Appendix 4. Drainage – Design Principles and Standards

3 Design standards and Principles

3.1 Introduction

The design criteria used for the drainage design and maintenance have been developed and modified over the many years that Bord na Móna have been harvesting peat. In order to facilitate the production and harvesting of milled peat it was necessary to develop a drainage network to lower the water level within the bog. The drainage in the bog is achieved through a network of open drains and pipes with all surface water discharges directed through silt ponds prior to discharge to local water courses. Where it is not possible to drain the bogs by gravity, pumps are provided. The drainage design criteria for surface water run-off from Bord na Mona bogs is set out below.

3.2 Drainage Design in Operational Bogs

It is Bord na Mona's preference to drain a bog by gravity flow where possible, however this is restricted by a number of issues including the flood level at the outfall, and the depth of the drains and the silt ponds required to achieve gravity flow. For milled peat production, a series of parallel drains were excavated at 15 metre intervals and the strip of bogs between these drains form the peat production fields. These fields are cambered to facilitate run-off and prevent standing water on the production fields. The drains generally fall towards the headland which is located at both ends of each production field. This headland allows for the plant such as harrowers, millers or ridgers to turn from one field into the next field. The open drains are generally piped across the end of each production field to facilitate production plant and machinery to travel from field to field. The drainage network continues by either open channel or pipe to a silt pond or ponds prior to discharging to a local watercourse.

Production bogs are by their nature very flat and subsequently it is necessary to excavate drains and pipes at a flatter gradient than would be normally permitted. The minimum gradient used for a pipeline within Bord na Mona operational bogs is 1 in 1000 and the minimum gradient used for an open channel ranges from 1 in 1,1,500 to 1 in 2000 depending on the size of the drain. These gradients provide less than the recommended self-cleansing velocities however these reduced velocities facilitate the settling out of silt. These gradients have been developed following years of drainage development and have been found to provide adequate drainage to facilitate peat production operations while avoiding very deep channels and pipes. These gradients also permit settlement of peat in advance of the silt ponds but not at a level that causes blockages of pipes or channels. As part of the design criteria for drainage design the minimum pipe size to be used for drainage of a production bog is 450mm diameter.

Surface Water Run-off – Production Bogs

Pipelines and pump capacities are assessed based on a run-off rate of 1.7 litres per second per hectare. This run-off rate is based on a report prepared by Bord na Móna in the 1980's and the run-off equates to approximately 60% of 25mm of rainfall falling in 24 hours.

This run-off rate can be compared with other means of calculating surface water run-off. Common methodologies for calculating greenfield run-off are as follows:

Institute of Hydrology Report 124

This method utilises the Institute of hydrology handbook report 124 Flood Estimation for small catchments to determine $QBAR_{RURAL}$

QBAR = 0.00108*(AREA)0.89 *(SAAR)1.17 *(SOIL)2.17 = mean annual flood m^2/s

Where AREA = catchment area km^2

SAAR = standard average annual rainfall in mm

SOIL = Soil Index based on WRAP values (winter rainfall acceptance potential)

Using a typical example of a Bord na Mona Bog catchment with an area of 50 hectares the QBAR is as follows:

Area = 50 hectares

SAAR = 902 mm (example based on Blackwater weather station)

SOIL = 0.47 (for a Soil Index of 4)

QBAR = 0.325m^3/s / 50 hectares = 6.5 litres/sec/hectare

Based on the above methods, the flow from the production bogs will be restricted by the channel gradients and pipe sizes used throughout the bog. This will result in surface water backing up into these drains during flood events allowing for storm water attenuation.

A monitoring programme is currently underway to assess the run-off from an operational peat production bog during various rainfall events. An area velocity probe that measures flow and velocity has been installed in surface water pipes at three bogs. These probes are linked to a data logger with an internet connection and rain gauges have also been installed at each probe location. A probe has been installed at Magheramore in Mount Lucas, which is an operating bog, upstream and downstream of Gowla Bog where production ceased in 2018 and in Garryduff bog which is an active bog with a pumped outfall. The flow and rainfall information will be gathered over a number of months and will be analysed to determine the run-off from the relevant catchment area. In Gowla Bog, where production ceased in 2018, the run-off will be monitored as the bare peat revegetates.

