OPERATIONAL REPORT FOR CONNOLLY'S RED MILLS ANIMAL FEED MILL LICENCE APPLICATION.

Prepared for:

CONNOLLY'S RED MILLS,

GRANGE LOWER,

GORESBRIDGE,

CO. KILKENNY

JRE Environmental Consulting

3254 – Connolly's Red Mills

November 10th, 2017

ISSUE/REVISION INDEX

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Prepared by; Billy Shanahan, M.Sc.

Reviewed by; John Rea, B.Sc., MIEnv.Sc.

1.0 Introduction

Connolly's RED MILLS (Red Mills) has been the home of the Connolly family business since 1908 in Goresbridge, County Kilkenny. With a wealth of experience in steam cooking, pressure cooking and extrusion, in 1963 the company began processing cereals for animal. By 1997, Connolly's RED MILLS was introduced into UK and the USA.

The Red Mills brand is sold in 40 countries around the world, and we continue to build on their reputation for converting fresh, natural ingredients into the most trusted feed for peak performance right around the world.

The facility is located approximately 1km to the north of the village of Goresbridge. The site has an area of approximately 67,600 m² as seen in Figure 1.

Figure 1. Site Area

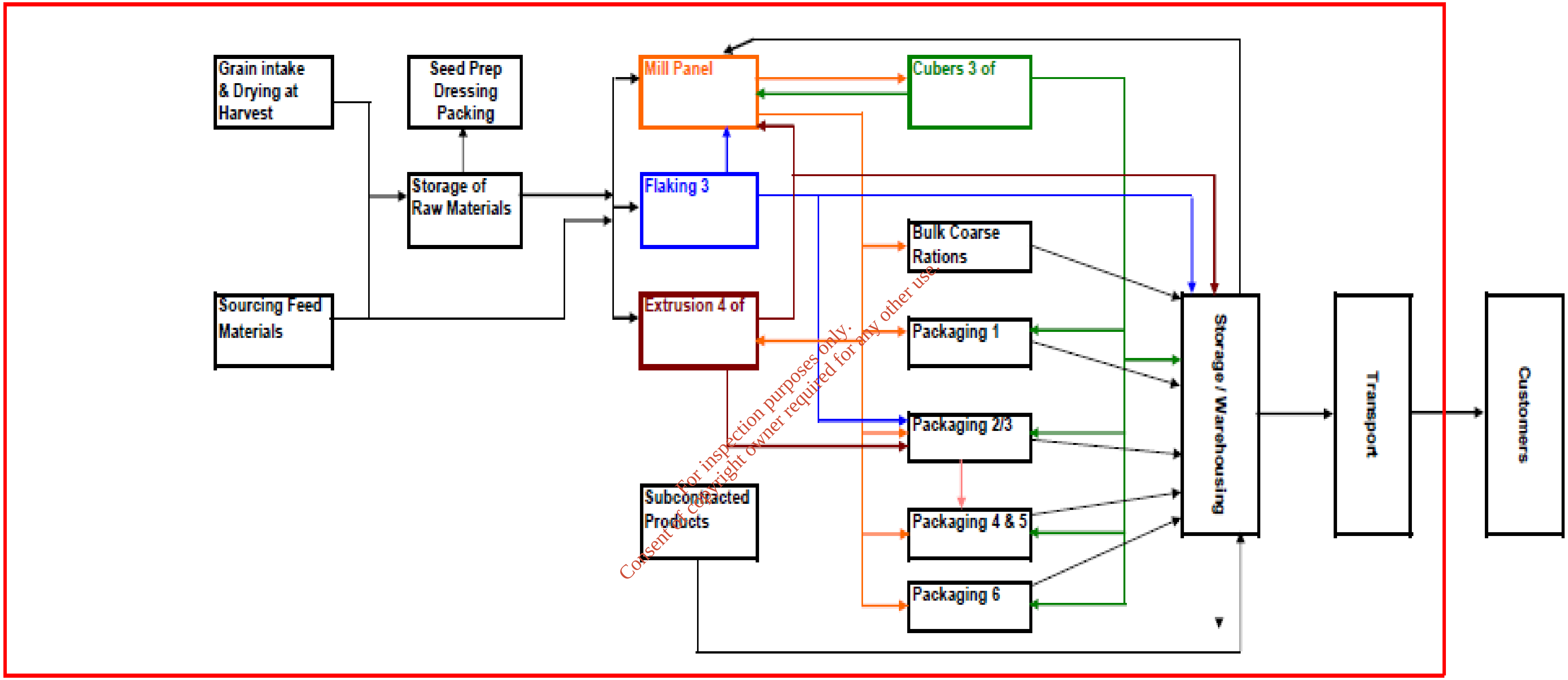
2.0 Operational Report

This section will outline the operations which occur at the Red Mills site, the process, plant abatement and recovery and treatment systems.

2.1 Operation Process

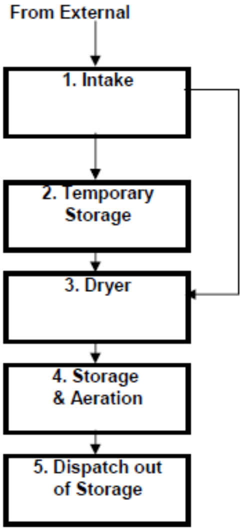
Under the Red Mills brand, the feed mill produces nutrition for a wide range of animals using advanced feed manufacturing technology and nutritional research, together with fully traceable ingredients, Red Mills offer high-quality, consistent and nutritious feeds to their customers. Figure 2 shows an overview of the processes at the Red Mills site.

Figure 2: Overview of Red Mills Process



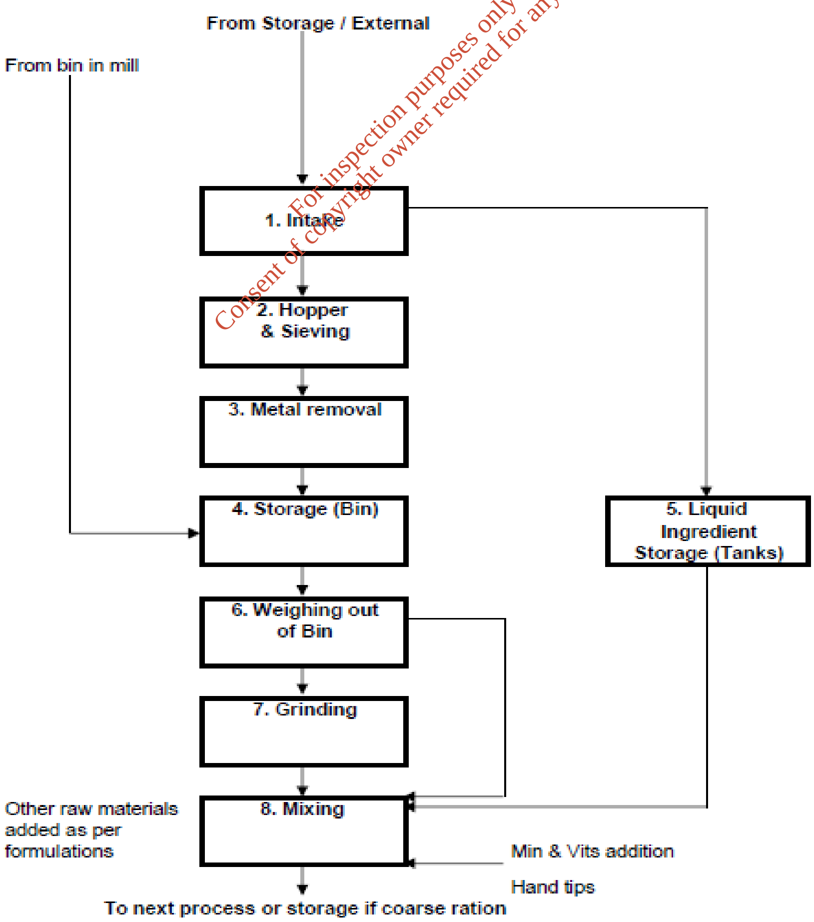
Grain is taken in at the site and is stored, dried and aerated before being dispatched out of storage, as shown in Figure 3.

Figure 3: Grain Intake and Drying



Grain from storage and some raw material from intake are put through the mill, as seen in Figure 4.

Figure 4: Mill Panel



Certain grains are sent from the mill to the flaker, the flaker process is seen in Figure 5.

