ANNEXURE 7

Preliminary Hazard Analysis

prepared by

Pinnacle Risk Management

ANNEXURE 7

Pinnacle
Risk Management Pty Ltd

PRELIMINARY HAZARD ANALYSIS, DDG DRYERS AND EQUIPMENT, SHOALHAVEN STARCHES, BOMADERRY, NSW

Prepared by: Dean Shewring

24 April 2016

Pinnacle Risk Management Pty Limited
ABN 83 098 666 703

PO Box 5024 Elanora Heights
NSW Australia 2101
Telephone: (02) 9913 7284
Facsimile: (02) 9913 7930

Preliminary Hazard Analysis, Shoalhaven Starches, DDG Dryers and Equipment

Disclaimer

This report was prepared by Pinnacle Risk Management Pty Limited (Pinnacle Risk Management) as an account of work for Shoalhaven Starches. The material in it reflects Pinnacle Risk Management's best judgement in the light of the information available to it at the time of preparation. However, as Pinnacle Risk Management cannot control the conditions under which this report may be used, Pinnacle Risk Management will not be responsible for damages of any nature resulting from use of or reliance upon this report. Pinnacle Risk Management's responsibility for advice given is subject to the terms of engagement with Shoalhaven Starches.

Rev	Date	Description	Reviewed By
A	23/2/16	Draft for Comment	Shoalhaven Starches
B	12/3/16	Final Issue	Shoalhaven Starches
C	24/4/16	Minor Typographical Corrections	Shoalhaven Starches

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

Shoalhaven Starches are proposing to modify the 'Shoalhaven Starches Expansion Project' approval (MP 06_0228). This modification application will seek to:

- Reduce the number of DDG (dried distillers grain) dryers from 6 to 4;
- Slightly modify the footprint of these DDG dryers on the site (it is proposed to locate the 4 dryers 28 metres to the north from the approved site);
- Introduce a mill feed silo and structure to feed the DDG dryers;
- Relocate cooling towers within the site;
- Provide an additional two biofilters;
- Construct a forklift maintenance building immediately to the south-west of the proposed relocated DDG dryers;
- Construct a freight container preparation area to the east of the proposed forklift maintenance building and south of the proposed relocated DDG dryers;
- Construct a container storage area to the west of the relocated DDG dryers; and
- Provide an emergency coal and woodchip storage area on the north side of Bolong Road within the Environmental Farm. The woodchip and coal are used as fuel sources within the Shoalhaven Starches operations.

The project is planned to be performed in two stages. During Stage 1, the existing coal and woodchip stockpiles will be retained on the south side of Bolong Road until this area is required for container storage. When the need for the container storage area occurs, the coal and woodchip stockpiles will be relocated to the north side of Bolong Road to the existing stockpiles located within the Environmental Farm, i.e. this is the Stage 2 scope.

As part of the project requirements, a Preliminary Hazard Analysis (PHA) is required. This report details the results from the analysis.

The risks associated with the proposed reduction in number of DDG dryers and associated equipment at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoP risk criteria.

In summary:

- The potential hazardous events associated with the DDG dryers and associated equipment are dust explosions and smouldering fires. Given the adequate separation distances to public land then no adverse off-site impacts are expected;
- All risk criteria in HIPAP 4 is expected to be satisfied for this proposal;

- Propagation to neighbouring equipment is not expected given that the potential dust explosions are either to be vented to atmosphere at a safe, elevated location or of limited consequential impact and the potential fires are of a smouldering nature; and
- Societal risk, environmental risk and transport risk are all considered to be broadly acceptable.

The recommendations from this assessment are as follows:

1. All dust explosion vents are to be either flameless or directed to a safe location to ensure propagation risks will be acceptable; and
2. Review the need for installing temperature sensors in the bucket elevator for fire detection and/or the installation of deluge or fire suppression system (Inergen). Operator detection of issue required plus response, e.g. opening a valve to initiate the deluge.

GLOSSARY

ATEX	Atmosphere Explosive (European Standard)
DDG	Dried Distillers Grain
DoP	NSW Department of Planning
FHA	Final Hazard Analysis
HIPAP	Hazardous Industry Planning Advisory Paper
LEL	Lower Explosive Limit
PHA	Preliminary Hazard Analysis
QRA	Quantitative Risk Assessment

REPORT

1 INTRODUCTION

1.1 BACKGROUND

From Ref 1, Shoalhaven Starches is a member of the Manildra Group of companies. The Manildra Group is a wholly Australian owned business and the largest processor of wheat in Australia. It manufactures a wide range of wheat based products for food and industrial markets both locally and internationally.

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

Shoalhaven Starches are proposing to modify the 'Shoalhaven Starches Expansion Project' approval (MP 06_0228). This modification application will seek to:

- Reduce the number of DDG (dried distillers grain) dryers from 6 to 4;
- Slightly modify the footprint of these DDG dryers on the site (it is proposed to locate the 4 dryers 28 metres to the north from the approved site);
- Introduce a mill feed silo and structure to feed the DDG dryers;
- Relocate cooling towers within the site;
- Provide an additional two biofilters;
- Construct a forklift maintenance building immediately to the south-west of the proposed relocated DDG dryers;
- Construct a freight container preparation area to the east of the proposed forklift maintenance building and south of the proposed relocated DDG dryers;
- Construct a container storage area to the west of the relocated DDG dryers; and
- Provide a coal and woodchip storage area on the north side of Bolong Road within the Environmental Farm. The woodchip and coal are used as fuel sources within the Shoalhaven Starches operations.

The project is planned to be performed in two stages. During Stage 1, the existing coal and woodchip stockpiles will be retained on the south side of Bolong Road until this area is required for container storage. When the need for the container storage area occurs, the coal and woodchip stockpiles will be relocated to the north side of Bolong Road, i.e. this is the Stage 2 scope.

As part of the project requirements, a Preliminary Hazard Analysis (PHA) is required. Shoalhaven Starches requested that Pinnacle Risk Management prepare the PHA for the above scope. This PHA has been prepared in accordance with the guidelines published by the Department of Planning (DoP) Hazardous Industry Planning Advisory Paper (HIPAP) No 6 (Ref 2).

1.2 OBJECTIVES

The main aims of this PHA study are to:

- Identify the credible, potential hazardous events associated with the modifications to the DDG dryers and associated equipment and facilities;
- Evaluate the level of risk associated with the identified potential hazardous events to surrounding land users and compare the calculated risk levels with the risk criteria published by the DoP in HIPAP No 4 (Ref 3);
- Review the adequacy of the proposed safeguards to prevent and mitigate the potential hazardous events; and
- Where necessary, submit recommendations to Shoalhaven Starches to ensure that the DDG dryers and associated equipment and facilities are operated and maintained at acceptable levels of safety and effective safety management systems are used.

1.3 SCOPE

This PHA assesses the credible, potential hazardous events and corresponding risks associated with the Shoalhaven Starches proposed DDG dryers and associated equipment and facilities listed in Section 1.1 with the potential for off-site impacts only. This includes any intermediate risks associated with the staging of the project.

The DDG dryers and cooling towers were previously proposed, assessed and approved (28/1/09) but not built (see the PHAs (Refs 4 and 5) and FHA (Ref 6)). These studies have been reviewed by Pinnacle Risk Management and are referred to throughout this report. Any existing assessment which remains valid for the current version of the proposal is not reproduced in this report.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoP in HIPAP 6 (Ref 2) the underlying methodology of the PHA is risk-based, that is, the risk of a particular potentially hazardous event is assessed as the outcome of its consequences and likelihood.