Although these bogs are not located within the Bog Group assessed in this report, the information gathered will also be relevant to these bogs as well as other Bord na Mona bogs.

3.3 Silt Pond Design

In accordance with the existing Integrated Pollution Control licence for Boora P0500-01, all drainage water from boglands in the licensed area is required to be discharged via an appropriately designed silt pond treatment arrangement as required in condition 6.6.

The silt ponds serving operational bogs are required to comply with Condition 6.10 of the existing Integrated Pollution Control Licence which states:

> *Within three years of date of grant of this licence all existing silt ponds serving operational bogs shall achieve the following minimum performance criteria (flood periods excepted):*
>
> - *Maximum flow velocity < 10 cms-1*
> - *Silt design capacity of lagoons, minimum 50m^3 per nett ha of bog serviced*
>
> *All new ponds installed shall be designed to achieve these stated minimum design criteria.*

A report prepared by Jim Harkins of Bord na Móna in 1991 “Silt Control Report” examined silt control ponds at three locations on a daily basis (other than weekends) for a year. Following on from the data collected, the report recommended that each silt control pond be designed to cater for 10 cubic metres per acre per annum for Midland bogs. This equates to 24.7 cubic metres per hectare per annum. The report also recommended that each silt control pond be cleaned twice per year to cater for production and ditching. This report was submitted for assessment by the EPA as part of the application process for the current IPC licence.

Silt ponds are generally designed and constructed with a width of 8 metres, however in some cases silt ponds are up to 12 metres in width. Silt ponds of 12m width are only provided in areas where access is available to both sides of the silt ponds for cleaning. The length of the silt pond will vary depending on the capacity required. In some locations baffles have been provided within the ponds to reduce the energy in the flow and elongate the pond thereby increasing residence time and aiding settlement. Silt ponds are generally excavated to a depth of 1.5 metres below the pipe invert level, however in some locations, due to restricted space the silt pond depth is greater than this. Some typical examples of silt ponds are shown in the Figures below.

There are circa 820 silt ponds in Bord na Mona bogs with 98 silt ponds in the Boora Bog Group.

Figure 2: Typical example of Silt Pond

Figure 3: Typical example of Silt Pond

Flow velocity through the silt pond is generally controlled by inlet and outlet pipes at the silt ponds or up-stream of the silt pond. These pipes control the velocity of the flow into and out of the silt ponds so that the velocity within the silt pond itself is less than 10 cm/sec. The table below shows the velocity through a silt pond of varying size from 8m width to 12m width with depths below the inlet pipe invert of 1.5m and 2m depth. This table has been prepared assuming the pipe used is a new Corri-Pipe with a smooth internal bore and the pipe is laid at a gradient of 1 in 300. This exercise has also been completed for a CorriPipe (insitu) and for a concrete pipe (See Appendix D herein). The velocities through the silt pond are set out in the Table below and the use of inlet pipes ensure that these velocities are less than that required by the licence.

This is conservative as pipes throughout Bord na Mona bogs are generally laid at a gradient of 1 in 1000. At some silt pond locations, the inlet pipes may be slightly upstream of the silt pond with an open drain flowing into the silt pond. These pipes, however, will restrict the flow into the silt pond provided there is no additional flow into the open drain between the pipe and the silt pond. The table below shows that use of a pipe up to a diameter of 750mm laid at a gradient of 1 in 300 or flatter will restrict the flow through a silt pond, 8m to 12m wide and 1.5m to 2m deep, so that the velocity is less than 10cm/sec.

