CHALLENGES OF STORMWATER TREATMENT FOR A HIGH RISK HEAVY INDUSTRY SITE

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ABSTRACT

Establishing a heavy industrial site where the activity was in a high risk category for stormwater discharge presented a unique challenge when the combination of treatment, site constraints and consent factors were considered. The subject site was constrained by existing infrastructure including shallow stormwater connections, a largely impervious runoff area, live surface stormwater storage to provide pre and post development peak flow neutrality and the in-ground structures needed to be designed to withstand very high wheel loadings.

Limited approved treatment options were available to treat the key contaminants present including a high hydrocarbon and heavy metal loading. Contaminant design loading rates for such activities were not well defined. The design process at the time was prescribed by ARC TP10 as a physical treatment train sized to store and treat the resulting design storm water quality volume from the catchment area.

These challenges were successfully overcome through a collaborative approach to design and development of the stormwater treatment train between consultant and supplier.

This paper presents the options assessed for the stormwater treatment train, design issues that were addressed to integrate the stormwater treatment train with the site and compliance constraints, and reports on the treated water quality.

KEYWORDS

Stormwater, treatment, sand, peat, filter, metal, oil, hydrocarbons

PRESENTER PROFILE

Tristan Bellingham began work as a chemical/process engineer at New Zealand Steel before undertaking doctoral study in the contaminated land field. With Fraser Thomas since 2007, he continues to develop wide ranging skills across the stormwater, wastewater and contaminated sites fields, with stormwater treatment a particular focus.

Peter Carroll is General Manager and Senior Civil Engineer of Hynds Environmental. He has been involved in the design and manufacture of innovative stormwater treatment systems since 1998. He developed the first proprietary Sand Filter system in New Zealand and set up Hynds Environmental in 2001 to focus on developing environmental protection systems.

1 INTRODUCTION

The subject site in Onehunga, Auckland, has an interesting history. It was used by the Auckland Regional Authority (ARA) as a bus depot with the requisite maintenance, refuelling and cleaning facilities. Over time it evolved into a significant works depot and offices for the ARA, and then Watercare Services Ltd. Watercare also established the site as a civil defence centre with its own power generator. In 2007 work began to transform the site into a scrap metal processing facility centred around a shredder capable of reducing car bodies and the like into hand-size fragments to dramatically improve efficiencies in handling, processing and transporting scrap metal. The site receives scrap metal from commercial and public sources for processing into various product streams. Larger, mainly ferrous material is loaded into the shredder. Various magnetic, eddy current and vibrating screen separators divide the material into ferrous metal, non-ferrous metal and waste streams. The metals are sold on local and international markets and waste material is transported to landfill. CMA Recycling Ltd operate the site and hold various regional and territorial authority council consents containing the conditions within which the site must be operated to minimize adverse effects on the environment and relevant stakeholders. Discharge consents administered by the Auckland Regional Council (ARC) include Industrial or Trade Process (ITP), stormwater and air discharge, and were required due to the nature of the proposed scrap metal processing operations on site.

2 STORMWATER TREATMENT CONSTRAINTS

2.1 ACTIVITY AND CONTAMINANTS

The site is very busy with a processing capacity of 600 tonnes of scrap metal per day, numerous truck loads into and out of the site, as well as internal wheeled scrap handling plant and forklift traffic. In addition to potential suspended solids, and dissolved and particulate heavy metals, other contaminants include total petroleum hydrocarbons (TPHs) and polycyclic aromatic hydrocarbons (PAHs), acids and bases, and substances with high biochemical oxygen demand (BOD). To optimise stormwater treatment requirements, the site was divided into high and low risk activity areas. Runoff from low risk areas, car parks, colour steel roofs and driveways, receives standard treatment via Enviropods and standard catchpits. Runoff from high risk areas, where all outdoor scrap processing and storage takes place, passes through a treatment train designed for the contaminants listed above.

Photograph 1: Shredder feed stockpile and loading.

2.2 SITE CONSTRAINTS

The site had many constraints that made design of the stormwater treatment systems very challenging. There were two main stormwater lines traversing the site, both of which were under capacity for at least some of their length. Sewer lines running parallel to and at the same level as some sections of stormwater line made connections difficult. Other services such as gas, power, water, fire water and telecom, also limited the positioning of stormwater devices and other equipment.

An overland flow path also passed through the main proposed scrap metal processing area of the site. An existing depression in the middle of the site was utilised for reducing runoff peak flows with heavy duty pavement design optimising this stormwater ponding while still meeting freeboard requirements for the various floor levels in new and existing buildings. Precast lids for in ground structures 500mm thick were also designed for high wheel loads and were tied into the heavy duty pavement. Cantilevered foundations for acoustic boundary walls, a requirement of the land use consent, further restricted the positioning of stormwater treatment devices.