The PHA has been conducted as follows:

- Initially, the proposed DDG dryers and associated equipment and facilities and their location were reviewed to identify credible, potential hazardous events, their causes and consequences. Proposed safeguards were also included in this review;
- As the potential hazardous events are located at a significant distance from other sensitive land users, the consequences of each potential hazardous event were estimated to determine if there is any possible unacceptable off-site impacts;
- Included in the analysis is the risk of propagation between the proposed equipment and the adjacent processes; and

- If adverse off-site impacts could occur, assess the risk levels to check if they are within the criteria in HIPAP 4 (Ref 3).

2 SITE DESCRIPTION

From Ref 1, the Shoalhaven Starches factory site is situated on various allotments of land on Bolong Road, Bomaderry, within the City of Shoalhaven (see Figure 1). The factory site, which is located on the south side of Bolong Road on the northern bank of the Shoalhaven River, has an area of approximately 12.5 hectares.

The town of Bomaderry is located approximately 0.5 km to the west of the factory site and the Nowra urban area is situated 2.0 km to the south west of the site. The "Riverview Road" area of the Nowra Township is situated approximately 600 metres immediately opposite the factory site across the Shoalhaven River.

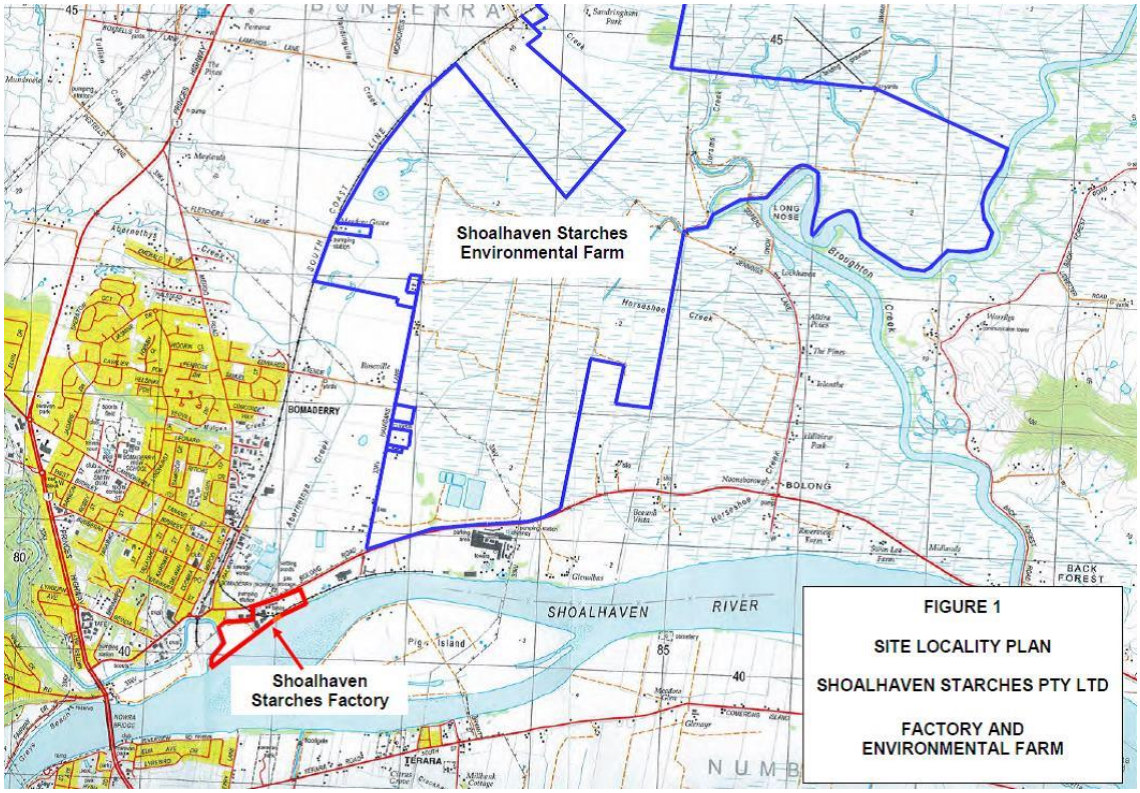
The village of Terara is situated approximately 1.5 kilometres to the south east of the site, across the Shoalhaven River. Pig Island is situated between the factory site and the village of Terara and is currently used for dairy cattle grazing.

There are a number of industrial land uses, which have developed on the strip of land between Bolong Road and the Shoalhaven River. Industrial activities include a metal fabrication factory, the Shoalhaven Starches site, Shoalhaven Dairy Co-op (formerly Australian Co-operative Foods Ltd – now owned by the Manildra Group) and the former Shoalhaven Paper Mill (Australian Papers). The industrial area is serviced by a privately owned railway spur line that runs from just north of the Nowra-Bomaderry station via the starch plant and the former Dairy Co-op site to the Paper Mill.

The Company also has an Environmental Farm located over 1,000 hectares on the northern side of Bolong Road. This area is cleared grazing land and contains spray irrigation lines and wet weather storage ponds (total capacity 925 Mega litres). There are at present six wet weather storage ponds on the farm that form part of the waste water management system for the factory. A seventh pond approved in 2002 was converted into the biological section of the new wastewater treatment plant has now been commissioned.

The Environmental Farm covers a broad area of the northern floodplain of the Shoalhaven River, stretching from Bolong Road in the south towards Jaspers Brush in the north. Apart from its use as the Environmental Farm, this broad floodplain area is mainly used for grazing (cattle). The area comprises mainly large rural properties with isolated dwellings although there is a clustering of rural residential development along Jennings Lane (approximately 1 kilometre from the site), Back Forest Road (approximately 500 metres to 1.2 kilometres to the west) and Jaspers Brush Road (approximately 1.2 kilometres to the north).

Figure 1 - Site Locality Plan



Source: Ref 1.

Security of the site is achieved by a number of means. This includes site personnel and security patrols by an external security company (this includes weekends and night patrols). The site operates 7 days per week (24 hours per day). Also, the site is fully fenced and non-operating gates are locked. Security cameras are installed for staff to view visitors and site activities.

Current security measures north of Bolong Road include:

- Card access via a gate; and
- Personnel on site during weekdays and some shifts.

There are approximately 120 people on site during Monday to Fridays 8 am to 5 pm and 30 people on site at other times.

The main natural hazard for the site is flooding. No other significant external events are considered high risk for this site.

Layout drawings showing the proposed location of the proposed DDG Dryers and associated equipment and facilities are shown in Figures 2, 3 and 4. Figure 3 shows the DDG dryers area during Stage 1, i.e. the coal and woodchip stockpiles are in their current position. Figure 4 shows the DDG dryers area during Stage 2, i.e. the coal and woodchip stockpiles are relocated to the north side of Bolong Road and the container storage area is shown.