In the Boora Bog group the inlet and outlet pipes provided are generally 450mm and 600mm dia pipes which ensures that the velocity through the silt ponds is less than 10 cm/sec. While it is preferable to have both the inlet and the outlet piped, once one or other is piped with a pipe diameter not exceeding 750mm the flow through the silt pond is controlled.

New Corripipe (Ks =0.006)							
Silt Pond width (m)	Silt Pond Depth (m)	Inlet and Outlet pipe Diameter (mm)	Inlet and Outlet pipe Slope (1 in ..)	Flow through inlet and outlet pipe (New Corripipe) Q (m^3/s)	Velocity through Silt pond V (m/s)	Velocity through Silt pond V (cm/s)	Permitted Velocity through Silt Pond V (cm/s)
8	1.5	375	300	0.149	0.012	1.2	10
8	2	375	300	0.149	0.009	0.9	10
12	1.5	375	300	0.149	0.008	0.8	10
12	2	375	300	0.149	0.006	0.6	10
8	1.5	450	300	0.242	0.020	2.0	10
8	2	450	300	0.242	0.015	1.5	10
12	1.5	450	300	0.242	0.013	1.3	10
12	2	450	300	0.242	0.010	1.0	10
8	1.5	600	300	0.517	0.043	4.3	10
8	2	600	300	0.517	0.032	3.2	10
12	1.5	600	300	0.517	0.029	2.9	10
12	2	600	300	0.517	0.022	2.2	10
8	1.5	675	300	0.706	0.059	5.9	10
8	2	675	300	0.706	0.044	4.4	10
12	1.5	675	300	0.706	0.039	3.9	10
12	2	675	300	0.706	0.029	2.9	10
8	1.5	750	300	0.931	0.078	7.8	10
8	2	750	300	0.931	0.058	5.8	10
12	1.5	750	300	0.931	0.052	5.2	10
12	2	750	300	0.931	0.039	3.9	10

Table 3: Velocity through Silt Pond for Various Inlet and Outlet Pipes and Silt Pond Sizes.

3.4 Silt Pond Maintenance

All silt ponds serving operational bogs are cleaned as a minimum twice a year and more frequently as inspections may dictate in accordance with Condition 6.8 of the existing IPC licence for the Boora Bog Group. Cleaning of the silt ponds is overseen and arranged by the Compliance Officer for the area. Bord na Móna inspect and maintain the silt ponds in accordance with the Silt Pond Cleaning Procedure (FS-BM-07) which is included in Appendix E. A visual inspection of each silt pond is carried out on a fortnightly basis in accordance with Condition 6.7 of the existing licence and based on this visual assessment the silt ponds may be cleaned more frequently than twice a year. A log of all silt pond cleaning is maintained by the Compliance officer.

All silt ponds prone to flooding are de-silted by 1st November each year in accordance with the existing licence and excavated material from these silt ponds is removed for disposal to a location outside the flood plain as required in the existing licence. There are no silt ponds in the Boora Bog Group that have been specifically identified as prone to flooding.

3.5 Drainage Design in In-active Bogs

A significant number of Bord na Móna bogs and areas of bogs are no longer in active production. As production fields come out of use they become naturally colonised with vegetation and field drains that are not in use become overgrown. In the Boora Bog group, peat production has now ceased on eight

bogs and ten bogs will have production in some areas of the bog. In the bogs still in production, not all of the licenced area is operational and some areas have revegetated.

The run-off from these areas of the bog that are no longer in production will continue to be diverted through the silt ponds in accordance with the existing IPC licence requirements. These in-active areas, however, are not taken into consideration when calculating the silt pond capacity as the silt run-off from these areas is greatly reduced. This is due to the fact that no milling, ridging, harvesting or other peat production activity is taking place on these fields so the silt generated will be greatly reduced. In addition, as vegetation is established on the in-active production fields the peat will be stabilised. Cleaning and deepening of field drains is no longer carried out when production has ceased and this permits the natural vegetation of these drains. The field drains will not function efficiently with this vegetation, ensuring the retention time in the drain of runoff from the former production fields is increased. This will ensure any silt that may be present from the run-off will settle out or will be trapped by the vegetation in the drain.

