Review of the Storm Emma Event on the Greenfield Farm

Final Report

28th November 2018

Table of Contents

Executive Summary 2

1. Introduction 4

1.1 Acknowledgement 4

1.2 Terms of Reference 4

1.3 Scope 4

2. Background to the Greenfield Dairy Farm 5

2.1 Operating Structure, Ownership and Governance 5

2.2 Management and Staff 6

2.3 Operational Management 6

2.4 Knowledge Transfer 7

2.5 Greenfield Farm Facilities 7

3. Storm Emma Weather Event on Greenfield Farm 9

3.1 Red Weather Alert 9

3.2 Conditions on Greenfield Farm 9

3.3 Nutrition 10

3.4 Staff Health and Safety 11

3.5 Mortality Rates 13

3.6 Knackery Records 14

4. Reflections and Recommendations for Further Consideration 15

4.1 Reflections on the Farm Management and Governance 15

4.2 Reflections on Health and Safety 16

4.3 Reflections on Animal Welfare 17

4.4 Recommendations 20

5. Conclusions 21

Appendix 1: Members of Review Committee 22

Appendix 2: Agreement between Teagasc and Greenfield Dairy Partners 23

Appendix 3: Preparing for Unexpected Weather Events 24

Executive Summary

At the end of February/beginning of March 2018 Ireland experienced two extreme weather events known as Storm Emma and the 'Beast from the East'. Storm Emma was the most extreme weather event to hit Ireland in over 30 years significantly impacting daily life across the country.

With regard to agriculture, the storm occurred at one of the busiest times of the year for farmers, particularly spring calving dairy farms. Many farms experienced unprecedented conditions and significant damage to their farms, predominantly in the east and south of the country. Unfortunately, despite the best efforts of the staff and stakeholders involved, the storm resulted in the deaths of two cows and six calves on the Greenfield Dairy farm in Kilkenny.

The Greenfield Dairy farm is a demonstration farm operated as a limited company, Greenfield Dairy Partners Ltd (GDP), with three shareholders (each owning one third of the company); Glanbia, The Agriculture Trust and the Phelan family. It was established in 2009 to demonstrate that a new dairy enterprise, delivering a satisfactory financial return, can be established by adopting the key principles, skills and technologies required for successful dairy farming and covering all land, capital, labour and operating costs.

The Greenfield Farm, located in Co. Kilkenny, is a 120 hectare farm with over 370 dairy cows and a farmyard including out-wintering facilities. Teagasc provides management services to the farm under an agreement with the Board. The Greenfield farm has been valuable to the stakeholders and Teagasc as a platform for knowledge transfer and disseminating information on best practices and key technologies for dairy production, particularly at a time of growth and expansion in Ireland's dairy industry in a post-quota context.

In May/June 2018 Teagasc/GDP Ltd, commissioned a review of the Storm Emma event on the Greenfield Farm with the aim of establishing how to be better prepared to deal with unexpected weather events in future. The review was carried out by an external review committee and the main findings and recommendations are presented below.

Key Findings and Recommendations

Responding to a natural disaster, such as Storm Emma, was highly stressful for all those involved and the dedication and commitment of the staff and stakeholders in managing the Greenfield farm during the hazardous storm conditions is acknowledged. The impact of the event placed significant stress on the farm, testing and exposing the vulnerability of the systems and practices in place at that time. The unprecedented event also provided an opportunity for learning, particularly, in relation to the governance of the project including the allocation of roles and responsibilites, health and safety, animal welfare and general farm management which, if addressed, will enable the company to be better prepared to respond to future crises that may impact the Greenfield Dairy farm. In turn, this may provide assistance to other dairy farms in preparing for future status red weather events.

In particular, the crisis tested the management system in place on the Greenfield farm and highlighted a lack of clarity around the governance and management structure of the farm including responsibilities, lines of command and communication channels, thus increasing the risk of not being able to deal adequately with such an unexpected event. It is recommended that the governance and

management structure for the project is reviewed to provide clear lines of command and responsibility and enhance communication among all those involved with the management and operation of the Greenfield farm as well as reporting to the board on a regular basis.

While prepared for usual storms, it was apparent that the management and staff were not adequately prepared for the severity of the storm experienced. The safety statement at the time was inadequate in terms of risk assessments, contingency and emergency plans to enable the staff to respond effectively. It is recommended that all the stakeholders associated with the Greenfield farm engage in a process to review and update the safety statement to ensure they fully understand their role and responsibility and include contingency plans to mitigate potential risks.

The animal welfare issues that arose during the storm revolved around cow and calf mortality, and discomfort and distress from exposure to hypothermia. While the farm had a good record of animal care prior to the storm, it highlighted the need for improved facilities to protect animals if the farm was to experience a similar event in the future. It was apparent that shelter for cows, protection of calves in the calf shed, management of new born and young calves, and protection of the milking parlour during severe weather needs improvement. It is also recommended that the annual feed budgets for the farm incorporate reserves to allow for severe weather events.

Storm Emma impacted many farms across the country, some of whom will have faced similar challenges. It is expected that the learnings from the Greenfield farm, the development of facilities, emergency plans and training in response to the storm will be shared with the dairy community in the spirit of Greenfield Farm as a demonstration farm.

1. Introduction

Teagasc, in association with the board of GDP, commissioned a review of the Storm Emma event on the Greenfield Farm with the aim of establishing how to be better prepared to deal with unexpected weather events in future. This report presents the outcome of this review, providing a background to the establishment, management and operation of the Greenfield Dairy farm; and details of the weather conditions on the farm during the storm and an account of the issues and preparations on the farm before, during and after the storm as reported by the staff and stakeholders. This report also presents the reflections of the external review committee on the handling and response to the weather event and outlines the recommendations arising from their deliberations for consideration by the management and stakeholders of the Greenfield Dairy farm.

1.1 Acknowledgement

Teagasc, the Board of GDP Ltd, and the external review committee would like to acknowledge the dedication and commitment of all the staff and stakeholders involved in managing the Greenfield farm during the hazardous storm conditions. The review committee acknowledges the full co-operation and assistance of all those who contributed to their work.

1.2 Terms of Reference

The review was carried out by an external review committee composed of the following members: Tom Moran (Chairperson), Tom Butler, Tommy Cooke, Andrew Reilly, Jim Reynolds, Michael Sheahan, Kevin Twomey and Jane Kavanagh (Secretariat) (Appendix 1).