Figure 5: Flaking

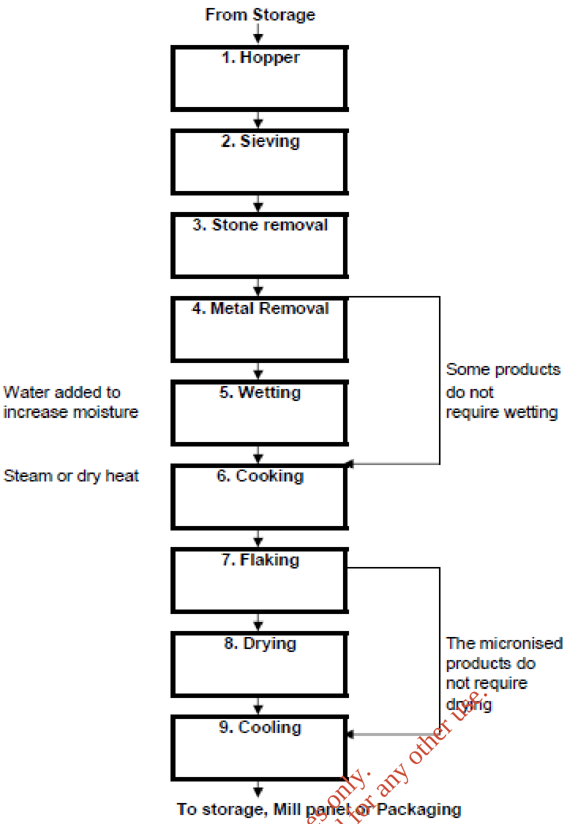
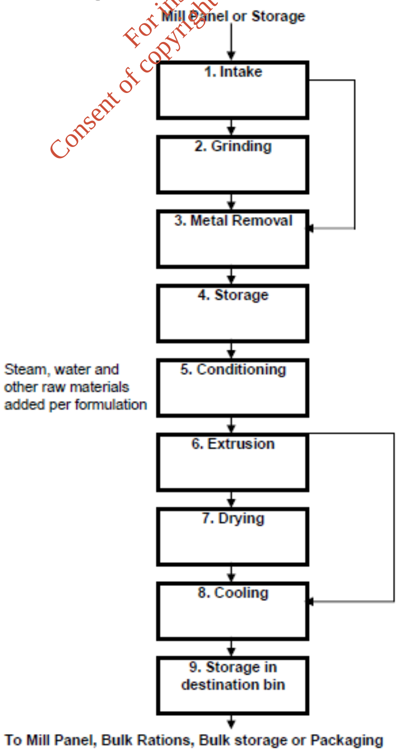


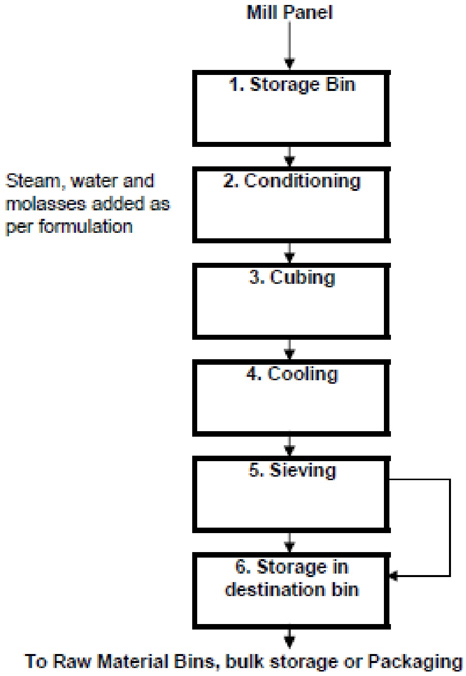
Figure 6 shows the flow of products through the Extrusion Plant.

Figure 6: Extrusion Plant Process



Grain moves from the mill panel for cubing, the flow process of the Cubing Plant is shown in Figure 7.

Figure 7: Cubing Plant



Processed Product is then sent to the Packers, there are six packers on site. The packaging lines are paired as lines 1 & 3 and lines 2, 4, 5 & 6. The flow process of both are outlined in Figure 8 and Figure 9.

Figure 8: Packaging Lines 1 & 3

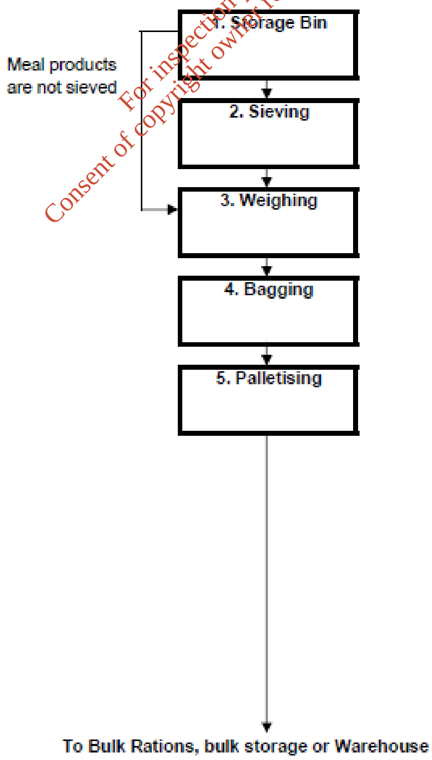
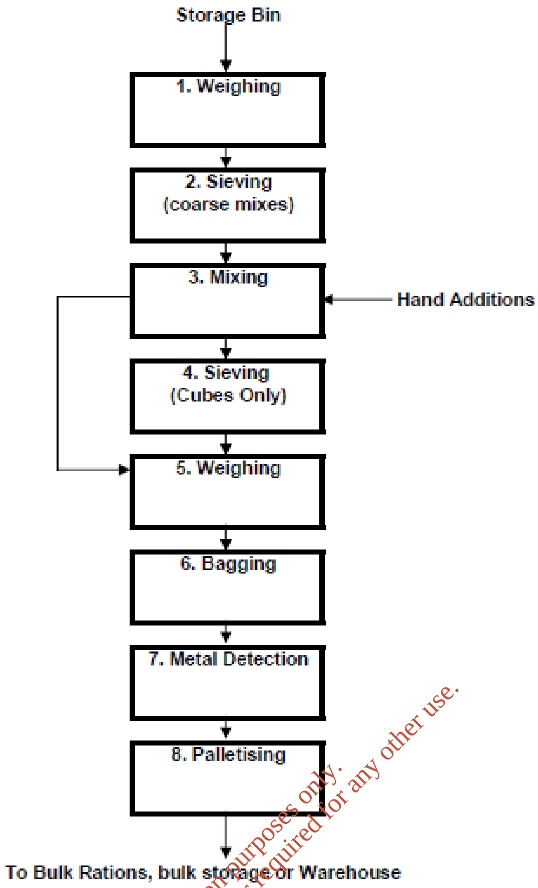
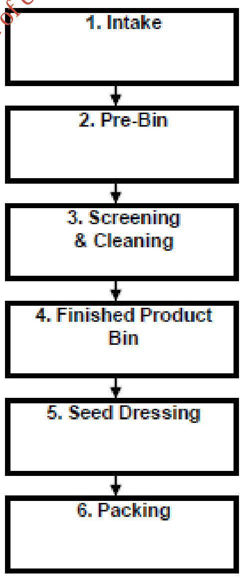


Figure 9: Packaging Lines 2, 4, 5 & 6



Seed is taken in at the Red Mills site, Figure 10 outlines the process which occurs in the Seed Plant.

Figure 10: Seed Plant



2.2 Process Control Systems

The main emission from all the unit operations at the Red Mills site is particulate output from the various processing associated with the Mill operations. There are a significant number of dust recovery cyclones included on emission ducts from areas of the site to reduce dust emissions from the site. For certain activities the cyclones may also have sock filters included also to further reduce potential particulate emissions.

2.3 Abatement Systems

The main cyclones used in the mill process (e.g., Flakers, Extruders and Cubers) are Geleen cyclone systems.

Kamas bag / sock filters are also employed as abatement at a number of emission points to reduce potential dust emissions (e.g., mill grinders in mixing and blending area, and the grinder at extruder 2).

2.4 Site Capacity & Throughput

The current throughput at the Red Mills facility is approximately 200,000 tonnes per annum. The site capacity is for the production of up to 300,000 tonnes of product per year. The site does not operate on Sundays or Bank Holidays. Based on an average number of 304 operational days per year (i.e., 365 Days minus 52 Sundays and 9 Bank Holidays) the daily capacity of the site is 987 tonnes per day.