Figure 2 – Site Layout showing the Proposed Scope

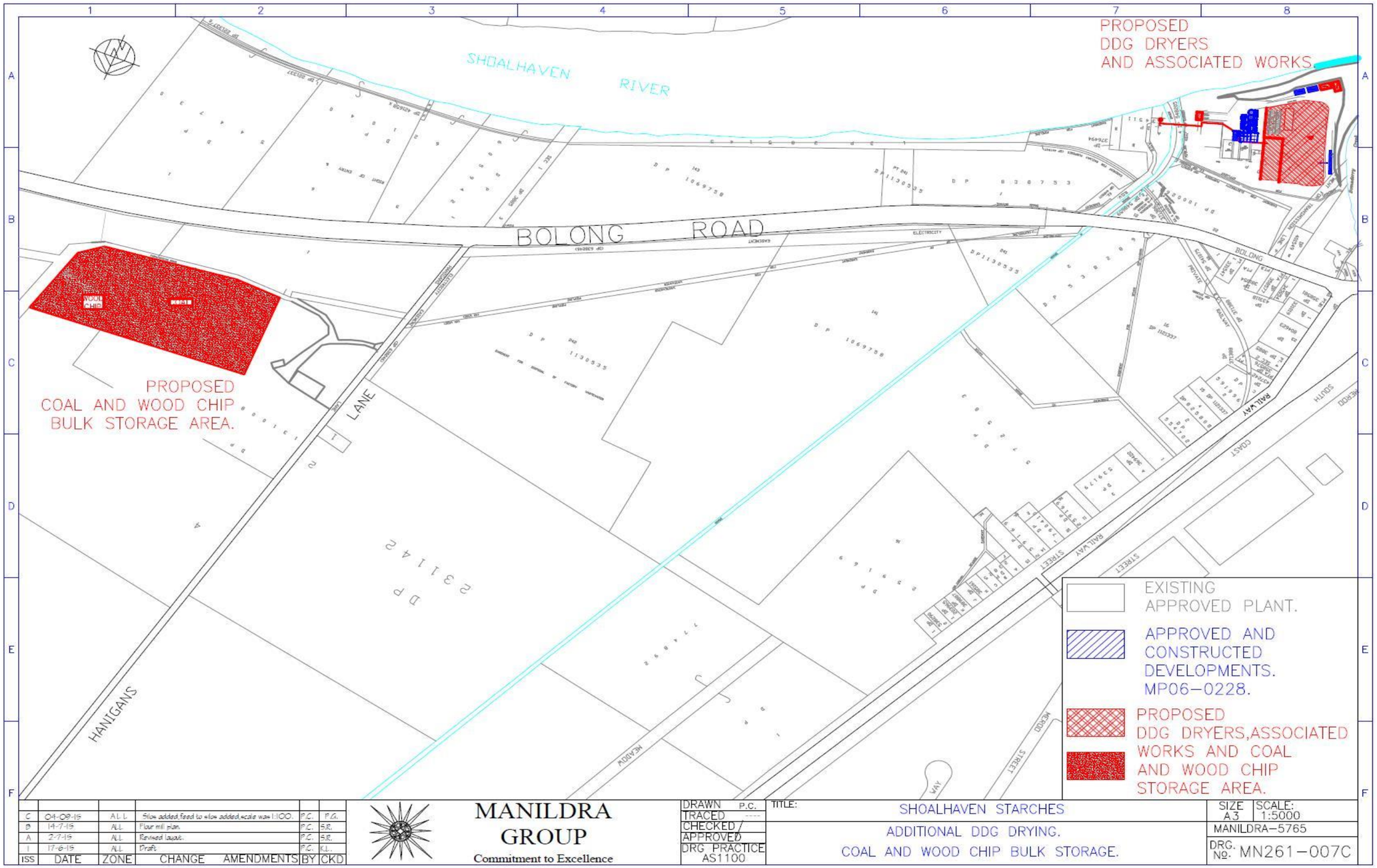


Figure 3 – DDG Dryers Area – Stage 1

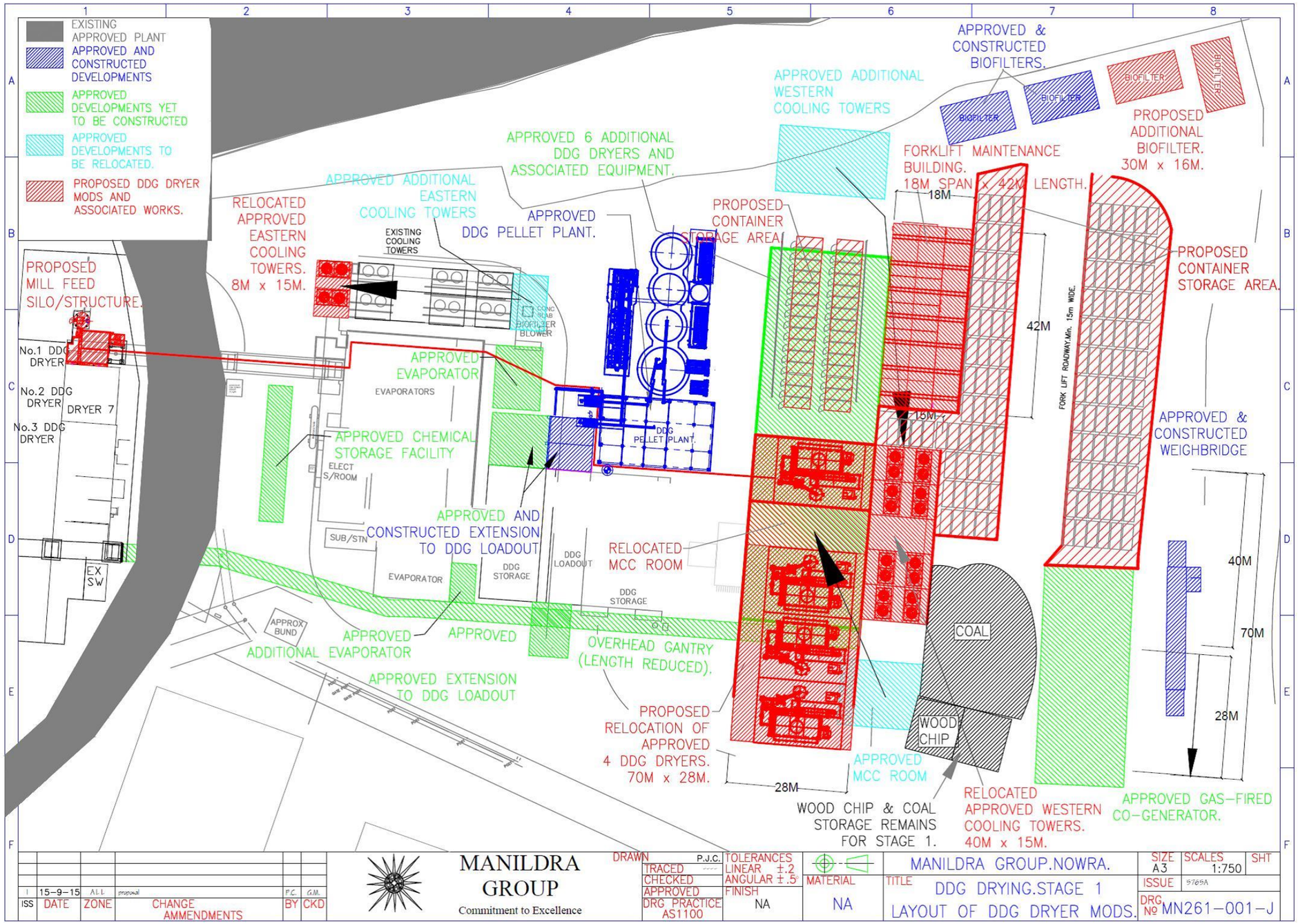
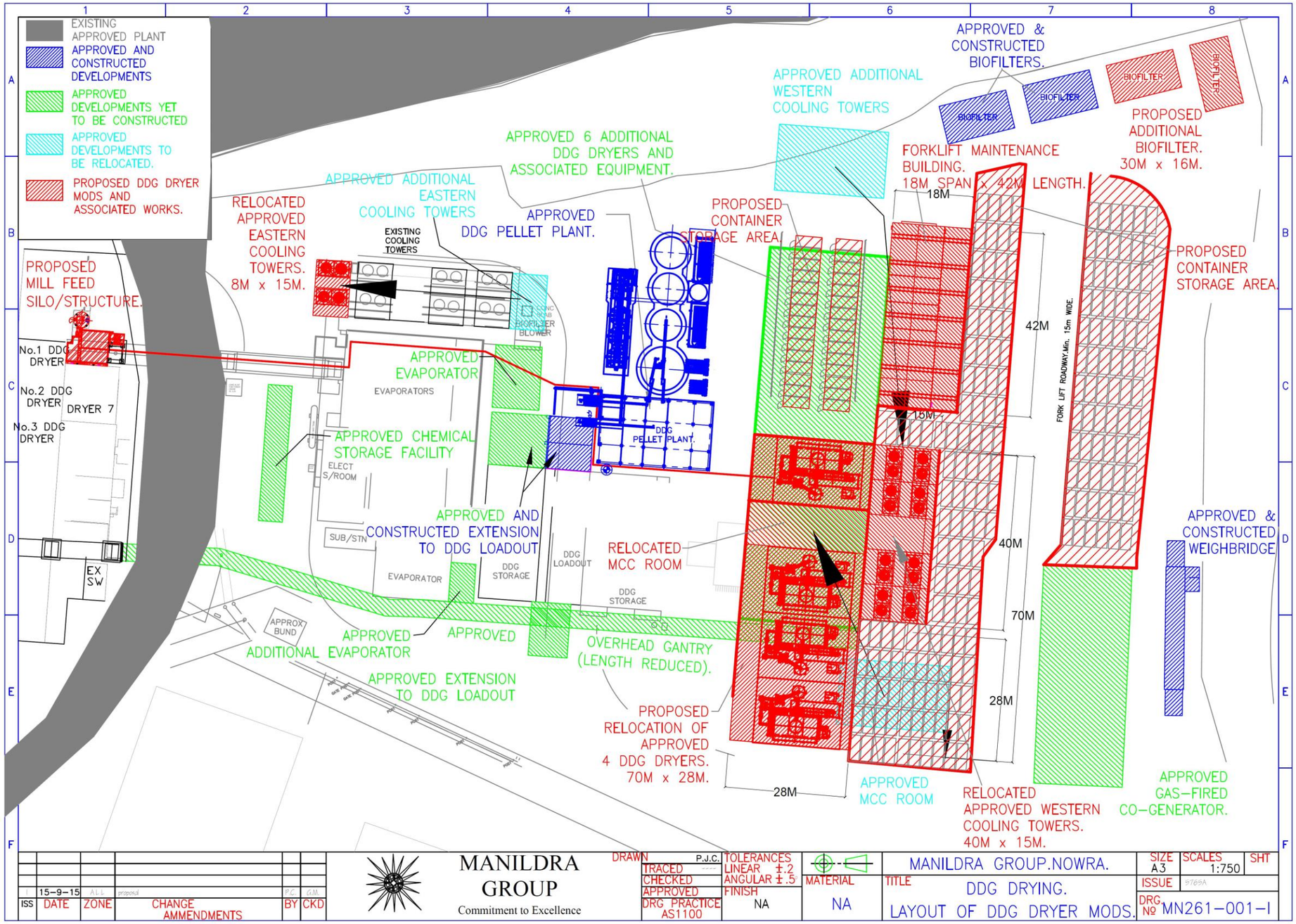


