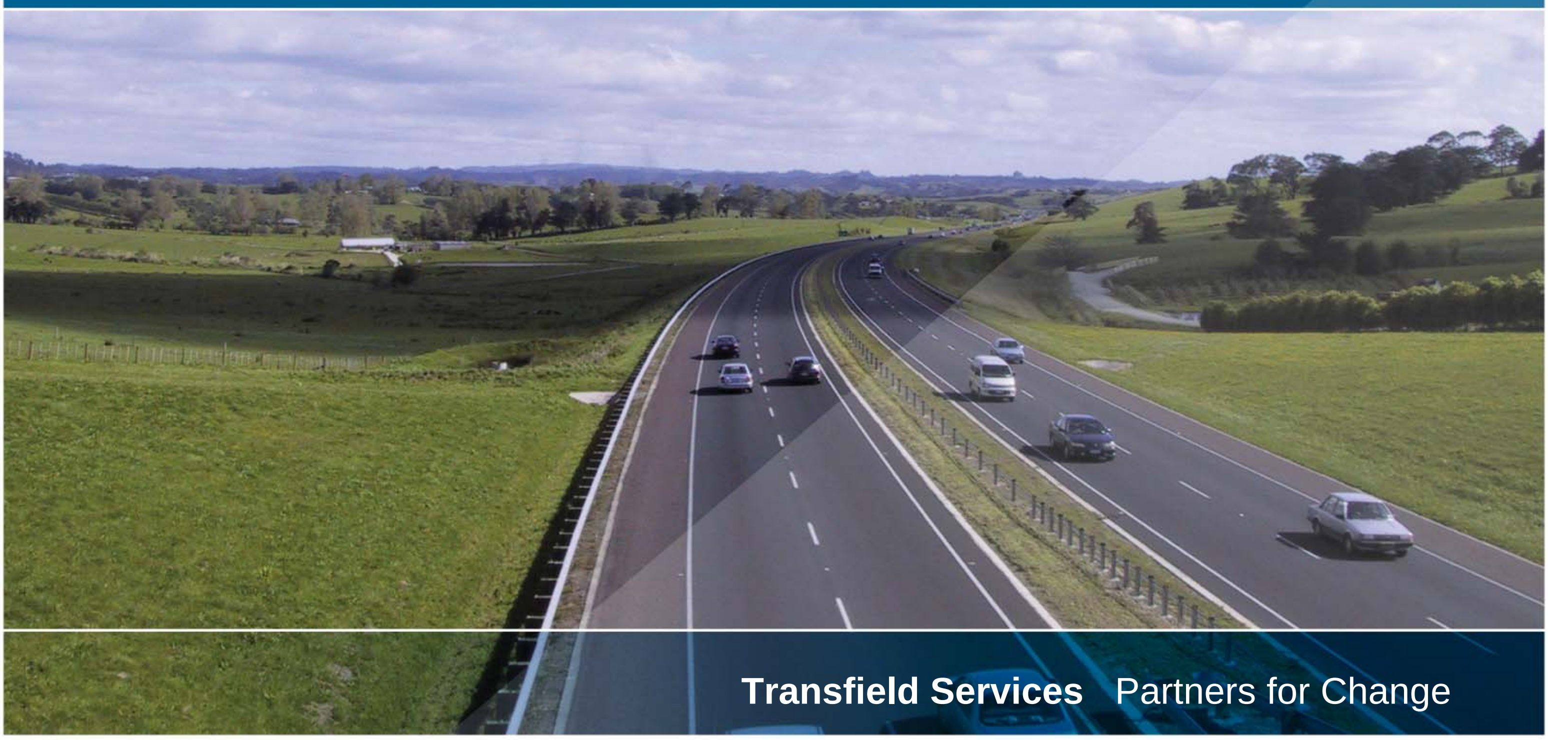
TRANSFIELD SERVICES

ALPURT Sectors A2 and B1Stormwater Management System Review

Application of the NZTA Draft Stormwater Standard

NZ Transport Agency

November 2008



Transfield Services Partners for Change

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1.0 INTRODUCTION

Transfield Services (NZ) Limited has been commissioned by the NZ Transport Agency (NZTA) to provide a report which assesses the NZTA Stormwater Standard against the stormwater standards that were applied during the design and construction phases of the stormwater treatment system for sectors A2 and B1 of the ALPURT project.

