MANAGEMENT OF STORMWATER ON LARGE SCALE INDUSTRIAL SITES

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ABSTRACT

Management of stormwater on large scale industrial sites has its unique challenges, in particular when those sites involve the production of food related products. Risks and tensions differ from those in traditional developments and considerations for the associated design solutions need to be amended accordingly.

Fonterra has undertaken significant stormwater upgrades at a number of its major plants. Risks associated with spills, industrial waste streams, chemical unload, and tensions around food safety all necessitate assigning different design priorities. Bunding of high risk areas, filters, isolation valves, lined spill/ first flush tanks, live water quality monitoring, parallel stormwater networks, attenuation ponds, and treatment devices are all part of potential suite of design tools suitable for on-site management. However restrictions exist on how these can best be applied.

This paper outlines key considerations in the design of Stormwater for large scale industrial developments, assessment of risks, suggests associated priorities, and addresses the relative merits of the various design solutions. It includes reference to several recent project examples and associated challenges for both the Lichfield and Edgecumbe site works, including measures undertaken ensuring operating staff are on board with the management and operation of the new stormwater systems. Both of these upgrades look to ensure Fonterra is future ready for stormwater management requirements, restore community trust, and address historical indiscretions.

KEYWORDS

Industrial Stormwater, Future Ready, Risk Management

INTRODUCTION

The focus of stormwater management on large industrial scale sites presents a series of unique challenges. The risks and opportunities differ from that presented in a more conventional urban development context, necessitating different processes for assessment and priorities for inclusion in any associated design response.

This paper provides a particular focus on considerations at large scale Fonterra processing plants. It includes examples from a series of recent stormwater upgrades, part of a larger programme of works nationally to improve environmental outcomes on its sites nationally.

As with any capital investment it is important that the operation of the assets are not undermined by poor operation. To this end, a key focus for Fonterra has been the balance of engineering with the need to lift knowledge, understanding and appreciation of why there is a need to improve management of the stormwater systems.

HISTORY

Co-operatives have long been the organizational structure of preference in the dairy industry. The first dairy co-operative was established in Otago in 1871 and by 1920 there were 600 dairy processing factories nationally, of which about 85% were owned by co-operatives (Stringleman and Scrimgeour, 2009). Improved transportation, processing technologies and energy systems led to a trend of consolidation, where the co-operatives merged and became larger and fewer in number. By the late 1990s, there were four co-operatives: the Waikato-based New Zealand Dairy Group, the Taranaki-based Kiwi Co-operative Dairies, Westland Milk Products and Tatua Co-operative Dairy Company.

Fonterra was formed in 2001 from the merger of the two New Zealand's largest co-operatives, New Zealand Dairy Group and Kiwi Co-operative Dairies, together with the New Zealand Dairy Board, which had been the marketing and export agent for all the co-operatives (NZ Herald, 2001).

Due to the aggregation of various companies, each factory site had differing standards and applications. Development on its sites has been incremental, with land usage and applications often changing over time provisional on market drivers.

Many of the sites date back to a different age where environmental protection was not a key focus nationally, with many of its original site processes developed little regard of the consequences of its associated discharges. It has been acknowledged by Fonterra and nationally that the standards of the past are not acceptable going forward. Fonterra's environmental policy states that "Fonterra shall demonstrate a global commitment to protecting the environment. Sustainability, good environmental practice and environmental improvement are cornerstones of Fonterra's environmental commitment." (Fonterra, 2006). As part of this initiative a programme of work has been developed to improve stormwater management and environmental outcomes across its manufacturing sites nationally. This paper outlines key design considerations undertaken as part of this process.

STORMWATER MANAGEMENT CONSIDERATIONS

The sites tend to have very high impervious areas, large footprints and have limited grade (typically very flat). On-site Stormwater infrastructure tends to be pit and pipe based solutions. The context of the sites is typically rural, often located adjacent to a waterway and/ or water-source (with many of the site processes reliant on a consistent source of water). Given that sites are typically fully reticulated with high impervious areas, there is typically a fast response and the corresponding hydrographs tend to be short and sharp.