When the full bog area comes out of production a decommissioning and rehabilitation plan will be implemented for each bog. The rehabilitation plan will be submitted to the EPA for approval prior to the commencement of any rehabilitation works.

A number of rehabilitation measures comprising naturalisation and development of alternative after uses have been already explored at the Boora Bog Group, including coniferous forestry, biomass, agricultural grassland, amenity use, rare species conservation management (specifically Grey Partridge) and wetland creation. Agricultural fields and coniferous forestry have also been developed successfully on the cutaway bogs at Boora, however these require significant financial investment.

3.6 Drainage Design – Rehabilitated Bogs

The rehabilitation bog drainage will be set out in the rehabilitation plan for each bog which will be submitted to the EPA for approval prior to the commencement of the work. Assessment of the existing drainage and re-wetting scenarios will be carried out for each bog to assess the potential to enhance wetland development. The potential impact on adjacent lands will also have to be considered in this assessment. This is addressed further in the section on Rehabilitation and de-commissioning below.

3.7 Drainage design in Flood Risk Areas

The following specific actions / procedures to address the flood risk shall be implemented in all bogs and silt pond areas at risk of flooding

- All fields liable to winter flooding to be cleared of milled peat or re-compacted at the end of the production season;
- All silt ponds prone to flooding to be de-silted by the 1st November each year;
- Excavated silt to be removed for disposal to an area outside the flood plain;

3.8 Bunds

The IPC licence for the Boora Bogs requires that all tank and drum storage areas are bunded. There are eleven external bunds in the Boora Bog group and integrity testing is carried out on these bunds every two years.

Bord na Mona have a Bund Maintenance & Integrity Procedure to provide for the efficient maintenance and integrity testing of bund structures (SOP-BM&IP Rev 4). Bord na Mona have a procedure in place for Gas Oil Loading that includes external delivery, internal loading and dispensing (SOP-VSD-Rev 1).

Appendix 5. Example of a Drainage Layout – Monettia Bog.

NOTES:

1. THIS DRAWING IS FOR PLANNING APPLICATION PURPOSES ONLY.
2. DRAWING NOT TO BE SCALED. FIGURED DIMENSIONS ONLY TO BE USED.
3. ALL LEVELS TO MALIN HEAD METRES ABOVE DATUM

REFERENCE OSI MAP NO: 3545, 3546, 3594, 3595, 3650, 3651
ORDNANCE SURVEY IRELAND LICENCE REF NO: EN0035620

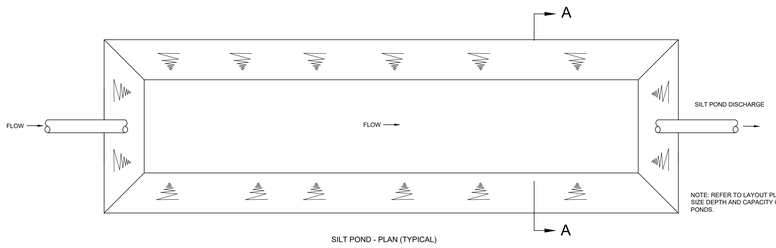
LEGEND:

- SUBSTITUTE CONSENT APPLICATION BOUNDARY:
- PRODUCTION FIELD DRAINS
- EXISTING DRAIN
- EXISTING SURFACE WATER PIPE
- EXISTING SILT POND
- MILLED PEAT PRODUCTION FIELDS (2012 ONWARDS):
- MILLED PEAT PRODUCTION FIELDS PROPOSED EXTENTS (2020 ONWARDS):
- TREES

