Investigation of the Application of Structural Isolation for Reducing Stormwater Pollution from Industrial Premises



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Contents

Executive Summary

Protection of stormwater quality is an important issue for the City of Kingston. There are more than 4000 industrial premises within the municipality and stormwater pollution from industrial premises has been identified as one of the highest risks to stormwater quality.

Ainley Projects has been engaged by The City of Kingston to investigate the application of structural isolation measures to reduce stormwater pollution from industrial premises. The project has focused on new small and medium sized industrial premises constructed as shells to suit a range of uses.

Treatment options that have been considered include recessed areas, trench grates, ramps, and bunding of areas. Specifically the project has explored the practicality of these structural isolation treatment options including practicality of construction, maintenance requirements, impact on use, and measure of protection to stormwater quality. This has been done through initial investigations and drafting of possible options, a consultation workshop and several meetings with developers, builders, leasing agents and factory users.

Several businesses and organisations have contributed their time and expertise to this project including: Pritchard Design and Construction, Cellstruct Industries, Brickwood Holdings, Kevin Nixon Real Estate, Leigh Mardon, Price Plastics, Pegulan Floor Coverings, Wickham Plastics, Brian Bird Engineering

Funding for this study has been provided by Kingston City Council and Melbourne Water.

Recommendations:

1. For loading that occurs within a building, a recessed area with a pit or a trench grate across entrances are the preferred options identified during consultation for this project.
2. Structural isolation treatments could be included in the approved building documentation and verified upon construction through the building inspection process.
3. Further investigations are required to determine the relative importance and effectiveness of structural isolation, due to the levels of risk to stormwater pollution internally and externally.
4. Further investigations are required into the role of spill kits and whether they should be mandatory requirements.
5. Any industrial stormwater pollution treatment should integrate education, enforcement and infrastructure to ensure it is effective.

1 Introduction

The City of Kingston is home to more than 4000 industrial premises ranging in size from small operations to large international manufacturers. Pollution from these industrial premises has been identified as one of the highest risks to stormwater pollution in Kingston. Industrial areas generally have a high percentage of imperious surfaces allowing pollutants to easily enter the stormwater system and use and store substances that can pollute the stormwater system. Through several innovative projects, the City of Kingston has established a reputation as a leader within local government in working to address stormwater pollution from industrial areas.

Figure 1. Typical industrial premises within Kingston

1.1 Project Scope

Ainley Projects has been engaged by the City of Kingston to investigate and establish the technical viability and measure of protection to stormwater quality provided by incorporating structural isolation measures in the construction of new small and medium sized industrial premises. It is known that premises of this size regularly change tenants and with these changes the risk to stormwater pollution and type of pollutants change.

An earlier report by Ecological Engineering identified that pollution from work areas could be prevented from entering external stormwater runoff pathways. This would require all work areas to be roofed and their floor drainage disconnected from the external stormwater drainage system. Building in structural isolation measures was identified as the preferred method for preventing pollutants from entering the stormwater pathway.

The intent of the structural isolation treatments is that they be applied to the building shell and applicable to all uses. This project is to deal primarily with liquid spills or leaks but should also consider surface flowing materials such as fine granules. It was considered that the treatment measures should be aimed at capturing pollutant spills of up to 1000 liters as this is the maximum likely spill in small to medium sized premises.

Small and medium sized factories are typically from 150 square meters to 400 square meters. They can be stand alone or be part of a factory estate.

The design and features of industrial premises can vary considerably. Some premises have several access points, which increase opportunities for pollutants to enter the stormwater pathway. All new buildings must have a personal access/emergency access door in addition to a roller door or main access point. In the use of structural isolation measures, all of these access points need to be included in the treatment for it to be effective.

Figure 2. Some industrial premises have several access points.

1. 2 Project Objectives

This project has specifically addressed the technical viability, practicality of use and measure of protection provided by incorporating structural isolation measures in the construction of new small and medium sized industrial premises regardless of the particular use of the building.

The specific objectives of this study have been identified as:

- to investigate suitable options for achieving protection through structural isolation
- to investigate the effectiveness of these options identifying further improvements or impediments

- to investigate the practicality and cost of construction of these options for a range of different sized, multi purpose industrial premises
- to investigate the maintenance requirements of each option and the potential loss of effectiveness if maintenance is not carried out
- to recommend an appropriate structural treatment and the overall cost of incorporating this mechanism into the construction of the premise
- to identify the effectiveness of the recommended mechanism listing any limiting factors

There were several industries and organisations identified as stakeholders in this project, including developers, construction companies, leasing agents, small and medium sized factory operators, Kingston City Council, Environment Protection Authority (EPA) Victoria and Melbourne Water.