Figure 4 - DDG Dryers Area – Stage 2



3 PROCESS DESCRIPTION

3.1 REDUCE THE NUMBER OF DDG (DRYERS FROM 6 TO 4)

As ethanol demand has not reached the predicted levels then the number of DDG dryers required has correspondingly reduced. The reduction in the DDG dryers' footprint on the site results in additional space for other development, i.e. a forklift maintenance building (see below).

The proposed DDG dryers are similar in design to that in previous assessments, i.e. from the same supplier and designed for the same capacity.

The DDG dryers will process mill feed, i.e. wheat bran (the hard outer layer of wheat grains), and syrup to produce dried DDG product for the Pellet Plant.

The major components of the DDG dryers are:

- Tube bundle dryer;
- Wet scrubber;
- Condenser;
- Screws;
- Double shaft mixer;
- High speed mixer; and
- Cooling towers.

Mill feed (bran) is to be stored in a new silo (see Section 3.3). Mill feed will be conveyed from the new silo to the conveying screw, where it will be mixed with a portion of the dried DDG product before entering the double shaft mixer.

The other feed ingredient, syrup, is to be pumped to the double shaft mixer where it is mixed with mill feed before entering the high speed mixer for more thorough mixing. The mixture will then be fed to the tube bundle dryer through the feed screw. In the tube bundle dryer, the mixture of mill feed and syrup is to be dried by saturated steam before being discharged through the discharge chute into the discharge screw.

Part of the dried product leaves the discharge screw to go to the Pellet Plant through a blowline while a small portion is returned to the double shaft mixer through the dosing screw and the conveying screw.

The vapour evaporating from the mill feed and syrup mixture during the drying process is to be extracted by the leakage air fan to the wet scrubber for processing. Wet vapour will flow from the top of the wet scrubber to the condenser while the sludge is to be collected at the bottom of the scrubber and sent to the evaporator (existing).

A process flow diagram is shown in Appendix 1.

The above description is provided for the reader's information. This proposal reduces the number of approved DDG dryers from 6 to 4. The DDG dryers have been previously assessed (Refs 4, 5 and 6). As discussed in Section 4 of this report, the DDG dryer design does not impose unacceptable levels of risk. Reducing the approved number from 6 to 4, of course, does not adversely

impact unit risk, however, included in Section 5 of this report is an assessment of propagation risk.

In the previous assessments for the DDG dryers, dust collectors and their explosion vents were assessed. The new design (from the same supplier) has no dust collectors associated with the DDG dryers. Hence, there are fewer dust explosion hazards in the current proposal.

3.2 SLIGHTLY MODIFY THE FOOTPRINT OF THE DDG DRYERS

It is proposed to move the DDG dryers building 28 metres to the north from the approved site (see Figure 3). This will provide more area surrounding the forklift maintenance building for forklift manoeuvring. As discussed above in Section 3.1, Section 5 of this report includes an assessment of propagation risk given the new location.

3.3 MILL FEED SILO AND STRUCTURE TO FEED THE DDG DRYERS

It is proposed to install a mill feed silo on the eastern side of the factory near the DDG dryers 1 to 3 (see Figure 4). Mill feed from the silo will be conveyed by bucket elevators and pipework (blowline) to the DDG dryers.

The silo is to be approximately 3.5 m diameter by 20 m high. This gives a volume 200 m^3. As the density of mill feed is approximately 350 kg/m^3, this is equivalent to approximately 70 te.

For the mill feed silo and bucket elevator, explosion prevention and protection measures will include:

- Zero speed sensor on the bucket elevator tail pulley;
- Tracking limits which stop the bucket elevator;
- Explosion vents;
- Anti-runback device on the bucket elevator;
- Earthing and design to Hazardous Area requirements; and
- The delivery chute will have a full limit switch to trip the bucket elevator.

The blowline system explosion prevention and protection measures include earthing, design to Hazardous Area requirements, dense phase conveying, and the receiving hopper and baghouse will have explosion vents.

3.4 RELOCATE THE COOLING TOWERS

It is proposed to relocate the approved but not yet constructed cooling towers located adjacent to the Shoalhaven River to adjacent to the proposed DDG dryer building (see Figure 4). This is proposed as the land they currently occupy is now zoned for environmental conservation.

It is also proposed to relocate the approved but yet to be built cooling towers from their position adjacent to the approved evaporator. A Biofilter Odour Recovery Unit Scrubber has been built in this location. The new location for the approved cooling towers is to the eastern side of this scrubber.

The proposed DDG Dryer No. 4 will be provided with cooling towers comprising standard 3 to 4 cells with total capacity of 1,000 m^3/hour (of cooling water). The remaining proposed DDG Dryers, will be provided with cooling towers with a capacity of 3,000 m^3/hour (of cooling water). The cooling towers will be fiberglass casing, stainless steel structure with a plastic fill.