2.5 Laboratory Activities Laboratory Activities

The laboratory area is used for quality control purposes (i.e., testing grain inputs and final products).

2.6 Abatement

This section will outline the abatement systems which are currently in place at the site. The air abatement in p[lace on site is included in the air emissions register included in Attachment 1. .

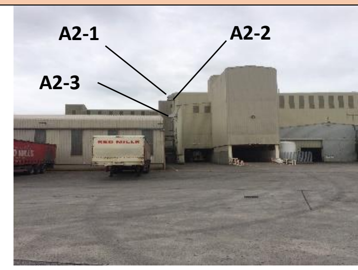
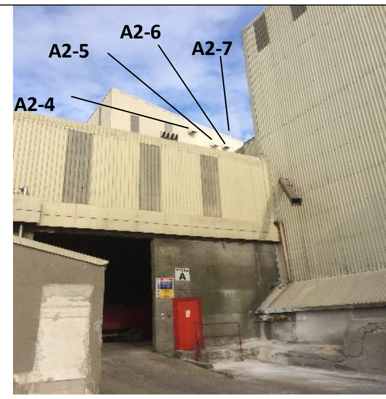
2.7 Sewerage & Surface Water Drainage

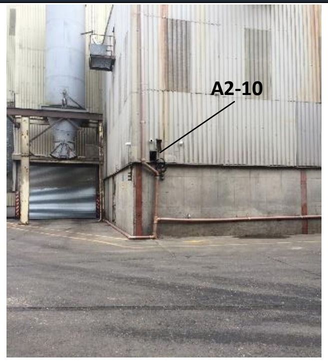
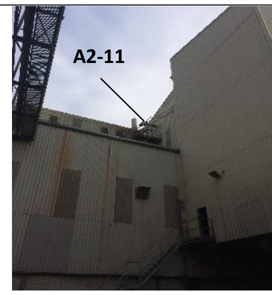
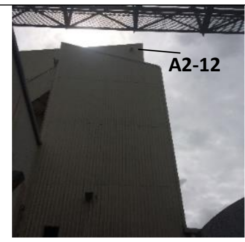
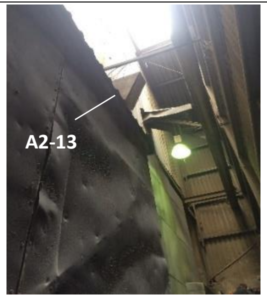
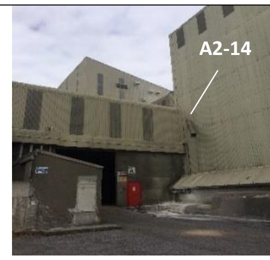
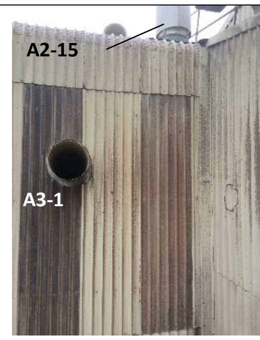
Details of the sewerage and surface water drainage systems are included in the surface water management system report included in Attachment 2

ATTACHMENT 1

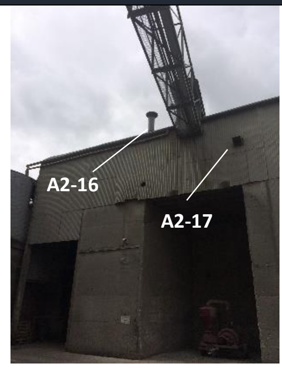
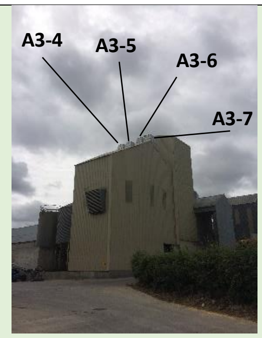
Air Emissions Register

Connolly REDMILLS Air Emission Register

Emission Reference I.D	Source Description	Emission Type	Major / Minor Emission	Abatement	Coordinates	Photo
BOILER HOUSE						
A1-1	Boiler	NOx, SOx	Major	N/A	667954E, 654321N	
A1-2	Back-up Boiler	NOx, SOx	Major	N/A	667951E, 654325N	
MILL PRODUCTION BUILDING						
A2-1	Cuber 1	Particulates	Major	Cyclone	667960E, 654238N	
A2-2	Cuber 2	Particulates	Major	Cyclone	667967E, 654243N	
A2-3	Cuber 3	Particulates	Major	Cyclone	667975E, 654247N	
A2-4	Flaker 1	Particulates	Major	Cyclone & Socks	667948E, 654226N	
A2-5	Flaker 1	Particulates	Major	Cyclone & Socks	667954E, 654273N	
A2-6	Flaker 2	Particulates	Major	Cyclone & Socks	667951E, 654259N	
A2-7	Flaker 2	Particulates	Major	Cyclone & Socks	667961E, 654262N	
A2-8	Flaker Cyclone	Particulates	Major	Cyclone	667944E, 654254N	
A2-9	Flaker Cyclone	Particulates	Major	Cyclone	667954E, 654243N	

Emission Reference I.D	Source Description	Emission Type	Major / Minor Emission	Abatement	Coordinates	Photo
A2-10	Soya Grinder Emission	Particulates	Major	Cyclone	667919E, 654292N	
A2-11	Soya Extruder Emission	Particulates	Major	Cyclone	667929E, 654271N	
A2-12	Soya Cyclone – Bin Filling	Particulates	Major	Cyclone	667943E, 654277N	
A2-13	Grinder 4 Dust Extraction	Particulates	Major	Sock Filter	667949E, 654280N	
A2-14	Main Grain Intake	Particulates	Major	Sock Filter	667950E, 654213N	
A2-15	Extruder Vent	Particulate	Major	Cyclones	667962E, 654306N	
A3 - 1	Extruder Dryer / Cooler Vent	Hot Air	Minor	None	667961E, 654321N	

Dryers

Emission Reference I.D	Source Description	Emission Type	Major / Minor Emission	Abatement	Coordinates	Photo
A2-16	Dryer 2	Particulates	Major	Cyclone	667899E, 654288N	
A2-17	Dryer 2	Particulates	Major	Cyclone	667902E, 654299N	
A3-2 & A3-3	Dryer 2	Hot Air Vents	Minor	None	667905E, 654288N 667904E, 654290N	
A3-4	Dryer 2	Carryover Vent	Minor	None	667903E, 654288N	
A2-18	Dryer 5	Particulates	Major	Cyclone	667964E, 654496N	
A3-5 A3-6 A3-7 A3-8	Dryer 5 – Hot Air Fan Exhausts	Hot Air Vents	Minor	None	667959E, 654495N 667965E, 654501N 667957E, 654491N 667961E, 654501N	

Dryers						
Emission Reference I.D	**Source Description**	**Emission Type**	**Major / Minor Emission**	**Abatement**	**Coordinates**	**Photo**
A3 - 9 A3 - 10	Dryer 6 – Coarse Rubble Dryer 6 – Fine Rubble	Coarse fines & Rubble	Minor	Cyclone – located inside shed	667972E, 654593N 667972E, 654577N	
A3-11 A3-12 A3-13	Dryer 4B - Hot Air Fan Exhaust Dryer 4B- Hot Air Fan Exhaust Dryer 4 - Hot Air Fan Exhaust	Hot Air Vents	Minor	None	667959E, 654465N 667961E, 654461N 667957E, 654470N	
A3-14	Dryer 4 & 4B - Coarse Rubble	Coarse fines & Rubble	Minor	Cyclone – located inside shed	667950E, 654474N	
			Seed Plant			
A2-19 A2-20 A2-21 A2-22	Seed Plant	Particulates	Major	Cyclones	667975E, 654441N 667983E, 654435N 667969E, 654419N 667977E, 654415N	

Connolly REDMILLS Air Emission Register

Laboratory						
Emission Reference I.D	**Source Description**	**Emission Type**	**Major / Minor Emission**	**Abatement**	**Coordinates**	**Photo**
A3-15 A3-16	Laboratory Fume Hood	Minor Chemical	Minor	Filters	668004E, 654433N 668011E, 654430N	
A2-23	Packer 2	Particulates	Major	Cyclone	667971E,654259N	