1.3 Methodology

A project working group consisting of three representatives from Kingston City Council and three representatives from Ainley Projects was formed to define the parameters of the project, and develop initial options to be tested with stakeholders. Others contributed to the project working group from time to time.

Several options were developed and feedback sought from stakeholders through a workshop and meetings with individuals.

2 Structural Isolation Options Explored

2.1 Structural Isolation

Structural isolation is part of Water Sensitive Urban Design (WSUD) an integrated approach to the planning, design and management of urban developments to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems (Healthy Waterways, 2006).

Structural isolation in industrial areas aims to prevent industrial pollutants entering the stormwater system. Without structural isolation, the WSUD methods designed to treat typical urban stormwater pollutants may be overloaded by industrial pollutants.

A range of structural isolation options for reducing stormwater were developed and explored as part of this investigative project. These options included:

1. Recessed Area – loading bay, front of building or entire factory floor
2. Small ramp – either side of the roller door, either side of the access doors
3. Trench grate – in front of loading bay, in front of access doors
4. Collapsible bund – around loading bay, around access door
5. Apron bund

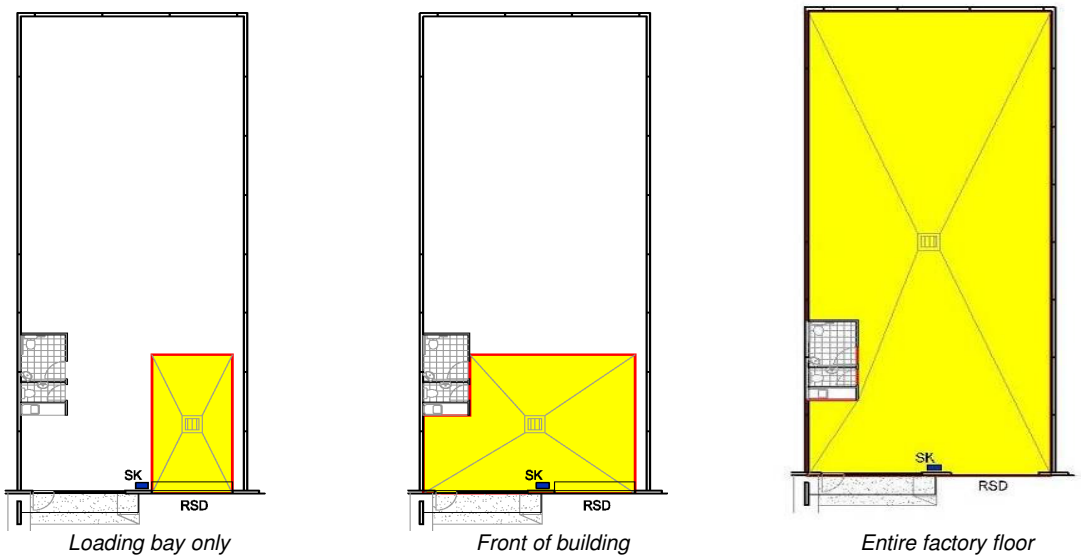
All of these options can be applied to a variety of industrial premise deigns and could be retrofitted to existing premises.

The above structural isolation measures are designed to contain spills within a building and do not treat spills occurring outside. In order to reduce stormwater pollution from industrial sites as much as possible, consideration needs to be given to including stormwater treatment options for outdoor areas within industrial sites.

It is acknowledged that all of the options explored rely to some degree on the behavior of operators of the premises to ensure that pollutants are disposed of appropriately. It is envisaged that any structural isolation treatments would be complimented by an education and enforcement program.

2.2 Recessed Area

A recessed area could be constructed, with a pit at the lowest point. This would allow all spill material to drain to a central location from where it could be collected and appropriately disposed of. The recessed area could be the entire factory floor, front section of the building or the loading bay only. The loading bay is considered to be an area of high risk for a spill. It is the location where trucks are unloaded and materials are moved around usually by a forklift.