Dosing chemicals used will be stored in small quantities (drums) next to the cooling towers. They will be stored in a bunded area between the cooling towers and segregated as per the Dangerous Goods storage codes, e.g. acids stored separately from the alkalis.

The chemicals will be transported to site every fortnight to monthly.

Given the information available to date, there are no potential hazardous events associated with the cooling towers that could adversely affect people off-site as defined by the HIPAP 4 risk criteria.

3.5 TWO NEW BIOFILTERS

Two new biofilters are proposed to be constructed (see Figure 3) as it is anticipated there will be more odorous air streams to filter as a result of the DDG dryers operation. The biofilters are of concrete and steel construction with a wood chip fill. Odours in air are initially adsorbed onto the surface of the woodchip and then biologically oxidised. The air stream is required to only have one pass through the woodchip. The process occurs within the moistened woodchip where micro-organisms are encouraged to grow.

There are no Dangerous Goods or hazardous materials associated with biofilters. Given the information available to date, there are no potential hazardous events associated with the biofilters that could adversely affect people off-site as defined by the HIPAP 4 risk criteria.

3.6 FORKLIFT MAINTENANCE BUILDING

It is proposed to construct a forklift maintenance building immediately to the south-west of the proposed relocated DDG dryers (see Figure 3). This will be a typical maintenance building (steel construction) with no significant quantities of Dangerous Goods or hazardous materials stored or used. There are no potential hazardous events associated with the forklift maintenance building that could adversely affect people off-site as defined by the HIPAP 4 risk criteria.

3.7 FREIGHT CONTAINER PREPARATION AREA

It is proposed to construct a freight container preparation area to the east of the proposed forklift maintenance building and south of the proposed relocated DDG dryers (see Figure 3).

The container preparation area is an area where empty containers are manually lined with plastic and cardboard (before they are loaded with products elsewhere). Whilst the plastic and cardboard is combustible, the quantities are limited and there are no credible ignition sources when lined the containers. Therefore, there are no potential hazardous events associated with the freight container preparation area that could adversely affect people off-site as defined by the HIPAP 4 risk criteria.

3.8 CONTAINER STORAGE AREA

It is proposed to construct a container storage area to the west of the relocated DDG dryers (see Figure 3).

The container storage area includes a mixture of empty containers (50%) and full containers (50%). The products in the full containers can be:

- Loose DDG (similar in consistency to bran);
- DDG pellets, dry starch (powder); and
- Dry gluten (powder).

Approximately 300 full containers currently leave the site each week by train (and a similar number of empty containers are brought to site each week). There are no planned changes to the transport frequency and arrangements.

DDG, starch and gluten are combustible solids. If released, they can be ignited. As this is an open area, a smouldering fire is the most credible outcome. There is no containment for any released combustible dust such that a dust explosion is a credible event. Smouldering fires are further detailed in Section 5 of this report. However, there are no potential hazardous events associated with the freight storage area that could adversely affect people off-site as defined by the HIPAP 4 risk criteria.

3.9 COAL AND WOODCHIP STORAGE AREA

The proposal includes the regularising and expansion of an area on the north side of Bolong Road within the Environmental Farm for the purpose of storing coal and woodchip (see Figure 2). The woodchip and coal are currently used as fuel sources for boilers within the Shoalhaven Starches operations. The current storage area within the south side of Bolong Road will eventually be used for the above scope (see Figures 3 and 4), hence it is proposed to expand the use of the existing coal and woodchip storage on the north side of Bolong Road.

The proposed coal and wood chip storage volumes on the northern side of Bolong Road will be approximately 10,000 m^3 (8,000 te) and 9,000 m^3 (3,000 te), respectively.

Coal and woodchip are delivered to site via trucks.

Coal consumption is approximately 220 tonnes per day (approximately 10 trucks from the storage area to site). Woodchip consumption is approximately 40 tonnes per day (approximately 2 trucks from the storage area to site).

Coal and woodchip are to be transported to the storage area on the north side of Bolong Road by trucks and stockpiled by an excavator. A front-end loader will load trucks to transport to the factory.

The coal and woodchip stockpiles on the north side of Bolong Road are in the open. There is to be a sprinkler system to supress dust and the runoff water is to be directed to a small retention pond.

The existing coal and woodchip stockpiles at the factory have a roof above the stockpiles.

4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

The hazardous materials for this proposal are summarised as follows:

- DDG;
- Syrup;
- Starch and gluten (within the freight containers). As discussed in Section 3.8, if the starch and gluten is released and ignited, a smouldering fire is the most likely outcome;
- Cooling water dosing chemicals (the chemicals are yet to be determined but these will be Minor Quantities);
- Coal and woodchip. These are combustible solids that form smouldering fires if ignited.

DDG:

This is the bran or outer layer from wheat husks, i.e. it is mostly fibre. Any dust with the bran is a potentially an explosive dust. Whilst the DDG is combustible when exposed to strong ignition sources, e.g. open flames, it typically burns as a smouldering type of fire and therefore do not pose significant radiant heat hazards.

Syrup:

Syrup is a dark brown soluble liquid fraction that remains after grains have been fermented in the process of producing bioethanol in combination with yeasts and enzymes. It is not a Dangerous Good or hazardous material. It poses no significant hazardous events on release.

4.2 POTENTIAL HAZARDOUS INCIDENTS REVIEW

In accordance with the requirements of *Guidelines for Hazard Analysis*, (Ref 2), it is necessary to identify hazardous events associated with the facility's operations. As recommended in HIPAP 6, the PHA focuses on "atypical and abnormal events and conditions. It is not intended to apply to continuous or normal operating emissions to air or water".

In keeping with the principles of risk assessments, credible, hazardous events with the potential for off-site effects have been identified. That is, "slips, trips and falls" type events are not included nor are non-credible situations such as an aircraft crash occurring at the same time as an earthquake.

The identified credible, significant incidents (in particular, with the potential for off-site impacts) for the DDG and associated equipment are summarised in the Hazard Identification Word Diagram following (Table 1).

This diagram presents the causes and consequences of the events, together with major preventative and protective features that are to be included as part of the design.

Table 1 – Hazard Identification Word Diagram

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation	Additional Safeguards
1	DDG dryers	Internal dust explosion			This event was analysed in Ref 5. In summary, the water content in the dryer is more than 50%. This reduces the oxygen content to approximately 10%. This is below the quoted minimum oxygen concentration of 11.5% to sustain a dust explosion. Therefore, dust explosions within the DDG dryers were deemed to be an acceptably low risk event.	None

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation	Additional Safeguards
2	Mill feed silo	Dust explosions and fires	Static, foreign object, hot work	Confined dust explosion with damage to the silo, potential for injury to people	All equipment containing mill feed are to be designed to ATEX standards. The silo is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed. Permits to work. Explosion vent	None
3	Mill feed bucket elevator	Ignition of confined mill feed	Foreign object, belt slip, poor belt tracking, baghouse fire / explosion propagating back to the elevators. Failure of the drive end clutch resulting in high temperatures. Flame will propagate upstream and downstream equipment	Product and equipment fire, potential for internal dust explosion	Bearings are external. Belt drift / mis-alignment sensors. Aspiration system (with interlocks). Equipment designed to ATEX including hazardous area assessment. Foreign objects removed via screen and separators. Explosion vents. Low belt speed (less than 3 m/s). Bonding and earthing	Review the need for installing temperature sensors in the bucket elevator for fire detection and/or the installation of deluge or fire suppression system (Inergen). Operator detection of issue required plus response, e.g. opening a valve to initiate the deluge

