bay Group. 2021. *TVH Stage 2 EHS Plan.* EHS Plan, BBG.

Burton, Professor Ed. 2019. “Professional Short Course: National Acid Sulfate Soils Guidance Identification and Assessment.” Lismore: Southern Cross University, 26 July.

Dear, S E, C R Ahren, L E O'Brien, S K Dobos, A E McElnea, N G Moore, and K M Waiting. 2014. *Queensland Acid Soil Technical Manual: Soil Management Guidelines.* Manual, Brisbane: Department of Science, Information Technology, Innovation and the Arts.

Greencap. 2019. *Stage 1 Biodiversity Management Plan.* Biodiversity Management Plan, Brisbane: Greencap.

Greencap. 2020. *Stage 2 Biodiversity Management Plan.* Biodiversity Management Plan, Hamilton: Greencap.

Sullivan, L A, N J Ward, R T Bush, N R Toppler, and G Choppala. 2018. *National Acid Sulfate soils Guidance: Overview and management of monosulfidic black ooze (MBO).* Guidance, Canberra: Department of Agriculture and Water Resources.

Water Quality Investigation, Department of Environment and Science. 2009. *Monitoring and Sampling Manual: Environmental Protection (Water) Policy.* Manual, State of Queensland.

Attachment 1 – Field Measurements and Laboratory Reports

Investigation	Site	pH	Turbidity (NTU)	Dissolved Oxygen (mg/L)
Preliminary Investigation	1	6.21	29.6	1.8
	2	6.2	44.1	1.71
	3	6.18	33.2	1.65
	4	6.28	26	1.52
	5	6.25	20	1.15
Site Visit	2	7.23	20.5	1.46
	2, after disturbance	7.12	128	0.27
	3	7.35	12	1.36
	3, after disturbance	7.2	230	0.23

MAZLAB Pty Ltd
Environmental Testing, Sampling and Drilling (Vibracore)
ABN 90 151 684 436 ACN 151 684 436

U1/ 33 MACHINERY DR., TWEED HEADS SOUTH, 2486
PO BOX 6879 TWEED HEADS SOUTH MC., 2486
PHONE: (07) 55239922 FAX: (07) 55239822
EMAIL: mazlab@bigpond.com

Client: Dmitri Medvedko **Project:** TVH Farm Dam

Mazlab Job No: **Date:** 17/09/2020

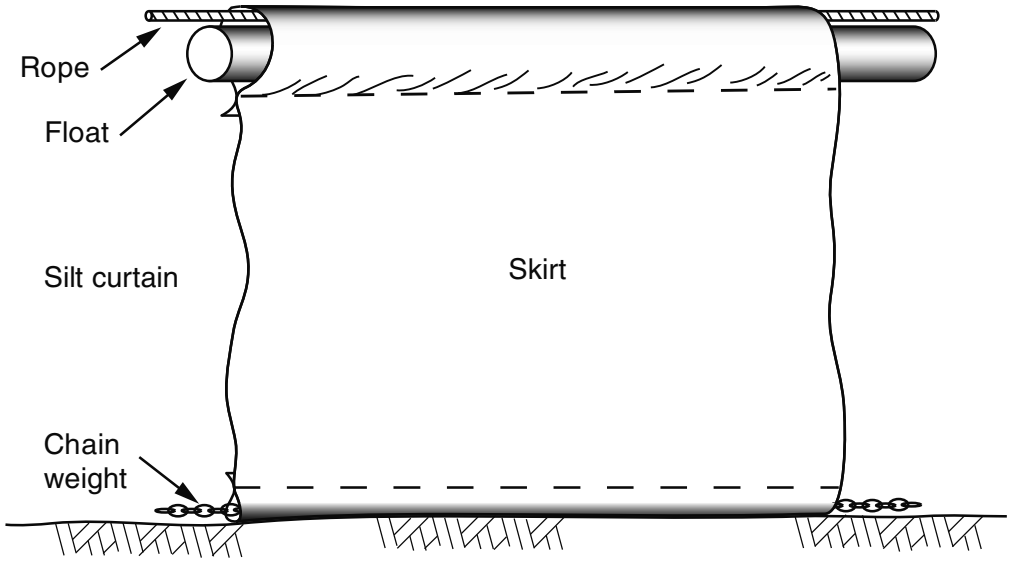
LABORATORY TEST RESULTS
Certificate of Test Results – Chromium Reducible Sulphur

Sample No.	Client I.D	Soil Description (truncated)	pH KCL	SCr mol (H+/t) %S	TAA mol (H+/t)	SNAS %S	ANC mol (H+/t) NA= Scr< action limit	Net Acidity mol (H+/t)	Liming Rate (Kg/ dry/ t)
	Sample 1	Large organic/swamp vegeration Etc. possible (MH) organic SILT	4.2	5775 9.26%	376	--	-	6151	477
	Sample 2	Clean clay sample	5.3	309 0.50%	36	-	-	345	26.8
	Sample 3	Moderate Amount of shells & shell grit	8.2	347 0.56%	-	-	820	-473	Nil