Loading bay only *Front of building* *Entire factory floor*

Figure 3. Recessed area options

The recessed area would require only a moderate fall to cause the material to flow to and collect in the central pit. This would require the concreter to create the grade to specifications when concreting. The pit would need to be of industrial strength to accommodate vehicles and machinery moving across it.

Figure 4. Example of a recessed area

2.3 Small Ramp

A small ramp could be installed to prevent pollutants flowing out of the premises through a doorway. This could be applied to the loading bay access area and other accesses within the premises. A spill would then need to be cleaned up from around the floor area. A ramp would need to meet relevant requirements for access such as disabled access and forklift operational safety requirements. In meeting these requirements for slope and grading a ramp may take up a substantial area within and outside of the premises.

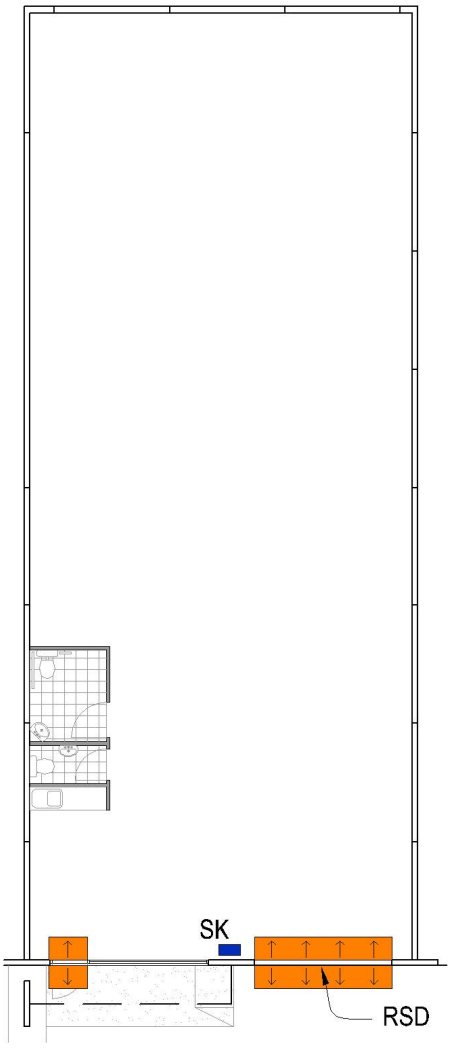


Figure 5. Small ramp at building access ways

2.4 Trench Grate

A trench grate could be installed across all entrance points to the premises. This would ensure that any spills were contained within the premises or flowed into the trench grate for appropriate removal. A trench grate would need to be industrial strength to accommodate vehicles and machinery moving across it. The trench grate would need to be installed well to ensure that it was level with the floor level to prevent it becoming an obstacle to forklift operation.

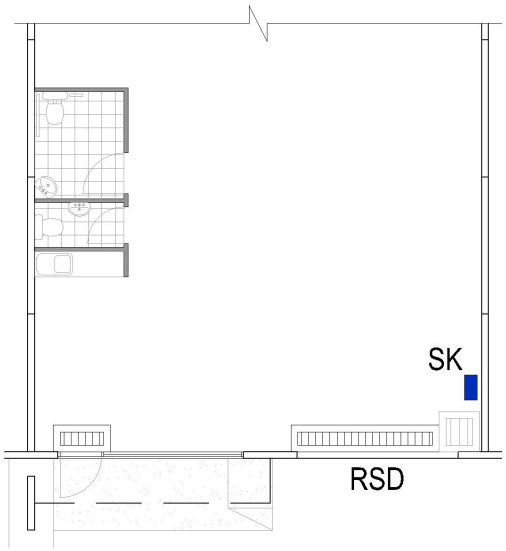


Figure 6. Trench Grate across entrances to contain spill material

Figure 7. Example of a trench grate

2.5 Collapsible Bund

A collapsible bund could be applied to any high spill risk areas of the premises such as the loading bay. This would contain the spill to a specific area for appropriate clean up. A collapsible bund could be made from rubber or other similar material and could be replaced and removed as required. A collapsible bund would require considerable maintenance as the material is likely to deteriorate over time due to wear.