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation	Additional Safeguards
4	Mill feed blowline	Internal dust explosion within the blowline	Low likelihood event, e.g. static	As the blowline is to be designed for containment then the flame front will travel to the downstream bin	Bonding and earthing of the entire blowline. The air blowers contain non-return valves, a relief valve and a spark arrester. Dust concentration normally above the upper explosion limit	None
5	DDG building	Dust explosion within the building	Loss of containment of dust within the building	Dust explosion within the building, loss of life, equipment damage, production downtime	Sealed process systems lowering the likelihood of leaks, aspirated system, instrument and electrics to hazardous zones, housekeeping. Permit to work system requiring adequate cleaning and control of ignition sources. Limited dust in the DDG	None

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation	Additional Safeguards
6	Baghouse filters	Explosion	Static, carryover spark. Propagation of fire event from elsewhere in the process, e.g. burning embers	Explosion	Earthing / bonding of all equipment. Hazardous area zones. Induced draft which keeps the concentration kept below the LEL. All baghouses are pulsed with air for cleaning, pressure is measured and checked every day. If issues arise the socks are changed. The socks are also changed every 6 months. Anti-static socks	None
7	Baghouse filters	Release of product	Failed sock	Product release – environmental impact	Visual detection, reporting from outside sources, sock replacement every 6 months - as above. LEL levels not reached, i.e. not considered to be an ignition risk	None
8	Transfer to mill feed hopper	Loss of containment of product due to overfilling	High level switch failure on a hopper	Overfill hopper and with the potential for a loss of containment. Fire if ignited	High pressure trip on the blowers. Level sensor calibration	None

Event Number	Facility Area / Activity	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation	Additional Safeguards
9	Coal and woodchip stockpiles	Fire	Strong ignition source or self-heating	Local smouldering fire	Stockpile management to include restricting the duration of storage. Firewater available via hydrants. Contaminated firewater will flow to the Manildra farm. Permit to work for any hot work in these areas. Security as discussed in Section 2	None
10	All areas	Flooding	Natural event involving significant rain fall	Potential for off-site environmental impact from material being swept away in the flood	The structural characteristics of the DDG building and associated equipment will be certified by an engineer as capable of withstanding flooding and will not become unsafe during floods or as a result of moving debris that would potentially threaten the safety of people or the integrity of the structures	None

5 RISK ANALYSIS

The assessment of risks to both the public as well as to operating personnel from the DDG dryers and associated equipment and facilities requires the application of the basic steps outlined in Section 1. As per HIPAP 6 (Ref 2), the chosen analysis technique should be commensurate with the nature of the risks involved. Risk analysis could be qualitative, semi-quantitative or quantitative.

The typical risk analysis methodology attempts to take account of all credible hazardous situations that may arise from the operation of processing plants etc.

Having identified all credible, significant incidents, risk analysis requires the following general approach for individual incidents:

Risk = Likelihood x Consequence

The risks from all individual potential events are then summated to get cumulative risk.

For QRA and hazard analysis, the consequences of an incident are calculated using standard correlations and probit-type methods which assess the effect of fire radiation, explosion overpressure and toxicity to an individual, depending on the type of hazard.

In this PHA, however, the approach adopted to assess the risk of the identified hazardous events is scenario based risk assessment. The reasons for this approach are:

1. The distance from the equipment to residential and other sensitive land users is large and hence it is unlikely that any significant consequential impacts, e.g. due to radiant heat from fires, will have any significant contribution to off-site risk; and

2. There are a limited number of process safety events. The main events of interest are dust explosions and fire events. Therefore, these are analysed in the remaining sections of this report.

The risk criteria applying to developments in NSW are summarised in Table 2 on the following page (from Ref 3).

Table 2 - Risk Criteria, New Plants

Description	Risk Criteria
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year
Fatality risk to residential and hotels	1×10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year

As discussed above, the consequences of the potential hazardous events are initially analysed to determine if any events have the potential to contribute to the above-listed criteria and hence worthy of further analysis.

5.1 EQUIPMENT DUST EXPLOSIONS

An analysis of the new equipment where potential dust explosions could occur is summarised below.

- DDG dryers (low risk event given the assessment in Ref 5);
- Mill feed silo (low risk given mill feed is fibrous bran);
- Bucket elevator. Note: low conveyor speeds and belt tracking with limit switches will be used to minimise the risk of ignition, and air purging to the baghouse filters is designed to keep the dust concentration below the lower explosive limit;
- Blowline (low risk event given the dense phase conveying and ignition source controls);
- Baghouse filters. Dust explosions are to be vented via explosion vents; and
- Mill feed silo (low risk given mill feed is fibrous bran).

Design data for the proposed dust explosion vents is not yet available. Therefore, modelling of the potential vented dust explosion is not performed. This is to be performed in the FHA for this project. Provided the dust explosion vents are either flameless or directed to a safe location then propagation risks will be acceptable. This is to be confirmed during detail design.

5.2 BUILDING DUST EXPLOSIONS

It is possible that dust explosions could occur in the DDG dryer's building, e.g. deposited dust is not removed due to failure of the housekeeping program. This hazard exists at the site now for the existing similar buildings.

The primary means to prevent this event is to design for containment, i.e. do not release combustible dust into the building. This is the basis for the design of the DDG dryers.

Should losses of containment of combustible dust occur then controls such as housekeeping, hazardous zoning and permits to work are required. These are discussed in more detail in Section 5.4 but are important measures to lower the risk of dust explosions within the existing building. As this hazard exists now on-site and the new equipment is being designed to the same standard as the existing equipment then no further safeguarding is recommended for this scenario.

5.3 DUST EXPLOSION SAFEGUARDING

For equipment processing a potentially explosive dust, it is generally not possible to always ensure the concentration of the dust is below the lower explosive limit. Rather, safeguarding is required to prevent and/or control the potential explosions as discussed below.

There are no mandatory standards or regulations that dictate the design criteria and features for equipment where dust explosions can occur. However, the main means for safeguarding against dust explosions are as follows.

A discussion of the proposed safeguards for the new equipment is included at the end of each Section.

5.3.1 Dust Free Process

Inherently safer options include operating with the materials being wet rather than dry, i.e. preventing dust formation. Not all processes are suited to this option though, e.g. wheat grains, as self-heating can occur and degradation of the grain can occur. For the DDG dryers where the objective is to remove water, this is not an option.

5.3.2 Dust Control

Measures to control dust and avoiding the explosive range include:

- Avoid large volumes as much as possible, e.g. to avoid equipment items running empty;
- Avoid dust formation by limiting the free-fall;
- Remove the dust at the point of production rather than convey it along ducts where it can accumulate;
- Buildings which contain plant handling flammable dusts should be designed to minimise the accumulation of dust deposits and to facilitate cleaning; and
- Regular housekeeping to avoid dust build-up.

All these measures are proposed for the DDG building.

5.3.3 Control of Ignition Sources

Measures used to control ignition sources which could give rise to dust explosions include:

- Avoid direct fired equipment;
- Bonding and earthing for static dissipation;
- Permits to work, training and auditing;
- Regular housekeeping to avoid dusts overheating, e.g. on hot surfaces;
- Hazardous area determination with compliant electrics and instruments;
- Preventative maintenance on equipment to minimise the probability of fault conditions;
- Use appropriate electrical equipment and wiring methods;
- Control smoking, open flames, and sparks;
- Avoid the possibility of a thermite reaction, e.g. aluminium reacting with iron oxide;
- Use separator devices to remove foreign materials capable of igniting combustibles from process materials; and
- Separate heated surfaces and heating systems from dusts.

All these measures are proposed for the DDG building and mill feed equipment.

5.3.4 Inerting

The suspension of a combustible dust in air may be rendered non-explosive by the addition of an inert gas. The main gases used for inerting of dust handling equipment are nitrogen, carbon dioxide, flue gas and inert gas from a generator, e.g. argon or helium.