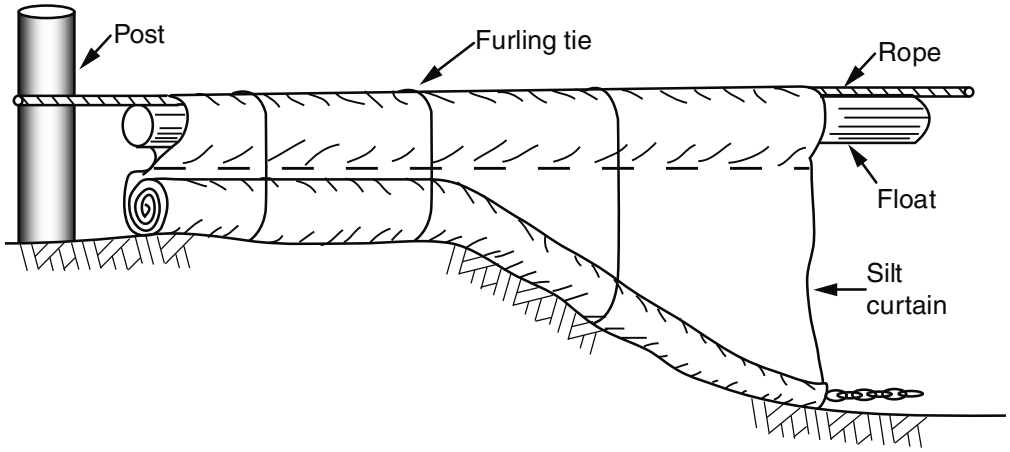
: :

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

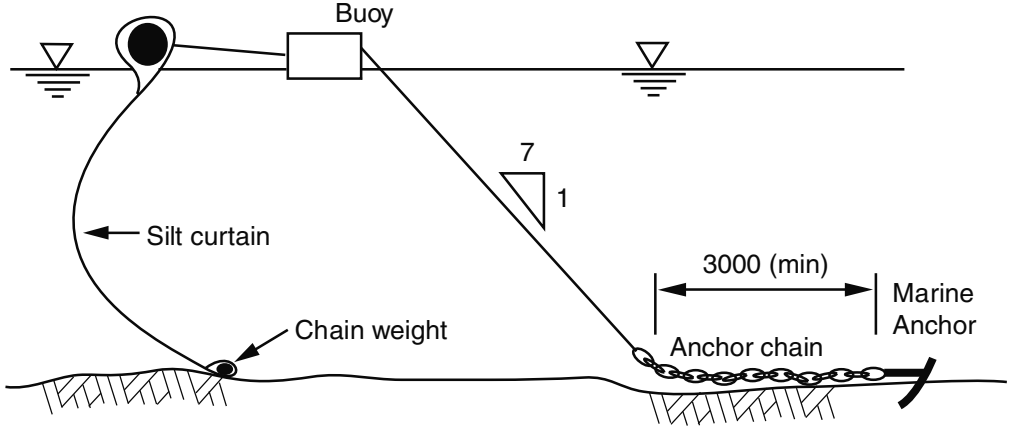
Attachment 2 – Sediment Curtain Standard Drawings



(a) Components of a floating silt curtain

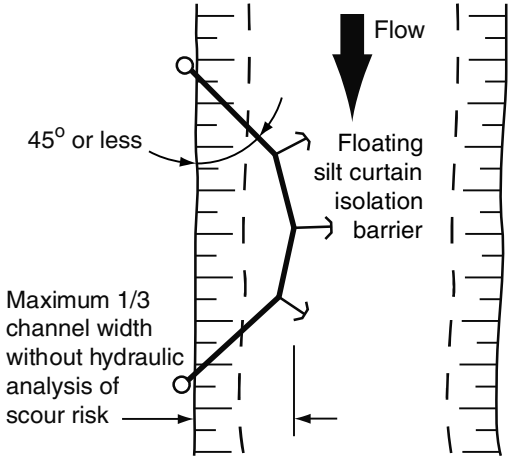


(b) Typical land anchorage system

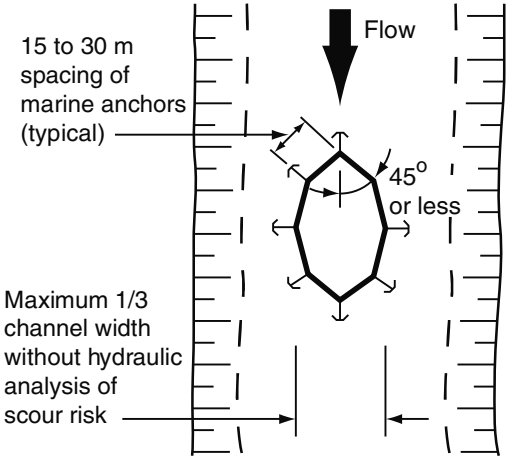


After Trow Consulting
Engineers Ltd (1997)

(c) Typical marine anchorage system



(d) Typical installation of floating silt curtain



(e) Typical installation of floating silt curtain

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-01

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. PRIOR TO THE INSTALLATION, CHECK WEATHER REPORTS FOR A SUITABLE WINDLESS, CALM DAY. DO NOT PROCEED WITH THE INSTALLATION UNLESS SAFE TO DO SO.

3. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

4. CLEAR THE IMMEDIATE LAUNCHING AREA OF ROCK AND DEBRIS. AVOID DISTURBING GROUNDCOVER VEGETATION.

5. LAYOUT A PLASTIC LAUNCHING PAD (SPILLWAY) AT RIGHT ANGLES TO THE WATERCOURSE BANK AND PEG OR ANCHOR IT DOWN. THIS IS TO PROTECT THE CURTAIN AND REDUCE FRICTION WHEN LAUNCHING.

6. UNFOLD THE CURTAIN IN AN OPEN AREA PRIOR TO ITS INSTALLATION. ENSURE THE BARRIER IS FABRICATED WITH SUFFICIENT DIMENSIONS TO BE IN GOOD CONTACT WITH THE BOTTOM OF THE CHANNEL. THE DEPTH OF THE BARRIER SHOULD BE APPROXIMATELY 10% GREATER THAN THE WATER DEPTH TO ENSURE IT RESTS ON THE BED.

7. IDEALLY, THE LENGTH OF THE BARRIER IS 10 TO 20% LONGER THAN THE MEASURED LENGTH OF THE PROPOSED ENCLOSURE.

8. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

9. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

10. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

11. PULL THROUGH THE ROPE USING THE DRAW CORD.

12. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE CURTAIN BEING DRAGGED ALONG THE CHANNEL BED.

13. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

14. DEPLOY THE BARRIER FROM THE END OF A BOAT. FASTEN THE FREE END OF THE BARRIER TO THE DOWNSTREAM ANCHOR POINT, THEN ANCHOR THE BARRIER AT INTERMEDIATE POINTS.

15. TAPER THE ENDS OF THE BARRIER TO THE SHAPE OF THE SHORELINE, OTHERWISE TIE THE ENDS OF THE BARRIER WITH FURLING STRAPS SO THE DEPTH OF THE BARRIER CAN BE ADJUSTED TO THE SHAPE OF THE BANK.

16. AFTER THE BARRIER HAS BEEN ANCHORED, CHECK TO SEE THAT THE SKIRT IS NOT TWISTED AROUND THE FLOTATION UNITS. WHEN THE BARRIER IS PROPERLY DEPLOYED, CUT THE TIE ROPES AND LET THE BALLAST WEIGHTS SINK TO THE BED.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-02

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

ALTERNATIVE LAND-BASED INSTALLATION PROCEDURE

1. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

2. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

3. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

4. PULL THROUGH THE ROPE USING THE DRAW CORD.

5. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE WEIGHTS BEING DRAGGED ALONG THE BOTTOM.

6. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

7. INSTALL AN EXTRA LENGTH OF ROPE OR CABLE IN THE FINAL CURTAIN POSITION IN THE WATER.

8. TIE THE END OF THE CURTAIN ROPE TO THE EXTRA LENGTH ALREADY IN POSITION AND PULL THE CURTAIN INTO THE WATER STOPPING WHEN THE END OF THE FIRST SECTION OF CURTAIN IS STILL ON THE BANK.

9. UNFOLD THE SECOND SECTION OF CURTAIN ON THE SLIPWAY MAKING SURE THE CURTAIN IS CORRECTLY ORIENTATED WITH THE FIRST SECTION OF CURTAIN

10. INSERT THE FLOATS, CHAIN AND ROPE AS BEFORE.

11. USING THE DRAW CORD FROM THE FIRST SECTION, TIE UP THE ENDS USING THE EYELETS ALREADY IN THE CURTAIN.

12. GATHER UP THE CURTAIN AND TIE TOGETHER WITH TWINE OR THIN ROPE.

13. LAUNCH AS BEFORE.

14. CONTINUE UNTIL THE ENTIRE CURTAIN IS INSTALLED.

15. ANCHOR WELL TO SHORE ANCHORS.

16. USING A SUITABLE BOAT, MOVE ALONG THE CURTAIN AND CUT THE TIES HOLDING THE CHAIN AND CURTAIN AND ALLOW THE WEIGHTED END TO SINK.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

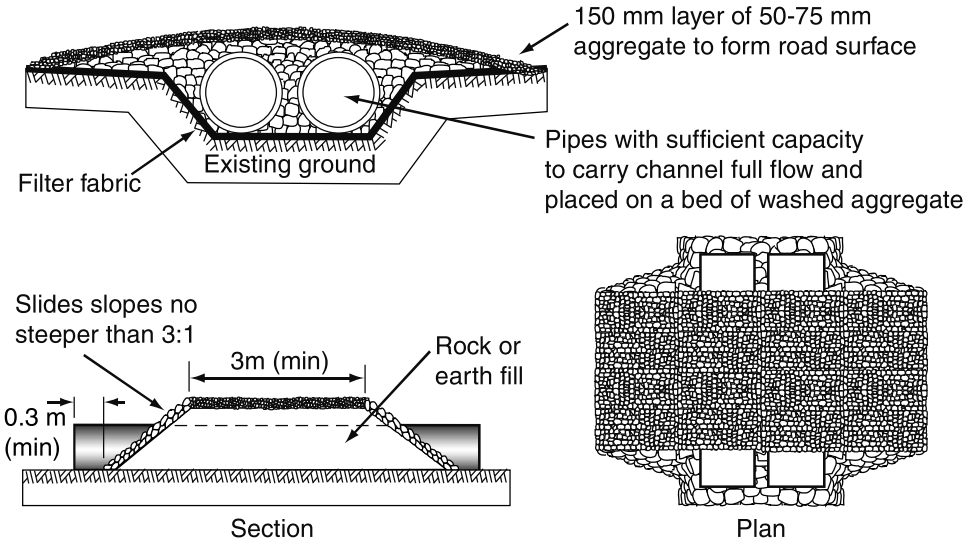
5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

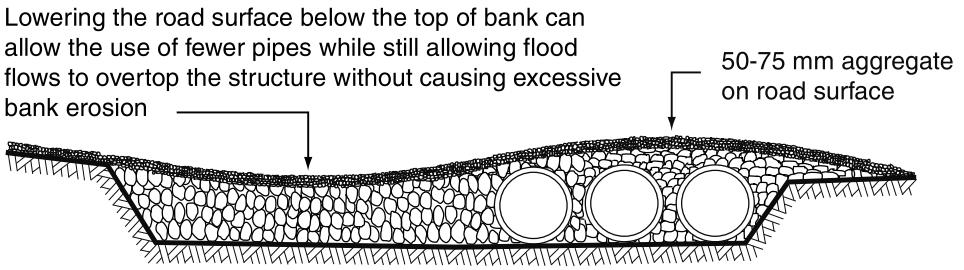
7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain (alt)	FSC-03

