HYDRO FUTURE CONSULTING

Environmental Management Plan

NORTH TERRACE DRAINAGE DESIGN

ENVIRONMENTAL MANAGEMENT TEAM

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Document Amendments

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Executive Summary

The following Environmental Management Plan (EMP) has being conducted for the North Terrace, Kent Town drainage system upgrade. The document highlights the key environmental issues in relation to the project, the appropriate environmental policies and environmental legalisations. The environmental impacts in relation to issues such as water quality, air quality, soil contamination, fauna, flora, existing infrastructure, noise, etc. have been taken into account and analysed. Strategies to mitigate the environmental impacts have been provided.

The chosen option to address the stormwater drainage issue is a:

- **Combined Drainage Network**, consisting of the following:
  - Infrastructure Upgrade: Updating the existing stormwater infrastructure with an increase in the number of inlets through the addition of more side entry pits (SEPs), grated pits and reinforced concrete pipes (RCPs).
  - Bio-retention Basin: Construction of a bio-retention basin in two locations along North Terrace to increase mitigation whilst providing environmental benefits through water filtration.
  - Water Harvesting: Implementation of a series of water tanks located within the project area to collect stormwater to be reused for irrigation, toilet flushing and laundry purposes.

This design also incorporates a gross pollutant trap (GPT) at the downstream end of North Terrace to capture debris and sediment before it reaches First Creek.

This EMP takes into account all of the environmental impacts and the best possible outcomes for the social and economic elements of the project. The Environmental Management Team at Hydro-Future Consulting highly commends the choice to implement a water sensitive urban design (WSUD) option in the form of two bio-retention basins for their environmental benefits including the filtration of stormwater runoff to remove harmful pollutants and contaminants as well as the decision to implement a gross pollutant trap.

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List of Abbreviations

Acronym	Meaning
AADT	Average Annual Daily Traffic
ARI	Average Recurrence Interval
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
EMP	Environmental Management Plan
EMR	Environmental Management Representative
FSL	Finish Surface Level
GPT	Gross Pollutant Trap
HFC	Hydro-Future Consulting
IFD	Intensity Frequency Duration
IL	Invert level
PPE	Personal Protective Equipment
RI	Rainfall intensity
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
VPD	Vehicles Per Day

1. Background

1.1. Introduction

This Environmental Management Plan (EMP) depicts the environmental management methodology to be applied for the North Terrace Drainage Design Project. Hydro-Future Consulting is responsible for delivering this aforementioned project to the client, Tonkin Consulting.

EMPs are used to stipulate mitigation, control and prevention strategies used and enforced by a company during the course of the project at hand for the identified project related impacts and issues. Hydro-Future Consulting's construction EMP or (CEMP) also includes maintenance and inspection checklists as well as any relevant information, to be used throughout the duration of the project to ensure it is actioned according to plan and ultimately meet's the client's needs and requirements.

In the feasibility study stage of this project, an Environmental Impact Assessment (EIA) was conducted. This has provided the team with the necessary project relative findings which state the potential environmental impacts and issues, which require to be addressed prior to and during construction. These impacts and issues are summarised in this EMP.

The EMP will be used as the guideline to the environmental management of the work site to ensure that any impacts on the environment will be neutralised, or minimised to an acceptable level, whilst at the same time meeting the client's needs.

The Environmental Management Plan will focus on potential impacts in the three key areas of the physical, biological and human environments and ensure the promised and promoted feasibility of the combined drainage option outlined in the feasibility study is delivered during the course of the construction and implementation phase.

1.2. EMP Framework and Objectives

There are 12 procedures consisted in the EMP framework:

1. Issues: Hydro-Future Consulting identifies its environmental issues and both the actual and potential impacts related with these issues.
2. Legal Requirements: To enable all employees to interpret legislative requirements and determine all applicable requirements to the business.
3. Objectives: Environmental objectives to be set up by Management Group based on impacts identified and the risk ranking assigned in the issues. Goals outlined in the Environmental Policy are supposed to be achieved.
4. Trainings: This procedure gives relevant employees a guideline for environmental awareness training to ensure Hydro-Future Consulting employees have the skills, knowledge of their roles to achieve the goals of the Environmental Policy.
5. Reporting and Communication: This procedure is to ensure there is a specific system for external parties relevant communication's receiving, documentation and responses.
6. Document Controls: This procedure is about controlling all documentation relating to the environmental plan.
7. Preparedness and Response for Emergency: This procedure provides a framework of establishing and maintaining procedures to classify all potential accidents and emergencies. Meantime, identify the response for them, prevent and mitigate the associating environmental impacts.
8. Monitoring and Measurement: This procedure is supposed to ensure any Hydro-Future Consulting activities which have a significant impact on the environment are undertaken by effective monitoring and measurement on a regular basis.
9. Non-conformance, Corrective and Preventative Action: This procedure aims to provide a guideline to ensure that major technical non-conformance are included and identified on the Issues Register. At the same time, system non-conformances are identified and addressed prior to the final audit report.
10. Records: Guidelines for the Identification, maintenances and disposal of environmental records will be provided in this procedure.
11. Audit for Management System: Methods and responsibilities for the planning, preparation, performance, reporting will be described in this procedure.
12. Management Review: In this procedure, a guideline for the Management Review of Hydro-Future Consulting's Environmental Management Plan

In order for Hydro-Future Consulting to ensure that the EMP is effective and enforced

efficiently, the following environmental management objectives are stated:

- To minimise all environmental impacts cause by the project on the work area and surrounding areas .
- Provide the most effective environmental managements practise in terms of planning, commitment and continuous improvement.
- Determine and control potential environmental hazards and incidents by using the appropriate correction or prevention actions.
- Provide proper procedures to ensure no environmental hazardous substances are stored on Commonwealth land.
- Identify and protect any special environmental cases found on site such as cultural or indigenous heritage.
- Define all environmental roles and responsibilities for all company personnel .
- Ensure implementation of the EMP to all company employees and subcontractors.
- Define the necessary monitoring and auditing processes to ensure the environmental outcomes are achieved and the EMP is continuously improving.
- Establish complaint and reporting records in order to manage and maintain complaint records.

1.3. Project Description

The City of Norwood Payneham and St. Peters is a metropolitan council, covering an area of 15.1km^2, east of Adelaide's CBD. One of the primary services that the council provides for the 34,000 residents is the stormwater drainage network. The drainage network allows for the effective collection of surface water in the area and provides flood protection throughout the city. The majority of the system comprises stormwater pipes, side entry pits, grated pits, junction boxes and culverts. The stormwater makes its way to First Creek, the River Torrens and ultimately Gulf St Vincent.

Over the years it has become apparent that as a result of heavy rainfall events, North Terrace, Kent Town has suffered significant flooding from College Road through to Hackney Road. The drainage solution aims to resolve these flooding events and future proof the existing system against any heavy rain events that may occur. Since submission of the Feasibility Study Report, the decision on the final design option for the drainage issue was made by the client based on the findings and retrospective company recommendations. This solution (as outlined in the Executive Summary) is a combined drainage network composed of a number of different

technologies including conventional stormwater, water harvesting and water sensitive urban design (WSUD).

1.3.1. Location

The drainage project area located on North Terrace, Kent Town between College Road and Hackney Road, as depicted in Figure 1 below. North Terrace is a major arterial road, with an average annual daily traffic (AADT) count of approximately 33,700 vehicles (Department of Planning, Transport and Infrastructure, 2015). The existing site conditions relative to the project area are defined in Section 2 of this EMP.

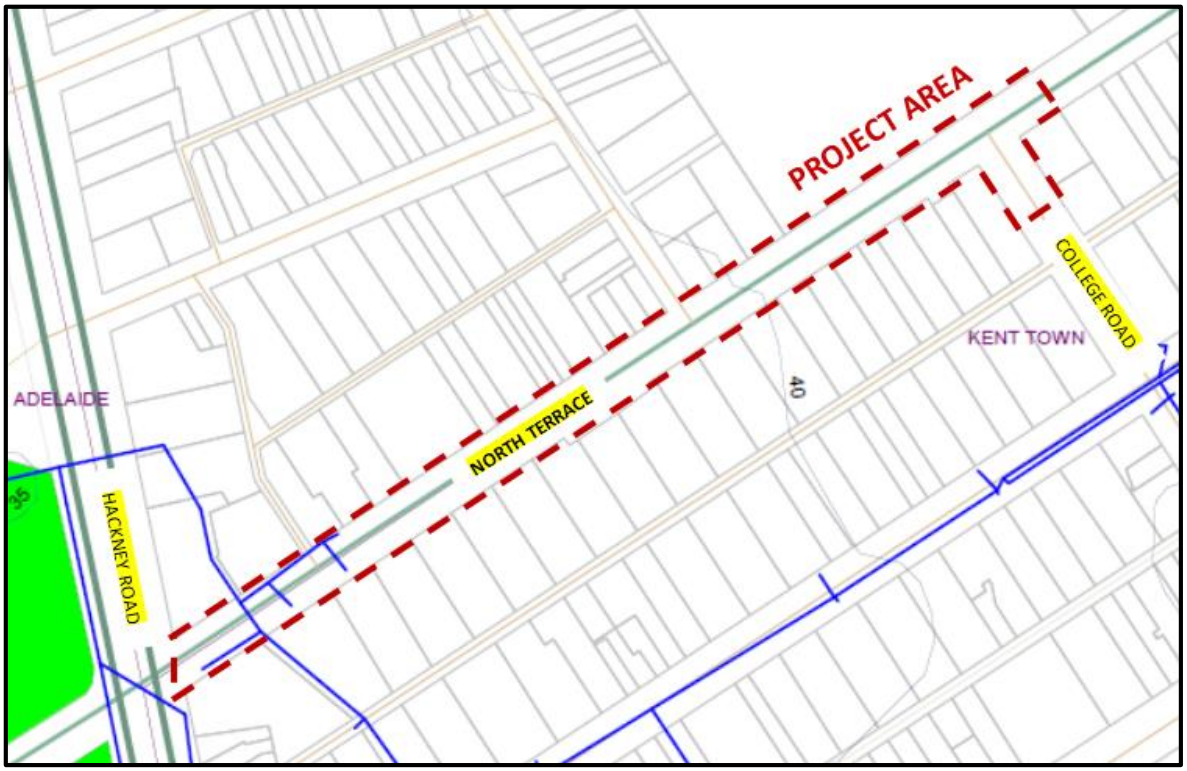

Figure 1 - Location of Project Area (Hydro-Future Consulting, 2015)

1.3.2. Construction Activities

Detailed descriptions of construction activities associated with the North Terrace Drainage project are needed to assess the environmental impacts of the project development. The construction activities of the North Terrace Drainage project are listed in Table 1 below:

Table 1 - Construction Activities

Component	Activities
System Set up	• Environmental Management Plans, licences and approvals
Site establishment	• Site set out • Site compound • Subsidiary sites including storage sites, access roadway for construction • Initial environmental safeguard
Services Relocation	• Identification and consultation • Relocation
Site preparation	• Clearing and grubbing • Construction access
Structures	• Rainwater Tanks • Upgrade to existing infrastructure including new RCPs and SEPs • Bio-retention basins • Gross Pollutant Trap • Alterations to a heritage listed sandstone arch culvert
Earthworks	• Cuttings • Excavations • Fill embankments • Select material zones
Other works	• Fencing • Landscaping • Pavement construction • Noise barriers • Safety barriers • Path for shared users • Lighting, signposting and line marking

Ancillary works	• Property access • Realignment of local loads
Finishing works	• Remove temporary works • Restore and landscape temporary sites

1.3.3. Scheduling of Construction

In order to assigning dates to project activities, the resources of equipment, materials and labour within the project work tasks over time should be matched to the project scheduling. A proper scheduling will eliminate problems and ensure a project is completed before the original plan completion date. For a healthy and effective schedule, the following criteria have to be achieved:

- The schedule has to be updated constantly (weekly schedule works effectively).
- The Estimation at Completion (EAC) value has to be equal to the baseline value.
- Efforts must be distributed among all employees (taking holidays or work leave for consideration).

The construction is suggested to commence in January 2016 and will take around 18 weeks before completion around the end of March.

1.4. Environmental Policy

Hydro-Future Consulting's vision is 'reducing our environmental footprint'. All environmental issues and risks are taken seriously to ensure that we preserve the environment we interact with. The company has its own Environmental Management Systems to ensure that all the environmental matters are managed with zero tolerance to any impacts that can damage the environment. Our Environmental Management Systems ensure that the business is compliant with ISO 14000 standards and Environmental Protection Act (EPA)-1993.

Environmental Policy Key Points:

- All activities undertaken by Hydro-Future Consulting comply with the relevant environmental legislations and policies.
- Any environmental impacts must be identified, assessed and mitigated in all phases of the project (initiation, design, management, construction, operation and maintenance).
- Hydro-Future Consulting's environmental advisers are to be consulted regarding any environmental matters, including any changes to the agreed Environmental Management Plan (EMP).
- All staff is to be inducted to the EMP, as well as the relevant legislations before commencing any work on site.
- Regular auditing by environmental advisers is to be undertaken, to ensure conformance to the agreed EMP and to identify any possible risk and manage them as soon as reasonably practicable.
- Hydro-Future Consulting's Environmental scorecards are to be evaluated annually to assess the environmental footprint and identify all opportunities for improvement.
- Adopt and promote energy and resource efficiency in all activities undertaken.
- All environmentally innovative ideas to be encourage though an annual internal environmental award.

2. Existing Conditions

During investigation of the project area, various factors were noted which included the existing condition of the infrastructure, vegetation, stormwater system, traffic volumes and road conditions. During the Feasibility Study all design options were considered against the current condition of the project site to determine the most beneficial option for the environment. Some of these include:

2.1. Stormwater

The current stormwater system collects water through grated inlets and side entry pits from both sides of North Terrace as well as the surrounding catchment area. As it stands, there is no surface drainage infrastructure for approximately 280 metres, along North Terrace. Currently there is no system in place to improve water quality from the project area to First Creek. Therefore, the current water quality is polluted from litter, rubbish and other pollutants that may be deposited on the road.

2.2. Vegetation

2.2.1 Significant trees

As stated in the Department of Planning and Local Government 2012, a 'significant tree' is a regulated tree that is: "*Any tree in metropolitan Adelaide and/or townships in the Adelaide Hills Council or parts of the Mount Barker Council with a trunk circumference of 3.0m or more measured at a point 1.0m above natural ground level*" (in the case of trees with multiple trunks, it is those with trunks with a total circumference of 3.0m or more and an average circumference of 625mm or more measured at a point 1.0m above natural ground level). Or any tree identified as a significant tree in the Development Plan of the City of Adelaide, City of Burnside, City of Prospect or City of Unley (Department of Planning and Local Government, 2012).

2.2.2 Existing Vegetation

The existing vegetation in the project area is minimal, there is no solid median in the centre of the road and there are multiple driveways which prevent a significant amount of vegetation along the footpath. A total of thirty-one trees are located within the project area, similar to that seen in Figure 2. A number of juvenile sized trees are placed at regular intervals along the southern side of North Terrace whereas the north side has fewer trees planted. These trees are of reasonable size and health, but none of the street trees are regulated or significant, the species is not highlighted under the Development Act 1993 as being of a significant type. Based on this Act, all thirty-one trees are not considered to be significant or regulated.

Figure 2 - One of the Pyrus calleryana 'Capital' trees located on North Terrace (Hydro-Future Consulting, 2015)

The species of the thirty-one trees located along North Terrace are all known as Pyrus calleryana 'Capital' trees (Figure 2). They are readily used for street planting due to their characteristic to grow upwards a great deal faster than outwards, limiting their risk with making contact with large trucks passing in the left-hand lane. As a result of these growing characteristics, they require minimal pruning and hence require minimal labour for up-keep. However, since these trees are located below power lines, their growth is monitored by the Council and pruning is undertaken at intervals, based on growth. These trees have the ability to withstand relatively dry conditions as well as periods of wet conditions. Most importantly, these trees are readily available and easy to re-plant if removed carefully. These trees are known to provide no habitat for native/local fauna or any specific food source (Yarra Ranges, 2009). During visits to the project site, no fauna was noted around or in these trees. There is no rubbish bin along the project construction area.

2.3. Traffic/Road

The road is an undivided dual carriageway that provides adequate walkways on either side. This section of North Terrace has an Annual Average Daily Traffic (AADT) of approximately 34,200 vehicles and is usually busy from 5am until 3am as it is one of Adelaide's key arterial roads providing access both in and out of the city centre to the North-Eastern Suburbs. This is a significantly busy road during peak hour periods, therefore a traffic management plan has been created by the Transport Engineering team to ensure that traffic flow has minimal interruptions during the course of the project and can be seen in Section 7 of the detailed design study.

2.4. Native Fauna

The project location is a relatively small area that is almost entirely paved and does not cater for native wildlife. First Creek runs through this section underground, emerging at the Adelaide Botanic Gardens. The only vegetation along this section of road are trees, these are primarily aesthetic as the large volumes of traffic would discourage fauna. During the site visit to North Terrace, a number of bird species were located, however none were located within the street trees, as depicted in Section 5.2 and none were seen to rely on the native vegetation along North Terrace. The species seen during site visits included the Crested Pigeon and the Australian Magpie as respectively depicted in Figure 3 below. Both species are not listed as endangered on the Environmental Protection and Biodiversity Conservation List (EPBC), (Department of the Environment, 2015).