Inerting by adding an inert dust is another means to prevent dust explosions. This is mainly done in mining, e.g. coal dust is mixed with ground stone to render the coal dust non-explosive.

In effect, the DDG dryers are inerted by the water vapour evolved from the DDG.

5.3.5 Explosion Containment

One option for dealing with a dust explosion is total containment, i.e. design the equipment to withstand the maximum generated pressure. For dust explosions, the maximum generated pressures are quoted as 7 to 12 barg for atmospheric processes or up to 12 times the initial pressure in the equipment item. Hence, if the equipment has a design pressure equal to or exceeding these values then the explosion will be contained with no flames being emitted. Grinding mills are an example of such equipment items which may be made strong enough to withstand a dust explosion.

This is not proposed for any of the DDG equipment given the cost involved.

5.3.6 Explosion Isolation

The two basic methods for explosion isolation are:

- Automatic isolation, e.g. a pressure sensor will send a signal to a fast closing valve to shut and isolation the equipment item or pipe; and
- Material chokes such as rotary valves, screw conveyors with baffle plates and/or part of the helix removed to prevent the conveyor emptying on no feed flow, and self-actuating float valves 9non-return valves).

At this stage, these controls are not proposed for the DDG equipment (non-envisaged necessary).

5.3.7 Explosion Suppression

Typically an increase in operating pressure is detected (e.g. pressure rises to 5 kPag) which then results in a suppressant being injected into the equipment item to suppress the flame. By suppressing the flame early, the pressure rise is limited. Suppressants include dry powder and water.

At this stage, this control is not proposed for the DDG equipment (non-envisaged necessary).

5.3.8 Explosion Venting

Explosion venting is an effective and economic way to provide protection against dust explosions, however, it is only suitable if there is a safe discharge for the material being vented. For equipment within a building, ducting the vent

to outside should be done provided it is short, e.g. less than 10 m (detonations can occur in pipes of 10 to 30 m in length).

It is proposed to install explosion vents on the silo, bucket elevator and baghouse.

5.3.9 Equipment Separation

It is possible that an explosion from one equipment item or building could propagate to another. This could be via secondary explosions due to dust lifting and forming a cloud or from projectiles embedding into thin-walled equipment and hence being a point of ignition due to heat. If layout considerations permit, adequately separately higher risk process items or buildings is an inherently safe option.

The proposed safeguards discussed in the above Sections are chosen to reduce the risk of this event to an acceptable level.

In practice (Ref 7), the assessment of dust explosion hazards is bound to be subjective because the problem is too complex for quantitative analytical methods to yield an indisputable answer. Therefore, the acceptable safeguards for any given design will vary from company to company. Ref 7 quotes work by Pinkwasser and Haberli who suggest most of the dust explosion hazards in the grain, feed and flour industry can be eliminated by soft means such as training, motivation, improving the organisation, good housekeeping and proper maintenance. All of these safeguards are in-place at Shoalhaven Starches.

When these are combined with the additional measures proposed for the new equipment then further risk reduction is achieved. These additional measures include all equipment handling potentially explosive dust is to be designed to ATEX standards including explosion vents, interlocks, equipment bonding and earthing, minimisation of horizontal surfaces in the buildings where dust can collect and hazardous area zoning with the electrics and instruments to suit the requirements.

5.4 FIRES

As stated in Table 1, it is possible to ignite the combustible material involved in the process, i.e. DDG, starch, gluten, coal and woodchip, if a strong ignition source is present.

Fires have occurred previously with these types of processes and are typically of a smouldering nature given the moisture content of the material and confinement within silos and other equipment.

From Ref 8, fires involving flammable or combustible powder are not believed to place the public at risk but could be a threat to employees. This is the same for coal and woodchip as the fires are of a smouldering type (see Figure 5 and Figure 6).

Figure 5 – Smouldering Coal Fire

Figure 6 – Smouldering Woodchip Fire

Given that the potential areas where smouldering fires can occur then the risk criteria in Table 2 will be satisfied.

5.5 AIRCRAFT IMPACT AND OTHER EXTERNAL EVENTS

Previous risk assessments (e.g. Ref 9) have shown that the likelihood of an aircraft crash is acceptably low within Australia. Typical frequencies associated with aircraft crashes are:

- Scheduled aircraft $1x10^{-8}$/year; and
- Unscheduled aircraft $4x10^{-7}$/year.

The likelihood of this type of event is acceptably low for a site of this size and location.

Other external events that may lead to propagation of incidents on any site include:

Subsidence	Landslide
Burst Dam	Vermin/insect infestation
Storm and high winds	Forest fire
Storm surge	Rising water courses
Earthquake	Storm water runoff
Breach of security	Lightning
Tidal waves	

These events were reviewed and none of them were found to pose any significant risk to the new equipment given the proposed safeguards. Flooding can occur at this site, however, the structural design for new building and equipment includes allowances for this hazard.

5.6 CUMULATIVE RISK

As shown in this PHA, the proposed changes to the Shoalhaven Starches site will have negligible impact on the cumulative risk results for the local area as the significant radiant heat levels and explosion overpressures are local to the equipment.

Therefore it is reasonable to conclude that the development does not make a significant contribution to the existing cumulative risk in the area.

A review of the potential on-site propagation risks was conducted for both Stages 1 and 2.

For the confined equipment dust explosions, provided the dust explosion vents are either flameless or directed to a safe location then propagation risks will be acceptable. As discussed in Section 5.1, this is to be confirmed during detail design.

Should the combustible dust containment systems fail in the existing or new equipment and the safety management systems, e.g. equipment not rated to the hazardous zones, also fail then ignition can occur with a dust explosion within the building. This could cause damage to the adjacent structures as well, e.g. the existing Pellet Plant and DDG storage area. As discussed in Section 5.2, building dust explosions is a known hazard and both hardware (e.g. design for containment and electrics and instruments rated for hazardous zones) and safety management systems (e.g. housekeeping) are required to lower the risk to an acceptable level. These measures are used in the processing buildings to lower the risk of propagation.

For the smouldering fires, it is possible that a coal fire could propagate to the new cooling towers between Stages 1 and 2. This is a business impact event only, i.e. no process safety issues. This risk is to be managed by separation and control of ignition sources (as currently used at the site). From the layout plans provided, there are no obvious fire propagation risks for the proposed coal and woodchip stockpiles on the north side of Bolong Road.

5.7 SOCIETAL RISK

The abovementioned criteria for individual risk do not necessarily reflect the overall risk associated with any proposal. In some cases for instance, where the 1 pmpy contour approaches closely to residential areas or sensitive land uses, the potential may exist for multiple fatalities as the result of a single accident. One attempt to make comparative assessments of such cases involves the calculation of societal risk.

Societal risk results are usually presented as F-N curves, which show the frequency of events (F) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the results for different risk levels, a societal risk curve can be produced.

In this study of the DDG dryers and associated equipment, the risk of fatality does not extend significantly from the equipment and is therefore well away from the residential areas or other populated areas. The concept of societal risk

applying to residential population or other off-site receptors is therefore not applicable for this proposal.

5.8 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations. The following discussion summarises the credible environmental impacts from process safety events.

There can be small releases of cooling tower dosing chemicals. This is to be mitigated with secondary containment and hence the environmental risk is low.

There will also be the cooling tower blowdown (typical requirement for all cooling towers). In this proposal, the cooling tower blowdown is to be directed to the Manildra farm for processing.

Biofilters can leak. As the liquid quantity is limited then the effect on the environment is also limited. This scenario is typically corrected through maintenance repairs.

Whilst fires can also effect the environment due to combustion products, these events are low likelihood given the history of these types of processes. Importantly, any spilt material will be contained in the area or via the environmental farm.