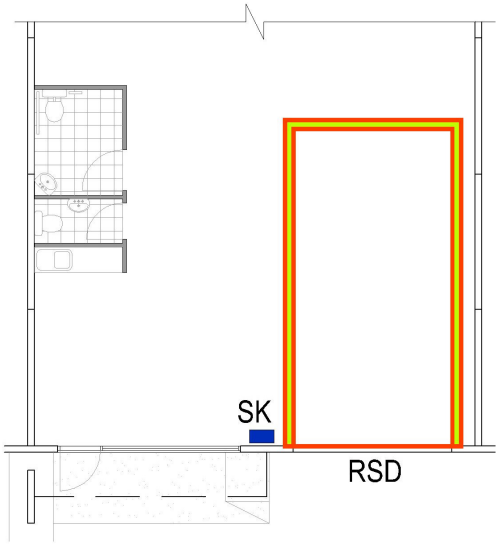


Figure 8. Collapsible bund

2.6 Apron Bund

An apron bund would be applied around the entire perimeter of the premises. This would be constructed from concrete and look much like a gutter or culvert. A small ramp or trench grate would need to be installed at entrances to enable access from the premises while containing spill materials within the premises.

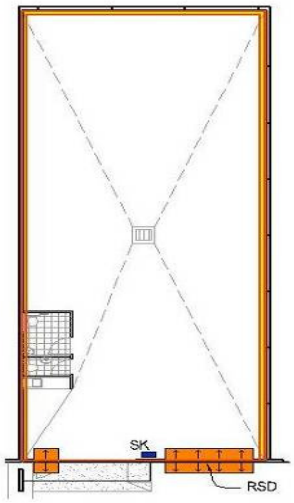


Figure 9. Apron bund

3 Consultation

3.1 Stakeholder Consultations

A workshop was held to work through the identified options and receive feedback from developers, construction companies, leasing agents and users. Additional meetings were also held with small and medium sized factory users who could not attend the workshop.

Organisations and individuals that participated in the workshop and meetings included:

- Stephen Dean, Pritchard Design and Construction – residential and industrial developers, located in Mordialloc
- Craig Watkins, Cellstruct Industries – builders and concreters with extensive industrial experience, located in Cheltenham
- Anthony Nixon, Kevin Nixon Real Estate – real estate and leasing agents specialising in industrial premises, located in Moorabbin
- Brian Bird, Brain Bird Engineering – engineering consultancy, located in Beaumaris
- Tim Roberts, Brickwood Holdings – plastics manufacturers, located in Cheltenham
- David Jackson, Leigh-Mardon – plastics manufacturer located in Highett
- Roger Blasse and Andre Blasse, Pegulan Floor Coverings – floor coverings warehouser, located in Braeside
- David Alexander,Price Plastics – plastic resin manufacturer, located in Dandenong
- Paul Crowe, Wickham Plastics – plastic manufacturer, located in Braeside

These stakeholders provided feedback on effectiveness of each option, costs and issues associated with construction, maintenance issues, impacts on factory operation and general practicality.

In particular, factory users and operators gave a valuable insight into the practicality of the options presented and the likely impacts on factory operations and occupational health and safety (OH&S) issues.

3.2 Outcomes

The following table summarises the outcomes of the consultation. A full list of comments is contained within appendix 1.

Option	Effectiveness	Estimated Costs	Maintenance	Practicality	Limiting Factors
Recessed Area	Relies on pit being emptied and spill material being disposed of appropriately. There is a risk of the pit being connected to the sewerage system over time.	$1000 for concreting works and labor (for loading bay option). $2000 for concreting works and labor (for entire floor option for small factory) $600 for pit. Additional cost to treat emergency access door depending on its location.	Maintenance of pit required to prevent it becoming filled with rubbish. No maintenance to recessed floor.	A spill is most likely in the loading bay so should cover this area.	This will effect the storage of some items, so should not be across entire floor
Small ramp	Relies on spill being cleaned up and material disposed of appropriately. Mopping up is time consuming.	$1000 for concreting works and other labor for each roller door entrance. $600 for each pedestrian entrance.	Maintenance required to ramp surface and indicators.	To be workable the ramp would need a very gentle slope. The space required to achieve this would impact on available usable space.	Ramps are dangerous to forklift operation and would affect leasing and selling.
Trench grate	Relies on spill being disposed of appropriately after collection. There is a risk of the trench being connected to the sewerage system over time.	$1350 for the grate for each roller door entrance (based on an entrance width of 4.5m) $300 for each pedestrian door entrance. Labor cost of $1500 per grate. The cost of construction is relatively expensive compared to other options.	Maintenance of grate required to prevent it becoming blocked.	Minimal impact on operation, leasing or sale.	Construction is difficult. Would need to meet high industrial standards for load bearing. Could have an impact on forklift operation.
Collapsible bund	Relies on regular maintenance to be effective. Relies on spill material being disposed of appropriately. Clean up of spill can be time consuming.	Under $1000 to purchase material and install. Ongoing maintenance and replacement cost.	High maintenance requirement to repair and replace material.	Can impede operation and are likely to be removed.	Viewed as a nuisance.
Apron bund	Relies on spill material being disposed of appropriately. Clean up of spill can be time consuming.	$5000 for 150 square metre factory would be added to the building cost. The cost of construction is relatively expensive compared to other options	Minor maintenance required to surface area and associated ramp or trench grate.	Would need a ramp or trench grate at doorways.	Would need a ramp or trench grate at doorways.