Sector A2 is 8.1km long and extends between the Awanohi interchange and the Silverdale interchange. Sector B1 is 5.6km long and extends between the Silverdale interchange and the Orewa interchange (see site location plan Appendix A.

This report draws on information from an initial report which provided information regarding design, construction, catchments and resource consents pertaining to the stormwater treatment system.

This report forms part of the Final Stormwater Management Standard and Valuation Review undertaken by the NZTA.

2.0 ENVIRONMENTAL FACTORS

2.1 Description of Catchments

2.1.1 Terrain

The terrain of the of the A2 and B1 sections of the ALPURT project is characterised by rolling hill country in both peri-urban and rural environments.

The area has an abundance of small perennial streams that run parallel to, and in several places run underneath the now existing motorway. The notable streams are identified as:

- Weiti Stream (B1);
- Johns Creek (A2);
- Top Road (A2); and
- Okura River (A2).

Estuarine environments are located at the start of the A2 sector (Awanohi Road) of the motorway and also at the conclusion of the B1 sector (prior to Grand Drive) of the motorway. These are identified as being:

- Orewa Estuary; and
- Okura Estuary (part of the Okura Marine Reserve).

2.1.2 Area

The A2 and B1 sectors of the ALPURT project are comprised of many catchment areas, for the purposes of this report they are listed in the table which details the different treatment devices.

2.1.3 Topography

The topography of the catchment can be characterised as rolling hill country. The motorway is bordered by, in some cases, quite steep hills and valleys to either side. This topography is consistent along the length of both the A2 and B1 sectors.

2.1.4 Drainage Features

The A2 and B1 sectors primarily utilise constructed swales which are located along the side of the motorway as the key drainage mechanism for ALPURT. The swales are extensive and run the length of ALPURT. The ALPURT stormwater treatment system utilises, as much as possible, the existing natural contours of the land and associated streams to provide efficient drainage.

With regards to sector A2, the swales divert the stormwater flows to the various detention ponds where the treated water is then discharged to the various streams and creeks within the catchment.

Sector B1 also utilises the swales for drainage however, the swales in B1 function as treatment devices for contaminated surface water. The only point at which this differs in the B1 sector is at treatment devices No.1 and 2.

Treatment device No.1 (see appendix A) consists of 2 sand filters. The stormwater is treated by the sand filter then, as in sector A2, the treated water is discharged into an adjacent stream.

Treatment device No.2 (see Appendix A) is a treatment pond which captures water from the Silverdale interchange. The water is treated and then discharged into Johns Creek.

2.1.5 Geotechnical Information

The composition of the ground underlying ALPURT is comprised of two distinct geologic formations identified as the Waitemata Group – East Coast Bays Formation and the Onerahi Chaos Breccia (see section 2.1.6).

An investigation on the structural stability of treatment ponds in sector A2 was undertaken by Beca Infrastructure Ltd in 2007. It revealed that three of the ponds sited on Onerahi Chaos Breccia had structural stability issues that were attributed to 'weak alluvium at depth' and also the ability of the clay to retain water leading to the saturation of the slope and toes of the treatment ponds. Each site was attributed a site risk ranking of 12 (out of a possible 45), with 15 representing minor risk and being the usual catalyst for a geotechnical investigation. The risk ranking criteria was developed by Beca Infrastructure Ltd and is specific to the ALPURT project. Given the high traffic volumes of the carriageway an investigation and further actions were recommended. The subsidence equated to the cracking and deformation of the mid to upper slopes of the treatment ponds and slight bulging at the toe of the ponds. At one of the sites minor cracking in the left hand northbound lane was also observed. The one treatment pond that exits in sector B1 was determined to be structurally sound primarily due to the fact it has been created through excavating down rather than being built up.

No stability issues have been identified with regards to swales within either sector.