The terms of reference of the review were to address the following questions:

a. Were preparations for the storm event adequate and proportionate?
b. Was the health and safety of the farm staff maintained before, during and after the storm event?
c. Was nutrition and management including milking procedure (once a day milking) of the cows adequate in advance of and during the storm event?
d. Are there any recommendations to improve animal welfare in the type of housing system used on the Greenfield farm given Irish climatic conditions?
e. Is the overall system in place 'fit for purpose' to address weather events in an Irish context in the future?
f. Are there recommendations the review team would make to help farmers cope with such adverse events in the future?

1.3 Scope

This review focuses on the impact of the severe weather event on the Greenfield farm and how it was dealt with. This review does not address the overall project itself or the performance of the farm.

2. Background to the Greenfield Dairy Farm

This section outlines the background to the Greenfield dairy farm, its operating structure and ownership, management and facilities. The information outlined in this section was provided to the review committee by Teagasc.

2.1 Operating Structure, Ownership and Governance

The Greenfield Dairy Farm was established in December 2009 as a demonstration farm. It is a 15 year project operating for eight years and with seven years left to run. The demonstration farm was established by Teagasc in conjunction with key stakeholders as part of a new milk production programme. The key objective of the programme was to provide family dairy farms who intended to increase milk production with the necessary skills and technologies to deliver a satisfactory financial return to the resources employed.

The farm, originally a tillage enterprise, was converted to dairying to demonstrate that a new dairy enterprise can be established by applying the key principles of successful dairy farming while also paying a cost for land, covering all labour and operating costs, and servicing the capital loan required for set-up. It had an initial target of 250 cows increasing over the years to 370 cows in 2018.

In terms of the structure of the project, the milk production enterprise is owned by a specially established company, Greenfield Dairy Partners Limited (GDP). Teagasc provides management services and advice to GDP under a management services agreement. Milk quota was initially licensed by the Department of Agriculture, Food and the Marine (DAFM) for use in this project. The GDP shareholders are (1) Glanbia (2) The Agricultural Trust and (3) Edward and Eamonn Phelan with each shareholder owning one third of the company. The Phelan's own the land (approx.. 120 hectares) and lease it to GDP on normal commercial terms.

The Board of GDP has representatives from each of the three shareholders, Glanbia, the Agriculture Trust and the Phelan family, and it is currently chaired by the Chairman of Glanbia. The Board meets approximately every three months.

Teagasc and GDP signed an agreement whereby Teagasc provides advice on the set-up, management and operation of the farm. The agreed services and service levels are outlined in Appendix 2. In return, and in agreement with GDP, Teagasc uses the farm for its knowledge transfer activities and as part of the BETTER farm programme. Teagasc disseminates information from the farm through multiple dissemination channels including open days, discussion group visits and newsletters. This has proven to be a very successful vehicle for the Teagasc research and knowledge transfer dissemination programmes.

In addition, in year 3 and all subsequent years of the agreement, Teagasc is entitled to 40% of the balance of net profits available for distribution in Greenfield dairy farm, after payment of costs, finances/loans and an 8% dividend to shareholders have been accounted for. The operation of the farm and the cost of all stock, equipment, structural alterations, fertilisation, feed, as well as the purchase, construction, reconstruction, repair, replacement, demolition or extension of all structures, fixtures and fittings and equipment are the responsibility of GDP. All staff on the farm, except for the Teagasc Moorepark Officer, are employed by GDP with the farm manager reporting to the Moorepark Officer. Teagasc staff attend the GDP board meetings in an advisory capacity.

2.2 Management and Staff

GDP employs a farm manager and 1-2 full-time assistants with seasonal staff and students also employed on the farm. In spring 2018, there were two full-time assistants and three college students on work experience until the end of February. Based on the agreement between Teagasc and GDP, the farm manager reports to a Teagasc staff member, known as the Moorepark Officer.

2.3 Operational Management

The Moorepark Officer visits the farm once or twice per week. These visits are for a combination of meetings with the farm manager, and meeting visiting groups of dairy farmers or other visitors. During these visits the farm manager can raise any issues or seek advice/guidance from the Moorepark Officer in relation to any management issues on the farm. In addition, the Moorepark Officer and the farm manager are in regular contact, both within and outside normal working hours. Visits may also occur at weekends depending on the issues arising on the farm. The mechanisms for interacting with the farm manager, giving guidance and advice, and checking on performance, are as follows:

Yearly Plan: The Moorepark Officer and the farm manager develop a plan for the year. This plan consists of Standard Operating Procedures (SOPs), weekly check lists for farm products, contact lists, herd health plan, drying off procedure plan, SCC management plan, seasonal and weekly grass plan (PastureBase), fertiliser plan, feed plan, calf rearing plan, breeding plan, and a health and safety plan. The plan also outlines and identifies training for staff, the roster plan, and periods when extra staff are required. Each year new ideas and methods of managing are put in place, to improve the work management and productivity on the farm. Monthly, weekly and daily plans are also developed with the farm manager. These are monitored on an ongoing basis by the Moorepark Officer.

Management Team: The farm also has a management team which meets every two months and is responsible for making management decisions that involve significant expenditure, bull selection, etc. The current members of this team are the farm manager, Moorepark Officer, senior Teagasc staff and the secretary to the board of GDP (who is a representative of the Agricultural Trust). This team is the mechanism for pulling together various expertise within Teagasc and having that expertise available to the Greenfield Farm. There is effective dissemination and reporting in the Irish Farmers Journal, with reports from the farm regularly featuring in the paper. In addition to the meetings the management team regularly communicate by email. There is a wide team of professionals to call upon when required including, relief milkers, veterinarian, accountant etc, and the farm owners regularly call to the farm also. The Greenfield farm has a comprehensive set of financial and physical performance indicators which are monitored and reviewed regularly by the management team.

2.4 Knowledge Transfer

Since its establishment, the Greenfield Farm has set out to demonstrate that a new dairy farm can generate sufficient profit to pay all costs including land and labour and repay investments by applying key grassland and animal technologies. It is the Teagasc view that in terms of knowledge transfer and disseminating information the Greenfield farm has delivered significant value to Teagasc.

A national open day is held on the farm every second year with over 1,500 people attending. Three or four focus days are organised each year for discussions groups where they can discuss particular topics such as hoof care, teat sealing, labour management, expansion, etc. Approximately 35-40 discussion groups visit the farm during these focus days. The participants on the Greenfield Dairy Academies and the Dairy Start-up programmes visit the farm most months. Other annual visiting groups include college students and students from the Dairy Business Degree and the Professional Diploma in Dairy Farm Management. Many other national and international groups visit the farm during the year. From Teagasc's perspective, there is significant demand for the type of knowledge transfer delivered from the farm. The farm staff, Moorepark Officer and staff at Teagasc Moorepark are actively involved in organising and delivering all the knowledge transfer events on the Greenfield farm.