Traffic and rail movements on these sites are high, with large numbers of staff movements, parking, and deliveries in addition to incoming milk tanker and outgoing product movement requirements. Many of the associated tankers collect milk from unsealed roads necessitating wash-down and regular cleaning.

Buildings and site facilities, while generally well maintained, are often aging.

Many of the processes and chemicals used in the associated processes are hazardous and can present very specific environmental threats, with a number of sites known Hazardous Activities and Industries List (HAIL) areas. As a result there is the potential for a large variety of pollutants, discharging from numerous outlet locations.

OPERATING CONSIDERATIONS

In addition to those Stormwater management considerations outlined above a number of operating considerations present both risk and opportunity for any resultant Stormwater management outcome.

- Food Safety – A key imperative, any risk to food safety has the potential to have a major impact on business outcomes and reputation. As a result all possible measures are taken to ensure any associated threat is mitigated. This can provide constraints on resulting Stormwater solutions with every attempt taken to remove potential habitats for pests. Similarly, dust, pollen, and airborne particulates can present a risk to packaged goods and every attempt is taken to maintain a sterile environment.

- High Risk Activities – Most sites include a number of high risk activities, including: raw milk and chemical unload, tanker wash-down, tanker internal cleaning operations (CIP – Clean in Place), tanker workshops, product loading and unloading areas. These activities can, provisional on the risk profile, necessitate isolation from the Stormwater network. This contributes to an independent industrial waste stream which requires specific treatment.

- Spills – While every attempt is made to minimize the risk of an occurrence, spills are likely to be an infrequent reality on an active site. This will extend to consideration of the potential failure of silo or associated storage facilities. Many of the substances stored on-site present specific environmental hazards. To fully understand this risk, an appreciation is required on what is stored, level of protection, likelihood of a spill, consequence and means of interception/ removal.

- Particulate Discharges to Air – In addition to spills to land, on-site processes often include the production of milk powder and the combustion of materials. While filters and air scrubbing equipment are often associated with these activities, discharge and the settlement of particulate material can occur locally with the potential of entering the Stormwater network.

- Process Connections – There is potential for process effluent networks to be connected to the Stormwater networks. From example, where the process discharge water meets quality objectives, connections often exist to the Stormwater networks. This does on occasion have potential temperature impacts (with cooling water a common example of such connections).

- Asset condition – Wastewater is collected on most sites with a parallel gravity networks. On historical brownfield sites overflow connections can exist between the two networks with previous spills damaging the existing pipe inverts. This combined with the age of asset can leave a legacy of poor asset condition.

- Site Opportunities – The opportunities for on-site management of Stormwater can be enhanced given the following:

    - Many of the sites are active on a 24-hour basis. Operational and maintenance support is readily available.

    - On-site wastewater processing capacity is often available.

    - Utilities are readily available to associated facilities.

    - Often in a rural context, Fonterra often own or have opportunity for access to adjacent properties.

Historically a large variety of pollutants could have entered the Stormwater networks and adjacent receiving environments via a number of mechanisms including: spills, discharges to air, runoff from aging facilities, high traffic and parking areas, wash-down facilities, and direct process connections.

PROJECT ASSESSMENT

So as to ensure future projects are future proofed and align with Fonterra objectives the following processes are proposed to assess key project risks and confirm the associated basis for design:

1. Project Scoping
    a) Confirm regulatory requirements
    b) Stakeholder confirmation/ requirements
    c) Define project objective
2. Gaps Assessment/ Data Collection
3. Site Assessment
    a) Confirm site characteristics (topography, soils, rainfall)
    b) Hydrological assessment/ Catchment delineation
    c) Network/ Condition assessment
    d) Receiving environment assessment
    e) Assess site usage and high hazard activities
4. Risk Assessment
    a) Confirm potential sources of pollution/ contamination
    b) Assessment of potential cross connections
    c) Confirm areas of spill risk
    d) Undertake risk assessment on a sub-catchment basis assessing contaminant, likelihood and consequence.