3.3 Other Issues

The following issues were discussed at length during the workshop and consultations. They are directly related to the practicality and effectiveness of structural isolation measures.

Loading and Unloading of Trucks

It was reported and observed that trucks are frequently loaded and unloaded in carparks, driveways, roadways and other open outdoor areas. Loading and unloading in open outdoor areas usually allows greater access to both sides of the truck and more space for maneuvering the forklift. It is presumably also quicker and easier than loading and un-loading in the designated loading bay area. Spills are more likely to occur when materials are being loaded and unloaded and when forklifts are transporting materials to storage areas.

Frequency and Location of Spills

Spills are most likely to happen when materials are loaded and unloaded from trucks and carried by forklifts. Much of the loading and unloading of trucks occurs outside of the building shell, in driveways, open flat areas and even on roads. Factory operators consulted during this project considered that a spill was much more likely to occur outside of the building area in the open when trucks were being loaded and unloaded, or when materials were being picked up and moved around by forklifts.

Spills inside of the building area could occur through accidental piercing (by forklift) of containers, collapse of support infrastructure, failure of valves and storage containers, and intentional actions. It was difficult to define the frequency of these spills, as it is likely to depend on the specific use of the building and factory operation. Factory operators indicated that these spills would be addressed promptly if the spill material was valuable and most likely through the use of a spill kit if there was one on-site.

A stormwater quality treatment was seen as being more effective and practical outside of the building where spills were more likely rather than the proposed structural isolation treatment within the premises.

Forklift Operation

Forklift operation and safety is a major concern for industry, and most small and medium sized factories will use a forklift at some stage. Forklifts carry a variety of goods and materials of varying weights and at varying heights creating a risk of a forklift tipping over. Ramps, slopes and other obstacles increase this risk. While there is no mandatory requirement for ramp gradient for forklift operation, as gentle a slope as can be achieved is preferable. Many factory operators will not lease premises with ramps or other ground obstacles due to the safety hazard they present for forklift operation.

All factory users consulted in regards to this project stated that forklift operation and safety was one of their biggest operational issues. Any structural isolation solution should not impact on safe forklift operation. The recessed area option and the trench grate option received a mixed reaction from factory users, due mainly to the perceived impact on forklift operation and safety.

Figure 10. Forklift in operation

Existing Requirements

Premises which store and use large volumes of materials or certain materials must comply with the requirement of the Environment Protection Scheduled Premises and Exemptions Regulations (1996). These premises are seen to have the potential for significant environmental impact and are subject to works approvals for construction or modifications, licenses for operating conditions, discharge limits, monitoring and reporting requirements.

The structural isolation treatment solution is not intended to duplicate or replace trade waste agreements or other requirements. It is intended as a treatment that addresses stormwater pollution from premises and businesses that don't require trade waste agreements or other prescribed treatments.

Spill Kits

Many factory operators consulted during this project had spill kits on site. The provision and effective use of spill kits has the potential to reduce the impact of any liquid spill. Spill kits are available commercially and generally as a minimum consist of absorbent pads or similar, contaminated waste bags, and personal protective equipment. A spill kit catering for spills of up to 1000 litres can cost up to $2,000 depending on contents. Spill kits are currently not a mandatory requirement.

During the consultation workshop there was some discussion on making spill kits mandatory in a similar way to fire service requirements. This could be implemented and checked through the building inspection process for new buildings and monitored on an ongoing basis in a similar manner to fire extinguishers. Spill kits could provide an effective way of dealing with 1000 litre liquid spills. However the effectiveness of spill kits is dependant on them containing the appropriate equipment and staff being trained and knowing how to use them. If spill kits were mandatory requirements they could be complementary to structural isolation treatments or in some cases an alternative.