2.5 Greenfield Farm Facilities

Farmyard: The overall objective when designing the farmyard was to provide a facility that could adequately milk and accommodate up to 350 cows in a labour efficient manner and minimise capital investment in the entire farmyard to less than €1,000/cow. The milking parlour and other farmyard facilities were set to be approximately central (considering current and future needs). The milking parlour, silage slab and standoff pad were sited where the land slope is suitable and favours easy drainage to the lagoon. The yard was designed to allow plenty of space for vehicle movement around the entire farmyard infrastructure.

Wintering facilities: The original wintering facilities on the farm comprises of a 4,200 m^2 Out Wintering Pad (OWP) which will provide adequate lying area for 350 cows @ 12 m^2/cow, an 87 m long head feed area at which approximately 150 cows can feed simultaneously. An earth lined slurry store (ELS) which has a net storage capacity of approximately 3,405 m^3 was constructed to store slurry, soiled water and dairy washings. The OWP and ELS are constructed in an area of the farm that is underlain by subsoil with relatively high clay content (>15%). This subsoil met the specifications for an earth lined OWP and ELS.

Most of the calvings take place on a designated area of the OWP and a small shed was constructed (10m x 6m) on the OWP to facilitate the catching and handling of cows at calving and to provide shelter to newborn calves during periods of inclement weather. The plan was that all calves would leave the farm within two weeks of birth with all male calves being sold and dairy replacement heifers sent to a contract rearer. A calf shed with five individual pens, each with capacity for 12-15 calves was constructed to house calves for their first two weeks, with each pen having isolated air and effluent movement. Five individual isolation pens of similar design were built.

Teagasc Moorepark investigated the suitability of unsheltered OWP's as a wintering accommodation for dairy cows over two years. In year 1 cows on an unsheltered OWP had similar live weight pre-partum, but both pre-partum and at calving, they had a lower Body Condition Score (BCS) than cows housed indoors on cubicles. In year 2 there were no differences in either live weight or BCS between housing systems. In year 1 the cows on the unsheltered OWP's lost more heat energy and tended to gain less body condition and produce less heat energy compared with the cows in the sheltered housing. Milk production and milk composition for the first 8-weeks of lactation were similar for both the cows on the unsheltered OWP and the cows housed indoor on cubicles.

Since 2012, additional infrastructure investments included an extension of the feed face to 173m to facilitate simultaneous feeding of 288 cows and the installation of 256 topless cubicles on an area of the OWP.

Farm layout: The original farm was designed with 29 paddocks – mostly of 4ha size to facilitate 24 hour grazing for a herd of 300 cows. An additional area of 7.84 hectares was added in 2015 (paddocks 30 and 31), giving a total area of 120.5 hectares. The paddocks are set up to be rectangular to square in shape and have the longest frontage along the races if they are in the wetter areas of the farm. Also to have cows in them for 24-36 hours during peak milk production and the breeding season. The paddock shape was designed to facilitate stock movement into and out of the paddock i.e. stock move downhill to exit paddocks.

3. Storm Emma Weather Event on Greenfield Farm

The following sections provide details of the weather and conditions on the Greenfield farm during the storm. It also provides an account of the issues and preparations on the farm before, during and after the storm as reported by the Moorepark Officer and Greenfield farm staff.

3.1 Red Weather Alert

At the end of February/beginning of March 2018 Ireland experienced two extreme weather events known as Storm Emma and the 'Beast from the East'. Storm Emma, a weather system originating in Portugal, containing strong winds and precipitation, met with the 'Beast from the East' weather system turning to snow and blizzard conditions. Met Éireann, the state meteorological service, issued a red snow-ice weather warning for the entire country prior to the event due to the anticipated hazardous blizzard-like conditions and freezing temperatures. The red alert is the highest level weather alert and was in place from 11.00pm on Wednesday, 28th February to 3.00pm on Friday, 2nd March 2018. The red alert was extended to 9.00am on Saturday, 3rd March for eastern counties. In the days leading up to the red alert, Met Éireann provided national forecasts on the deteriorating weather conditions.

The National Emergency Coordination Group (NECG) provided advance warning, regular advice and weather updates on the expected conditions before, during and after the storm. NECG emphasised the life-threatening situation and advised businesses to close and people to remain indoors during the red alert. There was blanket media coverage of the impending weather event. This was an extreme and rare weather event that Ireland hadn't experienced to this extent in over 30 years and significantly impacted daily life across the country. During the period of the alert all schools, other public buildings and services and most private sector businesses were closed. All Teagasc offices were closed on the 1st and 2nd March.

With regard to agriculture, the storm occurred at one of the busiest times of the year for farmers, particularly spring calving dairy farms. Many farms experienced unprecedented conditions, major disruption and significant damage to their farms, predominantly in the east and south of the country. Unfortunately and regrettably, despite the best efforts of the staff involved, the storm resulted in the deaths of two cows and six calves on the Greenfield Dairy farm in Kilkenny.

The following sections provide a description of the events and activities on the farm before, during and after the storm. The description of the conditions on the farm, nutrition, staff health and safety and the mortality rates (sections 3.2, 3.3, 3.4 and 3.5) were provided by Teagasc as background information for the review committee and sets the context for the review committee's reflections and subsequent recommendations.

3.2 Conditions on Greenfield Farm

Storm Emma hit the Greenfield Dairy Farm on Wednesday, 28th February and continued to affect the farm until Monday, 5th March with winds and snow blow peaking on the Thursday night into the morning of Friday, 2nd March. Approximately 26cm of snow fell which, when combined with easterly gale force winds, caused snow drifts of up to 1.5m on the farm. Drifts of snow also accumulated in

the milking parlour, uncovered cubicles and the calf house. This resulted in all access and internal roads being blocked with snow.

From a total of 370 cows, there were 290 cows on the farm at the time; 270 calved and 20 approaching calving. It was reported by staff that in preparation for the storm approximately 80 in-calf cows were moved to a nearby farmyard which provided more sheltered accommodation for these animals. Some of these cows calved during the storm and those cows were taken to the Greenfield farm post calving to be milked. All the cows were returned when the worst of the storm had passed. It was also reported that approximately 20-30 newborn calves were transferred to the Phelan's farm on the day of the storm.

3.3 Nutrition

All calves were fed warm milk twice daily prior to, during and after the storm. All milking cows were taken off grass due to snow cover on the day prior to the storm and were fed concentrate and had *ad-lib* access to grass silage while they were on cubicles. Cows were milked once a day in February which is normal practice on the farm during the busy calving period.