All underground assets, including stormwater pipes, will be surveyed and scored on asset condition within the next 5 years. Hydraulic function will be maintained, but importantly, water quality will become a shared objective of the system.

This process outlined above provides a *Basis for Design* and enables the rationale for selection of following project requirements:

- Emergency Storage Requirements,
- Requirements for First Flush capture,
- Quantitative design requirements (flood protection, attenuation)
- Establishment of Water Quality Targets, and

- Confirmation of monitoring and compliance requirements.

Risk mapping of the sites will allow for the identification of the most appropriate destination of water. That is, areas where there is a high chance of a spill are directed to wastewater or a spill pond, whereas roof and road runoff would be diverted directly through the stormwater network.

These level of service requirements can then be applied to the design process.

DESIGN PROCESS

Stormwater solutions on complex multi-faceted industrial sites require a complex multi-faceted design solution. Key elements for inclusion in the associated design for Fonterra sites include:

- Divert upstream catchments – On-site runoff is to be minimized through the diversion of upstream catchments.

- Isolation of high risk areas – Isolated (bunded) slabs with independent wastewater connections are to be provided to high risk areas outlined above.

- Cross connections – Review and remove Stormwater cross connections where possible.

- Source controls – Source controls are to be considered where possible to minimize the risk of pollutants entering the network. These include: bunding of chemicals/ storage silos, provision to isolate key sumps/ connections, oil/water interceptors, and localized treatment devices. The efficacy of treatment devices needs to be matched to the risk profile of the associated sub-catchment. The designer needs to be conscious of the aversion to creating potential pest habitat within the main factory site.

- Spill management – Storage is to be provided at discharge locations for medium to low risk catchments. This is to enable the continuous monitoring and impoundment of spill and washdown volumes. The sizing of required storage is provisional on the risk assessment of the contributing catchments. Consideration is required on the impact of coincident rainfall events. Stored volumes where possible are assessed and discharged to wastewater as appropriate.

- First Flush management – With the potential for particulate discharge to air, first flush management is a key consideration on many Fonterra sites. Pollutants are often dissolved and various options exist including the diversion of base flows to wastewater to treatment elements (wetlands etc) and will be provisional on the characteristics of the site. Contributing catchments will often include contributing roof areas.

  Fonterra has taken a position that first flush events are high risk events and need to be separated from the stormwater system and assessed for risk of contamination. If the contamination of the stomrwater is to a point where it not suitable for release to the environment this water is diverted to wastewater for further treatment.

- Quantitative assessments – The usual quantitative considerations apply including, network capacity, flood protection and as required peak flow attenuation. Design targets will be provisional on local authority requirements and downstream sensitivity.

In addition to the above, baseline monitoring is to be established in the adjacent receiving environments, with real time monitoring and verification sampling used at key discharge locations to control spill and first flush processes.

Many of the current upgrades and assessments are on brownfield sites. To meet budget constraints capital upgrades require prioritization. A total cost of ownership model is applied to develop priorities on capital spend, which is to include a life cycle cost assessment, consideration of risks and potential indirect costs associated with non-compliance.

In addition to the challenges outlined above, large site development does present opportunities not often present in an urban context:

- Readily Available Land – With many of the factories in a rural context and Fonterra owning several of the adjacent properties, significant opportunities existing to utilize adjacent land for off-site treatment options.

- Large Roof Areas – Many of the roof areas are significant. There is real opportunity to efficiently capture and reuse runoff from these areas (with an appreciation that soluble pollutants will need management).