Figure 3 - Crested Pigeon and Australian Magpie birds (Birdlife, 2012)

2.5. Soil

The geotechnical data indicates that the soil in the study area is predominantly made up of red-brown clay soils with granular structure over clay with variable lime. Table 2 below breaks down the soil types in the area.

Table 2 - Project Area Soil Description

Red-brown clay soils	
Soil Type	Soil Description
Red Brown Earth (RB3)	Heavy red-brown clay soils with prismatic or blocky structure over clay with variable lime.
Red Brown Earth (RB2)	Red-Brown Sandy clay soils with granular structure.
Red Brown Earth RB5a	Brown clay or sandy clay soils with granular structure over sandy clay with some lime.
Red Brown Earth RB9	Mottled silty clay over brown silty clay with granular structure, slight lime, becoming sandy with depth.
Alluvial Soils (AL)	Layered stream alluvium – silts, sands and gravel.

Clay layers exhibit high undrained cohesion strength. This potentially causes the soil to soften after loss of moisture from groundwater, thus causing ground settlement. However, when excavation extends to the groundwater table, caution must be taken so that no damaged is caused as a result of the heavy machinery used.

2.6. Waste and resources

North Terrace is the main access point for a number of businesses in Kent Town for the general public, including residents and everyday commuters. A site investigation determined that there is currently no rubbish bin along the footpaths in this location. For the environmental concerns, rubbish bins are highly recommended to be placed along in this area and especially close to bus stops. Regular services including side entry pit cleaning, street sweeping and 'Autumn Leaf' pick up services are currently operating in the area. These actions will be affected when the construction commences, large machinery will be unable to access into the specific location, however, manpower could replace large machinery to lean the pit and sweep the street.

2.7. Noise and Vibration

According to the NSW Environment Protection Agency Road Noise Policy, the desired road noise level during the daytime is to be less than 50-65dB (DECCW 2011). Without further data it will be assumed that this is the approximate level of noise experienced at the project location. As most of the works will be conducted at night, any noise that exceeds this will require a noise exceedance permit to ensure the works are closely monitored. By implementing the mitigation strategies discussed later, it will be possible to limit the effect of construction noise and vibration on the local residence and business owners.

2.8. Air Quality

Given the project location, large volumes of traffic, and limited air movement it can be assumed that the air quality will be below average. By implementing the mitigation strategies discussed later, it will be possible to limit any negative effect due to the construction phase, on air quality.

3. Environmental Management Framework

This section of the EMP discusses the legislative and contractual requirements relevant to the project. A significant segment of the environmental management framework is the explanation of project relevant roles and responsibilities, which work to manage and monitor the performance of environmental related aspects of the project.

3.1. Structure and Responsibility

The environmental relative roles and responsibilities for all individuals involved in this project are listed in Table 3 below.

Table 3 - Roles and Responsibilities

Role	Responsibility
Project Manager	• Responsible for overseeing the project as a whole
Quality Control Manager	• Management of onsite quality control
Environmental Manager and Environmental Management Representative if required	• Responsible for ensuring the EMP is successfully implemented and maintained throughout the duration of the project. • An environmental management representative (EMR) may be required to upkeep the EMP during the construction phase
General Contractor	• Planning and coordinating construction • Ordering of project materials • Management of onsite manpower • Conduct reports on site safety
Contractors	• Undertakes labour onsite • Reports to general contractor
Sub-Contractors	• Assist contractors in undertaking labour onsite • Report to general contractor

Therefore in accordance with the above information, an environmental management representative (EMR) may be required to upkeep the EMP during the construction phase. The environmental management rep is required for making sure that the EMP is successfully implemented and maintained throughout the project's duration.

3.2. Approval and Licensing Framework

The governing framework of Hydro-Future Consulting relative to this project is seen in Table 4 below. The Legislations and Acts relative to this project are listed alongside the licenses required, the conditions under which approval is required and who is responsible for obtaining the license(s).

Table 4 - Licensing Framework

Legislation	License required	Conditions under which approval is required	Person responsible of obtaining the license
Environment Protection Act 1993 (SA)	EPA license	For approval of work	Environmental Manager
Development Act 1993 (SA)	EPA license	Placing of spoil including neighbors and the council.	Environmental Manager
Environment Protection (Air Quality) Policy 1994	EPA license	For approval of work	Environmental Manager
Environment Protection (Water Quality) Policy 2003	Waste Discharge License	For approval of work	Environmental Manager
Environment Protection (Noise) Policy 2007	EPA License	For approval of work	Environmental Manager

3.2.1. Environmental Legislation

Hydro-Future Consulting ensures that all environmental legislations and the appropriate policies will be strictly adhered to throughout the duration of the project. The following list of legalisations and policies are relative to the project at hand and will be used as guidelines for all work that is being undertaken:

- Environment Protection Act 1993 (SA)
- Development Act 1993 (SA)
- Environment Protection (Air Quality) Policy 1994
- Environment Protection (Water Quality) Policy 2003
- Environment Protection (Noise) Policy 2007
- Environment Protection Regulations 2009
- Native Title Act 1993
- Heritage Places Act 1993 (SA)
- National Trust of South Australia Act 1955 (SA)
- Local Government Act 1999 (SA)
- Environmental Protection (Site Contamination) Amendment Act 2007 (SA)
- National Parks and Wildlife Act 1972 (SA)
- Native Vegetation Act 1991
- Environment Protection (Air Quality) Policy 1994 (SA)
- National Environment Protection Measure for Ambient Air (Ambient Air NEPM)
- National Environment Protection Measure for Air Toxics (Air Toxics NEPM)
- National Greenhouse and Energy Reporting Act 2007
- National Greenhouse Strategy (NGS)
- Environment Protection and Biodiversity Conservation Act 1999
- Water Resources Act 1997 (SA)
- EPA information sheet *Construction Noise 2014*
- Fire and Emergency Services Act 2005
- Management of Noise and Vibration: Construction and Maintenance Activities DPTI
- EPA information sheet *Bunding and spill management 2012*
- Real Property Act, 1886 (SA)
- Land Acquisition Information Guide (Roads and Maritime, 2012c)
- Land Acquisition (Just Terms Compensation) Act 1991.
- Environment Protection (Waste Management) Policy 1994

The list of persons who are responsible for obtaining the relevant licenses, permit and approvals, and the time when they need to obtain these approvals is indicated in the Table 4. Relevant issues such as the legislation, licenses required, people responsible for getting those licenses and the scenarios under which those licences are required have been stated in this table.

3.2.2. Reporting

Hydro-Future Consulting requires all project related outcomes and feedback to be compiled and reported. The reports that will be required throughout the course of this project are displayed as follows.

3.2.2.1. Monitoring of Construction Report

Hydro-Future Consulting ensures during construction that all potential environmental risks are identified and reported upon as well as recommending the necessary mitigation steps. The environmental manager and environmental management representative have a duty to ensure that there is commitment to the various legislation and all permits are adhered to by monitoring the environment related aspects of the project in order to ensure that all the environmental requirements are followed during the project. The frequency of the monitoring operations shall be once a week for the entire construction phase. In case any problem is noted, a corrective measure will be taken where it is warranted. Environmental issues related to reclamation will be addressed to recover the areas disturbed by the system during construction. Trips will be taken to visually identify problem that may have risen and were not anticipated. Upon completion of the monitoring and making the reports, the environmental officers or environmental engineers are expected to distribute their reports to the environmental manager. The environmental manager will then forward these reports to the project manager in accordance with the project manager's requirements with regards to how detailed or brief the reports need to be.

3.2.2.2. Reports Required by Government Agencies

Through on-site examination, issues to do with vegetation, watercourse crossings, slope movement, erosion deterioration, and weed infestation will be examined. The outcome of the report will be given to the relevant authorities to address the issues and give commitment in addressing the specific issues. The environmental manager upon receiving approval from the Project manager will send these reports to the relevant government agencies. Future issues that will arise will be taken as amendments to this monitoring process. Any issues flagged by the government agencies will be taken up by the project manager. The project manager can assign the correct personnel working under him to address those relevant issues. Various government issues are working for his cause. For example; Occupational Health and Safety (OHS), Workplace Health and Safety (WHS) and Safe work Australia.

3.2.2.3. Complaints Management Report

Environmental related complaints, especially those regarding wastewater from construction sites are to be controlled by Hydro-Future Consulting's management Team. If required, these

reports will be submitted to the Council and associated government agencies. These agencies aim to act upon the complaints in a timely manner. Any complaints regarding wrong disposal of waste on the street will be considered and addressed. Any complaints will be collected online and also physically which will then be forwarded to the relevant authority via emails and also online. The government authorities can officially write to the project manager if the complaints are received by the government and are specific to the construction project. The project manager will then forward these complaints to the relevant personnel. These complaints include environmental problems such as excessive noise. A standard complaints form for Hydro Future can be seen in Appendix B8. Complaints Report

3.2.3. Training

3.2.3.1. Objectives of the Training

Hydro-Future Consulting's environmental training programme is to be undertaken by all employees working on the North Terrace Drainage Design Project. The training provides awareness of the Company's procedures and trains each individual in regards to their specific roles within the project at hand. The training provided should be such that all employees understand their duty to carry out due diligence with regards to environmental matters. The term 'employees', in this context, refers to all personnel who are involved in work on-site and that includes sub-contractors and contractors as well.

3.2.3.2. Scope of the Training

Environmental training should include:

- Orientation and induction training for the project site
- EMP requirement familiarisation
- Training for adequate response to an environmental emergency
- On-site environmental control familiarisation
- Spill treatment, mitigation and management training
- Specific, targeted environmental training for each type of person involved, for example different specialised task related environmental training for contractors and sub-contractors (for dust control for example)

As stated above, training shall include general induction. This shall involve skills and knowledge of competency with a special emphasis on safety and on health training in construction industry. It also involves roles and duties and responsibilities of the employees, how to raise issues and report any risky working condition. The roles of the committee and the consultants are among others identification of hazards including noise.

General training involves Equipment maintenance including inspection. Basics of first aid are essential since people are working in confined places and heights are inevitable. It is the duty of the employees to attend to emergency incidences before any help arrives. Training will be offered under the relevant authority framework.

Specific task training is aimed at providing information to everyone who is engaged at any particular task including the risk factors and control measures relating to the task. This helps the people in gaining relevant knowledge for them to work in the particular areas. Task specific training will be offered to those people who work in high risk areas. The person controlling the construction will assess the areas and the risks involved and determine whether the specific training is needed. This should consider the nature and complexity of the task. Training on the use of spill kits, bunding trays and other associated clean up items will be covered by the trainer during the course of the training. The content should be tailored to overcome language barriers.

3.2.3.3. Record of Training

All trainings carried out must have documentary record. These records must be preserved and maintained at all times. A sample training report can be seen in Appendix B4 .This report is to be filed in by the authorised trainer, reflecting the training session(s) conducted on the day and is to be filed with the company for liability purposes. Based on the outcomes of the training, some or all employees may require revised training at later date, which is to be organised with the environmental management, including the EMR. The training report includes the following:

- Name, designation and relevant details of the person(s) who were trained
- Time and date of the training and when was it carried out
- Trainer's name
- General description of the content covered during the training

3.2.3.4. Prevention and Control of Spillages

In order to address any on-site spillages, including minor to major hazardous substances, Hydro-Future has its own Spill Prevention and Control Plan (SPCP hereafter), which reflects the considerations outlined by the Environmental Protection Agency's Spill Prevention and Control Plan (Environmental Protection Agency, 2014). The plan aims to teach and illustrate to employees the necessary measures required to prevent and control spillages. In the occurrence of a spill, Hydro-Future's SPCP outlines the following mitigation steps:

1. End the source of the identified spill
2. Use spill kit to clean up all traces of the spill
3. Properly dispose of the materials used to clean up the spill

4. Record details of spill on a Spillage Record Sheet
5. Take the necessary steps to prevent a similar spill from reoccurring

Hydro-Future's SPCP also stipulates a number of mitigation measures such as:

- Use overflow control measures where required such as bunding trays when moving drums or containers containing hazardous substances
- Use diversion or prevention measures to block off and protect side areas including entry pits or open pipelines from receiving hazardous substances
- Frequently check the adequacy of all on-site hazardous substance storage containers.

The environmental manager in conjunction with the head contractor will enforce the plan amongst all employees working on-site. All employees will be instructed on how and who to notify in the case of an emergency, as depicted in detail in Section 3.2.4. Emergency Details and Response.

The equipment to manage spillages is to also be explained in detail to all employees through training. The equipment and their location is located in Table 5 - Spillage Management Equipment and Location below.

Table 5 - Spillage Management Equipment and Location

Equipment to manage spillage	Details	Location
Spill Kits	240L Construction Spill Kit	In a safe position on-site with clear and large signage above for all on-site workers to see and be able to read
	Portable Spill Kit	Carried in General Contractor's vehicle
Drip Trays	For small leaks	Kept alongside construction spill kit
Bunding Trays	For large quantities of chemicals	Kept alongside construction spill kit

The location and use of safety data sheets (SDS) and materials pertaining to spill management and containment has to be a clear and important part of the environmental induction training. All safety data sheets are to be located at all hazardous chemical storage areas. A master copy of all safety data sheets is to be in the possession of the general contractor and can be viewed at any time by all employees. Hydro-Future implements the use of standard operating procedures (SOP) to assist in delivering the project to the client on time and to their satisfaction. The project manager is responsible for controlling all SOPs, and all SOPs relevant to machinery, tools or other equipment used during the course of the project will be controlled by the general contractor. Each of these items is to be tagged with an SOP.

3.2.4. Emergency Details and Response

In case of emergency, the emergency assistance number '000' needs to be dialled and emergency assistance will be given by volunteer fire companies from the area, red -cross, area police, rescue squads, the police and town officials. At any time residents are requested to seek an alternative shelter, they should obey. The fire house can be used as the designated shelter in such times. The overall responsibility of assistance in emergency times lies with the town officials and volunteer fire company situated in Adelaide. At the same time, Project manager and environment manager are also to play their roles in dealing with the emergency on the project site itself. Environmental emergency is described to include damage to the surroundings and material damage (Chen et al, 200). At the same time, the project manager shall act as the Fire Emergency Controller (FEC) and can decide what actions to take in the case of an environmental emergency. A list of the emergency contact roles and numbers is displayed in Table 6 - Emergency Contact List and Roles below.

Table 6 - Emergency Contact List and Roles

Emergency	Emergency service	Contact number
General emergency (fire, health and police)	General emergency and rescue service	000
Bushfire	Bush fire information call line	1300 362 361
Police	Non-urgent police assistance	131 444
Damaged roof, rising floodwater, trees fallen on buildings, or storm damage.	State Emergency Service (SES)	32 500
Traffic control for emergency	Road conditions and closures	1300 361 033
Power outage or power stoppage	Power supply and outages	13 13 66
Emergency	Project Manager,	476639634

	Eriny Abdelraouf	
Emergency	Environmental Manager Minghao Cui	465431734

From the construction point of view, the project manager has the right to immediately cease operations as well and order evacuation.

The **Emergency Contact List and Roles** are as follows:

Police: Police can investigate the entire matter due to which an environmental accident took place on a construction site. Moreover, they can assist the helpers in getting the individuals out of the accident site.

General emergency: In general emergency, issues like fire on a workplace or a health problem of any worker are highlighted. Various organizations are setup, through which these minor issues are resolved.

Traffic Control: The traffic control wardens are responsible for this. They have to make sure that the accident site is not covered up with people. Dispersing the individuals to other paths is very essential and traffic control police plays an important role in this regard.

In the event of an emergency, the project manager shall act as the Facility Emergency Controller (FEC) in accordance with the flowchart in Figure 4 below. This flowchart displays the necessary steps to take for all employees in the event of an emergency.