Prior to the storm, two issues arose on the Greenfield farm – due to a calculation error the cows did not receive the agreed allowance of concentrates; and there was a requirement to purchase additional silage for the farm.

During the spring of 2018, the cows did not receive the agreed daily allowance of concentrates (4kg rising to 6 kg later in the spring) due mainly to a calculation error. Although the error was identified in early-March the problem persisted to some extent over the following month. While this caused a drop in milk yield and milk protein content, it did not have a significant effect on cow body condition score. The BCS was checked on the 31st March and only 11 cows were separated out for extra feeding.

In spring 2018, the farm did not have enough silage and had to buy in additional silage for the following reasons:

- The herd was restricted until Christmas and 54 cull cows that should have been sold were still on the farm consuming silage. The farm had a higher stocking rate in October and November. These cows were culled in January 2018.
- Grass growth was poor in spring 2018. The farm had grown 1.5 tonnes of grass dry matter per hectare up to the 1st April 2017 compared to 0.5 tonnes grass dry matter per hectare during the same period in 2018, which equates to 120 tonnes of dry matter of a reduction in feed grown in a crucial period.

Up to the 7th April, 61 tonnes of meal were fed to the milking cows. Silage was purchased in February and again in late March and April 2018. In total, approximately 130 tonnes fresh weight of pit silage and 50 bales of silage were bought to meet the requirements of the farm. The fifty bales bought turned out to be very poor quality. The purchase of silage was a relatively small proportion of overall silage requirements, and given the difficulty of sourcing fodder this spring, it was a problem encountered on many farms.

Table 1 shows the body condition score of the cows on the 25th April 2018. This shows that the cows were in good body condition score prior to the start of breeding with only 4.8% of cows at a score of 2.5 or lower.

Table 1: Body condition score of the cows in the Greenfield Dairy farm on 25th April 2018 (Source: Teagasc)

Body Condition Score	Numbers of cows	Proportion of the herd (%)
2.25	3	0.9
2.50	12	3.6
2.75	62	18.5
3.00	131	39.0
3.25	77	22.9
3.50	49	14.6
4.00	2	0.6

3.4 Staff Health and Safety

The Greenfield Farm has a safety statement and the farm manager, staff and Moorepark Officer are proactive in relation to the health and safety of farm employees. Over the last three years, only two near misses were recorded. The farm has very little machinery except for a tractor.

For the duration of the storm both the farm manager and assistant stayed on the farm in the farm cabin to monitor the stock under the adverse conditions. There was no power outage so the farm staff who stayed on the farm had electric heating, a fridge and cooking facilities in the cabin.

On Friday morning 2nd March, the Moorepark Officer received communication from the farm manager that up to 1,200mm of snow had accumulated during the night from the blizzard. Based on communication with the farm manager, three Teagasc staff made a decision to travel from Fermoy to the farm in hazardous conditions during the red alert to assist the farm staff. They were concerned about staff safety on the farm and the risks to the business.

The farm manager also contacted the farm owners (Phelan) early on Friday morning to seek assistance in dealing with the snow accumulation. The farm owners arrived early that morning and used their loader to clear snow in and around the outdoor accommodation and feeding areas. They also cleared the passages and roads on the farm and assisted the farm manager in feeding silage to the cows. The Phelans also invited the farm staff to their home and provided them with a hot meal before returning to the farm to continue their work.

On arrival the Teagasc staff met with the farm owners and farm staff. Three Teagasc and one Farmers Journal staff and the Phelan family assisted the two farm staff with farm operations and getting the essential activities completed. This included defrosting the milking machine so that cows could be milked, removing the snow from calf pens and milking parlour, putting some bales of straw at the entrance to the parlour and re-bedding and feeding the calves. Teagasc staff brought food supplies to the farm staff. All those involved worked above and beyond the call of duty in carrying out all the necessary activities to ensure the animals were cared for, fed, watered and milked.

Unfortunately, despite best efforts, over the 24-hour period, four calves and two cows died due to the adverse effects of Storm Emma; an additional calf died in the following 24-hours due to an accidental injury and there was one still born calf. There was no autopsy performed on the dead

cows or the calves. The first cow that died had calved on the 24th February and she was lactation five, the second cow that died calved on the 28th February and she was lactation nine.

Table 2 provides a summary of the preparations and actions by the staff involved in Greenfield before and during the storm as reported to the review committee.

Table 2: Preparations and Actions before and during Storm Emma on Greenfield Dairy Farm

	Preparations and Actions before and during the Storm
Preparations for care and welfare of animals prior to the storm included:	• Warning of the storm was made on Monday, 25th February. • There were 370 cows on the farm at the time of the storm warning. • Communications from senior staff to the on-farm manager made certain an adequate supply of grass silage was available to feed when the cows were off pasture. • Arrangements were made with the neighboring farm and approximately 80 in-calf cows and 30 calves were moved there for shelter. This left 290 cows (270 calved and 20 approaching calving) on the farm.
Actions taken just prior to the storm:	• Snow coverage of pastures necessitated moving cows from pasture into the cubicles. • On the day prior to the storm, cows were moved into the cubicles and provided concentrates and ad-lib access to grass silage. • Cows expected to calve imminently were moved into the calving shed. • Calves were moved from the overwintering pad area to bedded pens in the calf shed. • Calves were fed warm milk twice daily prior to, during and after the storm. • Straw bales were stacked at the side of the milking parlor.
Actions to provide for care and welfare of animals during the storm:	• The farm manager stayed on the farm the night of Thursday, 28th Feb. • The farm manager looked at the cows in the cubicles and calving shed at approximately 2am on the morning of Friday, 1st March. • Cows were again inspected after daylight. It was reported that no cows calved during the night. • The roadway into the dairy was blocked with snow. Snow had blown around the straw bales protecting the milking parlour and filled the parlour. The milking equipment was frozen. Snow had blown into the calf shed and was piled in the shed.
Measures taken by staff on the Friday morning:	• The neighbouring farmer (Phelan) was contacted for assistance. • Calves that had been born on the pad during the morning of Friday, 1st March were taken to a room in the milking parlor and warmed with red lights. • After telephone discussion with stakeholder staff, snow was cleared with a shovel to make a path in the cubicle area. Silage was provided at the feed rail. Cows were roused to stand and walked to the feed rails. • Stakeholder staff arrived on the afternoon of Friday, 1st March and the following were accomplished: o The milking parlour was cleared of snow, a pathway was cleared

	for cows to enter the parlor and the milking equipment was de-frosted. Cows were milked that afternoon, a delay of approximately 6 hours from the normal morning milking. o The calf shed was cleared of snow and calves were bedded and fed warm milk.
Animal Mortality:	• Six calf deaths were reported associated with the weather event. o Four were reported to have died on the Friday from exposure to cold. o One was born in the calving shed and was injured by a cow and was euthanized. o One calf died later. • Two cow deaths were reported in those housed in the cubicles. o Both cows were found lying in the Southeast corner of the uncovered cubicle area.