ATTACHMENT 2

Surface Water Management Plan

WILLIAM CONNOLLY & SONS

CONNOLLY'S RED MILLS, GORESBRIDGE, CO. KILKENNY

SURFACE WATER MANAGEMENT PLAN (AMENDED)

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

Integrated Engineering Consulting

WILLIAM CONNOLLY & SONS

CONNOLLY'S RED MILLS, GORESBRIDGE, CO. KILKENNY

SURFACE WATER MANAGEMENT PLAN (AMENDED)

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Table of Contents

Appendix A	*Drawing Number IE1540_001_A*
Appendix B	*IE Consulting Report 784, March 2013*
Appendix C	*Log Keeping Documents*

1 Introduction

IE Consulting Engineers were requested by Connolly's Red Mills, Goresbridge, Co. Kilkenny to update the existing Surface Water Management Plan for the Red Mills factory complex at Goresbridge. This plan is supplementary to IE Consulting Engineers Report 264, which responded to Kilkenny County Council's Section 23 Notice of the 27th of September 2006. The following report has been amended and should be read in conjunction with *Drawing No. IE1540_001_A.*

The purpose of this plan is to ensure adequate day-to-day management of the drainage system and associated infrastructure, and ultimately, to ensure that surface water from the factory complex does not present a polluting risk to nearby watercourses.

2 Capital Works

A series of capital works have been undertaken since the original Surface Water Management Plan was developed in 2006 in order to improve the surface water drainage system within the facility since 2007. An Integrated Constructed Wetland (ICW) has been installed to treat surface water from the grain yard and details of the ICW and its management plan, *IE Consulting Report 784, March 2013* is included in *Appendix B*.

3 On-going Procedures

3.1 Inspection of Gullies

All gullies shall be inspected on a before and after the harvest period to ensure that there are no blockages and that water can enter the surface water drainage system without impediment. Gullies shall be cleaned when necessary.

3.2 Inspection of Separation Tanks

During the harvest period, all separation tanks and bypass separators are to be checked, on a fortnightly basis, to ensure that they are not full and are operating satisfactorily. Tanks shall be cleaned and de-sludged three times a year or when necessary. The sludge will be removed from site by a licenced contractor.

3.3 Cereal Control

If possible, the loading/unloading of loose materials (e.g. cereal) should take place under the cover of the stores. This is in order to minimise the cereal particles are left on a hard standing area. Any cereal material which is deposited on hardstanding areas should be removed by mechanical sweeper or otherwise.

3.4 Training

Appropriate work practices on site are vital to ensuring the quality of the surface water discharging to neighbouring watercourses. Training in order to ensure good site practice shall be provided. The aim of this training will be to increase awareness among staff of the risks to surface water, and to highlight the potential water pollution implications of certain activities on site.

4 Monitoring and Verification

4.1 Sampling

A sampling programme shall be put in place in order to monitor the quality of surface water discharge from the factory complex. 5No. locations of the sampling points are shown in *Drawing No. IE1540_001_A.*

It is proposed to take the samples on a quarterly basis. The samples shall be analysed for the following parameters:

- *Biochemical Oxygen Demand (B.O.D.$_{5}$)*
- *ph*
- *Suspended Solids*
- *Total Ammonia (as N)*
- *Nitrates*
- *Total Phosphorous*
- *Orthophosphate*
- *Fats/oils/grease*
- *Total Hydrocarbons*

The frequency of sampling can be modified, depending on the quality of the results.

It is also proposed that 2 No. samples are taken from the ICW system on a quarterly basis. The sample locations from the ICW system are, 1No. sample from the inlet to Pond 1 and 1No. from the outlet of Pond 4. The ICW samples are analysed for the same parameters as per the surface water samples above.

4.2 Log Keeping

Details of all inspections, as described in Section 3 above, are to be recorded. This shall involve a standard sheet being prepared, with the time and date of inspection noted, along with comments on any issues encountered during the inspection.

Records of the water quality results will be tabulated and hardcopies will be archived, if required for submission to the appropriate authority. An example of the tabulated results is shown in *Appendix C.*

5 Emergency Response Plan

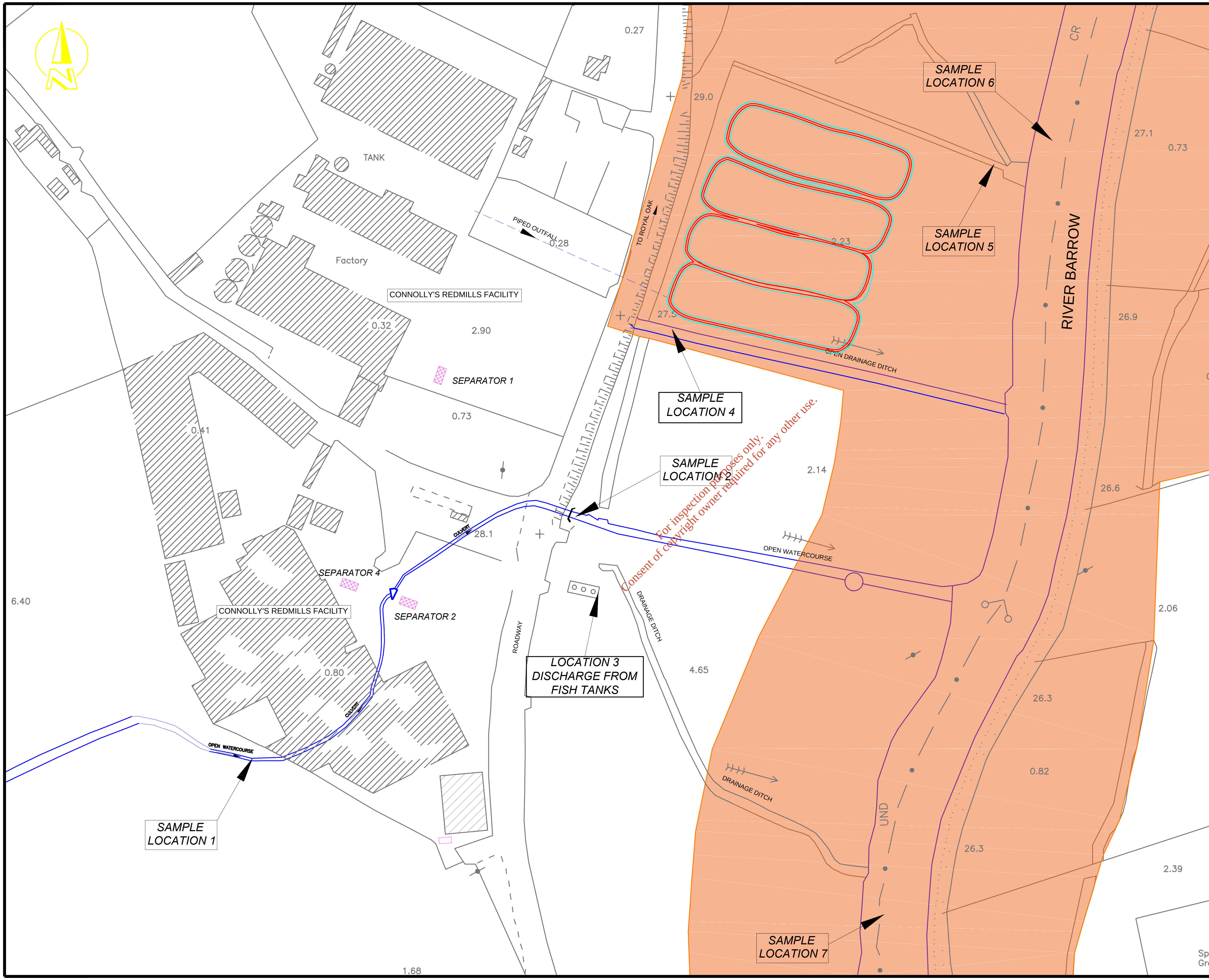
In the event of a major spillage of a PRO/DRO pollutant, the procedure below shall be adopted. Staff will be made aware of this procedure as part of the training process (outlined in Section 4.4 above).