PIPE IL:81.04 DIA:0.45
PIPE IL:80.67 DIA:0.45
SILT POND MA53A
PIPE IL:81.15 DIA:0.45
PIPE IL:80.67 DIA:0.45
PIPE IL:77.58 DIA:0.6
SILT POND MA51A
SILT POND MA51B
SILT POND MA51C
PIPE IL:78.54 DIA:0.6
PIPE IL:77.71 DIA:0.6
PIPE IL:77.79 DIA:0.6
PIPE IL:78.35 DIA:0.45
PIPE IL:78.54 DIA:0.45
PIPE IL:79.97 DIA:0.45
PIPE IL:78.72 DIA:0.6
PIPE IL:78.43 DIA:0.45
PIPE IL:79.21 DIA:0.6
PIPE IL:79.97 DIA:0.6
PIPE IL:80.03 DIA:0.45
PIPE IL:78.06 DIA:0.45
PIPE IL:77.84 DIA:0.6
PIPE IL:77.33 DIA:0.6
PIPE IL:77.55 DIA:0.6
PIPE IL:79.10 DIA:0.45
PIPE IL:80.45 DIA:0.45
PIPE IL:80.23 DIA:0.6
PIPE IL:79.78 DIA:0.6
PIPE IL:80.96 DIA:0.45
PIPE IL:80.13 DIA:0.45
PIPE IL:46.13 DIA:0.45
PIPE IL:80.91 DIA:0.45
PIPE IL:81.60 DIA:0.45
PIPE IL:81.35 DIA:0.45
PIPE IL:80.72 DIA:0.45
PIPE IL:80.70 DIA:0.45
PIPE IL:80.39 DIA:0.45
PIPE IL:79.34 DIA:0.6
PIPE IL:78.28 DIA:0.6
PIPE IL:77.80 DIA:0.6
SILT POND MA55
SILT POND MA52
PIPE IL:77.56 DIA:0.6
PIPE IL:78.22 DIA:0.6
SILT POND MA54
PIPE IL:77.6 DIA:0.6
PIPE IL:78.25 DIA:0.6
PIPE IL:77.6 DIA:0.6
PIPE IL:78.00 DIA:0.6
SILT POND MA53
PIPE IL:77.39 DIA:0.6
PIPE IL:79.50
PIPE IL:76.45 DIA:0.45
PUMP SUMP P15-05
SILT POND MA52A
PIPE IL:77.5 DIA:0.6
PIPE IL:77.99 DIA:0.6
PIPE IL:77.43 DIA:0.45
IL:79.445
681.37
Woodside Bridge
Ballyclare Bridge
River Boyne
DRUMMOND

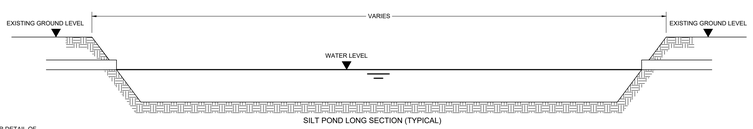
SCALE BAR 1:5000
0 100 500 1000

DRAINAGE LAYOUT PLAN
SCALE 1:5000

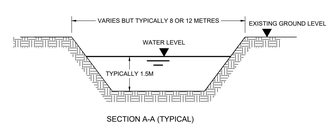


SILT POND - PLAN (TYPICAL)

NOTE: REFER TO LAYOUT PLAN FOR DETAIL OF SIZE DEPTH AND CAPACITY OF INDIVIDUAL SILT PONDS.



SILT POND LONG SECTION (TYPICAL)



SECTION A-A (TYPICAL)

SILT POND TYPICAL DETAIL
SCALE 1:100

REVISION	By	Date	Chk'd

Project: SUBSTITUTE CONSENT APPLICATION MONETTIA BOG

Title: DRAINAGE LAYOUT PLAN

Dimensions in	METRES		
Scale.	AS SHOWN @ A0		
Drawn By.	SD	16/04/20	
Checked By.	PN	17/04/20	
Approved By.	DK	17/04/20	

BORD NA MÓNA
Naturally Driven
Bord Na Móna Engineering Department
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Drawing No. SC-0500-MN-DR04 | Revision. | Sheet 1 of 1