3.5 Mortality Rates

The calf mortality rate on the Greenfield farm in 2018 was slightly higher than in previous yearswith four weather related deaths during Storm Emma. There was also one accidental calf death and one still born calf during this period. The level of cow mortality (2.1%) is well below the national average (3.9%) despite the loss of two cows during the storm.

Table 3 shows the calf and cow mortality compared to the national average over the period 2012 to 2018. Calf deaths on the Greenfield farm include both still births and calves that died prior to leaving the farm. The average calf mortality over the last seven years was 6.2% on the Greenfield farm compared to 5.5% national average. The figures recorded nationally may underestimate calf mortality especially in relation to still births.

Table 3: Calf and cow mortality in Greenfield farm and in the national dairy herd (Source: Teagasc)

Year	2012	2013	2014	2015	2016	2017	2018*	Avg.
Cow numbers on Greenfield farm at start of year	307	342	331	334	347	373	370	343
Calves dead at birth in Greenfield farm (source – ICBF report available at time of reporting)	5	5	7	5	11	12	9	8
Total calves dead on Greenfield farm (source-DAFM)	14	19	17	24	26	27	33	23
Number of cow deaths in Greenfield farm	6	8	9	4	7	6	10	7.1
Calf mortality in Greenfield (%) (calf deaths divided by number of cows calved)	4.6	5.6	5.1	7.2	7.5	7.2	8.9	6.2
Calf mortality nationally (%) (AIM Bovine Statistics Reports)**	4.9	6.0	5.2	5.7	5.9	5.3		5.5
Cow mortality in Greenfield (%)	2.0	2.3	2.7	1.2	2.0	1.6	2.7	2.1
Cow mortality nationally (%)(AIM Bovine Statistics Reports**)	4.0	4.6	3.6	3.5	3.8			3.9

* Up to date April 2018 ** AIM Bovine Statistics Report not yet available for 2017 and 2018

3.6 Knackery Records

Table 4 shows the knackery records for the Greenfield farm in 2017 and between January and April 2018. From 1st January to 1st April 2017 two cows and 22 calves were recorded as being sent to the knackery. From 1st January to 1st April 2018 seven cows and 29 calves were recorded as being sent to the knackery. One dead cow and six dead calves that died before the storm hit the farm were on the farm during the storm and were despatched to the knackery on 5th March together with the animals that died during the storm. The dates of birth for the 12 calves that were despatched to the knackery on 5th March are shown in Table 5.

Table 4: Knackery Records for Greenfield Farm 2017 and 2018 (Jan – April) (Source: DAFM)

Week beginning 2017	No. Animals	Week beginning 2018	No. Animals
16-Jan		15-Jan	
23-Jan	1 calf	22-Jan	2 calves
30-Jan	1 cow & 2 calves	29-Jan	1 calf
06-Feb	5 calves	05-Feb	1 cow & 3 calves
13-Feb	5 calves	12-Feb	6 calves
20-Feb	3 calves	19-Feb	1 cow & 2 calves
27-Feb	1 calf	26-Feb	
06-Mar	1 cow	05-Mar	3 cows & 12 calves
13-Mar		12-Mar	
20-Mar	2 calves	19-Mar	2 cows & 3 calves
27-Mar	3 calves	26-Mar	

Table 5: Date of Births for Calves despatched to the Knackery on 5th March (Source: DAFM)

Date of Birth
09-Feb-18
20-Feb-18
24-Feb-18
24-Feb-18
24-Feb-18
24-Feb-18
28-Feb-18
28-Feb-18
28-Feb-18
2-Mar-18
2-Mar-18
4-Mar-18

4. Reflections and Recommendations for Further Consideration

On the 28th and 29th May the review committee met with the members of the board of Greenfield Dairy Partners Ltd, the Moorepark Officer, the farm manager, the vet and members of the Teagasc team. They also visited the Greenfield Dairy farm. In advance of the meeting the review committee received a report on the Greenfield farm outlining its objectives, performance and a description of the events leading up to, during and after the storm. The following sections outline the review committee's reflections on the way in which the weather event was dealt with on the Greenfield farm and the recommendations arising from their deliberations.

4.1 Reflections on the Farm Management and Governance

The weather event in March was an unusual and extreme event and the review committee would like to acknowledge the dedication and commitment of Teagasc, the management team, farm manager, the staff and the Phelans in managing the Greenfield farm during the hazardous storm conditions.

The weather event tested the management system in place on the Greenfield farm and highlighted areas which may require attention in the future. These areas are discussed below:

The governance and management structure of the project is unclear. The lines of command and responsibility require clarification and consideration in the future from board structure right down to farm manager. It was not clear to the committee the precise roles and responsibilities of the farm manager in planning for a major weather event or emergency.

The unclear governance and management lines manifested itself in the attention paid to risk planning and emergency planning. While on the day of the snow, there was considerable help brought to bear on the farm, and enormous effort made by the manager, his team and the Teagasc team, and the Phelan family, it was the view of the committee that better planning at all management levels would greatly assist in dealing with the weather events or other emergencies in the future.

A more structured relationship between the management team and the staff on the ground is required. The committee could not establish clearly who is actually in charge on the farm. This becomes particularly problematic in the event of unusual or non-routine events.

The approach to investment needs and learnings from events might need to be considered on an ongoing basis even as the arrangement for the farm lease approaches the end of the initial phase.

Overall management needs to pay greater attention to areas such as health and safety working conditions for on farm staff, risk identification and mitigation, training and development of staff. Greater attention needs to be paid to the provision of adequate and appropriate training for staff commensurate with the size of the farm.

The committee found that communication overall around this farm is not satisfactory and allied to the unclear management and reporting lines, this heightens the risk of inability to adequately address hazardous events and even non-routine emergencies.

The committee was of the view that there may be quick win investments that might be considered which would strengthen the farms capacity to deal with events and also free up farm workers

including the manager to concentrate on management issues. These include a generator, parlour feeders, bale opener etc. Some of this investment is required as the farm scales up and day to day tasks take the time of farm staff away from management.

The committee considers that greater emphasis could be placed on building an adequate feed reserve to cope with eventualities.