HEARTS AND MINDS

With different regional objectives and the incremental development of the stormwater networks, the consistency and priority operators placed on management varied significantly. Numerous measures have been implemented to provide a greater focus and buy in from site operations and maintenance staff, including:

- Raise awareness through daily management meetings,

- Discussions with staff on the importance of the stormwater system,

- Weekly and monthly reports to the sites of the progress of improvements,

- Working with contractors to ensure their practices match the improving standards,

- Reward and recognizing those staff that address impending issues,

- Refresher training of all staff in what to do in the occurrence of a spill,

- Working closely with senior operators as advocates within the Plant, and

- Regular inspection of Plant perimeters by all Staff inspecting the infrastructure for proper function and reporting any anomalies.

Significant stormwater upgrades are currently being progressed at the Edgecumbe site. This work programme was established so as to address previous environmental transgressions.

A major change for roll out on this project has been the inclusion of a clinical psychologist who works across the construction, operation and delivery teams. This person has had a clear directive to provide linkage, fostering empathy between teams and assist in creating a common understanding of the motivations and associated vision.

The role of the psychologist is more as a facilitator to connect people to their heart through the use of an “Absolute question” technique, where staff are asked to put aside rationale and logical considerations and connect to their heart when answering these

exploratory questions. For example, if the site could not operate due to the inability to irrigate wastewater, or discharge contaminated Stormwater, or truck wastewater, what would happen to them? Why is the environment important to them? What do they want as outcomes from the project?

In addition to connecting people on site there has been a key focus for the site to reconnect with the local Edgecumbe community. This is important because the previous company, Bay Milk, was a local Co-operative with strong linkage to its local suppliers. As Fonterra moved to a centralized and larger Co-operative these local connections were lost.

The site is making large strides in the engagement with the local community through open days, regular community meetings and one-on-one meetings with the local farmers that operate the wastewater irrigation system. It is this reconnection through operators, senior staff and site managers that the interdependent thinking will take hold.

The process is focused on reinforcing behaviors and mindsets by aligning the head and heart as these are easy to change over a short period of time compared to changing the culture which is over a much longer time frame.

This is not an overnight outcome; it is a journey together as change occurs. It is important to develop a core group of people of who will sustain the improvement and continue a connection to the Fonterra values, challenge boundaries, and do what is right. These values are fundamental as these will ensure the site reconnects to the local schools, community and Iwi.

Given previous transgressions and the accountability called upon by senior staff at regulatory and community levels, the messages conveyed in this forum have been at time very personal, with an understanding on the need to win back community trust and that failure to improve will come at a heavy cost.

DESIGN EXAMPLES

The following section overviews two recent upgrade projects that included significant Stormwater networks.

Project Florence – Through 2015/ 2016 a significant upgrade was undertaken at the Lichfield dairy processing site. A approximately $375M project was completed building a new 30 metric tonne an hour dryer and a 3 hectare store and facilities upgrade, including a new biological wastewater treatment plant (Figure 1).

Associated catchment plans were established identifying isolated high risk areas. Pavements in medium risk areas connect to an existing, monitored, concrete lined, spill management pond (Figure 2). Main roof and lower risk areas connect to a series of ponds, with provision for soakage and peak attenuation.

In addition to pond upgrades, works included the installation of targeted source control devices for the impounding of hydrocarbons and two additional ponds servicing low risk areas.

Additional training was supplied to staff along with materials to assist in the isolation and remediation of site spills. Post-development peak discharges were confined to pre-development levels.

Figure 1 Project Florence upgrades

Above left: Dryer – approximate 50m tower, **Above right:** Dry store – in the case of Lichfield a 3ha roof area, **Centre right:** Wastewater treatment and irrigation plant. With over 600,00m^3 of earthworks, construction activities included an extensive erosion and sediment control plan and a major pond upgrade. **Below:** Catchment and network maps with clear identification of at risk areas.