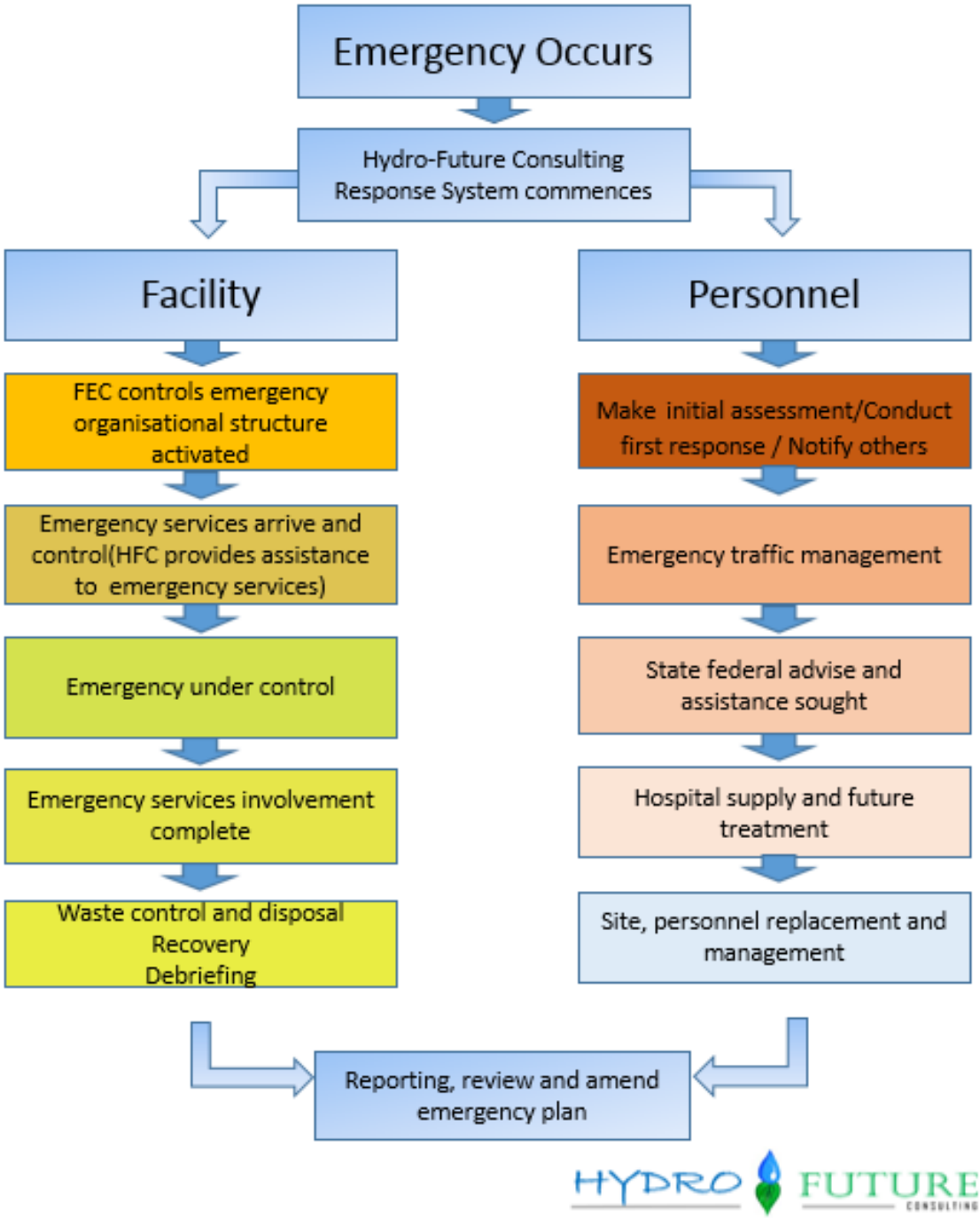

Figure 4 - Emergency Response Flowchart (Hydro-Future Consulting, 2015)

3.2.4.1. Targeted Emergency response

The following emergency response strategy can be used:

Figure 5 - Steps for Dealing with Hazards (Hazard Identification, Risk Assessment and Control Procedure, 2015)

The project manager and the environmental manager shall consult throughout this four stage process. As the first step, each hazardous or harmful occurrence needs to be identified. As the second step, the known risk and control procedures shall be discussed in order to deal with the hazardous occurrence. And then strategies for controlling risks, reviewing them and dealing with them shall be discussed in order to successfully encounter the problem.

3.2.5 Hazardous substances and dangerous goods

Hydro-Future Consulting requires that all substances, materials and tools are safe to all employees and to the environment. Unsafe use of hazardous substances can cause cancer, skin disease, poisoning and respiratory illness.

Hydro-Future requires all dangerous goods are stored, handled and transported safely. Dangerous goods are corrosive, explosive, toxic, water-reactive or flammable substances may have the potential possibilities of causing chemical burns, poisoning and other serious health

problems. Petrol, paints, acids and pesticides are commonly used dangerous goods (Work Safe Victoria 2015).

As defined in the Dangerous Goods Act 1985, all dangerous goods storage and handling requirements are listed in below:

- Classification and labelling (this has to be clearly shown on the materials)
- A Safety Data Sheet (formerly known as Material Safety Data Sheet) is needed for the hazardous goods
- Proper training and worker consultation
- Risk assessment and review
- Fire protection system
- Registers
- Incidents and
- Notification of quantities in excess of manifest quantities.

When using or storing dangerous goods or hazardous substances, Hydro-Future must ensure:

- To obtain an up to date SDS for each of these products
- The access to the SDS is available for all employees, contractors and emergency services.

The safety data sheet (SDS) is located in Appendix B5.

4. Environmental Issues and Concerns

The environmental team at Hydro-Future Consulting has recognised the potential environmental impacts that may occur during the construction phase of the project as a result of conducting the Environmental Impact Assessment. The key areas and impacts have been listed below.

4.1. Environmental Impacts

Through investigation during the feasibility study (detailed in the EIA), the environmental team has identified the following potential environmental impacts that are relative within the scope of this project:

- Air Quality and Greenhouse Gas Emissions
- Noise and Vibration
- Water Quality
- Flora and Fauna
- Waste Management and Soil Contamination
- Earthworks

The main goal of this environmental management plan is to address the issues that were outlined by the environmental team during the feasibility. Environmental protection procedures will be fabricated and implemented to mitigate each impact ensuring both short and long term sustainability and development within the project area. The accomplishment of these implemented mitigation strategies will determine the success of the project in terms of the environmental management plan.

Listed below are the construction procedures that raise concern for environmental impacts:

- Earthworks for all three sub-options (conventional stormwater, bio-retention basins, and rainwater tanks)
- Operation on machinery
- Vehicle movement
- Transportation of excavated soil
- Vegetation clearance
- Construction noise
- Excavation of bulk earthworks
- Handling of waste (soils, scrap metal, concrete, bitumen)

- Handling of chemicals
- Road resurfacing.

Listed below are the potential environmental impacts from the construction procedures:

- Dust generation resulting in poor air quality
- Noise generation resulting in adverse effects on amenity
- Soil contamination resulting in contamination of ground water
- Water contamination
- Top soil layer disturbance resulting in reduction of top soil nutrients for vegetation
- Loss of natural vegetation adversely affecting the ecological system.

These construction procedures and environmental impacts are discussed in more detail within their relative impact section. Additionally mitigation strategies for all environmental impacts are included within these relative sections.

The environmental team at Hydro-Future Consulting is committed to taking the appropriate steps to address all potential impacts discovered and depicted upon in the environmental impact assessment and to devise innovative mitigation strategies to combat them. The following sections outline potential impacts that may be present and provide an associated mitigation method.

4.2. Materials Check

4.2.1. Embodied Energy and Greenhouse Gas Impact

Hydro-Future Consulting is responsible to ensure that all materials used are sustainable and environmentally friendly. HFC is committed to reduce or avoid the detrimental effect of building materials to the environment. The energy and materials impact of rainwater tank and pipes manufacture and operation are relatively higher than the equivalent for reticulated water supply. However, the absolute impact of rainwater tanks and pipes are not large in proportion to other impacts. In terms of greenhouse gas emissions, the overall additional impact of a rainwater and pump is equivalent to 50 to 100 kilometers of car travel (ACT Planning and Land Authority, 2007). In respect to greenhouse gas emissions, steel tanks and pipes have the lowest impact, followed by concrete and plastic tanks and pipes have the highest (ACT Planning and Land Authority 2007). However, the choice of pipes, tanks and other materials will need to combine with price, feasibility and client's requirements.

5. Environmental Management Program

This section follows through with the environmental impacts and their mitigation strategies. Each impact will have a detailed section regarding the appropriate mitigation procedures to be implemented for this stage. These procedures will aim to follow the provided criteria and indicate the level of environmental performance, ensuring that all potential impacts are minimised.

5.1. Water Quality

Water quality is an important consideration for design options. There is particular concern during the construction phase that stormwater may be polluted. The Environmental Protection Agency (EPA) stormwater pollution prevention code of practice states: "*it is more cost effective and far more preferable to reduce, and where possible eliminate the causes and sources of stormwater pollution than to treat it downstream*" (EPA 1999). The stormwater quality will also need to be considered post construction as well. The project area resides in the middle of a large catchment area; therefore any runoff from North Terrace will add pollutants to the system, such as heavy metals, oils and sediments. Through proper management and careful design the stormwater run-off can be utilised as a valuable resource rather than a waste product.

5.1.1. Objectives and Requirements

Water quality in South Australia is protected using the Environment Protection Act 1993 and the associated Environment Protection (Water Quality) Policy 2003. The principal aim of the Water Quality Policy is to achieve the sustainable management of waters by protecting or enhancing water quality while allowing economic and social development. In particular, the policy seeks to:

- Design for a 100 year ARI
- Maintain water quality by preventing contamination during construction
- Ensure that the natural ecosystem benefits from the chosen design
- Ensure that pollution from both diffuse and point sources does not reduce water quality; and
- Promote best practice environmental management

5.1.2. Issues

With the upgrade and redesign of the stormwater drainage system, the risk of new and unwanted pollutants entering the surrounding waterways need to be minimised or eliminated. As the North Terrace redesign is within the Adelaide CBD area, the pedestrian activity areas, car

traffic volumes and litter levels are expected to be higher than the South Australian average. Pollutants that can enter the waterways are listed below:

- Motor oil, petrol, diesel, fertilisers, pet waste and other toxic materials
- Sediment from construction sites and from nearby soil erosion
- Litter including bottles, cans, paper, plastic and cigarette butts

5.1.3. Mitigation Strategies

In order to minimise any polluted stormwater run-off and to maintain the stormwater in an acceptable quality, the following strategies will need to be adhered:

- Ensure minimise litter quantity before it enters the water system, a Gross Pollutant Trap is recommended to be installed to collect letter, leaves. Detailed information is presented in section 5.1.4
- In order to remove pollutants such as toxins and heavy metals, bio retention basins are recommended, the water can then be reinjected into the waterways by following through to a final drain at the end of the basin
- Ensure vehicles entering the construction site, are mechanically sound to minimise faults causing spills of potentially hazardous substances (e.g. oils and hydraulic fluids) to the ground
- No chemicals or products are allowed to enter the immediate environment or waterways
- Appropriate stormwater diversion controls will be installed and maintained to divert runoff waters around/away from potential sources of contamination
- Provision and use of spill kits, drip trays, bunding trays and lined areas to minimise pollution to the ground and/or waterways
    - Spill kits are to be located within all vehicles responsible for transporting oils, chemicals and/or wastes.
    - Drip trays are to be used when and where ever any vehicles or machinery relative to the project are leaking oils or fuels.
    - Bunding trays are to be used where ever drums containing oils, chemicals and/or wastes are required, to catch spillage.
    - Area are to be lined, particularly through the course of trenching for new pipes, SEPs, the GPT, rainwater tanks and bio-retention basins to minimise soil erosion.
- Provision and monitoring of temporary washout basins for concrete pumps and trucks

- Provision of sediment control structures to prevent sediment entering drainage systems particularly where surfaces are exposed or soil is stockpiled for extended periods on site

5.1.3.1. Removal of Contaminants in stormwater using Modelling

Generally speaking, a number of contaminants exist in stormwater, particularly in business areas similar to North Terrace where urban runoff is present. The three main sources of pollutants found in stormwater in which are investigated in this study include total suspended solids (TSS), total phosphorous (TP) and total nitrogen (TN).

As depicted in Section (E&S refer this to section discussing location of basin), the first basin is located on the Southern side of North Terrace, outside of The Royal Hotel car park and the second is located on the Northern side, outside of St Peter's College. Both basins are 111m^2 in size and collect water before and after the road's sag point to minimise surface water pooling.

Using computer modelling in the form of software named MUSIC, the team at Hydro-Future Consulting has been able to test the bio-retention basins in terms of their pollutant removal capabilities and overall efficiency over an annual mean load. The target removal inputs were set at 80% for TSS and 45% for both TP and TN. The results for the basin located outside of The Royal Hotel car park can be seen in Figure and denotes reduction percentages greater than the target inputs of 90.6% for TSS, 45.1% for TP and 57.9% for TN.

	Inflow	Outflow	% Reduction
Flow (ML/yr)	1.95	1.79	8.1
Peak Flow (m3/s)	0.115	82.8E-3	28.2
Total Suspended Solids (kg/yr)	308	28.8	90.6
Total Phosphorus (kg/yr)	0.690	0.379	45.1
Total Nitrogen (kg/yr)	5.12	2.16	57.9
Gross Pollutants (kg/yr)	97.4	0.00	100.0

Figure 7 - MUSIC Analysis of the Reduction in Contaminants in Stormwater for Bio-Retention Basin 1 (Southern Side).

For the second bio-retention basin on the Northern side of North Terrace, the same input parameters in regards to target removal were input. The results showed that the pollutant reduction exceeded the targets set, similar to that seen for the basin on the Southern side. The

results as displayed in Figure show a reduction of 90.9% for TSS, 45.6% for TP and 58.4% for TN.

	Inflow	Outflow	% Reduction
Flow (ML/yr)	1.84	1.68	8.5
Peak Flow (m3/s)	0.109	78.0E-3	28.4
Total Suspended Solids (kg/yr)	291	26.4	90.9
Total Phosphorus (kg/yr)	0.652	0.354	45.6
Total Nitrogen (kg/yr)	4.84	2.01	58.4
Gross Pollutants (kg/yr)	92.0	0.00	100.0

Figure 8 - MUSIC Analysis of the Reduction in Contaminants in Stormwater for Bio-Retention Basin 2 (Northern Side).

5.1.3.2. Impacts on Rainwater Tanks

The potential water quality impacts regarding the implementation of rainwater tanks (the third and final sub-option, which makes up the combined drainage system) are mainly to do with the untreated, collected water. As explained in Section 4.4.1 in the Detailed Design study, the usage for this collected water is for irrigation purposes (watering of plants and associated vegetation), toilet flushing, laundry usage, car washing, etc. This rainwater is not for human or animal consumption and therefore will not require any treatment to reduce any potentially harmful contaminants to make it safe for consumption.

The main issue to be addressed for the rainwater tanks is in regards to the micro-organisms (such as enteric pathogens) and larger living organisms in which may reside in the collected water within the tanks as a result of water sitting stagnant in tanks for a period of time. Enteric pathogens including faecal matter from animal droppings and pathogens from dead insects and animals also contribute to rainwater contamination as it passes through guttering and into rainwater tanks. The mitigation strategies to be implemented are required to safeguard the tanks from the aforementioned by ensuring the tanks are as sealed as possible (apart from inlet and outlets). Micro-organisms will still find their way into the tanks, as they reside in the collected stormwater and are invisible to the naked eye so tend to pass through most filtration systems, but for larger organisms such as mosquitos, which produce their offspring in water (mosquito larvae), strategies are required to be put in place to ensure the tanks do not allow for any unwanted organisms that could further contaminate the water and create health concerns.

5.1.3.2.1. Inlet Strainers

The inlets of traditional off-the-shelf rainwater tanks use a large opening with a plastic grate to catch leaves, and the downpipe is elbowed to the inlet, but is not connected, which introduces further contaminants into the water. The majority of off-the-shelf rainwater tanks today use a finely-screened inlet strainer (Figure 6) to filter our smaller contaminants as well as block mosquitos from entering. These strainers can simply be clipped off and removed from the inlet for cleaning purposes. All rainwater tanks implemented for this project are required to be fitted with finely-screened inlet strainers in basket design like that seen in Figure 6.

Figure 6 - Inlet Strainers for Rainwater Tanks (Rainharvest, 2014)

5.1.3.2.2. First Flush Water Diverters

An important preventative measure commonly implemented with both dry and wet stormwater systems is a first flush water diverter. It is installed in-line with the existing downpipe from the gutter to the rainwater tank and works by using a ball and seat setup, as depicted in Figure 7. Through a dry period where the gutters and rainwater tank have not collected water, the diverter chamber is empty, and as the first lot of water runs through the gutters and picks up all of the stagnant dirt, leaves, insects and pathogens, it is diverted straight to the ground through a release valve at the bottom of the diverter pipe and simply bypasses the tank. As the diverter chamber fills with water, the ball rises, and once it reaches the top it creates a temporary seal to allow the water to now pass directly into the water tank. The first flush diverter in-turn reduces tank maintenance as a result of the aforementioned suspended solids and contaminants

being bypassed from the tank and to the ground. This system will be implemented on all existing and new downpipes relative to the rainwater tanks within the project area.