The committee considered that standard operating procedures need to be drawn up to cover routine and non-routine activities and events. These should be signed off and approved by the management team.

While not within the remit of the committee, it was felt that the GDP board may need to consider a review of the overall project to ensure the experience gained so far, in relation to the weather event and other developments are incorporated into practice for the remaining period of the lease. The environment likely to prevail in the second period of the lease may be very different to that for the early part. The committee acknowledges the success of the farm as a model from the outset but, they felt there may be new objectives which could be built in for the second half of the project.

4.2 Reflections on Health and Safety

The following are the review committee's reflections on health and safety before, during and after the storm event. Employees and management, while prepared for usual storms, were not adequately prepared for the severe storm experienced. Plans need to be developed and implemented prior to the next emergency.

The review committee noted the inadequacy of the safety statement at the time of the event in terms of risk assessments, definitions of roles and responsibilities, organisational chart, emergency plans and procedures. There were no protocols for severe weather events. The absence of a backup power supply would create some safety risks in the event of a power outage. There was no evidence of adequate safety training being provided to employees, such as induction, manual handling etc.

The committee felt that developing a comprehensive list of Standard Operating Procedures (SOP) for tasks on the farm would be useful for induction purposes as well as for reference for existing staff taking on new or infrequent tasks.

With regard to employee welfare, the committee were of the opinion that accommodation and welfare facilities should be at an appropriate standard. There was no system apparent to ensure adequate personal protective equipment was provided for working outside in severe weather. In circumstances such as those that arose during the event, attention needs to be paid to the psychosocial aspects of work to protect employees' mental wellness, including factors such as stress, workload management and external pressures. Employees reportedly worked extremely long hours to complete their workload.

The committee commented on several areas of potential risks to employees from animal handling including; lack of calving boxes or pens to segregate cows during calving; suitability of calving facilities during difficult calvings or caesareans; removing calves from unrestrained cows on the outwintering pad; use of vasectomised bulls.

The committee also noted that the nature of certain manual type tasks on the farm creates a risk of musculoskeletal injury. These include; lifting newborn calves; opening large numbers of silage bales; and barrowing high volumes of concentrate feed.

In relation to fire safety, the committee noted the presence of some fire extinguishers on the farm. However, there was a lack of preparedness for a fire event in terms of a fire safety plan, training and fire drills.

Specifically, in relation to the storm, the review committee noted the following health and safety issues during the storm:

- Teagasc and Greenfield staff travelling during red alert snow event.
- With regard to resources required, there was adequate food, thermal clothing, gloves, heat, and shelter. There was adequate feed and water for livestock. Extra manpower was required and ideally this would have been considered and in place before the event. With regard to machinery, the farm owner's loader was relied upon to clear roadways.
- Working at night in blizzard conditions is a high risk activity.
- Teagasc and Greenfield staff performing high levels of physical work such as digging snow that they may not be accustomed to.
- Risk of slips and falls – it is noted that salt supplies were in place. No incidents occurred.
- Risk of hypothermia and frostbite. Staff required adequate thermal clothing and gloves.
- Risk of lone working or two employees working in isolation. Had an incident occurred it would have been difficult to access help on the 1st March.
- Any measures taken to mitigate risks during weather events should give priority to health and safety before being implemented, including any equipment to be used such as emergency heating lamps, generators etc.

The most important outcome is that nobody was physically injured during the event. This extreme weather event highlights the need to review and revise the Greenfield Farm safety statement and review the effectiveness of measures undertaken prior to, during and after the event, and the need to develop contingency plans for similar events in the future. The event was highly stressful for all involved and priority should be given to ensuring the welfare of staff is protected following exposure to such high stress events.

4.3 Reflections on Animal Welfare

The animal welfare issues revolved around cow and calf mortality, and discomfort and distress from exposure to hypothermia. The farm appears to have had a good record of animal care prior to the storm, indicating the facilities and staff were prepared for usual storms. The dairy was unprepared for the severity of the storm and direction of winds. The animal welfare issues were compounded by the event occurring during heavy calving time.

Delayed milking: the cows were milked once daily at the time of the weather event. The snow drifts and frozen equipment delayed milking during the storm. Delayed milking may cause pressure in the udder and discomfort to cows. This may be associated with increased mastitis due to leaking and open teat sphincter. Milking was resumed after the parlour was cleared of snow and the equipment was thawed.

The information given indicated that the gap between milking from Thursday morning to beginning milking Friday evening was 30 hours, a delay of 6 hours. It is not likely a delay of this order was a significant welfare issue. Cows would be expected to have decreased feed intake during the storm, and therefore would have decreased milk secretion in the glands. It is unlikely pressure in the udder was increased significantly prior to resuming milking.

Exposure of cows and calves to hypothermic conditions: the cows in cubicles were covered by snow and snow blew into the calf shed and made deep drifts. This caused discomfort and distress for both cows and calves.

The thermal neutral zone for adult dairy cows is between 0^{o} and 25^{o} C (below 0^{o} for cattle with thick hair coats), and calves have a thermal neutral zone between 10^{o} and 25^{o} C in normal conditions. Certain issues make animals more susceptible to cold: wind, wet conditions, and conduction of surface body temperature. Wind penetrates the hair coat; wet conditions decrease the insulating quality of the hair coat; and lying on cold or frozen ground or cubicles will result in conduction of body temperature to the cold surface.

Newborn calves are especially susceptible to temperature challenges because they lack the ability to maintain core body temperature and have little energy reserves. Calves are unable to maintain body temperature at birth. They lack the neuromuscular ability to generate heat by shivering effectively. Also, they must have the energy present in colostrum. Calves are born with about 24 to 48 hours of energy reserves, and these reserves are depleted quickly in cold weather. Therefore, they need to be dried, kept warm and fed colostrum.

Cows lying on the mats on un-covered concrete cubicles would be expected to conduct body temperature to the concrete. In very cold weather, cattle in unprotected conditions will prefer to stand rather than lie on frozen ground. When they get tired, they will lie next to each other, effectively shielding each other from wind and providing body heat to each other.

The un-covered cubicles forced cows to lie separately, losing the wind and shared body heat advantages of normal behaviour. Grass or other straw bedding would be expected to provide more insulation on lying surfaces than the rubber matting in the conditions experienced. It was reported that no animals had clinical frostbite.

Three animal welfare issues potentially related to the weather event were recognized during the review.

Calf mortality (Total Calves Died (Stillborn + later) was reported at 8.9% for this season, and over 7% for the previous three years. The calf mortality (all calvings – stillborn) was 6.6% for the 2018 season to date reported. This is a high percentage of calf mortality, given calves are removed (normally) from the dairy at two weeks of age. The stillborn percentage is low (2.4%), indicating few dystocia and appropriate handling of cows at calving.