2.1.6 Soils

ALPURT passes through two main catchment areas which have two distinct soil compositions, these catchments are identified as the Alexandra catchment and the Orewa catchment.

Soils within the Alexandra catchment originate from the Waitemata Group – East Coast Bays geologic formation. The Waitemata Group –East Coast Bays Formation consists of graded turbite sandstones alternating with poorly sorted interturbite mudstones of the Miocene age. The catchment can be best characterised as having clayey to silty topsoils with underlying clay subsoils.

Soils within the Orewa catchment originate from the Onerahi Chaos Breccia geologic formation. This formation underlies the northern segment of sector A2 and sector B1. The formation is comprised of a mix of Miocene and Cretaceous period marine deposits which occur both above and below Waitemata Group sandstones and siltstones. The Onerahi Chaos Breccia comprises chaotic irregularly – bedded rocks and is associated in many instances with large ground creep movements. The clay soils formed by this composition are very smooth and impervious.

2.1.7 Erosion Potential

The potential for erosion within the stormwater system is limited. Gabion mattresses have been constructed around all outfalls into treatment ponds or streams to reduce the potential of erosion or scouring occurring.

Erosion could potentially occur on the banks, front or back slopes and bottom of the swales if the swales are not properly maintained or if damaged occurs due to vehicles driving through or into the swales.

The erosion of the wetponds is not currently an issue. However, the majority of ponds have weir outlets. Weir outlets in general are prone to scouring and undermining, therefore the potential exits for scouring and undermining to occur around the outlets if the outlets are not appropriately monitored or maintained.

Planting schemes and erosion protection around the various inlets and outfalls are in compliance with the NZTA Standard.

2.1.8 Flooding

A post –construction review of the ALPURT Sector A stormwater treatment devices undertaken by the NZTA identified that there were no expressed concerns identified in relation to their design, or capacity to handle stormwater run-off.

2.1.9 Design Storm Event

The vast majority of stormwater treatment devices for sector A2 and B1 are designed to effectively cope with a 1% Annual Exceedance Probability (AEP) storm event as stipulated by the Auckland Regional Council in the terms of resource consent.

The NZTA Stormwater Standard requires that where appropriate devices should be sized to accommodate a 1% AEP storm event and possibly the Probable Maximum Flood (PMF) limit. The treatment ponds located along ALPURT are sized to treat stormwater from such events and therefore have been constructed in accordance with the requirements of the Standard.

2.1.10 Vehicle Kilometres Travelled at Time of Opening

Traffic information for the B1 sector (SH1A) was not able to be obtained prior to 2002, possibly due to the traffic information loops not being installed. Data from 2002 shows that the daily vehicle flow count is on average, 12,800 vehicles per day. The length of this sector of motorway is 5.6 km giving a total of 71,680 vehicle kilometres travelled for the B1 sector.

For the purposes of consistency 2002 traffic levels for the A2 sector will also be used. The data shows that 35,000 travel through the A2 sector. The sector is 8.1 km long giving a total of 283,000 vehicle kilometres travelled.

2.1.11 Discharge Points

In terms of discharging treated water from the treatment devices a generic approach has been adopted in both the A2 and B1 sectors. The approach has been to discharge the treated water directly into the abundant streams and creeks that exist within the landscape via culverts with gabion mattresses at the outfall.

Discharges from the wetlands and ponds for sector A2 occur predominantly through weir structures. Only treatment devices 9, 14 and 16 are discharged through manhole outlet structures.

Stormwater from sector B1 is discharged into the streams directly from the drainage swales as these act as the treatment devices. The exception is treatment device No.1 which discharges water via sand filters.

2.1.12 Catchment Classification

Refer to the plan below for details on catchment classifications. The plan also provides a summary of the environmental factors affecting each treatment device.

2.2 Sensitivity of Receiving Environment

This section is referred to the NZTA document, 2007: "Identifying Sensitive Receiving Environments at Risk from Road Runoff, Land Transport Research Report 315".