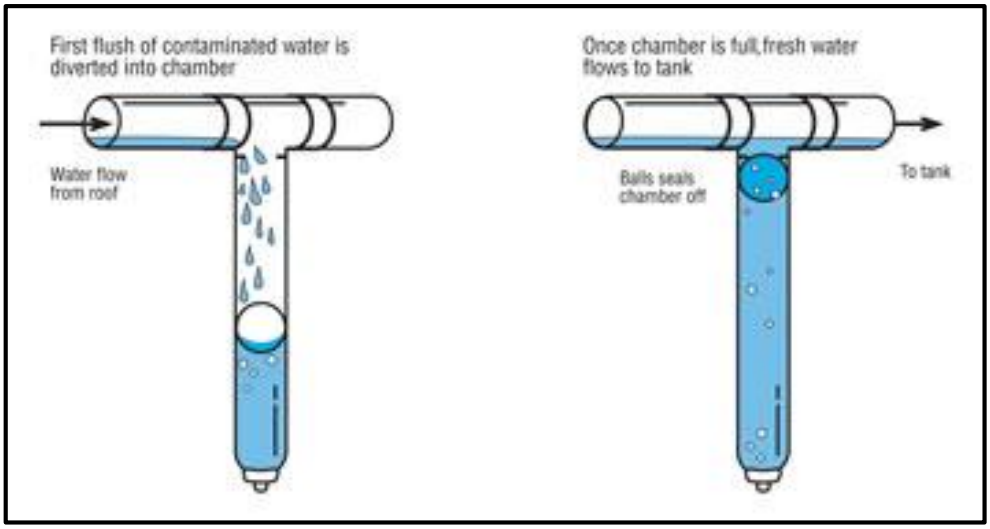

Figure 7 - First Flush Water Diverter Diagram (Rainharvesting, 2010)

5.1.3.2.3. Gutter Guards

Another preventative measure to be implemented for the water harvesting option is the use of gutter guards to prevent the aforementioned unwanted suspended solids and contaminants from entering the gutters and ultimately the rainwater tanks. Gutter guards are available in a range of different materials and types. The cheap gutter guards from hardware stores are plastic drop-in guards, which are essentially only advantageous for collecting leaves. The gutter guard to be used within this project is a 4mm thick aluminium guard available from Blue Mountain Mesh as seen in Figure 8. This guard is more expensive but it screens out smaller solids and contaminants and is very low in maintenance.

Figure 8 - Blue Mountain Mesh Gutter Guard (Blue Mountain Mesh, 2015)

5.1.3.2.4. General Maintenance

General maintenance for the rainwater tanks and their respective dry stormwater systems is to be conducted in a range of periods, depending on the task. A maintenance checklist is included in Appendix B3. Gross Pollutant Trap Maintenance Checklist, which depicts the maintenance requirements and how often they are required to be undertaken. A sample of the requirements is shown in Table 7 below.

Table 7 - Maintenance Requirements for Water Harvesting

Inspection Period	Maintenance Requirements
1 to 3 months	Clean gutters and gutter guards
	Clean inlet strainers and ensure re-fitted properly
	Clean and check first flush diverter
3 to 6 months	Check roofs and gutters for accumulated debris and remove
	Check rainwater tanks for defects and repair/replace if required
	Check rainwater tanks for evidence of enteric pathogens, mosquito larvae and algae growth.
2 to 3 years	Remove accumulated sediment/sludge

5.1.4. Gross Pollutant Trap

As discussed previously, a gross pollutant trap is to be implemented at the downstream end of North Terrace, at the end of and in line with the main 750mm stormwater collector pipe and before the sandstone arch culvert at First Creek. A secondary 750mm pipe will carry the filtered stormwater from the outlet side of the gross pollutant trap into the sandstone arch culvert, through a newly implemented opening in the side.

5.1.4.1. Purpose and Location

Gross pollutant traps (GPTs) are implemented in existing developments, new developments and infrastructure upgrade projects to remove debris, litter and sediments from stormwater, normally as a pre-treatment before the stormwater travels into a pond, creek or wetland.

For the North Terrace drainage system upgrade project, a GPT is required to be installed at the outlet of the main stormwater pipe at the downstream end, and before the heritage listed sandstone arch culvert.

5.1.4.2. Design Requirements

A number of design parameters are required for the GPT to ensure it functions with the complete drainage network along North Terrace.

A number of these include:

- Sufficient width for the 750mm inflow pipe
- The capacity to process the 1.57 m^3/s total flow rate from North Terrace (20 year ARI)
- The capacity to process a 1 in 3 month treatment flow/water quality storm to retain all litter and debris (as standard for all GPTs)
- The capacity to hold the 7.21 hectare sub-catchment area
- Easily cleaned by the use of eductor trucks (vacuum trucks)

5.1.4.3. Specific GPT Type

A number of different GPT types exist, each with varying benefits and limitations and ultimately design purposes. To meet the aforementioned design requirements, the GPT suited to the North Terrace drainage design application is the SBTR trap, as can be seen in Figure 9 below.

This GPT combines the functions of sedimentation basins and trash racks, hence the name. Some of the specifications and benefits of the SBTR trap include:

- An enclosed system, installed under ground
- Suited to urban/city areas as the system is virtually hidden

- Best suited to pipe drainage systems
- Ability to treat catchment areas up to 2000 hectares
- Cost effective (for both implementation and maintenance)

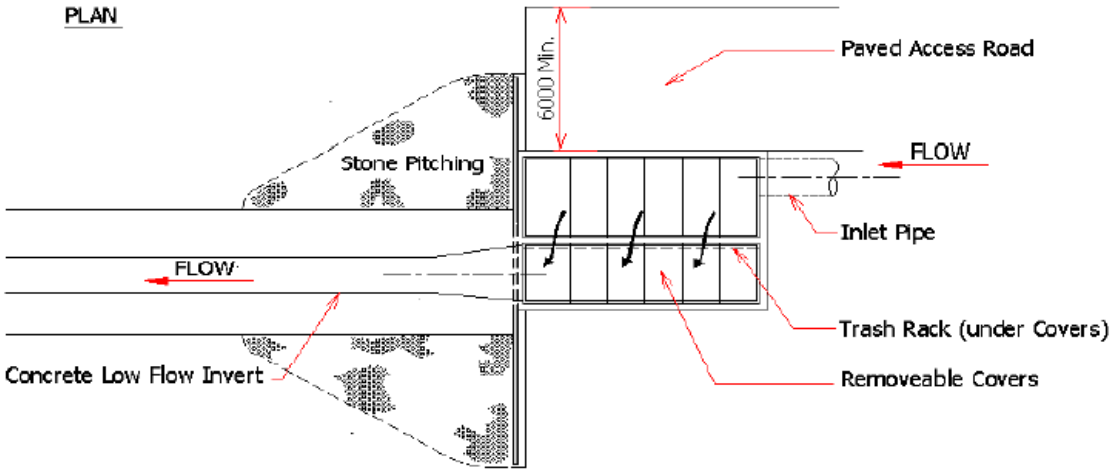

Figure 9 - SBTR Type 2 GPT Layout Diagram (Department of Irrigation and Drainage Malaysia, 2012)

A ranking chart of the SBTR trap in relation to other GPT types is shown in Figure 10 below and shows that the relative cost of the trap is medium and the relative cost effectiveness is high. The pollutant removal scores are high in comparison to some of the other GPT types.

	Pollutants						Combination of Pollutants													Cost-effectiveness	
	Litter	Organic Matter	Sediment	Oils and Grease	Metals	Nutrients	Litter, Sediment	Litter, Oils	Litter, Organics	Litter, Nutrients	Organics, Sediment	Organics, Nutrients	Litter, Organic, Oils	Litter, Sediment, Oils	Litter, Organic, Sediment	Litter, Sediment, Nutrients	Litter, Oils, Organic, Sediment	Litter, Oils, Organics, Metals	Litter, Organics, Sediment, Nutrients	Relative Cost	Relative Effectiveness
GPT STRUCTURES																					
Floating Debris Trap: boom, Bandalong	5	3	1	7	1	1	3	6	4	3	2	2	5	4	3	2	4	4	3	low	low
In-pit devices	5	5	3	1	1	1	4	3	5	3	4	3	4	3	4	3	3	3	4	low	low
Litter Control Device: Net-tech	7	7	1	1	1	1	4	4	7	4	4	4	5	3	5	3	4	4	4	medium	medium
Trash rack	7	7	6	1	6	1	7	4	7	4	7	4	5	5	7	5	5	5	5	medium	medium
SBTR trap	7	7	7	4	7	5	7	6	7	6	7	6	6	6	7	6	6	6	7	medium	high
Proprietary devices: Baramy	8	8	4	1	4	2	6	5	8	5	6	5	6	4	7	5	5	5	6	medium	medium

Figure 10 - Ranking of the SBTR trap in relation to other GPTs (Department of Irrigation and Drainage Malaysia, 2012)

As stormwater enters the SBTR trap, the coarse sediments settle, due to the decrease in flow velocity. As the channel depth and/or width is adjusted, the flow velocity is reduced and ultimately leads to a longer retention time, allowing more sediments to settle to the channel base.

Due to the design of sedimentation basin trash rack GPTs, they are generally not designed to withstand traffic loads, unless the interior is reinforced to meet the necessary structural requirements. For the purpose of this project, since the GPT is located under an arterial road,

with high AADT and VPD statistics, the GPT would require to be heavily reinforced to withstand traffic loads, which would increase the overall dimensions of the GPT. Normally, the top of the GPT would be constructed 150mm above the existing ground level or a barrier would be constructed around the GPT, both to avoid the GPT being driven over by vehicles (Department of Irrigation and Drainage Malaysia, 2012), however this would require a lane on North Terrace to be closed off. For the scope of this project, a bypass system will be constructed to allow vehicles to drive over the GPT, which will distribute loads to the existing surface of North Terrace at a distance of at least 2.5 metres either side of the GPT, which will allow all lanes to remain open on North Terrace, as can be seen in Figure 11 below.

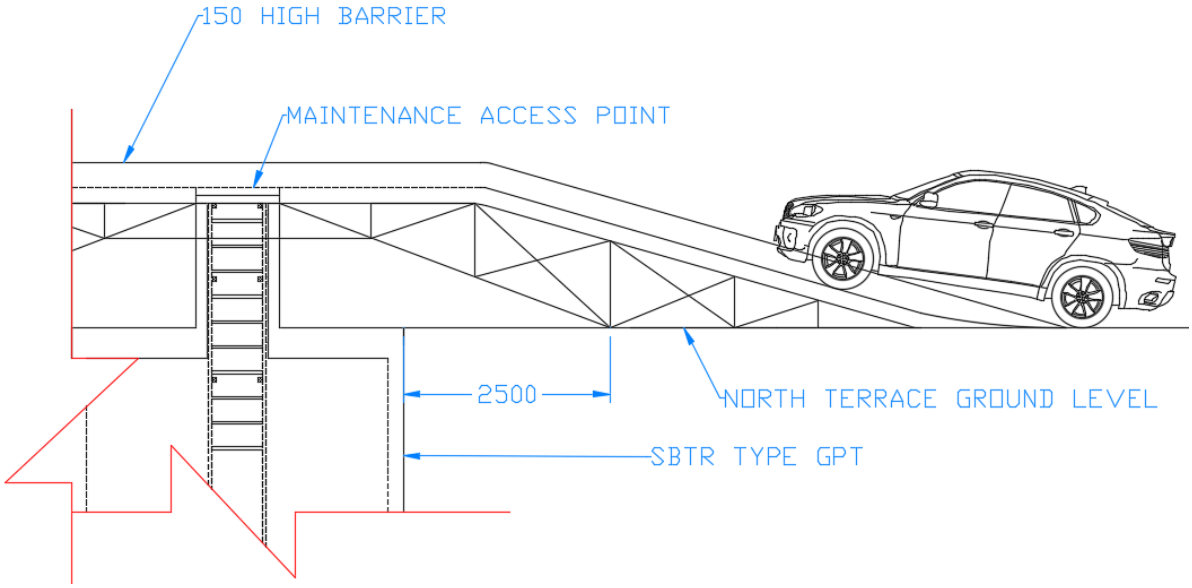

Figure 11 - GPT Bypass Design Drawing (Hydro-Future Consulting, 2015)

5.1.4.4. Trash Rack

Trash racks assists to collect the larger pollutants and debris such as litter in a GPT system. The location of the trash rack will be at the downstream end/side of the GPT and is placed perpendicular to the inflow pipe.

5.1.4.5. Design Requirements for SBTR Traps

- The width of sediment trap is required to have a ratio length between 2 and 3
- Velocity of stormwater flowing through the trap has to be less than or equal to 1m/s
- The trash rack is required to pass the required design flow efficiently without overtopping and with a 50% blockage rate.
- The trash rack is required to withstand log impacts and drag loads. In the event that the rack is completely blocked (100%), water should be diverted past rack (through the overflow clearance above trash rack).

5.1.4.6. Final Design

All design calculations and considerations of the GPT are included in Appendix A1. Gross Pollutant Trap Calculations. Table 8 below displays the final design specifications in terms of dimensions and internal areas. The detailed design drawing entailing these dimensions along with the location and associated items is included in the engineering CAD drawings HF-201A and HF-201B.

Table 8 - Gross Pollutant Trap Final Specifications

Gross Pollutant Trap Final Specifications	
Trap Size Area	7.2m^2
Length of Trap	4m
Width of Trap	1.8m
Sediment Trap Depth	0.4m
Trash Rack Height	0.2m
Wall Thickness	180mm

Table 9 below displays the GPTs final performance results, displaying that it meets the minimum or maximum requirements as specified by the Urban Stormwater Management Manual 2012, Department of Irrigation and Drainage Malaysia.

Table 9 - Gross Pollutant Trap Performance Outcomes

Gross Pollutant Trap Performance Outcomes		
Type	**Required**	**Final Design**
Trap Removal Efficiency	70% minimum	73%
Annual Average Sediment Export	-	6 tonnes
Average Annual Pollutant Retention	~70%	68.2%
Flow Velocity	1m/s maximum	0.30m/s
Min overflow clearance	0.35m minimum	0.40m

5.1.4.7. Maintenance

As discussed previously, the chosen GPT design is generally low maintenance when compared to some of the off-the-shelf products. Hydro-Future Consulting has created three maintenance checklists for managing the gross pollutant trap throughout its life.

The first checklist to be used during the construction phase will ensure the works reflect the design drawings and specifications and can be seen in Appendix B1 The second checklist is to be used post construction to again ensure the GPT has been constructed to specifications and to ensure construction related equipment and devices are removed when required and no debris or rubbish is left behind. This checklist can be seen in Appendix B2. Gross Pollutant Trap Post Construction Inspection Checklist. The final checklist is a maintenance checklist, which will be

submitted to the Council for their use. When each inspection is due, the Council will select a number of contractors (depending on maintenance period) to undertake maintenance works as outlined on the form, as can be seen in Appendix B3.

5.2. Air Quality and Greenhouse Gas Emissions

Management of air quality and greenhouse gas emissions is of the utmost importance in all construction projects due to the potential consequences that can arise as a result of neglecting the necessary guidelines and mitigation steps outlined in the Environment Protection (Air Quality) Policy 1994, which states "air pollution means the emission into the air of any pollutant" (SA Gov, 1994). Hydro-Future Consulting ensure to take the necessary steps to identify, manage and mitigate any air quality and greenhouse gas emissions, in excessive levels, beyond that denoted in the aforementioned policy.

5.2.1. Objectives and Requirements

The objectives and requirements conveyed by the Environment Protection (Air Quality) Policy 1994 and relative to this project include:

- Aim to minimise reductions in air quality (dust particles, gas emissions)
- Aim to minimise vegetation clearing
- Produce both safe conditions for workers and residents in terms of air quality
- Aim to comply with maximum pollution levels
- Aim to comply with relative legislation (Environment Protection (Air Quality) Policy 1994)
- Aim to adjust construction (times/noise levels) to adapt for any possible complaints from local residents or business

5.2.2. Issues

The issues identified through the EIS, relative to this project are:

- Greenhouse gas emissions (from plant, excavation and general construction equipment)
- Suspended dust particles in the air due to wind from excavations and earthworks
- Land clearing (loss of vegetation)

During construction both greenhouse gas emissions and suspended dust particles are primary concerns due to their potential for adverse effects on air quality The Air quality and gas emissions of the area will need to be regularly monitored due to the construction site being located within or close proximity of may residential homes as if unmonitored it could have negative effects on the surrounding publics' health.

This is why it is vital to implement dust suppression procedures to ensure the air quality is maintained to a high standard (keeping emissions below maximum emission levels, as out lined in Environment Protection (Air Quality) Policy 1994) (SA Gov 1994).

This will in turn provide a safe working /living environment for both workers on site and the general public within the area.

5.2.3. Mitigation Strategies

- Form of complaints register, whereby the general public can inform contractors of their concerns and appropriate action can be taken to reduce these air quality issues
- Construction areas, in particular exposed areas and stockpiles, should be wetted down frequently during the construction period.
- Stockpiled soils will be excavated and placed in order to minimise dust generation
- Disturbed areas will be stabilised as soon as practical
- Rehabilitation/remediation of construction areas to be undertaken as soon as practical
- Waste materials, excess soil being carted from site, soils being carted to site, and any other dust-generating materials are to be sufficiently covered during transport
- Equipment and machinery will be maintained to ensure optimal operation as well as being turned off when not in use
- Reduce fuel use by utilising material from local and not regional areas (i.e. reduce haul distances).
- Reduce fuel use by using appropriately sized equipment for construction activities.\
- Reduce fuel use by incorporating scheduled equipment maintenance procedures.
- Reduce fuel use through efficient construction planning; plan construction to reduce fuel use through transportation of equipment from one area to another. (i.e. conducting all work in one area prior to starting another, which may require back and forth transport).
- Reduce the amount of cleared land or vegetation clearing needed where possible
- Replant vegetation equivalent to vegetation cleared (i.e. if 50 metres squared of vegetation was cleared re plant 50 metres square of vegetation that provides the same or higher environmental benefits then the cleared vegetation)

5.3. Noise and Vibration

Environmental noise is unwanted sound and vibration coming from construction work and machineries. Noise and vibration pollution can be harmful for humans health which includes high blood pressure, hearing loss, stress related illnesses, sleep disruption and so on (EPA 2012). The Environment Protection Act 1993 requires reasonable and practicable measures to minimise noise and vibration at all times.