Table 6: Calf Mortality Greenfield Farm 2012 to 2018 (From Report)

Year	# Cows Calved	# Calves Stillborn	% Calves Stillborn	# Live Calves Born	Calves Died not Stillborn	% calf Mortality	Total calves died	% Total calves died
2012	307	5	1.6	302	9	3.0	14	4.6
2013	342	5	1.5	337	14	4.2	19	5.6
2014	331	7	2.1	324	10	3.1	17	5.1
2015	334	5	1.5	329	19	5.8	24	7.2
2016	347	11	3.2	336	15	4.5	26	7.5
2017	373	12	3.2	361	15	4.2	27	7.2
2018	370	9	2.4	361	24	6.6	33	8.9

Although the dairy reportedly performed well regarding animal welfare in previous years, the facility and management were not prepared for the severe winter storm in 2018. Animal welfare can be viewed as a combination of facilities and people on farms. Facilities must be provided to allow animals to interact, express behaviours, and, when necessary, be protected from severe weather. People on farms affect animal welfare through husbandry practices that provide calm handling, preventive medicine and prompt care, and are prepared through training and experience to care for animals in different situations. Excellent facilities tend to make it easier to care for animals. Well trained and well supported people on farms can overcome short-comings in facilities up to a point.

The Greenfield Dairy farm was established to be a resource for the dairy industry in Ireland. The minimal investment approach was chosen as a model for pasture-based systems that would be affordable for new dairy farmers and for expansion. It is recognized that the Greenfield Dairy partners and management conducted a thorough review of appropriate design for confinement facilities prior to building the un-protected cubicle area. This winter's storm exposed facility and management issues that severely affected the welfare of the animals on the farm. This raises the opportunities to address these issues and build them into the Greenfield model.

The outcome of the storm demonstrated improvements in facilities are needed for animals to be protected in another such extreme event. It is apparent that shelter for cows, protection of calves in the calf shed, management of new born and young calves, and protection of the milking parlour during severe weather needs improvement.

In the course of discussions by the review committee the following issues arose which were not directly related to the weather event.

Lameness: increased locomotion scores were noted on 31st March (17% LS 2 or 3). This is a high number of cows with clinical lameness. White line disease was reported as the cause of the lameness in the report.

White line disease in cattle has been associated with standing on concrete, shearing forces from cows being pushed by other cows and the crowd gate in the holding pen, material being forced into the white line during walking and changes in the foot around the time of calving. All these factors were in play during the Winter/Spring and confinement in the cubicles and in addition the level of

cow activity around the feed barrier method of feeding the concentrates may have exacerbated the problem.

Somatic Cell Count (mastitis): during testimonies and in the report provided to the committee somatic cell count was reported as an issue on the farm in 2018. This was reported to be associated with Staphylococcus aureus cows and the cows were in the process of being treated with antimicrobials. Cows with chronic Staphylococcus aureus mammary infections are not expected to recover.

4.4 Recommendations

The following are the four summary recommendations arising from the review for consideration by GDP and Teagasc:

1. The unprecedented storm tested the management system in place on the Greenfield farm and highlighted a lack of clarity around the governance and management structure of the farm including responsibilities, lines of command and communication channels, thusincreasing the risk of not being able to deal adequately with such an unexpected event. It is recommended that the governance and management structure for the project is reviewed to provide clearer lines of command and responsibility and enhance communication among all those involved with the management and operation of the Greenfield farm.

2. While prepared for usual storms, it was apparent that the management and staff were not prepared for the severity of the status red storm experienced. The safety statement at the time was inadequate in terms of risk assessments, contingency and emergency plans to enable the staff to respond effectively. It is recommended that all the stakeholders associated with the Greenfield farm engage in a process to review and update the safety statement to ensure they fully understand their role and responsibility and include contingency plans to mitigate potential risks.

3. The animal welfare issues that arose during the storm revolved around cow and calf mortality, and discomfort and distress from exposure to hypothermia. While the farm had a good record of animal care prior to the storm, it highlighted the need for improved facilities to protect animals if the farm was to experience a similar event in the future. It was apparent that shelter for cows, protection of calves in the calf shed, management of new born and young calves, and protection of the milking parlour during severe weather needs improvement. Consideration could also be given to expanding the calving shed to accommodate the number of cows expected to calve in a 24-hour period.

4. It is also recommended that the annual feed budgets for the farm incorporate reserves to allow for severe weather events.

Further issues that might be considered by those involved with the Greenfield farm to assist in preparing for unexpected weather events in the future are outlined in Appendix 3.

5. Conclusions

Ireland experienced a unique, rare, and extreme weather event in March 2018 which significantly impacted businesses across the country. It was particularly difficult for the farming community as it was one of the busiest times of year, particularly for those with spring calving herds. It is acknowledged that a huge effort was made by all the staff involved in the Greenfield farm leading up to, during, and after the storm and, in the circumstances that prevailed at the time, the consequences were mitigated to a significant extent. That said, the weather event provided a number of learnings for the stakeholders of the Greenfield farm in relation to governance, health and safety, animal welfare and general farm management which will be beneficial in the years ahead.

Appendix 1: Members of Review Committee

The review team was chaired by Tom Moran, former Secretary General of Department of Agriculture, Food and the Marine.

The members of the committee were:

- Dr. Jim Reynolds, Professor of Large Animal Medicine and Welfare, Western University of Health Sciences, College of Veterinary Medicine, California,
- Dr. Tom Butler, Director, FBA Laboratories
- Mr Andrew Reilly, Cohort Recruitment and Training
- Mr Michael Sheahan, Director of Veterinary Operations, Department of Agriculture, Food and the Marine
- Tommy Cooke, dairy farmer and member of the Teagasc Authority (ICMSA representative)
- Kevin Twomey, dairy farmer and chair of Teagasc Dairy Stakeholder Group
- Secretariat - Ms Jane Kavanagh, Head of Research Operations, Teagasc

Appendix 2: Agreement between Teagasc and Greenfield Dairy Partners

Schedule 1

Services & Service Levels

a) To direct the management, the design, layout and construction of all necessary infrastructural requirements for the farm project;
b) To advise on the recruitment of farm staff whose job will be to operate the Greenfield Dairy Farm Project and to procure the dairy herd.
c) To make available a member of Teagasc Moorepark staff ("Moorepark Officer") whose principal role will be to consult on developmental aspects of the farm project including infrastructural requirements and labour structures while providing technical assistance to make the farm project a success and to whom the Greenfield Dairy Farm Project farm manager (employed by Greenfield) will report and be able to consult with.
d) To have the Moorepark Officer report to the shareholders committee on the technical performance and productivity of the farm project on a quarterly basis.
e) The profitability of the business will be published annually by Teagasc Moorepark and will include a detailed analysis of the return on capital, equity, labour and land. This data may be made available to all visitors to the farm and to potential new entrants to dairying.
f) Teagasc Moorepark will develop and implement a dissemination programme for the farm project.