Attachment 3 – Temporary Waterway Crossing Construction Methodology

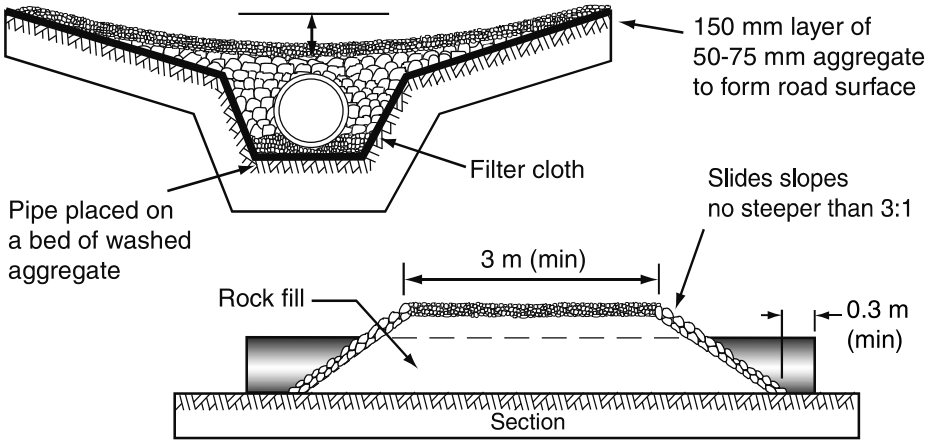


(a) Preferred arrangement for temporary culvert crossings

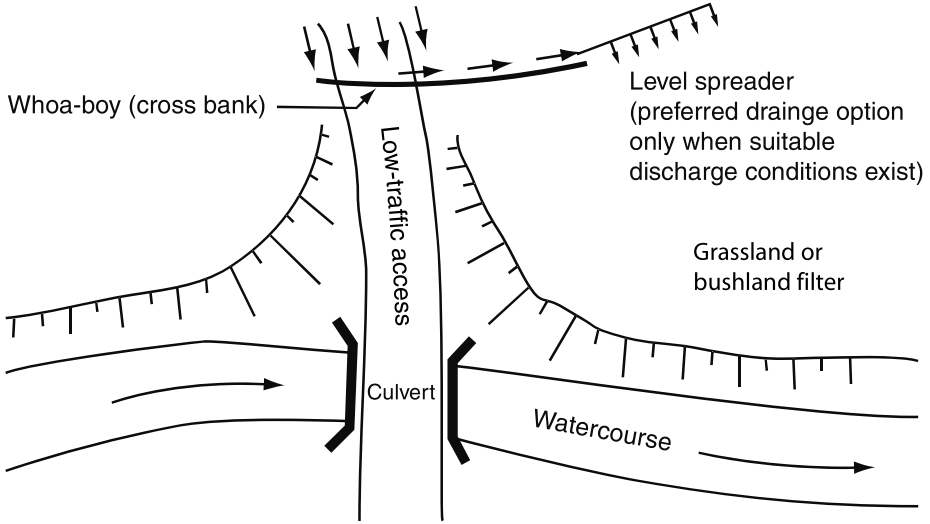


(b) Typical profile of temporary culvert crossings of wide channels

In situations where it is not practicable to allow overflows to initially passing around the culvert on a stable (well vegetated) stream bank, then the center must be set low to allow flow to pass over the culvert along the centreline of the channel



(c) Alternative layout for the crossing of confined channels



(d) Typical arrangement of surface runoff controls associated with approach ramps

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-01

MATERIALS

CULVERTS: ANY COMMERCIAL CONDUIT THAT IS SUITABLE FOR THE REQUIRED TRAFFIC LOADING.

ROCK: MINIMUM 150mm NOMINAL ROCK SIZE.

AGGREGATE: 50–75mm CLEAN AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH (MINIMUM BIDIM A34 OR EQUIVALENT).

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONSTRUCT THE TEMPORARY WATERCOURSE CROSSING, INCLUDING PERMITS FOR THE DISTURBANCE OF BANK VEGETATION, AQUATIC VEGETATION (e.g. MANGROVES) AND ANY TEMPORARY INSTREAM FLOW DIVERSION BARRIERS OR SEDIMENT CONTROL MEASURES.

2. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. ENSURE THAT THE LOCATION OF THE CROSSING WILL NOT INTERFERE WITH FUTURE CONSTRUCTION WORKS.

4. PRIOR TO SIGNIFICANT LAND CLEARING OR CONSTRUCTION OF THE APPROACH RAMPS, ESTABLISH ALL NECESSARY SEDIMENT CONTROL MEASURES AND FLOW DIVERSION WORKS (INSTREAM AND OFF-STREAM AS REQUIRED), CLEARING ONLY THOSE AREAS NECESSARY FOR INSTALLATION OF THESE MEASURES.

5. TO THE MAXIMUM DEGREE PRACTICABLE, CONSTRUCTION ACTIVITIES AND EQUIPMENT MUST NOT OPERATE WITHIN OPEN FLOWING WATERS.

6. MAINTAIN CLEARING AND EXCAVATION OF THE WATERCOURSE BED AND BANKS TO A MINIMUM. INITIALLY CLEAR ONLY THE AREA NECESSARY TO ALLOW ACCESS FOR CONSTRUCTION. CLEAR THE REMAINDER OF THE APPROACH RAMPS ONLY WHEN ADEQUATE DRAINAGE AND SEDIMENT CONTROLS ARE IN PLACE.

7. IF FLOW DIVERSION SYSTEMS CANNOT BE INSTALLED, THEN CONDUCT BANK EXCAVATIONS BY PULLING THE SOIL AWAY FROM THE CHANNEL.

8. WHERE PRACTICABLE, CONSTRUCT THE WATERCOURSE CROSSING PERPENDICULAR TO THE CHANNEL.

9. WHERE PRACTICABLE, THE APPROACH RAMPS SHOULD BE STRAIGHT FOR AT LEAST 10m AND SHOULD BE ALIGNED WITH THE CROSSING.

10. WHERE PRACTICABLE, DIRECT STORMWATER RUNOFF FROM THE APPROACH RAMPS INTO STABLE DRAINS, ADJACENT VEGETATION, OR APPROPRIATE SEDIMENT TRAPS TO MINIMISE THE RELEASE OF SEDIMENT INTO THE WATERCOURSE.