5.3.1 Objectives and Requirements

Hydro-Future Consulting aims to provide a comfortable work environment for all employees and as well to minimise the noise and vibration impacts on surrounding residents and business.

- Aim minimise noise and vibration due to construction that will have adverse effects on amenity
- Aim to comply with noise restriction levels
- Aim to comply with noise construction time restrictions
- Aim to comply with relative legislation (The Environment Protection Act 1993)
- Aim to adjust construction (times/noise levels) to adapt for any possible complaints from local residents or business.

5.3.2. Issues

EPA Information sheet *Construction Noise 2014,* states that noise includes vibration, and defines construction noise that will have an adverse impact on amenities as; the source noise level is continuous and exceeds 45 dB or if the ambience noise exceeds, or the source noise level at its maximum exceeds 60dB. There are however exceptions, where if the measured source ambience noise exceeds 45 dB continuously then construction noise does not have an adverse effect on amenity until it exceeds to measured continuous ambience noise, similarly if the measure source ambience noise exceeds a maximum 60dB the construction noise is also not considered to have an adverse effect on amenity until it exceeds the maximum measure ambience source noise.

Any construction activity that will exceed these noise limits will have restricted times for construction, depending on the type of construction and will also require to be conducted using the mitigation strategies later mentioned.

Below are a list of key issues due to noise and vibration:

- Local residence or business complaints
- Construction producing unacceptable noise levels

- Adverse impact on amenity.

Within the proposed option for the Detailed Design there are there sub options, conventional stormwater, rainwater tanks and bio retention basin(s). Due to the different requirements and restrictions of construction and construction noise each of these sub options will require different construction times. The Environment Protection (Noise) Policy 2007 states that construction noise that has adverse effects on amenity shall not take place on Sunday or any public holiday and shall only take place on any other day 7am -7pm, with the exception of construction work being allowed 9am-7pm on Sunday and Public Holidays to avoid unreasonable vehicle or pedestrian traffic interruption (SA Gov, 2007).

As the implementation of the rainwater tanks is conducted away from heavy traffic conditions this will be able to be conducted throughout the day with little obstruction to vehicle or pedestrian traffic. Therefore rain water tanks can be implemented and installed anytime Monday-Saturday 7am-7pm, which is both a reasonable time for workers and allows there to be some construction noise to occur and this will have potential adverse effects on the amenity, although it should be noted that even though there is an allowance for adverse effects on amenity mitigation strategies will always be used where possible to reduce or negate these adverse effects. Compared to the other two sub options little there is little concern for adverse noise due rainwater tank implementation due to the little potential for noise it has. However there is some greater potential of noise to have adverse impacts on amenity if the optional option to include underground concrete tanks is included in the final design possibly due to excavation for these tanks but the construction times chosen for these tanks allow for this.

The construction of the bio-retention basins is to occur roadside of North Terrace in two locations. Due to this construction occurring road side there is strong potential for some unreasonable interruption of vehicle or pedestrian traffic, this gives allowance for any construction that will have adverse impacts on the amenity to occur 7am to 7pm Monday-Saturday and 9am to 7pm on Sunday and Public Holidays included, however any particular noisy activities should occur after 9am on all days (SA Government, 2007). There is potential for site clearing, excavation, heavy machinery, compaction of layer construction of walls, construction spill ways and general other constructions of the bio retention basin to have adverse effects on amenity (mention other construction points about it), which is why the construction times have allowed for this potential. It should be noted that any construction that can occur without adverse impacts on amenity can occur outside these allocated times.

If any construction occurs that involves works with roads, railways or any other forms of public transport the application of restriction of construction times due to noise does not apply (SA Government, 2007). This is due to that fact that if constructions needed to occur due to these noise restriction times it would have extreme adverse effects of traffic conditions to the point of being not feasible. Knowing this and having this allowance the majority of the works will be conducted from 9pm-5am for the construction of the stormwater pipe. Even though due to the location of the stormwater pipe having no restrictions on construction times due to noise mitigations strategies will be used where ever possible in order to reduce or negate these adverse impacts.

Some activities are listed below that during the project construction may produce unacceptable noise levels for the combined three sub-options:

- Engine driven equipment
- Road resurfacing
- Jackhammers
- Hammering
- Friction sawing and grinding
- Vehicles entering and exiting site
- Excavations
- Compaction
- Cranes and their operations
- Warning alarms/sirens

5.3.2 Mitigation Strategies

- Engine driven equipment is to be fitted with noise suppression enclosures/devices
- Produce complaints register, where local residents or business can register their complaints and issues due to noise and vibration and then the construction can be adjust to reduce these complaints or negative effects
- Shutting or throttling equipment that is not in use
- Ensuring all separate constructions with adverse impacts on amenity due to noise occur within their restricted times
- Jackhammers are to be silenced and jack hammering operations are to be undertaken during less sensitive times of the day (9am-7pm Monday to Saturday) and kept to a minimum

- The use of friction sawing and grinding equipment is to be undertaken during less sensitive times of the day (9am-7pm Monday to Saturday) and kept to a minimum
- Vehicles entering and exiting the site will use pre-planned traffic routes
- All tasks that create noise exceeding 45dB (continuous) and 60dB (maximum) will require a noise exceeding permit that must be signed by the Project Manager and reviewed daily
- The use of acoustic barriers when any works are within close proximity to residential or commercial dwellings
- Regular monitoring of noise and vibration levels to ensure it is not exceeding the allowance depending on applied restriction
- Advanced notice of the works to be conducted that may produce adverse effects on amenity
- Conduct dilapidation reports on properties that have been identified as having a potential to be damaged by vibration during construction.

5.4. Flora and Fauna

A number of environmental issues are considered with this Environmental management plan and flora and fauna is considered to be fundamental to the environmental impact that the North Terrace Drainage Design project will have. The flora and fauna could be affected both during and after construction which will require a management plan to ensure no extensive damage is done that would impact the flora and fauna.

5.4.1. Objectives and Requirements

- Aim to minimise the impact on native vegetation
- Aim to minimise the potential for the introduction and spread of weeds
- Aim to avoid the penitential for the introduction of pests
- Aim for no increase to the occurrence and impacts of feral and pest animals within the site
- Aim to minimise any impact on threatened species that may exist in the area

5.4.2. Issues

After conducting a site evaluation it was noted that there are currently no trees in this location that meet criteria to be classed as a significant or regulated tree. A regulated tree in metropolitan Adelaide is a tree with a circumference of 2.0 metres or more (SA Government 2015). Vegetation in the area was very minimal due to the pavements and buildings. This suggests that local flora and fauna will not be impacted during the construction process however there is still a potential risk that the construction may affect the surrounding environment in the following ways:

- Long term decrease in vegetation
- Disrupt breeding cycle of fauna in the area
- Potentially decrease the size and quality of the habitat of the local flora and fauna
- Construction vehicles and personnel may accidentally introduce flora species to the project area and contaminates to natural environment
- Construction materials and vehicles may contaminate the site
- Dust from construction may pollute surrounding suburbs vegetation
- Ground compaction from heavy vehicles/materials disrupting vegetation growth
- Chemical/oil spillage may poison native flora and fauna
- Parking or operating heavy machinery on or near vegetation causing ground compaction and crushing of plant roots
- Site workers walking on vegetated areas

- Storage of construction materials in vegetated areas

5.4.3. Mitigation Strategies

- Avoid damage to flora and fauna on site when undertaking construction activities, particularly with operation of vehicles/machinery/equipment on site, fencing around the flora to protect them from getting damaged
- Required clearing of vegetation only to be done only with prior approval and kept to a minimum, there is always a way to steer clear of small tree.
- Works area to be clearly defined, no disturbance beyond edge of designated works area and bunting or staking out of areas with significant vegetation
- Stabilise disturbed areas to protect existing vegetation, fencing would need to be installed and employees or vehicles entering only with permission
- Minimise compaction in the vicinity of any trees by avoiding: parking of heavy equipment/vehicles and stockpiling within tree drip lines
- Locate stockpiles, construction materials and any potentially hazardous chemicals away from sensitive areas
- Remove excess spoil from the site in accordance with EPA and the Hydro-Future requirements, soil or excavated materials need to be dump into the proper location to avoid the impact on local flora and fauna
- Maintenance/watering of existing vegetation in the project area during the construction phase when necessary
- Conduct inspection of the area, monitor and track on the conditions of local flora and fauna, when any issue occurs, commence the corresponding solution to minimise the impact and damage.

5.5 Waste Management and Soil Contamination

The Protection of the Environment Operations Act 1997 defines waste as "any substance which is discharged, emitted or deposited in the environment in such a volume that alters the environment" (Ian, 2005). The following section tries to establish the issues presented by all forms of waste generated as well as providing solutions to minimize the threat posed by this waste to the environment, in the form of mitigation strategies.

5.5.1. Objectives and Requirements

- Aim to recycle all possible waste
- Aim to keep site clean both during and post construction
- Prevent any kind of contamination (soil, wastewater etc.)
- Aim to minimise generation of waste (scrap material, excavated soil, rubbish, food scraps)
- Handle all potential contaminants with care (fuels, chemicals for resurfacing road)

5.5.2. Issues

In all construction projects waste is always an issue, handling and managing these wastes appropriately however can be an effective mitigation strategy especially where reductions in amounts of waste are not possible. An example of this is excavated soil, something that will be occurring frequently and in large quantities it may not be possible to reduce the amount of waste soil produced but handling it correctly it can be recycled or backfilling appropriately. Listed below are some typical forms of waste that may be produced during the construction phase, as well as some of these may be already being produced from community activities and therefore will be a concern even post construction.

- Excess soil from excavation (from the road for the conventional stormwater system, bio retention basin and potentially from underground water)
- Rubbish (scraps form foods/drinks, cigarette butts) from food and drinks
- Green waste from vegetation removal
- Scrap concrete and bitumen from road and foot path excavation
- Rubble and construction materials from any demolished infrastructure
- Oils/fuels spill (may leak into and contaminate soil)
- Current littering of cigarette butts nearby bus stops

During construction there will be a large amount of machinery used for excavation, road surfacing, material transporting and other general vehicle operations/movements. This leads to a high potential of hazardous substances, such as fuel contaminating the soil. All measurements must be taken to prevent these leakages from occurring as once leakage occurs it is extremely hard to reduce or stop contamination. These soil contaminations can infiltrate down into groundwater and cause groundwater contamination.

Other forms of waste due to construction including green waste, construction scraps and excavation waste pose less of a risk in terms of soil contamination but still require appropriate waste management. These other forms of will need to be dealt with ongoing and as quickly as possible during to construction to ensure stockpiling of waste does not occur on site, causing congestion, preventing movements on site or producing untidy/unsafe working environments.

Through site inspections the environmental team has come to the conclusion that there is already some current waste being produced. The current waste being produced littered cigarette butts in close proximity to bus stops as seen in **Error! Not a valid bookmark self-reference.**. The environmental team has therefore concluded that if the waste is being produced pre construction that the waste will continue to be created post construction, which will be a problem, with the possibly of butts washing into pits contaminating water as well as being visual unpleasing and having adverse impacts on amenity of the local area. The issue must therefore be addressed.

Figure 12 - Cigarette Butts (Hydro-Future Consulting, 2015)

5.5.3. Mitigation Strategies

- All Hydro-Future Consulting's machineries are supposed to be checked for leakage before the project construction commences.
- Bins will be used on site for rubbish from workers (these bins will have appropriate restrictions to avoid wildlife to obtain food scraps with visual inspections daily to ensure they are not overflowing). The Council is responsible for these bins and to empty the bins weekly.
- Recycling bins will be used on site (for cans and bottles)
- Major repairs for machinery will occurring off site in appropriate workshops to prevent leakage risks and soil contamination
- Waste disposal will only occur if there are no other alternate options
- Green waste will be recycled (possibly taken to Green Waste Recycling and Mulch Centre located nearby, within North Adelaide on War Memorial Rd (Adelaide City Council, 2015))
- All leakages or spills reported immediately to Environmental Management Group so appropriate action can be taken to counteract contamination
- Spill kits to be available in all vehicles that carry hazardous chemicals
- Before construction all workers will be advised on recycling and waste management procedures on site
- Portable toilets on site will be regularly serviced (weekly or shorter depending on extent of use) to ensure no leakages occur
- Application of cigarette bins at bus stops
- Monitor acidity levels in soil during construction (as high acidity level can result in adverse effects on environment and used concrete in the conventional stormwater pipe)
- Testing excavated soil for contamination to allow it to be placed or dumped elsewhere with no risk or need to pay for dumped contaminated soil
- Testing acidity levels on soil to ensure they are not to high (causing adverse effects on environment or structures such as concrete or steel)
- All construction wastes will be collected and be dumped in the dumpling locations (close to the bioretention basin), and the wastes will be collected and dumped by the disposal company called ResourceCO.

The cigarette bins at bus stop would be located outside of the bus stop and not under or within the sheltered part. This is because smoking is not allowed and is a fineable offense under

sheltered public transport waiting areas such as bus stops (Adelaide Metro, 2012). Having the cigarette bins on the outside of the bus stops would allow smokers to smoke out from under the sheltered bus stop and have a place to place finished cigarettes rather than littering them creating waste. No smoking signs would also be implemented on the bus stop to prevent the cigarette bins from encouraging smokers to smoke within bus stops.

5.6 Earthworks

For redeveloping the drainage system, a large amount of earthworks and excavations are involved. Hydro-future aims to manage erosion and sediment control during the construction stage and outlines restoration and rehabilitation in order to minimise the environmental impact on the existing soil conditions.

5.6.1 Objectives and Requirements

- Aim to reduce potential erosion of top soil
- Aim to produce appropriate drainage for earthworks to prevent erosion and water pooling
- Aim to conduct earthworks with no contaminations
- Aim to conduct earthworks safely, both in terms on environment and those living within it (people, plants, animals etc.)

5.6.2 Issues

The loss of topsoil can be a frequently occurring and serious issue when dealing with earthworks and excavation on construction projects. Erosion can either occur by removal of soil with heavy equipment or by wind and water, it is the worst type of on-site damage in urban areas. This layer of soil has the highest biological activity, organic matter, and plant nutrients—all key components of healthy soil. The onsite loss of this upper layer of soil nearly eliminates the soil's natural ability to provide nutrients, regulate water flow, and combat pests and disease (USDA 2000).

Erosion control practices need to be implemented to hold soil in place and reduce soil removal. Planning before construction is vital to conserve the topsoil, prevent costly flooding problems, conserve natural areas and native species, reduce paved areas, prevent property damage and minimise stormwater runoff. As the project area is mostly paved the risk of erosion is minimal, but careful consideration should be made in areas where any vegetation is present and when construction/excavations are ongoing.

5.6.2 Mitigation Strategies

- Avoid trenching in areas where water flow is concentrated,
- Avoid working under heavy rainfall.
- Ensure the trench size is minimised, an important management tool is to limit the width of the disturbed area within the easement.
- Ensure the time for openings as a result of excavation is minimised, (try to avoid leaving trenches open for more than three days)
- Avoid opening trenches when there is a possibility of the occurrence of a storm and/or heavy rainfall.
- Organise service installations to enable progressive backfilling
- Remove excess or spoil from the site, then replace top soil
- Wet down soil to prevent wind erosion where applicable, especially on dry and windy days
- Ensure excavated areas have appropriate drainage (drainage that allows water to flow away without pooling and causing soil to erode away)
- Replant vegetation as soon as possible in bare areas around excavation to reduce water runoff and potential soil erosion
- Excavated soil cannot be placed on the road or in area of runoff, excavated soil will be collected in an appropriate way such as in skip bins. In any event, all soil should have a plastic sheet or tarp placed over to ensure no further soil erosion can occur.
- During transportation of soil for reuse and dumping purpose, a plastic sheet or tarp is to be placed over the container (truck bed or skip bin) to ensure no soil can become airborne during transport.
- Plastic sheeting is to be placed under the excavated soil to avoid any pollutant seeping down to the pre-existing soil, particularly during heavy rain conditions.
- After the excavation work is completed, all soil which is not suitable for backfilling will be removed and dealt by the waste disposal company.