- Upon the identification of a spillage, the outlet from the nearest downstream manhole shall be blocked with a suitable bung.
- If the spillage is located in the cereal storage area and enters the ICW the outfall from the first ICW pond shall be blocked with a suitable bung.
- If deemed necessary, the downstream outlet for the surface water shall also be closed off. On the southern side of the site, this implies that the penstock at the 'Triangular Bridge' shall be closed, while on the northern side of the site, there shall be a valve installed before the outlet pipe discharges from the site, and this shall be closed.
- A specialist contractor shall be commissioned to remove the contaminating spillage from site, and also to clean the manholes/pipework affected by the spillage.

It is important that there are a ready supply of bungs available on site and that all relevant persons know where they can be found in the event of a spillage.

APPENDIX A

Drawing Number IE1540-001-B



LEGEND

- WATERCOURSE
- RIVER BARROW AND RIVER NORE SAC
- CONSTRUCTED WETLAND

NOTES:-

1. DO NOT SCALE FROM THIS DRAWING. FOR INFORMATION ONLY
2. ANY DISCREPANCIES OR ERRORS ON THIS DRAWINGS ARE TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER

rev.	date	amendment	drn	ckd
B	04.01.18	REPORT	DB	PMS
A	13.12.17	REPORT	DB	PMS

CONNOLLY'S RED MILL, GORESBRIDGE, CO. KILKENNY

SURFACE WATER MANAGEMENT PLAN

SURFACE WATER SAMPLING LOCATIONS

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EMAIL: info@iece.ie

file location:	N:\IE1540\DRAWINGS		scale:	NTS
				A3
drawing status:	REPORT		datum:	N/A
			drawn:	DB
drawing no.	IE1540-001	rev B	checked:	NOM
			approved:	PMS
			date:	04/01/2018

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

APPENDIX B

IE Consulting Report 784, March 2013

Connolly's RED MILLS

WILLIAM CONNOLLY & SONS

REDMILLS,

GORESBRIDGE, CO KILKENNY

PROPOSED INTEGRATED CONSTRUCTED WETLAND (ICW) SYSTEM

SUMMARY PLANNING REPORT

IE CONSULTING
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VEARNCOMBE ASSOCIATES
CONSULTING ENGINEERS

Integrated Engineering Consulting
An Associate Company of VA Consulting Engineers & Geotechnical & Environmental Services Ltd

GES Limited

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

WILLIAM CONNOLLY & SONS

REDMILLS,

GORESBRIDGE, CO KILKENNY

PROPOSED INTEGRATED CONSTRUCTED WETLAND (ICW) SYSTEM

SUMMARY PLANNING REPORT

IE Consulting
Innovation Centre
Green Road
Carlow

Client :-
William Connolly & Sons
Redmills,
Gorebridge,
Co. Kilkenny.

Document No:	IE771/874
Issue No:	01-issue
Project No:	IE771
Date:	4th March 2013
Revision:	1.0
Prepared By:	Maeve Rochford, BSc Geology, MSc. Environmental Engineering
Checked By:	P McShane BEng (Hons) MIEI J Keohane MSc BSc CGeol FCIWEM

Table of Contents

1 Introduction

IE Consulting were requested by Connolly's Redmills, Goresbridge, Co Kilkenny, to undertake the planning stage design for a proposed Integrated Constructed Wetlands (ICW) system to be constructed on lands directly opposite the Connolly's Redmills facility.

The purpose of the proposed ICW system is to treat potentially organic enriched surface water run-off from an area of the Connolly's Redmills facility. Surface water run-off from this area has the potential to become organically enriched during the grain harvest campaign period, which generally occurs during the months of August and September each year.

This planning report summaries the requirement and design of the proposed ICW system and should be read in conjunction with the accompanying drawings, maps and relevant details.

2 Requirement for ICW System

In September 2011 Kilkenny County Council issued a Section 12 Notice to Connolly's Redmills in relation to discharge from a surface water drainage pipe to a ditch watercourse on lands opposite the Connolly's Redmills facility. IE Consulting subsequently prepared a reply to the Section 12 Notice which assessed water quality sampling undertaken by Kilkenny County Council and Connolly's Redmills Ltd, identified the probable cause of the pollution incident as highlighted in the Section 12 Notice, discussed future mitigation works and provided details of remediation works which were undertaken on the drainage ditch watercourse.

As identified in the Section 12 Notice reply the probable cause of the pollution incident is due to the generation of organic enriched surface water run-off from stockpiles of grain during precipitation events and from spilled grain modules which become crushed by vehicular traffic and mix with hardstanding yard run-off. This mix of run-off from grain stockpiles and crushed grain modules accounts for the elevated levels of COD, Ammonia (N) and Ortho-Phosphate (P) as previously sampled and analysed by Kilkenny County Council. The area within the Connolly's Redmills facility which generates the potentially organic enriched surface water run-off is illustrated within the yellow line in *Figure 1* below.

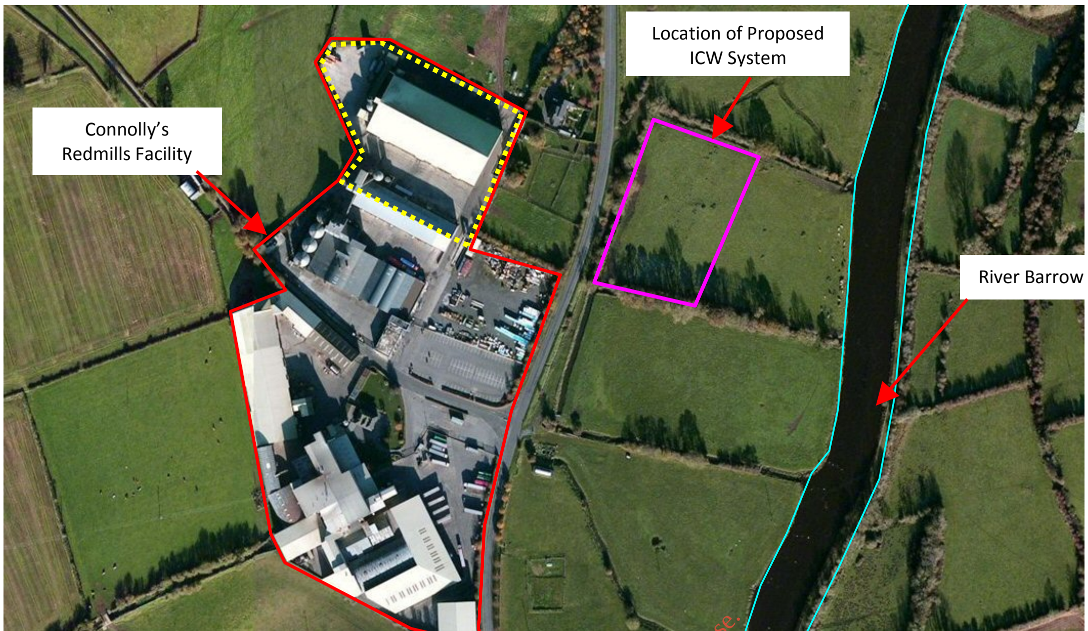

Figure 1

This area is approximately 12,300m^2 and comprises roof areas and hardstanding yard areas. Stockpiling of grain is generally not undertaken in any other hardstanding area of the Connolly's Redmills facility.

Any organically enriched surface water run-off is only likely to occur during the grain harvest campaign period, which generally runs from August to September each year.

In order to mitigate against any adverse impact to the receiving watercourse, due to surface water run-off from the catchment area shown above (*Figure 1 -yellow line*), a number of possible mitigation measures were assessed and a feasibility scoping exercise undertaken. The outcome of this scoping exercise concluded that a suitably designed and constructed ICW system would provided the most economically viable and environmentally sustainable method of intercepting and treating potentially organic enriched surface water run-off from this area of the Connolly's Redmills facility. The location of the proposed ICW system is shown in *Figure 1* above.

Section 3 below provides additional detail of the proposed ICW system to be implemented.

3 Proposed Integrated Constructed Wetlands (ICW) System

Calculations detailing the size and performance of the proposed ICW system are presented in *Appendix A*. It is proposed to provide an ICW system within a minimum pond surface area of 8500m^2 (0.85 hectares). The methodology used to size and assess the performance of the proposed ICW system is summarised below.

3.1 Surface Water Run-Off Area

The proposed ICW system will deal with surface water run-off from a total catchment area of approximately 12,300m^2, comprising approximately 4810m^2 of roof area and approximately 7190m^2 of hardstanding yard area. The catchment area is illustrated in *Figure 1* above (*yellow line*).