Figure 11. Example of spill kit contents

Retrofitting of existing premises

It was felt that in order to make an impact on stormwater pollution from industrial areas, it is necessary to retrofit existing premises. The costs associated with retrofitting are likely to be significantly more for each treatment, due to the likely work required such as cutting concrete and recreating it. For example the cost of creating a recessed area over a loading bay and installing a pit is estimated at $1,600 for new premises, the cost of retrofitting existing premises is in the order of $7,000.

Current Practices and Education

Stormwater education generally was something that was supported by developers and factory operators as a way of changing current behaviors and practices. It was agreed by all that something needed to be done to change current practices of tipping things down the drain. It was thought that much of this occurs simply because people are unaware that stormwater goes directly to Port Phillip Bay and is not treated. Workcover requirements were seen as a good analogy where everyone wanted to do the right thing and behavior has been changed as a result of education, enforcement and infrastructure.

4 Conclusions

During the consultation with stakeholders it became clear that some options for structural isolation were practical and feasible and some were not.

In summary:

- The preferred options were a recessed area over the loading bay or a trench grate at the doorway.
- An apron bund was also seen as a workable option if a trench grate was installed at the doorways. This was the most expensive option and becomes redundant if a trench grate is installed.
- A collapsible bund was seen as too reliant on maintenance. It would be ineffective if it was not maintained.
- The ramp was seen as a totally unworkable and unpractical option due to the impact on forklift operation and safety
- A sunken floor was considered however it was ruled out due to the risk of flooding.

4.1 Practicality

The main issue associated with practicality involves the safety and operation of forklifts. Industrial premises of the size addressed in this project typically use a forklift for the loading and unloading of trucks and for moving pallets and other stock around. The key issue for safe forklift operation is to have a level and clear floor area. The trench grate option and recessed area achieved this to some degree, however some users still had concerns with the impact of these treatments on safe forklift operation. Other users did not see a problem with these options for safe forklift operation provided they were constructed well.

4.2 Effectiveness

The risk of a spill was seen to be higher in outside areas where trucks are often loaded and unloaded. The risk of a spill inside of the building was perceived as being much lower than outside. To have greater impact on stormwater quality from industrial areas, a treatment solution may need to addresses outside areas where the risk of a spill is higher.

Structural isolation measures can contain pollutants within a building and prevent them entering the stormwater pathway, however the treatment and disposal of the pollutants from that point creates a risk to stormwater pollution. The effectiveness of structural isolation in reducing stormwater pollution from industrial areas is dependant on the appropriate disposal of the pollutants once they have been contained and collected. The trench grate option and recessed area with pit were considered more effective options as they contain the spill to a smaller area allowing easy disposal.

One of the greatest challenges to stormwater pollution from industrial areas is changing behavior. Any structural isolation solution will also require a well researched and resourced education and enforcement program aimed at industrial premise users to be effective.

4.3 Maintenance and Costs

The costs of all structural isolation options investigated are considered to be minimal if incorporated into the cost of a new building. The costs will vary depending on the size and number of access ways. Any costs would be likely to be passed onto the lease, although it appears this would have a minimal impact on rental costs. Due to the turnover of tenants in multi-purpose industrial premises, treatments that require no maintenance are preferable. The recessed area option and trench grate option will require minimal maintenance to the grate and pit to ensure that they do not become blocked and that they do not move and create a hazard for forklifts.

It is important that a trench grate or pit in a recessed floor are constructed well from the outset to ensure that they can tolerate the load of equipment traveling across them. They must sit flat with the floor surface to prevent them becoming a hazard to safe forklift operation.

5 Recommendations

From our research and consultation undertaken, the use of a recessed area and pit in the loading bay or a trench grate across the entrances appears to be the most cost effective and practical structural isolation solution. There are clearly other ways to address stormwater pollution from industrial premises and other methods such as the use of spill kits, treatment of outdoor areas and other engineering design options should also be considered.

As a means of regulating and monitoring structural isolation treatment, they could be included in the approved building documentation, which would be appropriate through the planning approval process. This could then be verified as being constructed via the building inspection process by the nominated Building Surveyor for the development project. A spill kit could also be regulated and monitored through the approved plans ad inspected as part of the occupancy control.