Treatment Device No.	Erosion Potential	Flooding	Design Storm Event	Vehicle KM Travelled at Time of Opening	Discharge Points	Catchment Classification
1 (B1)	Low Risk	No concerns over capacity	10% AEP	71,680	Swale/Filters/ Stream/Estuary	Peri-urban
2 (B1)	Low Risk	No concerns over capacity	1% AEP	71,680	Swale/Pond/Stream	Peri-urban
3 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
4 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
5 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
6 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
7 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
8 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
9 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
10 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
11 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
12 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
13 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
14 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Rural
15 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
16 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
17 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
18 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban
19 (A2)	Low Risk	No concerns over capacity	1% AEP	283,000	Swale/Pond/Stream	Peri-urban

2.2.1 Schematic of SRE Rating Framework

The proposed method is based on a hierarchical system whereby the receiving environment (RE) is sequentially classified according to three attributes:

- Physical ‘type sensitivity’ (depositional vs. dispersive);
- Ecological values; and
- Human use values (including cultural values).

Within each of the above attributes, the receiving environments are classified as being of ‘high’ (H), ‘medium’ (M), or ‘low’ (L) sensitivity and assigned a numerical number accordingly.

The overall sensitivity rating for each receiving environment is calculated by adding the scores for the type sensitivity, ecological value and human use value. The sensitivity rating is grouped under three broad categories, based on the total score, with high ratings indicative of high sensitivity, as follows:

- High sensitivity (high potential risk from road runoff): Total score >40
- Medium sensitivity (moderate potential risk from runoff): Total score 20-40
- Low sensitivity (low potential risk from road runoff): Total score <20

2.2.2 Sensitivity of Receiving Environment - Analysis

Type of Receiving Environment

The small streams which constitute the receiving environments along ALPURT are deemed to have ‘high’ sensitivity due to the low gradient and low velocities of these streams. The low gradients and velocities of the streams make them strongly susceptible to the deposition and accumulation of sediments. Treatment devices No.1, 18 and 19 ultimately discharge into nearby estuarine environments which also are identified as highly sensitive receiving environments.

Ecological Values

The ecological values of the majority of the streams and creeks within the catchment have relatively ‘low’ ecological values. However, there are a few exceptions within the ALPURT catchment.

Treatment devices No. 18 and 19 ultimately discharge into the Okura River which forms part of the Long Bay - Okura Marine Reserve. The Long Bay - Okura Marine Reserve is a habitat for several species of benthic fauna and functions as a spawning ground for many species of marine life such as sharks, Snapper, Kingfish and Kahawai. Based on these compelling factors Long Bay -Okura Marine Reserve is highly sensitive in ecological terms.

Treatment device No.1 discharges into adjacent Orewa Estuary. The estuary also has forms a habitat and spawning ground for various coastal species, however these species are not threatened or endangered and the estuary holds no formal conservation status and as such it is identified as having ‘medium’ ecological values.

Treatment Devices No. 5 and 6 discharge into the Weiti Stream and devices 13 and 14 discharge into the stream at Top Road. Both streams have hold species such as the Banded Kokopu and as such can be deemed to have ‘medium’ ecological values.

Human Use Values

The small size of the streams and creeks within the catchment means that the human use values are mostly identified as being 'low'. There are however two exceptions to this, these being the Okura River (TD No.18 and 19 discharging into the Long Bay - Okura Marine Reserve and the Orewa Estuary (TD No.1).

The Long Bay - Okura Marine Reserve has a 'high' human use value due to the many recreational activities that take place within the marine reserve, and adjacent Long Bay Regional Park. These include swimming, paddling, kayaking, sailing and recreational walks.

The Orewa Estuary has a 'medium' human use value. The estuary is used for activities such as fishing, kayaking and occasionally swimming although due its size and practicality (of use) the extent of its recreational use is not as high as that of the Long Bay - Okura Marine Reserve.

Below is a table providing a summary of the Overall Sensitivity Rating.