For surface water run-off assessment purposes roof areas and yard areas are assumed to have a run-off co-efficient of 0.90 and 0.80 respectively, therefore the effective contributing catchment area =

(4810 x 0.90) + (7190 x 0.80) = 10,081m^2

3.2 Quality of Surface Water Run-Off As Discharged to the ICW

The performance of the proposed ICW system has been assessed in consideration of the main surface water quality parameters of Ammonia (N) and Otho-Phosphate (P) *(assumed to equate to Molybdate Reactive Phosphorus)* and also Chemical Oxygen Demand (COD). For the purposes of calculation and assessment of the performance of the ICW system the quality of the surface water run-off is assumed as having maximum COD, Ammonia (N) and Ortho-Phosphate (P) levels, similar to those recorded by Kilkenny County Council in September 2011 at the surface water outfall pipe which will discharge to the proposed ICW system i.e.:-

COD = 5410 mg/l

Ammonia (N) = 13.5 mg/l

Ortho-Phosphate (P) = 10.2 mg/l

It is important to note that the above COD, Ammonia and Ortho-Phosphate levels recorded by Kilkenny County Council in September 2011 are considered as a single one-off incident and a worst case scenario. Analysis of surface water samples taken from the same outfall pipe at approximate 4 month intervals between 2010 and 2012 indicates the following average values of COD, Ammonia and Ortho-Phosphate:-

COD = 22 mg/l

Ammonia (N) = 0.41 mg/l

Ortho-Phosphate (P) = 0.17 mg/l

Nevertheless, the proposed ICW system has been designed in consideration of the maximum parameters recorded by Kilkenny County Council in September 2011. This should provide the proposed ICW system with a relative factor of safety and significant buffering capacity. It is also noted that the proposed ICW system will only have to deal with potential organic enriched surface water run-off for approximately 2 months per year – i.e. August and September during the grain harvest campaign.

3.3 Volume of Surface Water Run-Off as Discharged to the ICW

The volume of surface water run-off which would discharge to the proposed ICW system will be wholly dependant on precipitation levels. It would not be possible to design an ICW system which would deal with all precipitation events that may be expected, therefore the design of the ICW system is based on an assumption of daily average rainfall amounts plus precipitation levels to an approximate factor of 5 in excess of this.

Based on Met Eireann data the annual average rainfall amount for this area of Kilkenny is approximately 823mm, which equates to an average daily rainfall amount of 2.25mm.

In August and September 2011 the average daily rainfall amounts for this geographical region was 0.82mm and 4.6mm respectively. In August and September 2012 the average daily rainfall amounts for this geographical region was 4.11mm and 1.3mm respectively. The design of the proposed ICW system is therefore based in consideration of daily rainfall amounts of 2.25mm (daily average), 5mm (approx 2x daily average) and 11.5mm (approx 5x daily average). This would result in daily discharge volumes to the proposed ICW system of approximately 22.7m^3, 50.4m^3 and 100.8m^3 respectively.

3.4 Assessment of ICW System Performance

The proposed ICW system will generally comprise of a 4 pond cell horizontal surface flow system planted with suitable emergent plant species. Each pond cell with have a minimum surface water area of 2125m^2, equating to a total ICW surface area of 8500m^2.

The predicted performance of the proposed ICW system was analysed using a plug flow reactor model decay equation as presented by Kadlec & Knight (1996) and O'Sullivan (1998). This provides a more detailed analysis of ICW performance in comparison to other methods as it considers ICW system water depth, decay rate constants, water quality background concentrations and the effects of temperature variation. The plug flow reactor equations used to assess the predicted performance of the proposed ICW system are presented in *Appendix A*.

The predicted performance of the proposed ICW system in terms of input and output water quality is summarised in *Table 1* and *Table 2* below. *Table 1* assumes a daily discharge volume of 100.8m^3 (10mm rainfall amount) whilst *Table 2* assumes a daily discharge volume of 50.4m^2 (5mm rainfall amount).

Pond No.	Pond Area (m^2)	COD_{in} (mg/l)	COD_{out} (mg/l)	$Ammonia_{in}$ (mg/l)	$Ammonia_{out}$ (mg/l)	$Ortho\text{-}P_{in}$ (mg/l)	$Ortho\text{-}P_{out}$ (mg/l)
1	2125	5400	1472	13.50	7.20	10.20	5.30
2	2125	1472	403	7.20	4.10	5.30	2.10
3	2125	403	112	4.10	1.90	2.10	0.98
4	2125	112	30	1.90	0.96	0.98	0.34
Total Area	8500		30		0.96		0.34
Final Predicted Discharge Concentration (mg/l)			30		0.96		0.34

Table 1 – Predicted Performance of Proposed ICW System – 100.8m3 Daily Discharge

Pond No.	Pond Area (m^2)	COD_{in} (mg/l)	COD_{out} (mg/l)	$Ammonia_{in}$ (mg/l)	$Ammonia_{out}$ (mg/l)	$Ortho\text{-}P_{in}$ (mg/l)	$Ortho\text{-}P_{out}$ (mg/l)
1	2125	5400	632	13.50	4.10	10.20	2.01
2	2125	632	79	4.10	1.70	2.01	0.97
3	2125	79	26	1.70	0.51	0.97	0.25
4	2125	26	9	0.51	0.24	0.25	0.08
Total Area	8500		9		0.24		0.08
Final Predicted Discharge Concentration (mg/l)			9		0.24		0.08

Table 2– Predicted Performance of Proposed ICW System – 50.4m^3 Daily Discharge

3.5 Significant Rainfall Events

During the months of August and September significant rainfall events in excess of 10mm per daily may be experienced. For example a 24 hour duration 2 year return period rainfall event would result in a daily rainfall amount of approximately 34mm, which would result in approximately 342m^3 of surface water run-off discharge to the proposed ICW system. A 24 hour duration 100 year return period rainfall event would result in approximately 665m^3 of surface water run-off discharge to the proposed ICW system.

Although the proposed ICW system will generally operate at an average water depth of 0.30m – 0.35m within each pond cell, the system can however easily deal with water depths of up to 0.50m-0.55m on a temporary basis. This will provide an additional storage capacity within the proposed ICW system of approximately 1700m^3 – 2125m^3. Therefore, during periods of significant rainfall events the full storage and attenuation capacity within the ICW system can be utilised. The operation and management procedures which will be provided for the proposed ICW system will include procedures for operating and controlling the ICW system during significant rainfall events.

It should be noted that the proposed ICW system has been designed and assessed on the basis that the system would receive a daily discharge of up to 100.8m^3 on a continual basis. In reality the surface water discharge to the proposed ICW system may be zero for durations of several days or more during the grain harvest campaign period.

4 Location & Construction of Proposed ICW System

It is proposed to construct the proposed ICW system on lands opposite the Connolly's Redmills facility. These lands are currently in the ownership of Connolly's Redmills. The proposed location is a suitable site for an ICW system as it allows direct discharge from the existing surface water outfall pipe and will allow a final gravity discharge from the proposed ICW system to an adjacent drainage ditch watercourse.

The location and general layout of the proposed ICW system is shown on *Drawing Number IE771-002-A* and *Drawing Number IE771-003-A.*

4.1 Site Investigation Works

In August 2012 a temporary storage lagoon was constructed within the site area of the proposed ICW system. This storage lagoon was intended to provide a temporary mitigation measure for the duration of the 2012 gain harvest campaign (*August – September 2012*). Details of the temporary storage lagoon were submitted to Kilkenny County Council under a Section 12 Notification.

During the course of construction of the temporary storage lagoon a number of insitu falling head tests were undertaken on the underlying sub-soil layers. These falling head tests indicated that the permeability of the underlying sub-soil material at the site of the proposed ICW system is at least 1 x 10^{-8} m/s. It was also observed that the underlying groundwater level was between 0.4m-0.5m below existing ground levels. Due to the significant rainfall amounts experience during the months of June-August 2012, the groundwater levels observed are considered to be at or close to the seasonally high groundwater levels for the area.

4.2 Construction of ICW Pond Bases & Embankments

The proposed ICW system shall be constructed entirely above existing ground levels using suitable imported sub-soil material. This is to ensure an adequate gravity flow through the various elements of the ICW system and to ensure that the outfall from the ICW system can discharge during periods of elevated water levels in the receiving watercourse.