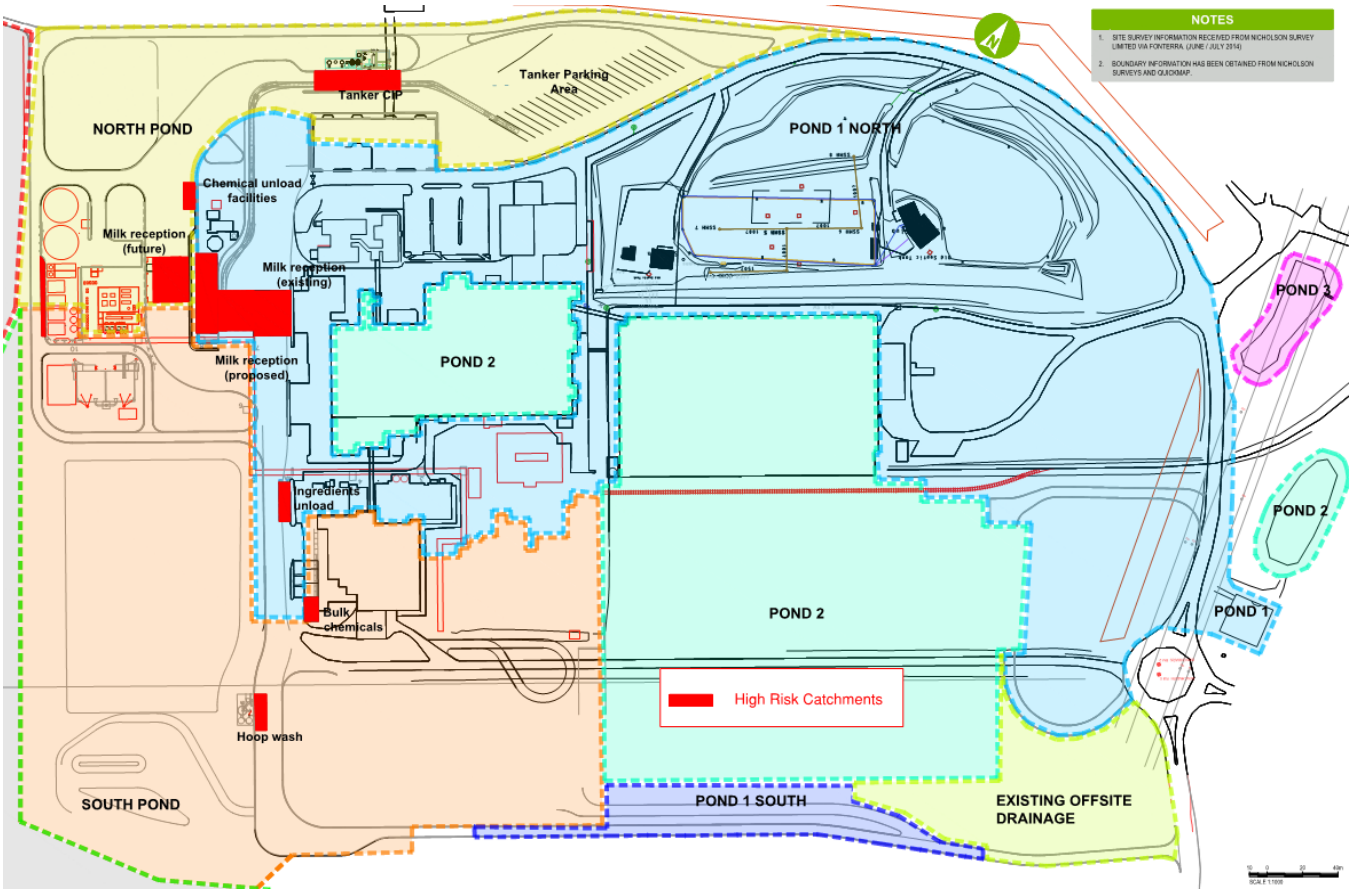


Figure 2 Project Florence soakage ponds and spill pond

Photos: Top left/ right – increased attenuation for peak attenuation of additional impervious areas, Middle left – low flows from low risk areas discharge to a series of soakage ponds, Bottom – concrete lined spill pond.