11. SHAPE THE CHANNEL, IF NECESSARY, TO RECEIVE THE PIPE/S.

12. IF HIGHLY EROSIVE SOILS ARE DETECTED, THEN APPROPRIATELY STABILISE SUCH SOILS AS SOON AS PRACTICABLE.

13. COVER THE CROSSING FOOTING WITH HEAVY-DUTY FILTER CLOTH.

14. COVER THE FILTER CLOTH WITH A MINIMUM 150mm OF CLEAN, 50 TO 75mm AGGREGATE.

15. PLACE THE SPECIFIED SIZE AND NUMBER OF CULVERT CELLS AND ALIGN THEM WITH THE DIRECTION OF THE DOWNSTREAM CHANNEL.

16. ENSURE THE PIPES EXTEND AT LEAST 300mm BEYOND THE PROPOSED EXTEND OF ROCK FILL.

17. FILL BETWEEN THE PIPE/S WITH 75 TO 100mm AGGREGATE.

18. COVER PIPE/S WITH SUFFICIENT ROCK (MINIMUM 300mm LAYER) TO SATISFY MANUFACTURER'S LOADING REQUIREMENTS TO AVOID DAMAGE TO THE PIPE/S RESULTING FROM THE EXPECTED TRAFFIC LOAD. SLOPE OF ROCK FACE UPSTREAM AND DOWNSTREAM OF THE CULVERT NO STEEPER THAN 3:1 (H:V).

19. FORM THE SHAPE OF THE ROAD SURFACE IN ACCORDANCE WITH THE PLANS AND/OR STANDARD DRAWINGS.

20. APPLY A SUITABLE COVER OF AGGREGATE OVER THE ROCK FILL TO FORM THE TRAFFICABLE ROAD SURFACE.

21. FINISH CONSTRUCTION AND STABILISATION OF THE APPROACH ROADS INCLUDING THE APPROACH RAMPS EACH SIDE OF THE BRIDGE CROSSING.

22. TAKE ALL REASONABLE MEASURES TO PREVENT EXCESS ROCK, DEBRIS AND CONSTRUCTION MATERIAL FROM ENTERING THE WATERCOURSE, ESPECIALLY ANY STILL OR FLOWING WATER.

23. IF IT IS NOT PRACTICABLE TO STABILISE THE ACCESS RAMPS AGAINST EROSION, THEN INSTALL FLOW DIVERSION BANKS ACROSS THE WIDTH OF EACH ACCESS RAMP ADJACENT THE TOP OF THE CHANNEL BANK, AND AT REGULAR INTERVALS DOWN THE RAMPS (AS REQUIRED) TO PREVENT OR MINIMISE SEDIMENT-LADEN RUNOFF FLOWING DIRECTLY INTO THE WATERCOURSE.

24. APPROPRIATELY STABILISE ANY DISTURBED WATERCOURSE BANKS.

25. STABILISE ALL DISTURBED AREAS THAT ARE LIKELY TO BE SUBJECTED TO FLOWING WATER, INCLUDING BYPASS AND OVERFLOW AREAS, WITH ROCK OR OTHER SUITABLE MATERIALS.

MAINTENANCE

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE INSPECTED WEEKLY AND AFTER ANY SIGNIFICANT CHANGE IN STREAM FLOW.

2. DEBRIS TRAPPED ON OR UPSTREAM OF THE CROSSING SHOULD BE REMOVED.

3. REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION TRAFFIC. IF TRAFFIC HAS EXPOSED BARE SOIL, STABILISED AS APPROPRIATE. MAINTAIN A MINIMUM 200mm COVER OVER THE CULVERTS.

4. CHECK FOR EROSION OF THE FORMED EMBANKMENT, CHANNEL SCOUR, OR ROCK DISPLACEMENT. MAKE ALL NECESSARY REPAIRS IMMEDIATELY.

5. CHECK THE BYPASS FLOODWAY MAKING SURE THE BANKS ARE STABLE.

6. CHECK FOR EXCESSIVE EROSION ON THE APPROACH ROADS.

7. CHECK THE CONDITIONS OF ANY FLOW DIVERSION CHANNELS/BANKS AND THE OPERATING CONDITIONS OF ASSOCIATED SEDIMENT TRAPS.

REMOVAL

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER ALTERNATIVE ACCESS IS ACHIEVED OR THE CULVERT IS NO LONGER NEEDED.

2. REMOVE ALL SPECIFIED MATERIALS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-02

Attachment 4 – Correspondence from Pacific Geotech

PG-3370 - Tweed Valley Hospital, Kingscliff

Peter Elkington <peter@pacgeo.com.au>

Fri 19/02/2021 5:37 PM

To: Dmitri Medvedko <dmitri@boydsbaygroup.com.au>

Hi Dmitri,

It is understood that the construction of a bund is required at the end of the Tweed Valley Hospital Fern Valley Dam. The dam at the intersection with the adjacent waterway is understood to be approximately 2m deep and the bund is required for a time period in the order of 1-2 weeks during the dewatering of the dam.

It is understood that a stockpile of the natural high plasticity silty clays is available for the construction of the bund. This material is considered to be generally suitable for use for a temporary bund provided it is nomically compacted. A nominal bund width of approximately 0.5-1m at the crest and side wall batters in the order of 1-1.5H:1V could be adopted.