2.3 CONSENT RELATED FACTORS

The nature of the proposed industrial activity and the complexity of the site meant that numerous controls were put on the development by the regulating authorities. ARC consents included an ITP consent, a stormwater discharge consent and an air discharge consent. A land use consent from Auckland City Council (ACC) ensured the impact of the proposed activity on the neighbouring properties and wider community was minimised. Metrowater conditions related to reducing peak flows through existing under capacity stormwater lines. A trade waste consent was also needed. In all instances a proactive approach was taken with the regulating authorities with pre-lodgement meetings and subsequent discussions paving the way for a successful consent application process.

3 TREATMENT DESIGN AND SELECTION PROCESS

3.1 OPTIONS ASSESSMENT

A number of stormwater treatment options were investigated for the high risk activity areas of the site. Several options such as ponds, wetlands, rain gardens and swales were not pursued due to space limitations and inappropriateness for an industrial site such as this. Proprietary modular filtration systems are often a practicable option for stormwater treatment, however none of these devices had ARC approval for standalone use on a high risk industrial site. Use of the site for a trial of proprietary modular filters was dismissed by the client for a variety of reasons. Therefore, the stormwater treatment options were narrowed down to the use of sand filters designed in accordance with ARC's TP10 guidelines, this being the only ARC approved treatment option for high risk industrial sites at the time.

Specific design of any stormwater treatment system must take into account the potential contaminants of concern. Simple sand filters perform well in the removal of suspended solids and particulate heavy metals, but do not target dissolved metals. Given the potential for dissolved metals in stormwater runoff, the filter media was specified as a 50:50 sand:peat mix to enable adsorption of dissolved metals by the peat. Hydrocarbons can be removed by sand/peat filters but may blind the filter surface prematurely. Hence pre-treatment for the removal of hydrocarbons was deemed worthwhile to reduce the load on the sand filters and maximise maintenance intervals.

The existing and proposed layout and contour of the site resulted in the high risk part of the site being divided into three separate catchments with one treatment train proposed for each. Each treatment train consisted of a primary sediment chamber, a proprietary ecoSep oil/water separator, a secondary sediment chamber and a sand/peat filter. Discharge from each treatment train was to the existing piped network.

In addition to the above, stormwater treatment for the lower risk hook bin storage area was via a sand/peat soakage filter of in-house design. This soakage filter was to be located in a non-trafficked area and hence a simpler design sufficed. Runoff from the hook bin area was captured in a standard street catchpit and distributed over the soakage filter media and then allowed to drain into the underlying basalt.

3.2 SELECTED TREATMENT DESIGN DETAILS

The final design separated the site into three distinct runoff areas and a treatment train approach was applied to each of the areas.

The treatment trains are a three stage process. The first stage is primary treatment of the course sediments through settling chambers. The second stage is the removal of the hydrocarbons in the runoff down to 5 ppm. This is achieved by passing the stormwater runoff through a proprietary ecoSep coalescing media system. The final stage of treatment is fine filtration and adsorption designed to remove the fine sediments and particulate and dissolved heavy metals through large sand/peat filters.

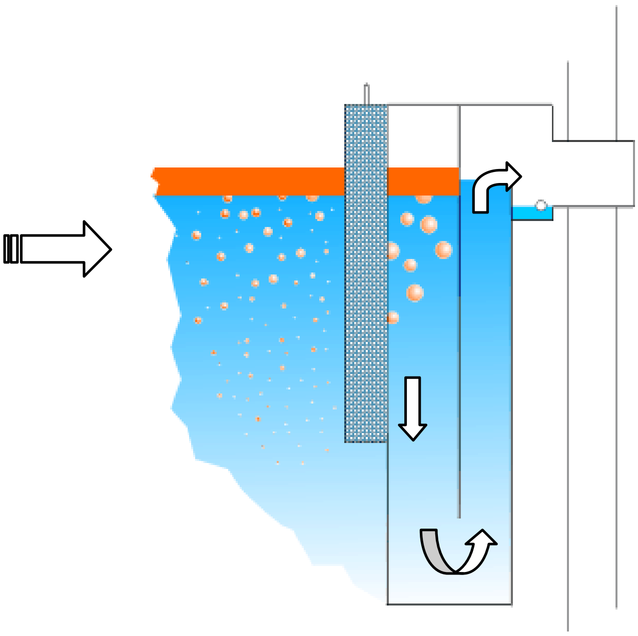

Figure 1: Coalescing media in the ecoSep unit.

The ecoSep system captures oil droplets that are too small to be separated by gravity alone. These droplets accumulate in the coalescing media forming larger droplets that then rise to the surface and are stored in the oil chamber. An automatic ecoStop shutoff valve is also incorporated to ensure any large spills are contained on site. This valve will automatically close once a specified amount of oil has been captured in the chamber. An electronic warning system is also installed in the ecoSep units to notify the operations department that a critical level of oil has been captured and the ecoSep unit requires maintenance.

Photographs 2 & 3: ecoSep oil separation systems.

The sand/peat filters are sized to store the design water quality volume (WQV – 1/3 of a 2 year storm event as calculated using ARC's TP108 stormwater runoff modeling guideline document) and slowly filter the stormwater over a period of 24-48 hours. The flow filtration removes suspended solids and the long retention time ensures sufficient contact time for adsorption of dissolved metals to the filter media.