Treatment Device No.	Sensitivity	Ecological Value	Human Use Value	Overall Sensitivity Rating
1 (B1)	30 (H)	20 (H)	5 (M)	55 (H)
2 (B1)	30 (H)	5 (L)	2 (L)	37 (M)
3 (A2)	30 (H)	10 (M)	2 (L)	42 (H)
4 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
5 (A2)	30 (H)	10 (M)	2 (L)	42 (H)
6 (A2)	30 (H)	10 (M)	2 (L)	42 (H)
7 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
8 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
9 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
10 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
11 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
12 (A2)	30 (H)	10 (M)	2 (L)	42 (H)
13 (A2)	30 (H)	10 (M)	2 (L)	42 (H)
14 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
15 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
16 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
17 (A2)	30 (H)	5 (L)	2 (L)	37 (M)
18 (A2)	30 (H)	20 (H)	10 (H)	60 (H)
19 (A2)	30 (H)	20 (H)	10 (H)	60 (H)

3.0 DESIGNED SOLUTIONS

This section provides a brief description of:

- The design philosophy;
- The stormwater management devices, design methodology, positioning and construction; and
- Cost and time.

3.1 Design Philosophy

The stormwater treatment devices for sector A and B1 have been designed and constructed to treat the stormwater run-off before it enters natural waterways. The level of treatment required is set by the conditions of the resource consents granted for the work under the Resource Management Act (1991). The stormwater standards applied to the project were based on the stormwater criteria stipulated in the Auckland Regional Council's (ARC) Technical Publication No.2 (TP2), 1992 "Design Guideline Manual Stormwater Treatment Devices".

The run-off from roads contains particulates, aromatic hydrocarbons, heavy metals and nutrients that potentially are toxic to the environment. A combination of swales, wetponds and sand filters has been used to ensure adequate treatment of stormwater before it enters natural waterways. Many of the temporary sediment control ponds utilised during the construction phase of the project for ALPURT have been converted into permanent wetponds in an effort to reduce time and costs.

The intent of these treatment measures is to remove at least 75% of the particulate and toxic substance from the run-off. The swales and ponds are constructed so that water flows primarily over the sediment and through the vegetation. An alternative is vegetated submerged beds in which water flow is engineered for contact with the plant roots. The ponds provide flood mitigation and abatement to ensure the post development flows from the road do not exceed the pre-development flows this ensures that flooding and erosion issues are not an issue for downstream environments.

If we incorporate the NZTA Standard into the design philosophy of the stormwater treatment system we would come up with an identical philosophy. This is based on the premise that the NZTA Standard has largely been derived from the Auckland Regional Council's Technical Publication No.10 (TP10), 2003 "Design Guideline Manual - Stormwater Treatment Devices". The TP10 document is a modified and improved version of the TP2, 1992 document on which the ALPURT stormwater treatment system specifications are based. Indeed, some of the calculations may be different for some aspects of the treatment devices but the design philosophy for stormwater treatment is the same.

3.2 Objectives

Assumptions

The objectives for developing the stormwater design in the A2 and B1 sectors were:

- To meet the stipulated requirements of the Auckland Regional Council (ARC) TP2, 1992 stormwater treatment guidelines;
- To provide a comprehensive approach to water resources mitigation during the design process, including provision for stormwater run-off and protection of wetlands and waterways;
- To effectively treat stormwater run-off before it enters the surrounding natural waterways; and
- To provide suitable flows and gradients within the stormwater system to allow for continued or enhanced fish passage.

Had the NZTA Stormwater Standard been applied from the onset of the project these objectives would have remained the same. This is primarily due to the similarities that have been identified between the

ARC TP2, 1992 document which provided the initial standard for the design and construction of stormwater treatment devices for ALPURT and the NZTA Stormwater Standard.

Options Analysis

Several approaches were considered with regards to the treatment of stormwater for ALPURT.

Option 1

Do Nothing. This approach consists of not providing any mitigation and was deemed unacceptable.

Option 2

Utilise swales along the entire length of the highway. This option offered cheap and relatively effective treatment of stormwater for ALPURT. This option was discarded due to the fact that swales could not effectively treat all the stormwater from such a large impervious area to a sufficiently high quality to be directly discharged into sensitive local watercourses.