The pond bases and embankments of the proposed ICW system shall be constructed to a particular earthworks specification to ensure a minimum basal permeability of 1 x 10^{-8} m/s. This earthworks specification has been developed over several years by IE Consulting with particular regard to the construction of ICW systems. A copy of the proposed earthworks specification for construction of the ICW system is contained in *Appendix B. Drawing Number IE771-004-A* illustrates the earthworks construction sequence of the proposed ICW system. All imported sub-soil material brought to site for the construction of the ICW system shall be inspected and certified by an engineer from IE Consulting prior to construction works. During construction of the ICW system several insitu falling head permeability tests shall be undertaken by IE Consulting to ensure minimum basal permeability is achieved.

4.3 Planting of Proposed ICW System

To ensure optimum treatment performance the proposed ICW system shall be planted with suitable emergent plants in accordance with a particular planting specification. This planting specification has been developed over several years by IE Consulting with particular regard to the emergent planting of ICW systems. A copy of the proposed planting specification for the ICW system is contained in *Appendix C*.

4.4 Discharge from ICW System to Receiving Watercourse

As illustrated on *Drawing Number IE771-003-A*, discharge from the final pond of the ICW system shall be to an adjacent existing drainage channel. This channel in turn discharges to the River Barrow approximately 140m downstream.

In order to assess any potential impact to the River Barrow an assimilative capacity assessment has been undertaken. Details of the assimilative capacity assessment are contained in *Appendix E*.

The assimilative capacity assessment indicates that the proposed ICW system would not have an adverse impact on the water quality of the River Barrow.

A Natura Impact Statement for the proposed ICW system has also been undertaken by Openfield Ecological Consultants, which has determined that, subject to certain mitigation measures, the project is not expected to result in any negative impacts to the surrounding environs.

5 Operation, Management & Maintenance of Proposed ICW System

The proposed ICW system shall be operated, managed and maintained in accordance with the specification and recommendations contained in *Appendix D*.

In order to assess the on-going performance of the ICW system it is proposed to undertake routine sampling and laboratory analysis of waters at selected locations within the ICW system. It is proposed that sampling and analysis shall only be undertaken during the period of the grain harvest campaign.

The proposed sampling and analysis regime is summarised in *Table 3* below:-

Sample Point	Sample Method	Analysis Parameter	Sampling Frequency
Inlet to ICW Pond 1	Grab	BOD (mg/l)	Monthly
	Grab	COD (mg/l)	Bi-weekly
	Grab	Ammonia-N (mg/l)	Bi-weekly
	Grab	Ortho-Phosphate-P (mg/l)	Bi-weekly
Outlet From ICW Pond 4	Grab	BOD (mg/l)	Monthly
	Grab	COD (mg/l)	Bi-weekly
	Grab	Ammonia-N (mg/l)	Bi-weekly
	Grab	Ortho-Phosphate-P (mg/l)	Bi-weekly

Table 3

The above sampling and analysis regime will enable the performance of the ICW system to be monitoring during the grain campaign period and to allow any issues with water quality to be identified and rectified, if required.

6 Summary

It is proposed to construct an Integrated Constructed Wetlands (ICW) system on lands opposite to the Connolly's Redmills facility in order to treat potentially organic enriched surface water run-off from an area of the Connolly's Redmills facility.

The occurrence of any potentially organic enriched surface water run-off is only likely to occur during the gain harvest campaign period, i.e. August-September each year.

The proposed ICW system has been designed to include a relevant factor of safety and significant buffering capacity. The system will be constructed to a particular earthworks specification to ensure a minimum basal permeably of $1x10^{-8}$ m/s and planted to specific specification. It is expected that the proposed ICW system shall be constructed and adequately established prior to the commencement of the 2013 grain harvest campaign.

The proposed ICW system shall be operated, managed and monitored during the grain harvest campaign in accordance with the recommendations contained in *Appendix D* - this shall ensure optimum performance of the ICW system.

The Natura Impact Statement and Assimilative Capacity Assessment indicate that the proposed ICW system will not have an adverse impact on the surrounding environment.

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APPENDIX B

ICW – Earthworks Specification

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1.0 GENERAL

1.1 Scope

This specification covers the requirements for earthworks in relation to the construction of the proposed integrated constructed wetland system and pond system to provide tertiary treatment for the proposed primary and secondary wastewater treatment system at Faha East, Faha, Killarney, Co Kerry. The works shall be in general accordance with B.S. 6031 "Code of Practice for Earthworks" and in accordance with *'Integrated Constructed Wetlands – Guidance Document for Domestic Wastewater Applications – DoEHLG, November 2010'.*

The recommended sequence of construction to comply with this earthworks specification is shown on *Drawing Number IE651-003-A*.

1.2 *Definitions*

1.2.1 Engineer

The Engineer referred to in this specification means the Civil/Structural Engineer appointed by the Employer or the Architect for the purposes of the construction contract.

1.2.2 Contractor

The Contractor (including sub-contractors) referred to in this specification means the person or persons responsible for the physical undertaking of construction of the proposed wetlands system and pond areas.

3.0 Subsoil Liner Construction

3.1 General

It is imperative that the subsoil liner in the floor and inner bank surfaces of each wetland cell and the pond areas and the core of the embankments are thoroughly compacted. If the subsoil liner is stony or has a relatively high gravel content the proportion of these materials present shall be such that they are embedded in the dense matrix of the subsoil liner itself and do not create any air-filled porosity by bridging or result in the liner subsoil losing any of its overall plasticity. If these conditions are met the overall hydraulic conductivity will be reduced rather than increased. A 20+ tonne (at minimum) tracked excavator shall be used to construct the store and effect optimum compaction. Floors and banks shall be built in layers/lifts of 150 mm and compacted until the desired density and sealing has been achieved.

A minimum of four runs (two each in cross directions) per lift should give adequate compaction in normal conditions. On sites susceptible to groundwater pollution a minimum of six runs or its equivalent with compacting machinery shall be used. Alternative compaction plant may be used if it can be clearly demonstrated that **at least** equivalent compaction will be achieved.

3.2 Compaction of Subsoils

The design and construction of compacted subsoil liners is governed by the strength and degree of compaction required to ensure low permeability. The geotechnical component of a subsoil liner is determined by the nature of the subsoil being utilised. The base and part slopes of the wetland system shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to a permeability of 1 x 10^{-8} m/s over a thickness of 0.3 m. Achieving the required permeability may require compaction of a minimum thickness of subsoil, resulting in a compacted subsoil liner.

3.3 Compactive Energy

Compactive energy is a function of the weight of the machine used to effect compaction, the thickness of the lift and the number of passes of the machine over each lift. Additional passes cannot be used to compensate for machines that are too light for the construction of the liner. Machine size is usually specified in terms of contact pressure exerted by the machine. For a hydraulic excavator, the contact pressure is determined based on the operating weight of the machine and the contact area of the machine on the ground. (e.g. Hydraulic excavator 20000 kg operating weight, track width 600 mm, tumbler length 2.5 m. Therefore the contact pressure = (20000/(2.5 x 2 x 0.6)) = 65.4 kPa).

Weight is important to ensure that penetration of the specified loose lift is attained. A lift thickness of 150 mm is suitable for most compaction procedures and coupled with a 20000 kg hydraulic excavator capable of exerting a ground pressure greater than 40 kPa and a minimum of four passes per lift, effective compaction should be achieved.

Table 1 below lists typical ground pressure values for various types of tracked excavators. If tracked excavators are to be used for compaction at this facility then the 'Track Length on Ground' should comply with *Table 1* below:-

Track length on ground	Track width	Machine weight	Ground pressure		
(m)	(m)	(kg)	(kg.m^{-2})	(kPa)	(psi)
3.00	0.6	13950	3875.0	38.0	5.5
3.27	0.6	19700	5028.1	49.3	7.2
3.28	0.6	20575	5235.4	51.3	7.4
3.37	0.6	18070	4468.3	43.8	6.4
3.37	0.6	19300	4772.5	46.8	6.8
3.37	0.6	20095	4969.1	48.7	7.1
3.37	0.6	19021	4703.5	46.1	6.7
3.45	0.6	19650	4746.4	46.5	6.8
3.66	0.6	23069	5252.5	51.5	7.5
3.66	0.6	21340	4858.8	47.6	6.9
3.83	0.6	24200	5265.4	51.6	7.5

Table 1 - Ground pressure values for a sample of hydraulic excavators

If the contractor proposes to employ a non-vibrating or vibrating roller for this facility contract he shall comply with the compaction requirements listed in *Table 2* below.