Business plan to be prepared by Teagasc Moorepark

Teagasc Moorepark shall prepare an annual business plan for the Company and it shall include in relation to the Financial Year to which it relates:

(a) a cashflow statement giving:
   i. an estimate of the working capital requirements; and
   ii. an indication of the amount (if any) that it is considered prudent to retain, for the purpose of meeting those requirements, out of those profits of the previous Financial Year that are available under the law of Ireland for distribution to Shareholders;
(b) a monthly projected profit and loss account;
(c) an operating budget (including capital expenditure requirements) and balance sheet forecast;
(d) a management report giving business objectives for the Financial Year; and
(e) a financial report which shall include an analysis of the estimated results of the Company for the previous Financial Year compared with the business plan for that year, identifying variations in sales revenues, costs and other material items.
(f) Any other relevant information.

Appendix 3: Preparing for Unexpected Weather Events

The following suggestions are for consideration by the Greenfield management team to assist in preparing for unexpected weather events in the future.

- Facilities should be provided near (or incorporated into) the calving shed to house the number of calves expected in a 24 hour period. Warming equipment should be available in the shed for calves. Dry towels should be available to dry calves that are born in wet conditions on the overwintering pad. Calf blankets should be available for very cold nights and days.
- Either portable or permanent shelter for all confined animals from strong wind and drifting snow during severe snow storms. Given cows' behavior to walk away from wind and inclement weather, or to group together and huddle if unable to evade severe cold, it may be best to allow space for cows to choose either the outwintering pad or the cubicles. Cubicles must be sheltered from severe wind and drifting snow
- Appropriate equipment for snow removal should be available, accessible or on-site in preparation for storms. Hand-operated snow blowing machines may be appropriate.
- Curtains may be appropriate for the parlour. Curtains can be raised or lowered as needed to protect the cows, employees and equipment during rain and snow and raised during warm weather to facilitate comfort. The eve on the parlour roof drops rain water in front of cow's faces. It was stated, in the interviews, that the cows are bothered by the rain water during milking. A gutter trough may alleviate this partially. A curtain may be more helpful.

- Develop protocols for severe weather events - develop actions that each level of warning will trigger e.g. if a red warning is likely a meeting of the management group should be convened and mitigation measures agreed as far in advance as possible. Guidelines should be issued for Teagasc and farm staff travelling during severe weather events. Ensure safety critical and mission critical measures are prioritised and actioned according to priority. Consider cold, snow, rain, flood, wind, fire. Contingency measures to be considered include:
    - Providing a generator for power outages.
    - Ensure extra help is available and on farm in advance of red warnings.
    - Schedule to complete as many necessary tasks as possible before warnings commence.
    - Hiring loading shovel, skid steer to clear snow if snow is anticipated.
    - Source sufficient supplies to cover the duration of the anticipated event. E.g. food, drinks, clothes, thermal PPE, batteries, lights, shovels.
    - All employees to carry charged mobile phones for communication purposes.

- Review of effectiveness of preparedness following events. A process for reviewing the effectiveness of measures should be undertaken following each severe weather event. Critically analyse all aspects and update plans for the future based on the findings. Consider measures to ensure the welfare of staff is protected following exposure to high stress or traumatic events.

General Health & Safety Recommendations - Not Relevant To future Severe Weather Events

- Employee Welfare - ensure that the proposed new accommodation is fit for purpose and adequate to meet the welfare requirements of employees. The company should be aware of the heightened duty of care to protect the safety of employees being accommodated on the farm. All employees should be provided with suitable PPE for the nature of the working conditions. Particular consideration be given to thermal clothing and gloves for cold weather.

- Training - the nature of the production model requires a small number of competent and physically suitable employees. A system of induction training is required to familiarise employees with the relevant aspects of the operation and to train them in their specific duties and responsibilities. All employees should have a training needs analysis completed and a training plan developed to address their training needs. Safety training should be provided such as manual handling, livestock handling, pesticide use. It is advisable to train at least one first aid responder to attend to minor first aid requirements on the farm. Provision of an AED should be considered.

- Fire Safety - fire safety measures should be advised on by a competent person. Particular attention to be paid to staff accommodation but also to buildings and vehicles. Fire safety plans including evacuation procedures, assembly point and fire drills should be developed.

- Standard Operating Procedures (SOPs) - task specific SOPs should be developed for all normal procedures on the farm e.g. operation of the milking machine, antibiotic use, calving, feeding, use of the water miner system, calf registrations, animal movement certs. In addition, SOPs for contingency measures should be developed e.g. defrosting the milking machine, changeover to generator.

- Safety plans should be developed for open events held on the farm. Aspects to be considered to include; traffic management, stewarding, paramedic / first aid availability, liaising with Gardaí / AA Roadwatch or other relevant bodies, parking arrangements and control of pedestrian movements to safe areas e.g. where electric fences are off.

- Animal handling - arrangements for handling cows at calving time should be reviewed to ensure employee safety. Assessment to include the number and location of calving gates, facilities for surgical procedures and caesarean sections, numbers of calving pens. Safe systems of work should be developed for taking calves from freshly calved cows / heifers to ensure employees are not attacked. It is noted that vasectomised yearling bulls are utilised on the farm. These bulls must be handled correctly and fitted with nose rings and chains. Should signs of aggression be observed cull immediately.

- Prevention of musculoskeletal disorders (MSDs) - an analysis of the physical tasks routinely undertaken on the farm should be conducted. A particular emphasis should be placed on repetitive type tasks. Some examples of the tasks to be reviewed are; lifting calves, use of baled

silage and requirement to cut and remove wrap and twine / net, barrowing of concentrate feed, milking procedures e.g. cluster removal, air purge.

Not Relevant To future Severe Weather Events

- Consider seeking advice from the appropriate faculties in UCD or elsewhere in developing improved facilities and addressing animal issues. Issues of lameness and mastitis (high SCC) were brought up during the interviews and in the report that indicate management of Greenfield Farm may not be receiving specialist veterinary advice on controlling and treating these diseases. It should be recommended the farm have regular visits and review by external sources with the relevant expertise.