6. Project Implementation

6.1. Environmental Risk Assessment

The Environmental Impact Assessment introduced the possible environmental impacts, issues and associated risks. Through site visits, inspections and further analysis, a number of project-relevant risks were identified and have been placed in a register, as seen in Table 10 - Environmental Risk Register. Each identified risk or hazard is rated through our Environmental Risk Assessment Matrix (refer to Appendix B9. Environmental Risk Assessment Matrix) in terms of each risk or hazard's likelihood and consequence. Based on a number in each column, a risk rating is provided.

Through undertaking the environmental risk assessment a number of significant construction risks have been noted and include:

- Dust emissions that may affect individuals with health problems (respiratory, etc.)
- Noise pollution as a result of machinery and vehicular use
- Excessive vibrations as a result of machinery and vehicular use
- Dirt, dust and mud on roads, which may cause issues to local residents and traffic
- Potential disturbance to water quality through construction stage as a result of foreign materials working their way into the system through open pipelines, inlets, etc.

Additional environmental risk assessments are to be conducted weekly at the project site as a minimum. If any notice is received from the environmental manager, contractors, stakeholders or nearby residents, regarding potential environmental risks, an immediate risk assessment is to be completed, whilst the issue is being rectified (if possible).

6.1.1. Environmental Risk Register

Through the environmental risk assessment, the following significant construction risks have been identified and are displayed in the environmental risk register, Table 10 - Environmental Risk Register below. Their category of risk is identified in accordance with the Environmental Risk Assessment, in Appendix B9. Environmental Risk Assessment Matrix.

Table 10 - Environmental Risk Register

Environmental Risk Register				
Risk Area	**Risk**	**Scale of Consequence**	**Likelyhood of Consequence**	**Risk Category**
Water Quality	Motor oil, petrol, diesel, fertilisers, pet waste and other toxic materials	4	2	Medium
	Sediment from construction sites and from nearby soil erosion	3	4	High
	Litter including bottles, cans, paper, plastic and cigarette butts	1	5	Medium
Air Quality and Greenhouse Gas Emissions	Greenhouse gas emissions (from plant, excavation and general construction equipment)	2	4	Medium
	Suspended dust particles in the air due to wind from excavations and earthworks	1	5	Medium
	Land clearing (loss of vegetation)	3	1	Low
Noise and Vibration	Local residence or business complaints	4	2	Medium
	Construction producing unacceptable noise levels	4	2	Medium

	Adverse impact on amenity	3	3	Medium
Flora and Fauna	Long term decrease in vegetation	5	1	Medium
	Disrupt breeding cycle of fauna in the area	3	1	Low
	Potentially decrease the size and quality of the habitat of the local flora and fauna	5	1	Medium
	Construction vehicles and personnel may accidentally introduce flora species to the project area and contaminants to natural environment	4	1	Medium
	Dust from construction may pollute surrounding suburbs vegetation	2	2	Low
	Ground compaction from heavy vehicles/materials disrupting vegetation growth	3	1	Low
	Chemical/oil spillage may poison native flora and fauna	5	1	Medium
	Parking or operating heavy machinery on or near vegetation causing ground compaction and crushing of plant roots	3	2	Medium
	Site workers walking on vegetated areas	3	2	Medium

	Storage of construction materials in vegetated areas	3	1	Low
Waste Management and Soil Contamination	Excess soil from excavation (from the road for the conventional stormwater system, bio retention basin and potentially from underground water)	1	1	Low
	Rubbish (scraps form foods/drinks, cigarette butts) from food and drinks	3	1	Low
	Green waste from vegetation removal	1	1	Low
	Scrap concrete and bitumen from road and foot path excavation	3	3	Medium
	Rubble and construction materials from any demolished infrastructure	4	1	Medium
	Oils/fuels spill (may leak into and contaminate soil)	5	2	High
	Current littering of cigarette butts nearby bus stops	3	3	Medium
Earthworks	Loss of topsoil	5	3	High

6.4. Environmental Control Plans

An environmental control plan has been created by Hydro-Future Consulting for the North Terrace Drainage Project to illustrate and highlight the key sensitive areas and zones and their respective buffer size. This plan can be seen in Appendix B.10. Environmentally Sensitive Zone.

This plan is to be handled by the General Contractor on site and will be used during training sessions to ensure all employees understand where the sensitive areas are located.

6.3. Environmental Schedules

Before, during and post construction, Hydro-Future Consulting keeps an eye on all aspects of the project at hand. In order to manage the works as well as identify any issues, a number of checklists and schedules are used. The schedules relative to the North Terrace drainage project are as follows:

1. Site Inspection Checklist (see Appendix B6. Site Inspection Checklist)
2. Incident Report (see Appendix B7. Incident Report)
3. Complaints Report (see Appendix B8. Complaints Report)

The site inspection checklist is used to inspect the project site to check that it meets the requirements outlined by Hydro-Future Consulting. Any issues are to be raised through the appropriate sections on this checklist.

The Incident report is to be used whenever an injury or associated incident occurs on-site. Both the person involved in the incident and the general contractor are to fill in this report and submit it to the Company's management. WorkCover South Australia would then be contacted by the Company to ensure the necessary steps are taken to assist the employee in returning to his/her duties as possible.

The complaints report is available from Hydro-Future Consulting's website and can be filled out by any individual who feels that the project is causing issues to their wellbeing or the City's amenity.

7. Project Review and Monitoring

7.1. Environmental Monitoring

Continual monitoring of the project's environmental aspects is paramount to the success of the project in terms of overall satisfaction from the client and stakeholders. The way Hydro-Future Consulting monitors such aspects is through frequent and thorough on-site inspections. The environmental manager and site contractor are responsible for these inspections. The inspections carried out can be seen in Table 11 below.

Table 11 - Frequency of Inspections

Area	Frequency of Inspection	Details	Inspector
Construction Environmental Management Plan	Weekly	A review of the EMP and to ensure all employees are taking responsibility to apply due diligence for the environment through all construction and project works.	Environmental Manager and EMR
Water Quality	Weekly	Water to be tested prior to construction, during construction (on a weekly basis) and post construction. The GPT's maintenance schedule includes a separate water testing inspection.	Contractor(s) trained in this area
Air Quality and Greenhouse Gas Emissions	Weekly at a minimum or more frequent if necessary	To be tested as a result of machinery and vehicles on site to ensure emissions are controlled as much as possible. Excess levels of dust and dirt to also be checked.	Contractor(s) trained in this area
Noise and Vibration	Whenever heavy machinery is in use	Requires monitoring to reduce social impacts through complaints from residents and stakeholders.	All Employees
Flora and Fauna	When necessary	To be inspected before construction, during various construction stages and post construction.	All Employees
Waste Management	Daily	To be constantly monitored, particularly through construction stages as rubbish	Contractor(s) trained in this area

		and debris makes its way into trenches and/or open water sources.	
Soil Contamination	When necessary	To be inspected if a spillage is noted or any level of suspicion exists in relation to contamination to the sub-soil, which could ultimately reach the water table.	Contractor(s) trained in this area
Earthworks	Daily	To be inspected during all construction stages to monitor, minimise and eliminate any potential issues.	All Employees

7.4. Environmental Auditing

At Hydro-Future Consulting environmental auditing is taken very seriously, ensuring to access the extent of potential harms or risk, while trying to reduce these potential harms or risk with appropriate auditing processes. Our environmental auditing processes include:

- Construction inspection checklists, both during and post construction
- Maintenance checklists
- Safety data sheet
- Site inspections checklists
- Incident report
- Complaint reports

These auditing processes are put into place in order to determine site condition and suitability for construction or to advise on needed changes for site to be considered suitable for construction. Additionally they are put in place in order to access possible industrial processes or activities produce harmful waste, substance noise etc. and understanding the potential harms risks that these potential types of contaminants can cause. An example of this could be a chemical spill, which may lead to soil contamination, water pollution or general environmental harm. For this incident site inspections and checklists would be used to determine if a spill has occurred and the extent of the spill. Also incident reports would be conducted in order to address the problem and possibly make appropriate changes to reduce this risk from reoccurring, which may involve re-addressing Hydro-Future Consulting's handling hazardous chemical procedures to workers or any other possible suitable actions. It should be noted that there are actions in place such as safety data sheets, site worker inductions, procedures etc. that

have been put into place as mitigation strategies to reduce these potential risks before any occurrences, such as a chemical spill.

Furthermore complaint reports are utilized in order to address potential issues that may not be seen or noted by the company. These complaint reports enable those effect by the project to have a say at any adverse impacts that the construction is having on surrounding environment and provides reasoning for appropriate actions to occur to reduce these adverse effects.

All the environmental audits at Hydro-Future Consulting will deliver commanding, independent and evident advice and recommend measures to reduce identified risks to the environment from construction site activities.

As well as contractors undertaking audits for their roles and responsibilities, a member of the Hydro-Future Consulting management team is nominated to conduct audits. After completing the report for an audit, it is to be filed for future use and all feedback is to be expressed to the Company's employees through weekly meetings and additional emails.

7.5. EMP Review

The Environmental Management Plan requires constant reviews throughout the life of the project in order to improve the overall outcome of the project, particularly in regards to its environmental aspects. As noted in Table 11, the EMP is reviewed on a weekly basis, but may require additional changes at any time during the course of the project.

The environmental manager and particularly the elected environmental management representative are responsible for controlling, reviewing and applying the appropriate updates and changes to the EMP. The EMP is to be updated with a new and subsequent document number each time it is amended, to ensure a copy of all previous documents is available on file to track any changes made. All changes made to the EMP will be conveyed to the project team through an appropriate company memo and associated email.

Requests from all relevant authorities for a copy of the latest EMP will be met based on their relevance to the project and their reasoning. Hydro-Future Consulting believes environmental management plans should be submitted and shared for the process of education in the area of developing EMPs and to correlate information that may be beneficial for other projects.

8. Bill of Quantity

9. Bill of Quantity

Client: Tokin Consulting

Project: North Terrace Drainage System Upgrade

Department: Environmental

#	Item name	Catalogue reference or special specification (if needed)	Unit	Quantity	Rate	Cost ($)
Subject: GPT						
1	35 degree bend DN750 pipe	Hynds Catalogue Item #: 401628	m	2	1500	3000
2	GPT- 32MPa concrete	Hason Heidelburg Cement Group	m^3	14	239.5	3339
3	Rubber ring	Hynds Catalogue Item #: RO750	No.	1	35	35
4	Labour	Includes truck/crane drivers off site concrete workers & on site workers for placement at average wage	Hourly	22	50	1100
5	50 tone truck mounted crane	A1 Lift Crane Hire	Hourly	2	250	500
6	Flat top truck	Rentco Transport Equipment Rentals	Daily	1	400	400
7	25mm no slip steel plate	Shore Sales	m^2	2	1000	2000
8	Wall mounted galvanized ladder	Hydnes Catalogue Item #: RO750	m	5.3	200	1060
9	Manhole liner and lid (600mm diameter)	Mr Manhole Australia	No.	1	500	500
			Sub-total (1)			10734
Subject: Trash Rack						
1	Steel-flats 20mm*180mm	Southern First For Steel	m	3.64	150	546
2	Steel-RHS (100*50*0.3) mm	Southern First For Steel	m	3.64	35	127.4
3	Steel-flats 10mm*75mm	Southern First For Steel	m	12	32	384
4	Welding labour	Includes welding time, welding wire and gas	-	-	-	650
5	M16 Bolts	James Glen Steel Fasteners Item	No.	16	1	16
6	Installation	Placement of trash rack within GPT	Hourly	1	50	50
			Sub-total (2)			1773.4
Subject: Other						
1	240L Spill Kits	Stratex Australia	ea	3	408	1224
2	Bunding Trays	Containit C4DBP-P 4x250L Drums	ea	2	515	1030
3	PVC Spill Tray	Containit 3m x 3m PVC Tray	ea	3	1600	4800
			Sub-total (3)			7054

9. GPT Safety during Construction

Task Specific Safety Assessment Form	
Department/Section:	Environmental
Task/ stage Name:	Gross Pollutant Trap Construction

Brief Description of works to be undertaken

Off-site

- Have gross pollutant trap constructed to design specifications (reinforced concrete shell only), fixtures to be added on site.
- Allow for adequate curing time before being transported to site and implemented for use
- Have overpass frame constructed to design specifications

On-site

- Removal of existing road surface
- Excavation of sub-surface soils to the designated depth of the GPT
- Apply trench stabilisation measures
- Create void in sandstone arch wall suitable for new 750mm RCP connection from GTP
- Apply reinforcement to void based on design specifications
- Compact and level new base soil for placement of the GPT
- Transport GPT to site
- Install fixtures to GPT (trash rack panel and ladder)
- Lower GPT into location using appropriate machinery
- Connect existing 750mm RCP into inlet side of GPT along with new 750mm RCP elbow
- Connect outlet RCP from side of GPT into newly created void in sandstone arch culvert wall
- Backfill and compact to geotechnical design specifications
- Resurface with appropriate soil and wearing course layer thicknesses to design specifications
- Transport overpass frame to site
- Drill post holes for overpass
- Concrete overpass frame posts into correct position using appropriate machinery
- Create road surface for overpass level with the maintenance cover of the GPT

Summary of major risks or hazards

- Moving of heavy loads
- Working in confined spaces
- Injuries resulting from machinery and/or tools
- Dust inhalation
- Exposure to chemicals and dangerous substances
- Loud noises
- Vibration from machinery and/or tools
- Tripping
- Slipping

Mitigation strategies

- *Moving of heavy loads* - use machinery as much as possible to reduce the risk of injury as a result of moving heavy loads. Where possible exercise team lifts and always follow manufacturer's recommendations on the number of individuals required to lift a specified object (if available)
- *Working in confined spaces* – all employees working in confined spaces on site (such as the trench for the GPT) are to have obtained a confined space permit and are to only enter confined spaces if the space is deemed structurally safe and is of a safe large enough to work appropriately and safely in.
- *Injuries resulting from machinery and/or tools* – all employees on-site are to follow occupational health and safety (OH&S) guidelines outlined by their key employer and Hydro-

Future Consulting. Personal protective equipment (PPE) is to be worn at all times on-site and will be strictly monitored by an OH&S representative who will perform random visits to the site. Proper use of PPE will ensure injuries resulting from machinery and/or tools is minimised and avoided as much as possible.

- *Dust Inhalation* – All employees on-site are to wear safety masks whenever they are in the presence of air-borne substances such as dust.
- *Exposure to chemicals and dangerous substances* – the use of PPE should minimise the chance of exposure to chemicals and dangerous substances. In the event an employee is exposed to chemicals and/or dangerous substances the appropriate procedures are to be actioned by those trained in first-aid such as using first-aid kit for small injuries, or other relevant items such as an eye cleaning kit or calling the ambulance and following their instructions while waiting for the vehicle to arrive for more serious cases.
- *Loud noises* – all employees using or within close proximity of machinery and power tools are to wear ear muffs (inclusive of standard PPE).
- *Vibration from machinery and/or tools* – employees are advised to take small breaks when using machinery and tools such as compactors or jack-hammers, which cause vibration to minimise any adverse effects to their health.
- *Tripping* – appropriate signage is to be used on-site where a sudden change in elevation exists or where any potential tripping hazards exist. This could include brightly-coloured flagging on heavy items placed on the ground. Constant cleaning and tidying up around the site is to be actioned by all employees.
- *Slipping* - appropriate signage is to be used on-site where any potential slipping hazards exist. In the case a substance is spilled, a spill-kit should be used to clean up the substance and remove any trace of it from the site, to reduce any slipping hazards. Constant cleaning and tidying up around the site is to be actioned by all employees.

Safety equipment required & number

Personal Protective Equipment (PPE):
Steel-Toe Safety Boots
Safety Glasses
Safety gloves
Safety masks
Safety ear muffs

10. GPT Safety during Maintenance

Task Specific Safety Assessment Form	
Department/Section:	Environmental
Task/ stage Name:	Gross Pollutant Trap Maintenance/Cleaning

Brief Description of works to be undertaken

Routine Inspection involving:

- Cleaning of trash rack if more than 50% is blocked
- Determination of the amount of debris removed by GPT (caught by the trash rack)
- Reporting of any visible damage to the GPT

Routine Clean Out involving:

- Clean out sediment trap with eductor truck
- Cleaning of trash rack is more than 50% is blocked
- Reporting of any visible damage to the GPT
- Determination of the volume of debris and sediments removed from the GPT as captured by the eductor truck

Annual Inspection involving:

- Reporting of any visible damage to the GPT
- Water testing if required

Summary of major risks or hazards

Routine Inspection:

- Through cleaning the trash rack, the qualified tradesperson may be exposed to chemicals, suspended solids, and other hazardous substances
- Through cleaning the trash rack, the qualified tradesperson will be in a relatively confined space

Routine Clean Out:

- Through cleaning the trash rack and inspecting the GPT for damage, the qualified tradesperson may be exposed to chemicals, suspended solids, and other hazardous substances
- Through cleaning the trash rack and inspecting the GPT for damage, the qualified tradesperson will be in a relatively confined space

Annual Inspection:

- Through water testing, the qualified tradesperson may be exposed to chemicals, suspended solids, and other hazardous substances

Mitigation strategies

Routine Inspection:

- The tradesperson(s) cleaning the trash rack will need to wear protective clothing for cleaning purposes including gloves, waterproof overalls, safety glasses and a ventilated mask

Routine Clean Out:

- The tradesperson(s) cleaning the trash rack and inspecting the GPT for damage will need to wear protective clothing for cleaning purposes including gloves, waterproof overalls, safety glasses and a ventilated mask
- The tradesperson(s) entering the GPT for cleaning and inspection purposes will need to have obtained a Confined Space Permit

Annual Inspection:

- **The tradesperson(s) cleaning the trash rack will need to wear protective clothing for cleaning purposes including waterproof gloves, waterproof overalls, safety glasses and a ventilated mask**

Safety equipment required & number

Each tradesperson designated to undertake maintenance and cleaning of GPT will need to have obtained a *Confined Space Permit* and

Council to supply:
1 x Pair of waterproof gloves
1 x Set of waterproof overalls
1 x Set of safety glasses
1 x Ventilated Mask
For each tradesperson trained to undertake maintenance and cleaning of the GPT.