Option 3

Use wetponds or wetlands to treat all stormwater along ALPURT. This option would have provided a high quality of water treatment. The option was discarded due to the high costs associated with constructing wetponds along the entire length of the highway and the topographical restrictions posed in some sections adjacent to the carriageway.

Option 4

A multi-functional approach to stormwater treatment utilising swales, wetponds and sand filters. This approach represented a balance between costs and the high quality treatment of stormwater that was required for the project. This was the approach that was adopted for the project.

3.3 Criteria

Water Quality

The effect of stormwater ponds and swales on the groundwater is considered to be less than minor, primarily due to the low permeability of the Waitemata group clays on which the stormwater system has been constructed.

The stormwater ponds and swales assist in retaining pollutants and suspended solids generated from the motorway. The intent of these treatment measures is to remove at least 75% of the particulate and toxic substances from the run-off before the water is discharged.

Testing of the wetponds and swales has been undertaken by NIWA which assessed the effectiveness of the treatment devices. The results showed that the ponds were treating stormwater to a very high standard and no concerns were expressed.

Water Quantity

The construction of the A2 and B1 sectors of the motorway involved the construction of large impervious areas. The stormwater treatment system was designed to reduce the impact of increased surface water flows on the surrounding receiving environments that would result from the newly constructed impervious surface areas. This has been achieved by utilising the drainage swales to and ponds to dissipate and absorb the energy of the stormwater flows before the water is treated and discharged.

Stream Channel Erosion Criteria

There will be minimal increases in stormwater velocities within existing streams. The ponds are designed to cope with a 1% AEP storm event and thus provide sufficient detention time so as not to significantly increase the water velocities within the streams.

4.0 STORMWATER MANAGEMENT DEVICES METHODS

4.1 Erosion and Sediment Control

Due to its size and close proximity to sensitive receiving environments, ALPURT required a comprehensive approach to erosion and sediment control during the construction phase of the project. The temporary sediment treatment devices were constructed to TP2, 1992 specifications with sediment treatment ponds having a prominent role in treating contaminated water from the site(s). Many of these temporary ponds were converted into permanent stormwater treatment ponds once construction of ALPURT was completed.

The soil composition of the area (Waitemata Group clay and Onerahi Chaos Breccia) meant that a strong emphasis was placed on ensuring that preventing erosion was the first priority as the size of the clay particles meant it was unlikely that the sediment would settle out within a temporary pond. Practices to ensure that erosion was minimised included:

- Extensive hydro-seeding upon completion of stages;
- Stabilising the site during the winter;
- Stabilising cut off drains fill batters and other erodible surfaces;
- Sediment control devices with outlet structures that control and dissipate discharges to prevent scouring; and
- Lining of contour drains with geotextile.

Sediment control practices included:

- Sediment control ponds;
- Ponds constructed to withstand 1%AEP;
- Silt fences;
- Decanting Earth bunds;
- Disposal of cleanfill to areas with sediment controls; and
- Cesspit protection.

A typical section of sediment control involved protecting the watercourse or bottom section of the slope with silt fence. Contour drains would capture runoff from the slope and divert the sediment laden water into a sediment treatment pond or a decanting earth bund. This methodology was applied where possible along the length of the project.

Shown in Appendix C are schematics of the erosion and sediment control devices used for ALPURT as designed by Beca.

4.2 Operational Stormwater Management (Permanent)

The operational stormwater management system primarily utilises swales and wetponds to provide treatment for the stormwater runoff. The exception being the sand filter (treatment device No.1) that are located at the northern aspect of sector B1.

The design specifications for the treatment devices are derived from the Auckland Regional Councils Technical Publication No.2 (TP2), 1992 “Design Guideline Manual - Stormwater Treatment Devices”. As discussed in Section 3.1 the NZTA Standard draws largely from the TP2, 1992 document.

This section provides a synopsis of the current treatment system by outlining the processes of collection, conveyance, attenuation and treatment. As applying the NZTA Standard would have no impact on the configuration of the stormwater treatment system no comment on the Standard will be provided, however comment will be provided in Section 4.2.1 on the impacts of the NZTA Standard on the specification of the three main treatment devices for ALUR, these being; swales, wetponds and sand filters .