The table below is adapted from the NRA specification for roadworks and gives guidance on the required construction requirements for different types of compaction plant to ensure an impermeable compacted subsoil liner.

Type of compaction plant	Category	Max. depth of compacted layer	Minimum number of passes
		(mm)	(No.)
Smooth wheeled roller (mass per metre width of roll):	over 2100 kg to 2700 kg over 2700 kg to 5400 kg over 5400 kg	125 125 150	8 6 4
Grid roller (mass per metre width of roll):	over 2700 kg to 5400 kg over 5400 kg to 8000 kg over 8000 kg	150 150 150	10 8 4
Tamping roller (mass per metre width of roll):	over 4000 kg	225	4
Vibratory roller (mass per metre width of a vibratory roll):	less than 700 kg over 700 kg to 1300 kg over 1300 kg to 1800 kg over 1800 kg to 2300 kg over 2300 kg to 2900 kg over 2900 kg to 3600 kg over 3600 kg to 4300 kg over 4300 kg to 5000 kg over 5000 kg	100 125 150 175 200 225 250 275	Unsuitable 12 8 4 4 4 4 4 4

Table 2 – Compaction Guidance for Roller Plant

3.4 Construction of Liner to Achieve Required Impermeability

Constructed liners for the proposed wetland system and pond areas at this facility shall have, on completion, a permeability of less than 1 x 10^{-8} m/s and shall be at least 0.3 m thick, over at least 0.75m of undisturbed subsoil.

The liner on the banks and floor shall be constructed of suitable excavated dense plastic subsoil material only. It is imperative that the subsoil liner in the base of the ponds, the inner bank surfaces and the core of the banks are thoroughly compacted, as listed in this specification.

The liner on the pond base and banks shall be built in layers/lifts of 150 mm and each layer/lift compacted until the desired permeability has been achieved. The excavator shall make a minimum of 4 passes per lift (two each in cross directions) over the liner soil so as to compact the material for 0.3 m thick liners. Each layer comprising the compacted subsoil liner shall be fully compacted prior to placement of the next layer.

Once the full depth of liner has been constructed, the inside floor and bank slopes shall be smoothed off and compacted (plastered) with the track machine using a remoulded subsoil. This is particularly necessary when the liner is constructed in dry conditions.

Compaction shall be effected by means of a hydraulic excavator with a minimum weight of 20 tonne capable of exerting a ground pressure of at least 40 kPa (40 kN.m^{-2}) (e.g. a 20 tonne excavator with tumbler length 3.7 m and track width 0.6 m shall exert a ground pressure of 44.17 kPa). Alternative suitable compaction plant may be used if it can be demonstrated that ***at least*** equivalent compaction can be effected.

4.0 Construction of Embankments

Embankments should be constructed from firm sub-soil material with at least a 10-13% clay content. An impermeable liner should be provided to embankments for a minimum face height of 0.45m on the pond side only. The liner should be constructed as per *Section 3.0* above. Top-soil material can be used to landscape the embankments prior to any seeding.

APPENDIX C

ICW – Planting Specification

1 Table of Contents

2 Introduction

This planting specification has been prepared for a proposed Integrated Constructed Wetlands system (ICW) at Connolly's Redmills, Goresbridge, Co Kilkenny.

To ensure the successful treatment of the effluent waters each constructed wetland area will be densely vegetated with suitable emergent plant species.

The proposed planting specification is in accordance with *'Integrated Constructed Wetlands – Guidance Document for Domestic Wastewater Applications – DoEHLG, November 2010'.*

3 Consideration

Plant establishment of the wetland areas require the following considerations.

- Plant species selection and density
- Sourcing – native and non-native species
- Water levels – variable- different plants for varying depths
- Setting – wind direction/exposure, sun or shade
- Liner protection

4 Proposed Planting Specification

4.1 The Role of Plants Within the System

Vegetation, emergent, marginal and aquatic, play an essential role in the functioning of an integrated constructed wetland system.

The emergent plant species within the system provide the following functions:

- Provide support structure for microbial colonies to develop
- Facilitate aerobic microbial activity (principal cleansing process)
- Absorption of nutrients
- Bind nutrients in the accumulating organic matter
- Reduce the flow of water → improves settlement
- Reduce preferential flow and increase residence time
- Reduce final volumetric discharge through plant transpiration and interception

4.2 Suitable Plants for the Integrated Constructed Wetland Areas

There are a number of different plant species that are recommended for the proposed constructed wetland areas.

The constructed wetland areas are suitable for range of different plants species. The list below gives a selection of plants that are tolerant of varying water depths. Plants which prefer shallower waters will be established along the waters edge (0-5cm), with deeper living plants planted in 5-35cm.

Alisma plantago-aquatica	Water plantain	0-30 cm
Acorus calamus	Sweet flag	0-20cm
Carex pendula	Drooping sedge	0-35cm
Carex elata	Sedge	0-10cm
Carex rostrata	Lesser sedge	0-20cm

Cladium mariscus	Saw sedge	0-30cm
Glyceria maxima	Water grass	0-20cm
Juncus effuses 'Spiralis'	Spiral rush	0-5cm
Phalaris arundinacea	Canary reed	0-15cm
Phalaris arundinacea 'varigata'	Variegated canary reed	0-15cm

The plant species below are non-native, but also suitable for planting within the wetland areas.

Cyperus spp.

Zantedeschia aethopica

Zizania latifolia

Gunnera manicata

There are many other plants also suitable.

Several bog or moisture loving plants that prefer saturated soils can be planted in areas along the edge of the proposed surface water pond areas, e.g. *Lysimachia punctata, Astilbe, hostas.*

4.3 Planting Density

To provide a dense plant cover as quickly as possible, depending on the species and maturity of the plants, it is recommended that the constructed wetlands are planted at a rate of 1-2 plants/m^2

4.4 Size & Maturity of Plants

The size and maturity of the plants to be used in the constructed wetlands will have to consider at least the following;

- Availability and sourcing
- How quickly cover is needed
- Planting conditions
- Costs

Physiologically mature plants from nursery stock (1-3 litre) will provide establishment of plants within the shortest period of time. The use of seedlings may be used if plant cover and establishment are not required within the first 1-2 years; however greater management will be required to ensure their success.

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5 Planting Procedure

Plants are easiest to establish when water levels are minimal and just sufficient to keep the soil wet. Following construction of each wetland pond base, at least 100mm of topsoil shall be placed with each ICW area to provide a suitable medium for planting. Once plants are established, ranging from weeks to months with physiological mature plants with good root systems, to months to a year for bare rooted and a year for seedlings. Ideally water levels in the wetland should be gradually increased.

The following should also be considered during planting;

Planting should be carried out manually to avoid damage to plants and liner.

Planting should be carried out mainly in groups of similar species type, but some mixing is encouraged.

Planting should ideally be carried out in late winter/early spring or early summer to avail of the full growing season (March-September for most species).

6 Maintenance

A permanent water depth of 0.35m will be maintained within the ICW system, however during heavy rainfall events the surface area of the ICW may increase and the water level would rise by a further 0.2-0.25m. The plants selected will cope with periods of being submerged during storm events once the plants are established. Likewise they are adapted to periods of drying out for periods of time.

The plants within the wetlands will require little maintenance. However, a visual inspection should be carried out regularly especially for the first growing season.

Replanting may be necessary if storm event occurs within the first twelve months, as plants may not be fully established and may be uprooted, due to heavy rain or winds.

The majority of emergent plant species are deciduous and die back during the winter, leading to an accumulation of dead plant material, most of which will be embedded in the soils.

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APPENDIX C

Log Keeping Documents

Appendix C

CONNOLLY'S RED MILLS SURFACE WATER MONITORING DATA (EXAMPLE)

Parameter	Date of Sampling	SAMPLE LOCATION: 31/1/17	30/4/017	27/7/17	31/10/17	31/1/18	30/4/18	31/7/18	31/10/18
Biochemical Oxygen Demand (mg/l)									
Chloride (mg/l)									
Chemical Oxygen Demand (mg/l)									
Electrical Conductivity (µS/cm)									
Copper (µg/l)									
E. Coli (MPN/100ml)									
Iron (µg/l)									
Manganese (µg/l)									
Ammonia (mg/l as NH3)									
Nitrate (mg/l NO_3)									
Fats, Oils and Grease									
Total Coliforms (MPN/100ml)									