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Appendices

A1. Gross Pollutant Trap Calculations

The Gross Pollutant Trap (GPT), as introduced in Section 5.1.4. Gross Pollutant Trap, is a sedimentation basin trash rash type, which essentially has an inlet side, as seen in Figure 13, which is designed based on procedures within Chapter 34 of the Urban Stormwater Management Manual 2012, Department of Irrigation and Drainage Malaysia. The outlet side, which is to the opposite side to the inlet side does not require design calculations, but is rather determined based on the outlet pipe diameter and the associated clearance for proper functionality.

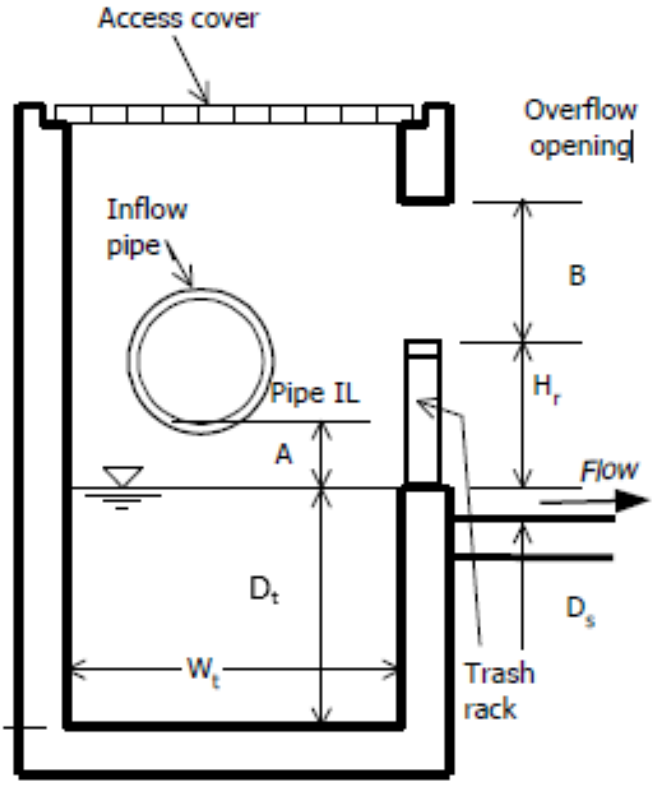

Figure 13 - SBTR Type 2 Gross Pollutant Trap Diagram (Department of Irrigation and Drainage Malaysia, 2012)

A number of the following calculations for dimension determination will relate to Figure 13 and are expressed as symbols, as seen above.

Required Removal Efficiency

As depicted in Figure 14 below, according to Chapter 4 of the Urban Stormwater Management Manual 2012, for a drainage system upgrade, the target pollutant removal rate of sediments is 20% (Department of Irrigation and Drainage Malaysia, 2012). Chapter 4 of the Urban Stormwater Management Manual also states that "*Gross pollutant traps (GPTs) shall be sized to retain 100% of all litter and debris greater than 1mm in size and a minimum of 70% of coarse*

sediments greater than or equal to 70%" (Department of Irrigation and Drainage Malaysia, 2012). Based on this a 70% target rate is used for the GPT design. The 20% target for upgrading of drainage systems is used as a starting point for trap area ratio determination and is adjusted according to the outcome, but will ultimately need to yield a 70% target pollutant removal rate for coarse sediments.

Table 4.5 Pollutant Retention or Load Reduction Targets

Pollutant	New Development	Land Redevelopment (see note)	Drainage System Upgrading
	Annual Average Pollutant Removal Efficiency (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)
Floatables	90	90	30
Sediment	70	50	20
Suspended Solids	60	40	20
Nitrogen	50	30	20
Phosphorus	50	30	20

Note: Local Authorities may set lower targets for redevelopment to take account of land constraints.

Figure 14 - Pollutant Retention or Load Reduction Targets for GPT Design (Department of Irrigation and Drainage Malaysia, 2012)

Catchment Area

The catchment area (A_c) as calculated in the Feasibility Study is:

$$A_c = 7.21ha$$

The percentage of impervious or urbanised area (U) for the catchment as determined in the Feasibility Study is 90%

$$U = 90\%$$

Trial Trap Area Ratio (R)

As previously mentioned, from Figure 14 above, the GPT in design for this project is required to have a 20% reduction target for sediments. This is based on the 'drainage system upgrading' category.

Since our catchment area is 90% impervious (U=90%), for the upper curve (curve A) for soil grain sizes above 0.04mm, the Area Ratio, R can be found. The annual sediment retention is taken as 20% as mentioned previously.

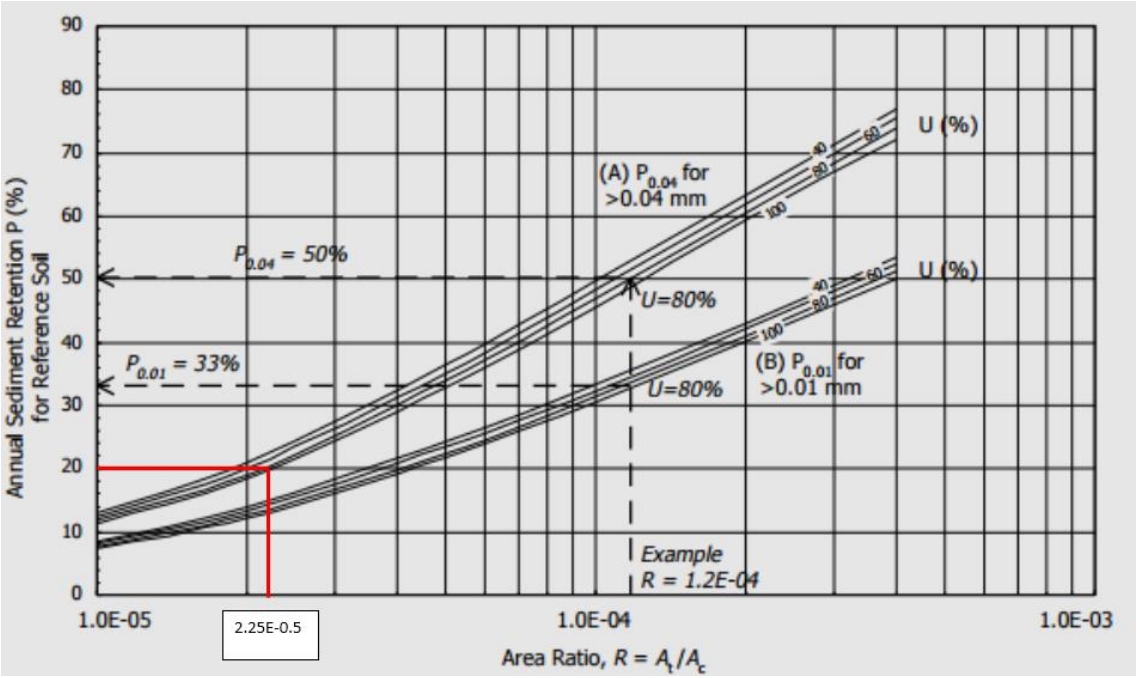

Figure 15 - Annual Sediment Retention vs Area Ratio Graph (Department of Irrigation and Drainage Malaysia, 2012)

The area ratio can be found from using the graph in Figure 15 above from chapter 34 of the Urban Stormwater Management Manual, based on a 20% sediment retention target and an urbanised area percentage of 90%.

$$Area\ Ratio, R = 2.25 \times 10^{-5}$$

Average Annual Retention of Sediment

Using the following graph in Figure 16, the F1 factor is found (which is used for soil grain size >0.04mm).

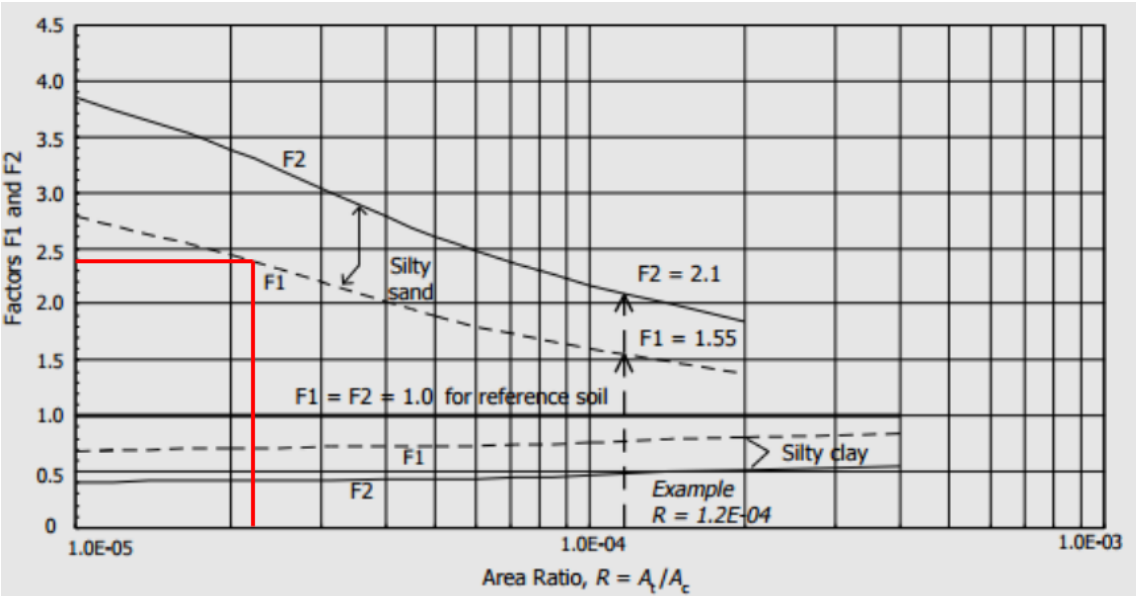

Figure 16 - F1 and F2 factors vs Area Ratio Graph (Department of Irrigation and Drainage Malaysia, 2012)

So based on the 20% target removal ($P_{0.04}$=20%) and the found Area Ratio, R,

F1 = 2.4 is found (F1 curve relates to 0.04mm soil grain size).

Trap Removal efficiency

$$P_{0.04} *= 20\% \times 2.4 = 48\%$$

Since the minimum target requirement for sediments over 0.04mm is 70%, as previously stated, the trap removal efficiency is no good and requires an increased initial target range.

Increase P target range to 45%:

$$R = 9.5 \times 10^{-5}$$

$$F1 = 1.62$$

$$P_{0.04} *= 45\% \times 1.62 = 73\%$$

Since this is greater than 70%, it is satisfactory.

Trap Size Area

As stated previously, the catchment area is 7.21 hectares. The trap size area is therefore:

$$A_t = R \times A_c = 9.5 \times 10^{-5} \times 72100m^2 = 6.85m^2$$

Length and Width of Trap

$\frac{L_t}{W_t}$ is required to between 2 and 3.

Try dimensions:

Lt= 4m and Wt = 1.8m

$$\frac{L_t}{W_t} = 2.22$$

Actual Trap Area:

$$A_t = 4m \times= 1.8m = 7.2m^2 > 6.85m^2$$

Trap is slightly bigger than required to allow room for placement of fixed trash rack.

Average Annual Sediment Export

In order to calculate the average annual sediment export (M), a basic formula is required. No South Australian data could be located for this application, so the data available for ACT and Brisbane has been used (Ahammed, 2015) as seen in Figure 17 below.

Table 15.A1 Storm Event Pollutant Exports (kg/km^2) for ACT and Brisbane, Australia

Pollutant	Landuse/vegetation categories		
	Native vegetation/ forest	Rural grazing	Established Urban
Sediment – ACT	$200R^{1.1}$	$400R^{1.1}$	$1000R^{1.4}$
(no Brisbane data)			
Suspended solids-ACT	8R	20R	200R
Brisbane	$130R^{0.75}$	6.1R	$166R^{0.75}$
Total phosphorus-ACT	$0.05R^{0.57}$	$0.12R^{0.57}$	$0.4R^{0.8}$
Brisbane	$0.17R^{0.9}$	0.022R	$0.15R^{0.9}$
Total nitrogen – ACT	$0.15R^{1.6}$	$0.3R^{1.6}$	$3R^{0.84}$
Brisbane	$1.5R^{0.86}$	0.16R	$1.45R^{0.86}$
Faecal coliforms ACT	$30\text{-}100x10^9\ R^{0.9}$	$300\text{-}1500x10^9\ R^{0.9}$	$400\text{-}1000x10^9\ R^{0.9}$
(cfu/km^2) Brisbane	$6.4x10^9\ R^{1.1}$	$1.0x10^9\ R^{0.95}$	$10.3x10^9\ R^{1.1}$

R = event runoff, in mm

Source: Willing & Partners (1999)

Reference areas: Brisbane and Canberra, Australia

Figure 17 - Storm Event Pollutant Exports for ACT/Brisbane (Department of Irrigation and Drainage Malaysia, 2012)

The formula required for this application is for the established urban category as follows:

$$M = 1000R^{1.4}$$

Where R = event runoff, in mm.

The rainfall depth (event runoff) is obtained through the Bureau of Meteorology Website for the project area. The IFD relationship requires input of the location in terms of geographical coordinates (Figure 18).

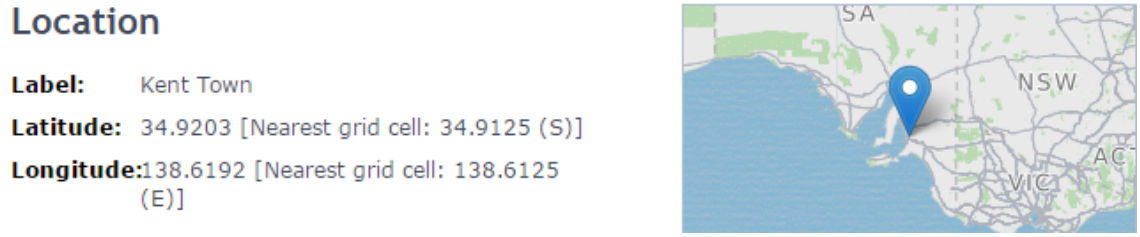

Figure 18 - Project Area Results for IFD Data System (Bureau of Meteorology, 2015)

The IFD design rainfall depth is then displayed as well as exceedance per year (EY) and respective annual exceedance probabilities (AEP), as seen in Figure 19 below.

IFD Design Rainfall Depth (mm)

Issued: 20 May 2015

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).

	EY	Annual Exceedance Probability (AEP)					
Duration	**1EY**	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
1 min	1.3	1.5	2.1	2.6	3.1	3.9	4.5
2 min	2.3	2.6	3.6	4.5	5.4	6.8	7.9
3 min	3.0	3.4	4.9	6.0	7.2	9.0	10.6
4 min	3.6	4.1	5.9	7.3	8.7	10.9	12.7
5 min	4.2	4.8	6.8	8.3	10.0	12.5	14.6
10 min	6.0	6.9	9.9	12.1	14.6	18.2	21.2
15 min	7.3	8.3	11.9	14.7	17.6	22.0	25.6
30 min	9.7	11.1	15.9	19.5	23.4	29.2	34.1
1 hour	12.6	14.3	20.4	25.0	30.0	37.4	43.8

Figure 19 - IFD Design Rainfall Depth Results for Project Area (Bureau of Meteorology, 2015)

From the 7.21 hectare catchment with 90% directly-connected impervious area (DCIA), the rainfall for 3 months ARI is as follows:

In reference to Figure 19, 1EY = 1 year ARI. For 10 minute duration (T_c) = 6.0mm.

Since there is no probability for 3 months ARI, take the event runoff, $I_{0.25}$ as 4mm (Ahammed, 2015).

$$I_{0.25} = 4mm$$

Since 90% of the catchment area is urbanised or impervious:

$$R = U \times I_{0.25} = 0.9 \times 4mm = 3.6mm$$

Therefore, the average annual sediment export (M) for Kent Town is found:

$$M = 1000 \times R^{1.4} = 1000 \times 3.6^{1.4} = 6\ tonnes$$

Average Annual Pollutant Retention

Again, referring to Figure 6, the pollutant retention for reference soil $P_{0.01}$ = 31% and F2 = 2.2.