There is concern as to the effectiveness of structural isolation measures inside of the building for reducing stormwater pollution from industrial areas. Many of the issues raised during consultation require further investigation and more specific consultation and discussion. Specific issues that require further investigation include the level of risk of a spill inside and outside of the building, and the role of spill kits and whether they should be a mandatory requirement.

Any industrial stormwater pollution treatment needs to be part of an integrated approach that involves education, enforcement and infrastructure to ensure that it is effective.

Recommendations:

1. For loading that occurs within a building, a recessed area with a pit or a trench grate across entrances are the preferred options identified during consultation for this project.
2. Structural isolation treatments could be included in the approved building documentation and verified upon construction through the building inspection process.
3. Further investigations are required to determine the relative importance and effectiveness of structural isolation, due to the levels of risk to stormwater pollution internally and externally.
4. Further investigations are required into the role of spill kits and whether they should be mandatory requirements.
5. Any industrial stormwater pollution treatment should integrate education, enforcement and infrastructure to ensure it is effective.

Appendix 1

Consultation Notes

Consultation Workshop

Option 1 – Recessed Area – loading bay, front of building or entire factory floor

- If storage is in graded areas does it effect operations? Limited effect but if it was the whole floor it would effect the storage of some items.
- Incorporate into the development costs of the building, this would then be passed on to the tenant.
- Schedule 6 – if it is a Schedule 6 pollutant you have to discharge it properly through a trade waste agreement that already exists.
- A chemical spill is likely to be in the loading bay or in the shared estate area.

Option 2 – Small Ramp – either side of roller door, either side of exit doors

- Ramps are unusable and too dangerous for forklift operation.
- The room required for a ramp to meet the forklift safety requirements is too large and impinges on too much space inside and outside the factory.
- Large majority of factory leases use forklifts at some stage and a ramp would severely effect the ability to lease or sell.
- All agreed that this option was not suitable.

Option 3 – Trench Grate – in front of loading bay, in front of exit doors

- The cost of construction could be expensive. Would need to be able to tolerate a substantial load.
- In this option once it is collected there is still the desire to tip it down the drain.
- Minimal impact from a leasing/selling point of view.
- Spill kits could be linked with hydrants and other essential services from a regulatory point of view. Yearly inspections. Spill kits need policing over time as the use and occupancy of the factory changes.

Option 4 – Collapsible Bund – around loading bay, around exit doors

- These are a nuisance to operation and so get removed and lost.
- They are not practical and require lots of maintenance which is likely not to happen and therefore they loose effectiveness.

Option 5 – Apron Bund

- Would add $10,000 to building cost
- Not a fool proof solution as it could end up back in the stormwater system
- It is not a visible benefit (bells and whistles) so it is not effective for corporate responsibility
- The developer takes the hit of the cost because the leaser can't

General Comments

- This needs to also apply to existing premises as small business will lease based on cost. The cost shouldn't be passed on to the consumer as it will drive business away.
- All municipalities should adopt the same approach as users will go to the municipalities that are easier.
- The solution has to be one that applies to the whole estate
- How would it be monitored and policed? Authorities (eg. EPA) seem to not have manpower.
- This should be integrated with water issues, climate change and other issues and not treated in isolation. There are now requirements for grey water, water retention and water harvesting, MC2 cells are now being used. Should it be incorporated into these requirements.
- Do nothing is not an option – this should be pursued in some form.
- Some people still refuse to acknowledge that they contribute to pollution
- Should apply to older buildings (retrofit) otherwise it is pointless and will have little impact.
- Treatment should be flagged at the development of land stage, this would be the easiest most effective way. The containment to an independent collection point should be put in by the developer.
- There needs to be some enforcement to make the effort worthwhile.
- Council misunderstands the practicalities of the operation in their legislative side.

Summary of comments from meetings with users

- The main risk to stormwater pollution is outside of the building and this needs to be addressed.
- Anything with a lip or that creates an obstacle is not suitable in areas where a forklift is operating.
- Current practice in some factories is for spills to be hosed outside into the stormwater drain.
- Floor space needs to be as flat as possible for the loading and unloading of trucks.
- The recessed area is the preferred option but it should be over a small area to maximise flat floor space for forklift operation and storage.
- The cost of any of the treatments would not be noticeable in the cost of a new building.
- Education and enforcement is an essential part of any treatment.
- There is an opportunity in industrial areas to capture stormwater from roofs for use on-site.