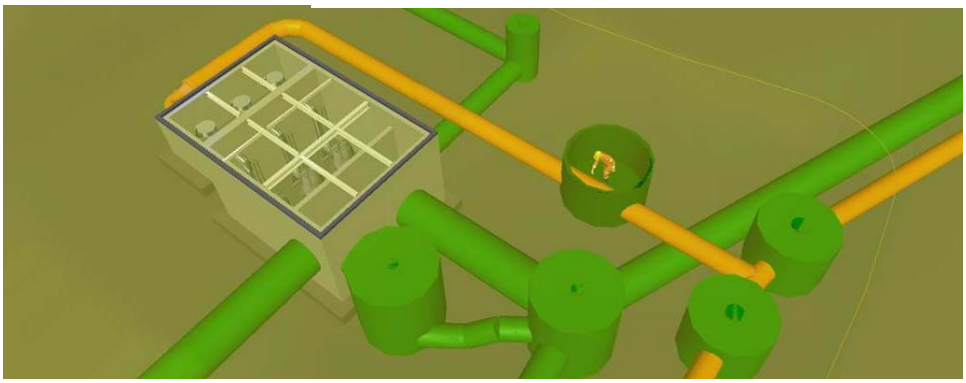
Wider project upgrades resulted in significant wastewater increases. Works have also included development of a new biological wastewater treatment plant and 100m^3 storage dam to enable irrigation discharge to land.

Project Picasso – With a history of environmental transgressions a significant investment is being made in the Edgecumbe site to better manage stormwater and associated waste streams on-site (Figure 3). Works include:

- On-site Stormwater Network Upgrades - A $10M upgrade to on-site reticulation, including: extensive relining of the gravity networks, new intercepting collector mains, new stormwater pump station, new emergency storage tank and provision of buffer storage.
- Cross Connections – Review of connections and separation of networks as appropriate.
- High Risk Upgrade - Upgraded spill containment facilities in areas of higher risk with provision for isolation during high risk activities.
- Increased Wastewater Capacity – Significant increases on the provision to process wastewater including major upgrades in the provision for discharge to land.

Figure 3 Project Picasso upgrades

Above: Perched on the edge of the Rangataiki River, the importance of this waterway to the community and local Iwi is paramount. **Left**: Key to improving on-site culture is the development of a clear and consistent project "vision". This is summarized in the project logo provided. **Below:** A new Stormwater pumpstation is proposed to accommodate all on-site flows, to monitoring the quality of the incoming flows and enable provision for diversion of non-compliant materials to storage/ wastewater.



In parallel to this programme a major initiative has been launched to bring on-site operations staff along for the ride. This includes formation of an operational leadership programme (OLP) and initiatives outlining the importance and relevance of the environmental upgrades.

The project looks to re-build community trust through delivery on upgrades and a programme of engagement and consultation.

SUMMARY

Different priorities exist when considering Stormwater management on industrial sites. In addition to the more standardized processes confirming scope/ stakeholders, catchment, network and receiving environment characteristics, a deeper understanding is required on the risk profile associated with each specific site. This assessment is to include: development of an understanding of the location of high risk activities, confirming the likely pollutant profiles, and an assessment of potential spill volumes.

Site specific challenges typically include: food safety requirements restricting the use of treatment solutions that create potential habitats for pests, need for accommodation of potential spills, accommodate the possibility of cross connections when developing brownfield sites, and the need to manage first flush.

The design response is to include as a minimum:

- Isolation of higher risk areas
- Review and removal of potential cross connections (brown-field developments)
- Source controls/ isolation (eg. Hydrocarbon, isolation of sumps adjacent to bunded areas)
- Provision for spill management
- Consideration of first flush volumes
- Quantitative assessments

Additional consideration should also be given to utilization of adjacent land for off-site treatment and potential rainwater harvesting.

Any successful Stormwater system on large industrial sites requires buy-in from the associated operating staff. Fonterra is committed to ensuring operational staff are engaged in this journey through a clear vision and extensive consultation.

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