The vapour evaporating from the mill feed and syrup mixture during the drying process is to be extracted by the leakage air fan to the wet scrubber for processing. Wet vapour will flow from the top of the wet scrubber to the condenser while the sludge is to be collected at the bottom of the scrubber and sent to the existing evaporator. Failure of the scrubber and/or condenser can result in excess water emissions with mill feed (no significant environmental impacts identified).

Water runoff from the coal and woodchip stockpiles has the potential to carry coal and woodchips to the environment. In this proposal, there is to be a slab with perimeter channel that directs all runoff water to the Manildra farm for processing.

Whereas any adverse effect on the environment is obviously undesirable, the results of this study show that the risk of losses of containment impacting the environment is broadly acceptable.

From the analysis in this report, no incident scenarios were identified where the risk of whole systems or populations being affected by a release to the atmosphere, waterways or soil is intolerable.

5.9 TRANSPORT RISK

There are no Dangerous Goods of significant quantities involved with the DDG dryers and associated equipment and facilities.

Whilst it is proposed to relocate the coal and woodchip stockpiles, the net number of trucks delivering these feedstocks to site will remain the same.

Given the low frequency for Dangerous Good transport then transport risk is deemed broadly acceptable.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed DDG dryers and associated equipment at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoP risk criteria.

In summary:

- The potential hazardous events associated with the DDG dryers and associated equipment are dust explosions and smouldering fires. Given the adequate separation distances to public land then no adverse off-site impacts are expected;
- All risk criteria in HIPAP 4 is expected to be satisfied for this proposal;
- Propagation to neighbouring equipment is not expected given that the potential dust explosions are either to be vented to atmosphere at a safe, elevated location or of limited consequential impact and the potential fires are of a smouldering nature; and
- Societal risk, environmental risk and transport risk are all considered to be broadly acceptable.

The recommendations from this assessment are as follows:

1. All dust explosion vents are to be either flameless or directed to a safe location to ensure propagation risks will be acceptable; and
2. Review the need for installing temperature sensors in the bucket elevator for fire detection and/or the installation of deluge or fire suppression system (Inergen). Operator detection of issue required plus response, e.g. opening a valve to initiate the deluge.

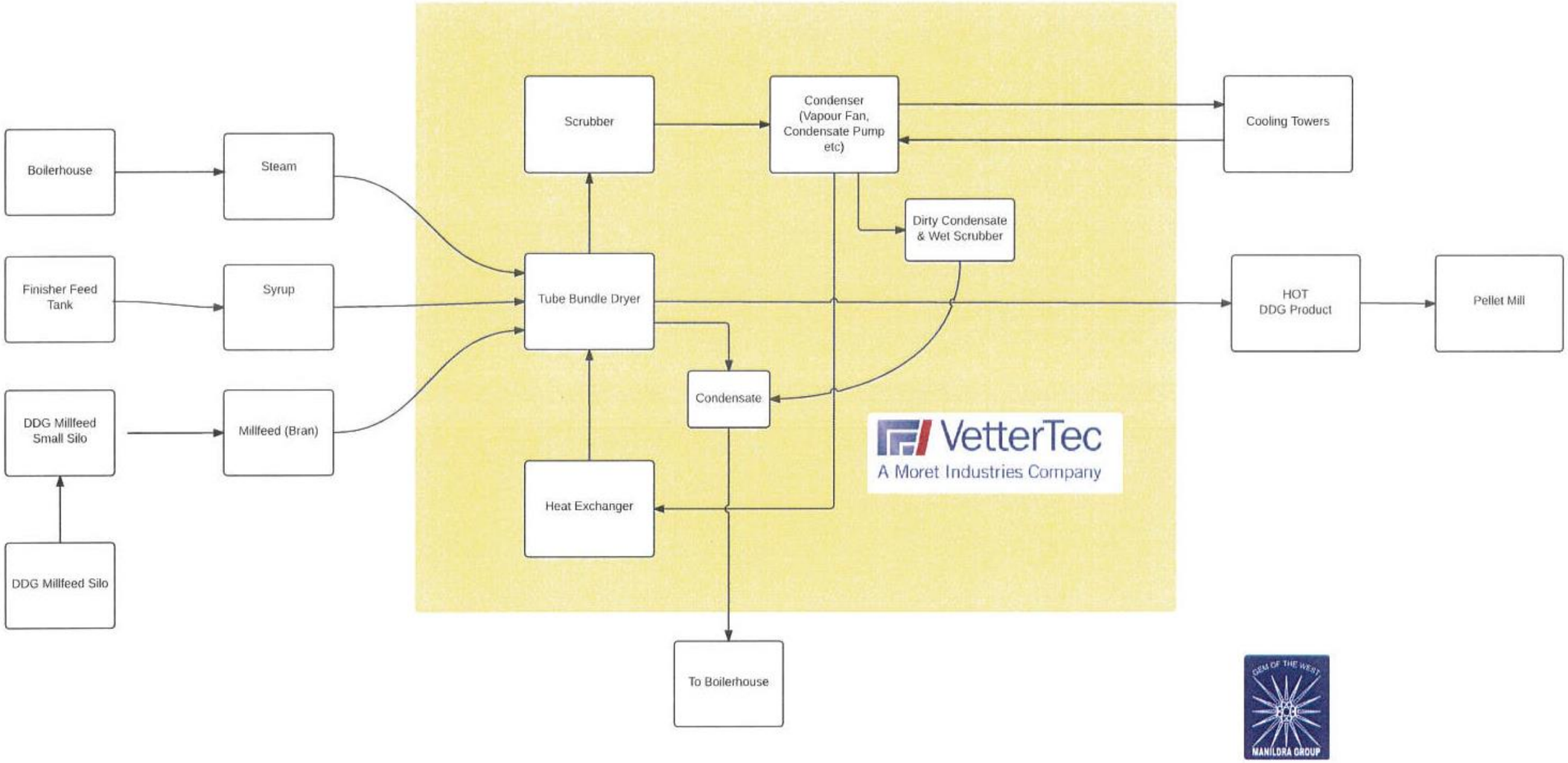
Appendix 1

Process Flow Diagram

Preliminary Hazard Analysis, Shoalhaven

Starches, DDG Dryers and Equipment

Appendix 1 – Process Flow Diagram.



7 REFERENCES

1 Cowman Stoddart Pty Ltd, *Environmental Assessment, Shoalhaven Starches, Proposed Modification in Relation to Location, Design and Footprint of the DDGSSSSS pelletising plant, Project Approval MP 06_0228*, February 2014

2 Department of Planning and Infrastructure (NSW) *Hazardous Industry Planning Advisory Paper No 6 – Hazard Analysis,* January, 2011

3 Department of Planning and Infrastructure (NSW) *Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning,* January, 2011

4 Bechtel Services (Australia) Pty Ltd, *Shoalhaven Starches Pty Limited, Bomaderry, NSW*, *Preliminary Hazard Analysis of Protein Isolate Plant,* 3/11/00

5 Bechtel Services (Australia) Pty Ltd, *Shoalhaven Starches Pty Limited, Bomaderry, NSW*, *Hazard Analysis of the Stillage production Facility, 1*/8/02

6 Bechtel Services (Australia) Pty Ltd, *Final Hazard Analysis, Report for Shoalhaven Starches Pty Ltd, Stage 1 of Stillage Process Plant at Shoalhaven Starches, Bomaderry, NSW*, 14/5/03

7 Eckhoff, R. K., *Dust Explosions in the Process Industries*, 2003

8 Tweeddale, M., *Managing Risk and Reliability of Process Plants*, 2003

9 Pinnacle Risk Management, Preliminary Hazard Analysis, Stage 5 Expansion Modifications, Bitumen Storage and Handling, Terminals Pty Ltd, Port Botany, NSW, 5 April 2011