Outlined below is a summary of how the stormwater treatment system for ALPURT operates.

i. Collection

The stormwater is collected through the drainage swales that run parallel to the motorway and is diverted to the sand filters or wetponds. The motorway is constructed in way that ensures water flows are directed to the swales.

ii. Conveyance

The stormwater is primarily conveyed to the treatment devices through the use of drainage swales and drainage culverts.

The stormwater at treatment device No.1 (B1) is firstly conveyed to a storage pond where it is then conveyed through piping to the sand filters.

Treated stormwater is conveyed from the treatment devices to the stream discharge points via weirs and culverts.

iii. Attenuation

The minimum required detention time for the ponds (according to TP2,1992) is 2.5 hours, with the preferred rate of detention being 5 hours. The wetponds at ALPURT conform to these parameters.

iv. Treatment

There is a multi-functional approach taken in terms of treating the stormwater. The initial treatment of the stormwater is undertaken by an extensive system of swales. The water is then treated through the process of attenuation which is undertaken by the various wet ponds that have been constructed. Twin sand filters offer treatment at treatment device No.1 (B1) after pre-treatment by the drainage swales.

The wet ponds treat the water by slowing the water flow down and allowing the coarser sediments to settle as the water is slowly discharged. Plants within the pond provide a secondary treatment by way of aerobic decomposition and the adsorption of contaminants. These processes assist in removing nutrients and sediments.

The sand filter is effective at removing sediments and contaminants from the stormwater through settling and filtration. The contaminants are removed by attaching themselves to sediments within the filter.

4.2.1 Treatment Device Specifications

This section contrasts and compares the applied TP2, 1992 Standard and the NZTA Standard for the three main treatment devices utilised in the treatment of stormwater for ALPURT.

Tables have been used where appropriate with comments provided on the implications of any changes in Standard.

4.2.1.1 Swales

Design Parameters for Swales		
Design Parameter	**ARC TP2**	**NZTA Standard**
Longitudinal Slope	<4%	<5%
Maximum Lateral Slope	0%	0%
Maximum Side Slope	3H:1V	4H:1V
Maximum Catchment Area Served	N/A	4ha
Maximum Velocity	0.8 m/s	0.8 m/s
10-year Storm Velocity	1.5 m/s	1.5 m/s
Maximum Water depth above Vegetation	<2xVH	<2xVH
Design Vegetation Height	35-150mm	100-150mm
Minimum Hydraulic Residence Time	>2 Minutes	9 Minutes
Minimum Length of Swale	N/A	30 Metres
Underdrain Requirement*	Slope <1%	Slope <2%
Check Dam Requirement	Slope >4%	Slope >5%
Concentrated Flow Mitigation	No Specific Guidelines	Level Spreader to be Provided at Head of Swale

From the above table it can be concluded that the ARC TP2, 1992 Standard and the NZTA Standard with regards to swale design are very similar with only minor deviations in the design parameters.

The most notable deviation between the two standards is the desired hydraulic residence time. The TP2 document recommends a time approximate to, or greater than 2 minutes whilst the NZTA Standard recommends an approximate residence time of 9 minutes. This is primarily due to the designed vegetation height being increased from 35-150mm to 100-150mm. The increased vegetation height causes the velocity of stormwater within the swale to be reduced, thus leading to increased hydraulic residence time.

Another difference between the two standards is the required design of the underdrain for low gradient swales. Below, figure 4-1 illustrates the design specifications for a swale underdrain as required by the ARC TP2 Standard. Figure 4-2 illustrates the design specifications for the NZTA Standard; this represents a more efficient drainage system in terms of removing water from saturated soils due to the location of the perforated pipe now being located at the lowest point, thus preventing saturation of the soils below the perforated pipe as is possible in the TP2 design. The requirement of the NZTA Standard to install underdrain's at a higher longitudinal gradient also means that potentially fewer swales will be prone to saturation issues along ALPURT.