The following construction sequence is suggested, subject to confirmation on-site at the time of the works:

1. The unsuitable material on the alignment of the bund should be removed from the base of the dam.
2. The clay material should be placed into the dam to commence the construction of the bund. The material should be compacted during its placement. This compaction may be achieved through the use of a pin-wheel or other suitable compactive equipment.
3. The initial layer of clay should be placed at a maximum thickness in the order of 1m. If the intial layer at this thickness is unable to be compacted, consideration should be given to increasing the dimensions of the bund to allow for the poorly compacted clay material. The extent of the bund width increase will be dependant on the material performance and the degree of compactiont that is able to be achieved and should be assessed by Pacific Geotech at the time.
4. Following the placement of the bund, confirmation of its suitability should be made by Pacific Geotech prior to the commencement of the dewatering operation.

If you have any questions in regards to the above, please don't hesitate to give me a call.

Regards,

Peter Elkington

Pacific Geotech
Consulting Geotechnical Engineers

3 Jowett St
Coomera QLD 4209

PO Box 499
Paradise Point Qld 4216

Phone: 07 5636 4680
Fax: 07 5636 0286
Mobile: 0407 425 090
Email: peter@pacgeo.com.au
Web: www.pacgeo.com.au

Attachment 5 – Cudgen Soil Landscape Report

cu CUDGEN

Landscape—low undulating hills and rises on Tertiary basalt plateau. Relief is 20–40 m; elevation 30–40 m; slopes 2–10% and steepening to 20% on plateau margins. Completely cleared closed-forest (rainforest).

Landscape Variant—cua—narrow drainage depression.

Landscape Variant—cub—sandy Krasnozems.

Soils—deep (>100 cm), well-drained Krasnozems (Uf5.12, Uf6.12, Uf6.21).

Limitations—acid and highly erodible soils with high aluminium toxicity potential.

LOCATION

Low hills and rises on Lamington Basalts forming on the north-easterly extension of the Burringbar Hills, extending into Kingscliff. Also includes Fingal Head and Cook Island. Type location is on the Cudgen Plateau (Area reference 5 55000E, 68 73000N).

LANDSCAPE

Geology

Lamington Volcanics—Tertiary basalt, with members of rhyolite, trachyte, tuff, agglomerate, conglomerate.

Topography

Very low to low undulating hills and rises on the Cudgen Plateau and nearby basalt caps. Elevation is 30–40 m on the Cudgen Plateau. Relief is 20–40 m and slopes are 2–10%, steepening to 20% on the flanks and edges of the Cudgen Plateau. Slope lengths are long (up to 1 500 m) on the plateau. Sideslopes are moderately long (150–200 m). Slope shape is simple within the plateau, progressively waxing towards the edges. Drainage is generally incipient. Drainage depressions are common.

Vegetation

Completely cleared closed-forest (rainforest). Most of this landscape is cultivated, but the original vegetation would have been be similar to that of the Limpinwood **(li)** or Green Pigeon **(gp)** soil landscapes.

Land Use

Vegetables (sweet potatoes, tomatoes, zucchinis, sweet corn, cucumbers, peas and beans) and tropical fruits (avocados, bananas, custard applies, mangoes, etc.). Residential at Cudgen and Kingscliff.

Existing Land Degradation

Topsoil erosion is a serious problem in the Cudgen area (Cole-Clark 1993). Soil structure decline is also a major problem (Riddler *et al*. 1982). Sheet and rill erosion have been observed during this survey.

Landscape Variants

The area mapped as **cua** is a narrow (up to 150 m) drainage depression. Otherwise, this variant has similar landscape features to the Cudgen soil landscape.

The area mapped as **cub** consists of Krasnozems mixed with aeolian sand, generally within the surface material.

SOILS

Detailed soil profile and distribution information can be found in Riddler *et al*. (1982).

Dominant Soil Materials

cu1—Red self-mulching light clay (topsoil and subsoil–Ap and B horizons)

Colour	dark reddish brown (2.5YR 3/3, 5YR 3/6)
Texture	light clay, often subplastic (increase <2 grades)

Structure	strong, closely packed polyhedral, 5–10 mm parting to 2–5 mm
Fabric	smooth-faced and rough-faced, distinct clay coatings are common (10–50%)
Exposed condition	self-mulching
Permeability	moderate to high
Field pH	6.0–7.0
Coarse fragments	none observed
Roots	common, 1–2 mm
Type location	cutting 100 m south of Curragundi (Grid Ref. 2 **52**900E, 68 **68**250N). Soil Data System card 32, 0–20 cm

cu2—Red medium clay (topsoil and subsoil—Ap and B horizons)

Colour	dark reddish brown (2.5YR 3/4, 5YR 3/4)
Texture	light medium to medium clay, often subplastic (increase <2 grades)
Structure	strong, polyhedral closely packed, 10–20 mm parting to 5–10 mm and 2–5 mm
Fabric	smooth-faced, occasionally rough-faced; distinct clay coatings can be common (10–50%)
Exposed condition	self-mulching
Permeability	moderate to high
Field pH	4.5–5.5
Coarse fragments	often common (10–20%) sub-angular gravels (6–60 mm) of parent material
Roots	common, 1–5 mm
Type location	cutting 100 m south of Curragundi (Grid Ref. 2 **52**900E, 68 **68**250N). Soil Data System card 32, 20–100 cm

Associated Soil Materials

The following materials from Carool **(ca)** soil landscape occur in localised steeper areas, generally on the plateau margins:
ca2—Dark friable clay
ca3—Brown crumbly clay.

Occurrence and Relationships

The soils of the Cudgen soil landscape are predominantly Krasnozems. Riddler *et al*. (1982) has a very detailed soils map and report of this area.

Plateau. Up to 40 cm of red, self-mulching light clay **(cu1)** overlies up to 100 cm or more of red medium clay **(cu2).** Boundaries are gradual to diffuse. **cu2** may often be the only soil material due to sheet and rill erosion [well-drained Krasnozems (Uf5.12, Uf6.12, Uf6.21)]. Total soil depth is 100–>200 cm.