Equation 34.4 of the Urban Stormwater Management Manual displays the pollutant retention for site soil (Department of Irrigation and Drainage Malaysia, 2012) as follows:

$$P_{0.01} * = 31\% \times 2.2 = 68.2\%$$

Minimum Sediment Trap Depth

Equation 34.5 of the Urban Stormwater Management Manual displays the pollutant retention for site soil (Department of Irrigation and Drainage Malaysia, 2012) as follows:

$$D_t = 0.0065 \times P_{0.01} * \times \frac{M}{A_t} = 0.0065 \times 68.2 \times \frac{6}{7.2} = 0.37m$$

Peak Flow for Water Quality Design Storm

In order to calculate the peak flow for a 3 months ARI water quality storm, Argue's design principles of source control are used from the 1986 book 'Storm drainage design in small urban catchments: a handbook for Australian practice'.

From Section 13.2.8 and using equation 13.5b of the Urban Stormwater Management Manual the IFD value for frequent storm events can be calculated (Department of Irrigation and Drainage Malaysia, 2012) as follows:

$$0.25_{I_D} = 0.5 \times 2_{I_D}$$

Where 2_{ID} is the rainfall intensity for a 2 year ARI, for the project area. From Figure X below, the 2 year ARI is displayed for 10 minutes duration.

Intensity-Frequency-Duration Table

Location: 34.925S 138.625E NEAR.. Kent Town Issued: 24/5/2015

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

	Average Recurrence Interval						
Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	45.9	61.4	83.6	99.7	121	154	182
6Mins	42.7	57.1	77.7	92.6	113	143	169
10Mins	34.5	46.0	62.2	73.9	89.7	113	133
20Mins	24.6	32.6	43.7	51.5	62.2	78.0	91.4
30Mins	19.6	26.0	34.6	40.7	49.0	61.2	71.6
1Hr	13.0	17.2	22.6	26.4	31.7	39.3	45.8
2Hrs	8.53	11.2	14.6	16.9	20.2	24.8	28.8
3Hrs	6.67	8.73	11.3	13.0	15.5	19.0	21.9
6Hrs	4.37	5.69	7.27	8.33	9.82	12.0	13.7
12Hrs	2.80	3.63	4.60	5.25	6.17	7.48	8.56
24Hrs	1.69	2.20	2.80	3.20	3.77	4.58	5.25
48Hrs	.957	1.25	1.61	1.85	2.19	2.68	3.09
72Hrs	.671	.882	1.14	1.31	1.56	1.91	2.21

(Raw data: 17.77, 3.79, 0.91, 35.01, 6.8, 1.72, skew=0.56, F2=4.47, F50=14.98)

Figure 20 - Intensity Frequency Duration Results Table (Bureau of Meteorology, 2015)

Based on 10 minutes storm duration (Ahammed, 2015) and 2 year ARI:

$$2_{I_D} = 46mm/hr$$

So as introduced before:

$$0.25_{I_D} = 0.5 \times 46mm/hr = 23mm/hr$$

Now, by using Argue's principles, presented in 'Storm drainage design in small urban catchments: a handbook for Australian practice', 1986, the flow rate for a 3 month ARI can be calculated.

$$\mathrm{Q} = \frac{\mathrm{CIA}}{360} \text{ where:}$$

$$\mathrm{Q} = \text{design flow rate } \left(\frac{\mathrm{m}^3}{\mathrm{sec}}\right); \mathrm{C} = \text{runoff coefficient;}$$

$$\mathrm{I} = \text{rainfall intensity } \left(\frac{\mathrm{mm}}{\mathrm{hr}}\right); \mathrm{A} = \text{catchment area (ha);}$$

The basic runoff coefficient for our catchment area (U=90% from before) can be found using Table 5.3 or Argue's 1986 aforementioned book, as see in Figure X below and is taken as C_{10}=0.9 for paved areas in South Australia Zone.

Surface	Basic runoff coefficient (C_{10})	
	Northern Australian Zone	Southern Australian Zone
Paved areas - roads - roofs	0.90	0.90
Pervious areas	0.70	0.10

Figure 21 – Basic Runoff Coefficient Values (Argue, 1986)

The derived runoff coefficient is also required, however, in Table 5.5 of Argue's 1986 aforementioned book, there is no value provided for 0.25 years ARI (Figure X). Therefore C_{10} as 1 year ARI (Ahammed, 2015) is taken. So C_{10} = 0.8.

ARI (yrs)	1	2	5	10	20	40	60	80	100
C_{10}	0.8	0.85	0.95	1.00	1.05	1.13	1.17	1.19	1.20

Figure 22 - Derived Runoff Coefficient Values (Argue, 1986)

To find the 3 month ARI:

From Argue's 1986 aforementioned book:

$$C_y = F_y \times C_{10}$$

Paved Areas:

$$C_{0.25_{paved}} = 0.9 \times 0.8 = 0.72$$

Pervious Areas:

$$C_{0.25_{pervious}} = 0.1 \times 0.8 = 0.08$$

Now, the effective runoff coefficient can be derived:

$$C_{10} = \frac{a1.C1 + a2.C2}{A}$$

$$C_{20} = \frac{(90 \times 0.72) + (10 \times 0.08)}{90 + 10} = 0.656$$

Finally the flow rate can be calculated, using the formula introduced earlier:

$$Q_{0.25} = \frac{0.656 \times 23 \times 7.21}{360} = 0.302 m^3/s$$

Trash Rack Height

Equation 34.7 of the Urban Stormwater Management Manual (Department of Irrigation and Drainage Malaysia, 2012) displays the formula for trash rack height (H_r) as follows:

$$H_r = 1.22\left(\frac{Q_{0.25}}{L_r}\right)$$

Try length of trash rack as 1.8m to be same as width of trap.

$$H_r = 1.22 \times \left(\frac{0.302}{1.8}\right) = 0.20m$$

Take height of rack to be 0.2m for ease of construction.

Nominal Flow Velocity

Equation 34.8 of the Urban Stormwater Management Manual (Department of Irrigation and Drainage Malaysia, 2012) displays the formula calculating flow velocity for a 3 month ARI and stipulates a maximum velocity of 1m/s:

$$V_{0.25} = \frac{Q_{0.25}}{(D_t + H_r)W_t}$$

$$V_{0.25} = \left(\frac{0.302}{(0.4 + 0.2) \times 1.8}\right) = 0.30m/s < 1m/s$$

Minimum Overflow Clearance

Equation 34.9 of the Urban Stormwater Management Manual (Department of Irrigation and Drainage Malaysia, 2012) displays the minimum overflow clearance (B) formula as follows:

$$B = \left(\frac{Q_p}{1.7L_r}\right)^{\frac{2}{3}}$$

Using the total flow rate from the inlet pipe (1.57m^3/s) based on 20 year ARI:

$$B = \left(\frac{1.57}{1.7 \times 1.8}\right)^{\frac{2}{3}} = 0.64m > 0.35m$$

Since the catchment area is relatively small, the overflow clearance does not need to be this large as it would be excessive. Take as 0.40-0.45m (Ahammed, 2015). The minimum overflow clearance for the design is 0.43m.

Wall Thickness

The GPT structure is constructed of reinforced concrete at a thickness of 180mm for all walls to withstand associated soil pressure as well as any contributed loads from trapped debris and hydrodynamic pressures and loads.

B1. Gross Pollutant Trap during Construction Inspection Checklist

GROSS POLLUTANT TRAP CONSTRUCTION INSPECTION CHECKLIST (DURING CONSTRUCTION PHASE)

Project Name	Project ID	Inspection Number

Items Inspected	Completed (please tick)	Satisfactory (Y/N)
Preliminary Works		
Traffic and safety control measures in place		
The location reflects plans		
The site is protected from existing stormwater flows		
Earthworks		
Excavation carried out reflects plans and design drawings		
Pre-treatment		
The catchment contributing to GPT is stabilised appropriately		
The catchment contributing to GPT is not collecting excess rubbish/sediments		
Structural Components		
The location and levels of both inflow and outflow pipes reflect plans		
The pipe connections reflect plans		
The concrete components reflect plans		
Sediment and Erosion Control		
Appropriate stabilisation is implemented following earthworks		
If appropriate, temporary protection is in place		
Operation Establishment		
Temporary protection equipment removed		
Diversion for GPT removed		

INSPECTOR DETAILS	
Name	
Date of visit	
Time of visit	
Signature	
Notes and Comments	

B2. Gross Pollutant Trap Post Construction Inspection Checklist

GROSS POLLUTANT TRAP CONSTRUCTION INSPECTION CHECKLIST (POST CONSTRUCTION PHASE)

Project Name	Project ID	Inspection Number

Items Inspected	Checked (please tick)	Satisfactory (Y/N)
Levels of inlet and outlet conform to plans and drawings		
Traffic control measures in place		
Dimensions of structural components reflect plans and drawings		
Access provided for maintenance and inspections		
Any sediment and debris generated during construction has been removed		

INSPECTOR DETAILS	
Name	
Date of visit	
Time of visit	
Signature	
Notes and Comments	

B3. Gross Pollutant Trap Maintenance Checklist

City of Norwood Payneham & St Peters

NORTH TERRACE UPGRADE PROJECT
GROSS POLLUTANT TRAP MAINTENANCE CHECKLIST

Asset ID	GPT Location	Inspection Number

Please Tick	Inspection Type	Maintenance Requirements	Checked (Please Tick)	Result
	Routine Inspection (once per month)	Amount of debris removed by GPT		__%
		Is trash rack is 50% blocked? If so clean out required		
		Is there any visible damage to the GPT? (If yes, report in notes)		
	Routine Clean Out (a minimum of 8 times per annum)	Volume of debris and sediments removed		__m^3
		Is there any visible damage to the GPT? (If yes, report in notes)		
	Annual Inspection	Is there any visible damage to the GPT? (If yes, report in notes)		
		Is water testing required?		

Component Condition	Checked (Please Tick)	Condition	Comments
Inlet			
Outlet			
Concrete Walls			
Trash Rack			
Removable Lids			

CONTRACTOR DETAILS	
Name	
Job Title	
Organisation	
Date	
Signature	
Notes	

B4. Construction Environmental Management Plan Training Report

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN TRAINING REPORT

To be conducted by all employees (all those working on site) to ensure a thorough understanding of their responsibility to apply due diligence for the environment and relative matters is achieved

Training Type (site induction, emergency response, etc)	
Date of Training	
Name of Authorised Trainer	

Trainee's Name	Trainee's Signature	Trainer's Signature Upon completion

Topics Covered	Completed (please tick)
Site Induction	
Environmental Management Plan Introduction and Familiarisation	
Emergency Response	
Familiarisation with Site and Relative Environmental Controls	
Training for Specific Employees (please specify)	
Other (please specify)	

TRAINING APPROVAL	
Approved By	
Signature	
Notes and Comments	

SAFETY DATA SHEET (SDS)

Version:	Issued:
Classification of Material	
1. Identification of the material and supplier 1.1 Product: 1.2 Recommended use: 1.3 Supplier: 1.4 A.B.N: 1.5 Address: 1.6 Telephone Number: 1.7 Facsimile: 1.8 Emergency Telephone Numbers:	
2. Hazards Identification 2.1 Hazard Classification: 2.2 Risk Phrase(s): 2.3 Safety Phrases:	
3. Composition/ Information on ingredients: 3.1 Chemical Name:	
4. First Aid Measures 4.1 Description of Necessary First Measures: 4.2 Medical Attention and Special Treatment	
5. Fire Fighting Measures 5.1 Suitable Extinguishing Media: 5.2 Hazards From Combustion Products: 5.3 Special Protective Precautions and Equipment For Fire Fighters： 5.4 Hazchem Code：	
6. Accidental Release Measures 6.1 Emergency Procedures: 6.2 Methods and Materials for Containment and Clean Up:	
7. Handling and Storage 7.1 Precautions for Safe Handing: 7.2 Conditions for Safe Storage: 7.3 Storage Regulations:	

8. Exposure controls/ Personal Protection

8.1 National Exposure Standards:
8.2 Biological Limit Values:
8.3 Engineering Controls:
8.4 Personal Protective Equipment:

9. Physical and Chemical Properties

10. Stability and Reactivity

10.1 Chemical Stability:
10.2 Hazardous Reactions:

11. Toxicological Information

11.1 Health Effects From Likely Route of Exposure:

12. Ecological Information

12.1 Ecotoxicity:
12.2 Environmental Protection:

13. Disposal Consideration

13.1 Disposal Method:
13.2 Special Precautions for Landfill or Incineration:

14. Transportation Information

14.1 UN Number:
14.2 UN Proper Shipping Name:
14.3 Dangerous Good Class:
14.4 Hazchem Code:

15. Regulatory Information

15.1 SUSMP Poisons Schedule:
15.2 Prohibition / Licensing Requirements:
15.3 Industrial Chemicals Act 1989:

16. Other Information

16.1 Issue Date:
16.2 Contact Points:
Title / Position:
Telephone:
E-mail:
16.3 After Hours Emergency Medical Assistance:
Telephone:

B6. Site Inspection Checklist

SITE INSPECTION CHECKLIST

Project	
Location of Work	
Scope and Duration of Work	
Contract Administrator	

General Issues	**Yes**	**No**	**Action**
All persons on site have read the Hydro-Future Consulting's COP and completed a site induction program			
All persons on site have signed in and are displaying approved passes.			
All potential hazards have been identified prior to commencement of work.			
Site Safety System	**Yes**	**No**	**Action**
Risk assessment/Method Statements have been completed and made available to all parties.			
All persons are aware of the Safety Systems			
Activity that may compromise the Fire Detection System is strictly controlled.			
Appropriate barriers and site safety signage are in place			
All plant and machinery is right for the job, in a safe condition and staffs are adequately trained.			
There are proper arrangements for the collecting and disposing of waste materials.			
Emergency Procedures	**Yes**	**No**	**Action**
Emergency procedures been developed and all persons are aware, e.g. evacuating the site in case of fire or rescue from a confined space?			
The quantity of flammable materials / liquids/gases on site is kept to an absolute minimum and is managed.			
Suitable First Aid provision in place.			

Scaffolds	Yes	No	Action
Risk Assessments have been completed and made available to all parties.			
Safe access is available to the scaffold.			
Uprights are provided with base plates and sole plates.			
Roof Work	**Yes**	**No**	**Action**
Roof Access Permits are enforced			
Harnesses are available and used where appropriate			
No work is allowed under areas with persons working at height, cordon off and signs in place.			
Vehicles on Site	**Yes**	**No**	**Action**
Separate pedestrian and vehicle routes are clearly marked.			
Contractors vehicles are parked only in agreed locations			
Vehicles have reversing warning alarms.			
Protecting the Public	**Yes**	**No**	**Action**
All work areas are clearly and securely segregated.			
All adjacent public access areas and walkways are level and free from trip hazards, obstructions such as stored materials and waste.			
Approved notices detailing the content, duration of work and, where appropriate, details of alternative arrangements are displayed.			
Additional Items	**Yes**	**No**	**Action**

Notes

Name		Position	
Signature		Date/ Time	

B7. Incident Report

INCIDENT REPORT

To be completed by staff within 12 hours of incident/accident

Incident Date	Incident Time

Details of Injured Individual	
Name of Injured Individual	
Male/Female	
Date of Birth	
Address	
Contact Number	

Details of Incident	
Injury Type	
Further Details	

Does Injury require Hospital/Physician?	
Hospital Name	
Address	
Contact Number	
Signature of Injured Individual	
Date	

Additional Notes and Comments	
Prepared By	
Date	
Approved By	
Signature of Approved By	

B8. Complaints Report

COMPLAINTS REPORT

Name:
Would you like to provide : Complaint ☐ Opportunity for Improvement ☐
Date and Time Issue Arose:
Location
Persons or Process Involved
Brief Description of Issue/Concerns
Signed:
Contact Details
Hydro-Future Consulting will respond within 3 business days **We thank you for your time taken in lodging this information**
For official Use Only
Evidence to support the complaint confirmed : Yes ☐ No ☐
Management approval of form: Yes ☐ No ☐ **Signed :**

B9. Environmental Risk Assessment Matrix

		ENVIRONMENTAL RISK ASSESSMENT MATRIX				
		LIKELYHOOD OF OCCURANCE				
SCALE OF CONSEQUENCE		1	2	3	4	5
		Very Unlikely	Unlikely	Possible	Likely	Very Likely
1	Negligible *Negligible damage with no notable impact on the environment*	Low	Low	Medium	Medium	Medium
2	Minor *Minor damage/impact, repairs to be actioned within a day*	Low	Low	Medium	Medium	High
3	Moderate *Controllable or short-term damage on the environment, repairs may take 1 day to 1 year.*	Low	Medium	Medium	High	High
4	Significant *Medium-term damage on the environment, repairs may take 1 month to 2 years.* *Notable effects on public amenity.*	Medium	Medium	High	High	Extreme
5	Severe *Long-term damage on the environment, repairs may take more than 2 years.* *Long-term effects on public amenity.*	Medium	High	High	Extreme	Extreme

B.10. Environmentally Sensitive Zone