Photographs 4 & 5: Installation of sand/peat filter tanks in Area B & Sand/peat filter tanks in Area C after backfilling.

Based on this assumption, the detailed design for each area was then completed to treat the relevant stormwater flows and to fit into the existing stormwater infrastructure and available space. The specific design parameters for the sand/peat filters are detailed in the table below. Standard ecoSep units with 20L/s (Areas B and D) and 10L/s (Area D) capacity were used with surface ponding providing attenuation of peak flows as required.

Table 1: Sand/peat filter design parameters.

Treatment Train	Catchment (m^2)	WQV Q_p (L/s)	Attenuated WQV Q_p (L/s)	Sedimentation Area (m^2)	Filter Area (m^2)	Live Storage (m^3)
B	5150	19	19	12	24	39
C	7400	28	20	12	48	56
D	3100	12	10	5	19	23
Soakage Filter	1000	3	3	Standard catchpit	17	5

3.3 CONSTRUCTION

Construction of the treatment trains occurred in parallel with other construction activities onsite including modifications to several buildings, installation of the shredder plant and associated footings, erection of boundary walls, installation of weighbridges and construction of a heavy duty pavement. Given the limited available head, tolerances for the installation of treatment devices and associated pipe work was very tight.

4 OPERATION, MAINTENANCE AND MONITORING

4.1 CONSENT AND OPERATIONAL REQUIREMENTS

The ITP consent specifies quarterly stormwater monitoring of a variety of parameters with samples taken from the outlet of the sand/peat filters and also from the peizometer installed in the sand/peat soakage filter.

Soon after the site became operational in April 2009, it became apparent that the loading on the stormwater treatment devices in Areas C and D would be very high. These devices take runoff from under and around the shredder. The shredder feed area (C) where trucks are off-loaded is particularly dirty with obviously high suspended solids and hydrocarbon loads. The ferrous product stockpile (D) also has very high suspended solids loading, due at least in part to rusting of the ferrous metal fragments.

4.2 MONITORING RESULTS

Monitoring results are still being gathered and quarterly monitoring is proving to be surprisingly difficult given recent weather patterns in Auckland, especially from November to April. The typical range of results for each parameter from the limited testing undertaken to date are shown below. Preliminary results for inflow samples indicate that percent removal efficiencies exceed 75% for the parameters tested. The quality of the treated stormwater is within the range for each parameter based on published data (Williamson 1993).

Table 2: Typical Monitoring Results and Treatment Train Performance

Contaminant	Typical Concentration Range (mg/L)	Typical % Removal	Typical Published Concentration Range (mg/L)
BOD	8 - 15	-	5 - 13
TSS	20 - 60	80%	50 - 470
Total Copper	0.01 - 0.29	90%	0.015 - 0.11
Total Lead	0.01 - 0.11	90%	0.06 - 0.19
Total Zinc	0.10 - 0.63	90%	0.09 - 0.80
TPHs	<0.3 - 1.5	-	1 - 5

4.3 INSPECTION AND MAINTENANCE

Regular inspection and maintenance of the sediment chambers, ecoSeps and sand/peat filters has occurred since installation and the commencement of site operations in April 2009. Accumulated sediment is removed from sedimentation chambers as required. Oil trapped in the ecoSep devices is removed as necessary based on inspection and the EcoWarn alarm system. The sand/peat filter bed is checked for standing water on a monthly basis, supported by quarterly permeability testing, to determine maintenance requirements. The first maintenance on the sand/peat filters occurred in January 2010 with the top 100mm of sand/peat filter media being replaced. Inspection during maintenance indicated that apart from the top layer, the filter bed was otherwise in good condition.

4.4 ONGOING MONITORING AND IMPROVEMENTS

Quarterly sampling of treatment train outflows will continue as specified in the ITP consent, as will permeability testing. Further inflow stormwater sampling will be conducted subject to funding. Source control and other environmental site operation issues will be reviewed during the site audit and update of the Environmental Management Plan. The experience and knowledge gained during the first year of operation will be used to optimise content and timing of inspection and maintenance activities.

5 CONCLUSIONS

The design of stormwater treatment trains for a proposed scrap metal recycling operation in Onehunga, Auckland, presented many challenges. The subject site contained many constraints, including limited space and available head, numerous existing and new underground services and obstructions, overland flow paths and heavy wheel loads. All of these constraints had to be considered during the stormwater treatment design process.

After a busy and compressed construction period, the site became operational in April 2009. While the contaminant loading, primarily suspended solids, heavy metals and hydrocarbons, in the high risk scrap processing areas is significant, preliminary results indicate that the treatment trains installed are functioning well. Stormwater outflows after treatment are typical of urban runoff and removal efficiencies between 80% and 90% are achieved. Experience and knowledge gained over the past year, along with ongoing inspection and maintenance activities, will ensure that this level of treatment is maintained for the duration of the consent.

ACKNOWLEDGEMENTS

CMA Recycling Ltd

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