Localised, steeper areas may have 5–10 cm of dark, friable clay **(ca2)** gradually overlying up to 100 cm of brown, crumbly clay **(ca3)** [well-drained Chocolate Soils (Uf6.21)]. Total soil depth is up to 100 cm.

QUALITIES AND LIMITATIONS

Productive arable land

Landscape Limitations

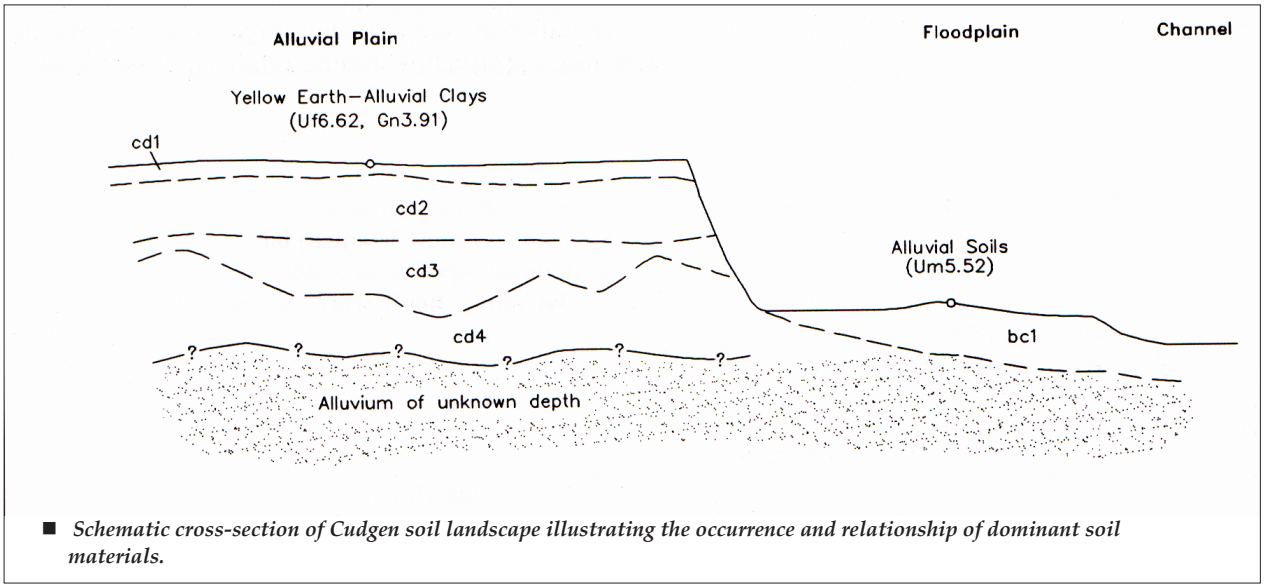
Mass movement hazard (localised)
Water erosion hazard on cultivated land

Soil Limitations

cu1	High shrink-swell High erodibility Moderate plasticity
cu2	Strong acidity High aluminium toxicity potential High erodibility Moderate plasticity

Fertility

Soil Materials as Growth Media. Krasnozems have excellent physical qualities but have some chemical problems—soil material fertility is moderate to high. Soils are strongly structured, have very high pH buffering capacities and have high organic matter contents. All soil materials have very high P sorption and therefore very low available phosphorus. Topsoil **(cu1)** is neutral and subsoil **(cu2)** is strongly acid and has a high aluminium toxicity potential. CEC ranges from low **(cu2)** to high **(cu1).** Base saturation is very high and response to fertilisers may be minimal. Riddler *et al.* (1982) note that there has been a decline in phosphorus since the 1970s and a serious recent decline in calcium levels.



■ *Schematic cross-section of Cudgen soil landscape illustrating the occurrence and relationship of dominant soil materials.*

Soil Profile Fertility. Moderate to high suitability as a growth medium for deep, well-drained Krasnozems. Soil volumes available for root penetration are high.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
cu1	0.006	very low-high	very high	high
cu2	0.015	low-high	very high	high

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	moderate	high	slight
cultivation	high	very high	high
urban	high	very high	moderate

Foundation Hazard

Low to moderate foundation hazard on plateau due to the shrink-swell potential of topsoils. Localised areas of moderate to high foundation hazard may exist on steeper slopes where mass movement hazard exists. Topsoil depth is 20–40 cm. Total soil depth is 100–>200 cm.

Septic Absorption

Generally low for **cu1** and **cu2. cu1** has high shrink-swell and soil materials can have high rock content and moderate to high permeability. Sites on slopes >15% should be avoided.

Urban Capability

Generally low limitations for urban development, but this land is best left under cultivation.

Rural Capability

Generally low limitations for cultivation and low limitations for grazing.

Sustainable Land Use Suggestions

This land is best retained as agricultural land due to the favourable characteristics and versatile nature of Krasnozems. Where residential development exists, appropriate waste disposal systems should be used (i.e., not septic).

Use of aggressive tillage practices should be avoided due to the associated decline in soil structure. See Cole-Clark (1993) for erosion control management recommendations.

Attachment 6 – Dam Infilling Checklist

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
1.	**Conduct a threatened frog survey**			Note the date of the survey in the “Date” column and note the title of the reference document in the “Reference / Decision tree / Signature” (e.g. Pre-start) column.
1.1.	Communicate results			Note the date in the “Date” column and note the title of report or correspondence from the ecologist that outlines survey results and management measures in the “Reference / Decision tree / Signature” column.
1.2.	Do survey results necessitate management measures in addition to those stipulated in Section 8 of the Dam Infilling Environmental Plan?		Yes ☐ No ☐	If yes, go to 1.3, if no, go to 1.4
1.3.	How are management measures documented and communicated? Prestart meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.
1.4.	HOLD POINT - Threatened frog survey results are communicated to the Environmental Scientist and adequate management measures are implemented			signed by Jono Hooper
1.5.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 1.6, if no, go to 2
1.6.	Who provided the additional information?			Put the name of the person providing additional information into the “Reference / Decision tree / Signature” column
1.7.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
2.	**Install instream sediment controls**			Note the date of the sediment control installation commencement in the “Date” column and note the title of the reference document in the “Reference / Decision tree / Signature” (e.g. Pre-start) column.
2.1.	HOLD POINT – sediment controls are installed in accordance with relevant standards			signed by Dmitri Medvedko
2.2.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 2.3, if no, go to 3
2.3.	Who provided the additional information?			Put the name of the person providing additional information into the “Reference / Decision tree / Signature” column
2.4.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.
3.	**Remove floating vegetation on the dam surface,**			Note the date of the floating vegetation removal commencement in the “Date” column and note the title of the reference document in the “Reference / Decision tree / Signature” (e.g. Pre-start) column
3.1.	HOLD POINT – Floating mat of vegetation is placed in an appropriate location			Signed by Bo Walton
3.2.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 3.3, if no go to 4
3.3.	Who provided the additional information?			Put the name of the person providing additional information into the “Reference / Decision tree / Signature” column
3.4.	How are management measures documented and communicated? Pre start meeting ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
	Toolbox ☐			
4.	**Deploy fyke nets, further classify MBO, and construct an access track**			Note commencement date in the “Date” column and note the title of the reference document in the “Reference / Decision tree / Signature” (e.g. Pre-start) column.
4.1.	Communicate results			Note the date in the “Date” column and note the title of report or correspondence from the aquatic ecologist, laboratory, and environmental scientist that outlines results and management measures in the “Reference / Decision tree / Signature” column.
4.2.	What option is selected for MBO management?		A ☐ B ☐	
4.3.	What option is selected for managing MBO that will be generated during cofferdam construction?		A ☐ B ☐ C ☐	
4.4.	HOLD POINT – Access track is constructed in an appropriate location			Signed by Bo Walton
4.5.				
4.6.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 4.5, if no go to 5
4.7.	Who provided the additional information?			Put the name of the person providing additional information into the “Reference / Decision tree / Signature” column
4.8.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
5.	**Construct a cofferdam and pump outlet,**			Note the date of the cofferdam construction commencement in the “Date” column and note the title of the reference document in the “Reference / Decision tree / Signature” (e.g. Pre-start) column
5.1.	Has the geotechnical engineer amended cofferdam construction design or methodology?		Yes ☐ No ☐	If yes, go to 5.2, if no go to 5.3
5.2.	How are management measures documented and communicated? Prestart meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.
5.3.	HOLD POINT – cofferdam is adequately constructed			signed by Peter Elkington or nominated representative
5.4.	HOLD POINT – pump outlet is adequately constructed			signed by Dmitri Medvedko
5.5.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 5.6, if no go to 6
5.6.	Who provided the additional information?			Put the name of the person providing additional information into the “Reference / Decision tree / Signature” column
5.7.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the “Date” column and note the title of the toolbox talk, if applicable, in the “Reference / Decision tree / Signature” column.
6.	**Dewater while capturing and relocating aquatic fauna,**			Note the date of the cofferdam construction commencement in the “Date” column and note the title of the reference document in the ““Reference / Decision tree / Signature” (e.g. Pre-start)

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
6.1.	Communicate results *Note: for this step, the aquatic ecologist will generate a report outlining the aquatic fauna salvage effort. Report will include a discussion on water quality.*			Note the date in the "Date" column and note the title of report or correspondence from the aquatic ecologist and environmental scientist that outlines results and management measures in the "Reference / Decision tree / Signature" column.
6.2.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 6.3, if no go to 7
6.3.	Who provided the additional information?			Put the name of the person providing additional information into the "Reference / Decision tree / Signature" column
6.4.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the "Date" column and note the title of the toolbox talk, if applicable, in the "Reference / Decision tree / Signature" column.
7.	**Manage MBO** *Note: for this step, the environmental scientist will generate a site diary or similar documenting MBO management.*			Note the date of the MBO treatment commencement in the "Date" column and note the title of the reference document in the ""Reference / Decision tree / Signature" (e.g. Pre-start)
7.1.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 7.2, if no go to 8
7.2.	Who provided the additional information?			Put the name of the person providing additional information into the "Reference / Decision tree / Signature" column
7.3.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the "Date" column and note the title of the toolbox talk, if applicable, in the "Reference / Decision tree / Signature" column.

Dam Infilling Checklist

#	Step	Date	Reference/ Decision tree / Signature	Notes
8.	**Infill the dam** *Note: for this step, the environmental scientist will generate a site diary or similar documenting dam infilling*			Note the date of the dam infill commencement in the "Date" column and note the title of the reference document in the ""Reference / Decision tree / Signature" (e.g. Pre-start)
8.1.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 10, if no go to 6
9.	**Decommission the access track, sediment controls, and pump outlet**			Note the date of the decommissioning commencement in the "Date" column and note the title of the reference document in the "Reference / Decision tree / Signature" (e.g. Pre-start)
9.1.	Has additional relevant information outside the scope of this Section been provided?		Yes ☐ No ☐	If yes, go to 9.2, if no, then you're done with the checklist.
9.2.	Who provided the additional information?			Put the name of the person providing additional information into the "Reference / Decision tree / Signature" column
9.3.	How are management measures documented and communicated? Pre start meeting ☐ Toolbox ☐			Note the date of the prestart talk or toolbox in the "Date" column and note the title of the toolbox talk, if applicable, in the "Reference / Decision tree / Signature" column.