One final design feature that has been incorporated into the NZTA Standard is the requirement to install a level spreader at the start of the swale to reduce channel erosion within the swale. This has obvious benefits in terms of reducing maintenance costs and also increases the effectiveness of the swale to treat stormwater as the potential to contribute sediment to the system through channel erosion is reduced.

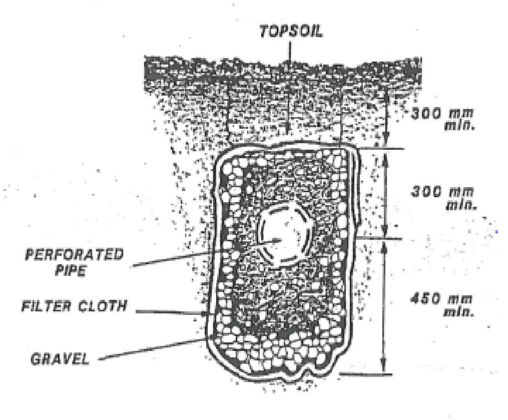


Figure 4-1
Underdrain for Swale Derived from ARC TP2, 1992

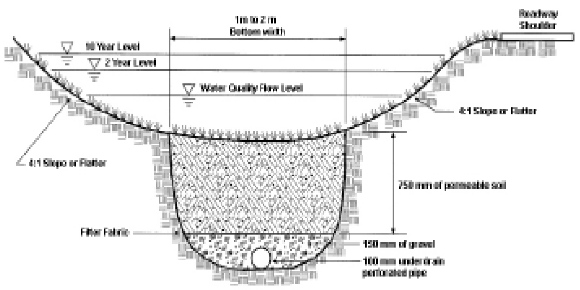


Figure 4-2
Underdrain for Swale Derived from NZTA Standard

4.2.1.2 Wetponds

Design Parameters for Wetponds		
Design Parameters	**ARC TP2**	**NZTA Standard**
Embankment Slopes	3H:1V, 4H:1V (if bank mowed)	2.5H:1V
Pond Depth	2-3 Metres	<2 Metres
Pond Bench	300mm deep bench- distance from shoreline not stipulated	300mm deep extending 3 metres from shoreline
Berm Requirement (forebay-mainpond separation)	Required, however no design parameter specified	Required to be keyed in to base of pond. Slope of 2H:1V required for berm. Built to 300mm below WS
Forebay Volume	5% of Water Quality Volume (WQV)	15% of Water Quality Volume (WQV)
Maximum Forebay Flow Velocities	<0.25m/s for 20% AEP	<0.25m/s for 20% AEP
Forebay Depth	>1 Metre	<2 Metres
Emergency Outlet Conveyance	1% AEP with 300mm freeboard	1% AEP with 300mm freeboard
Vertical Slot Weir Calculations	$Q_{ED}= 1.8w(h_{ED})^{3/2}$	$Q_{ED}= 1.8w(h_{ED})^{3/2}$

With regards to the ARC TP2, 1992 Standard and the NZTA Standard subtle differences do exist in terms of the sizing and construction of some features of wetponds. The above table identifies the primary differences in design parameters between the two standards for wetponds.

Prominent differences between the two standards in terms of design parameters are noted for the design of the forebay and also the berm that separates the forebay and main pond.

The sizing of the forebay for the NZTA Standard is 15% of the total pond volume compared to 5% as detailed in the TP2, 1992 Standard. This has benefits in terms of increasing the ability of the pond to treat stormwater in a more effective manner as the increased forebay size aids in preventing larger volumes of sediment from reaching the main pond, thus aiding the efficient treatment of sediment laden water within the main pond.

Under the NZTA Standard the berm separating the forebay and the main pond is required to be keyed in the bottom of the pond rising up to 300mm below the WS, with stones placed at the top of the berm which represents the forebay outlet. The placement of stones prevents the inflow velocities from the forebay re-suspending sediment within the pond, thus aiding efficient treatment of stormwater in the main pond.

The below schematic is extracted from the ARC's TP2, 1992 this is the same schematic utilised for wetpond design in the NZTA Standard.

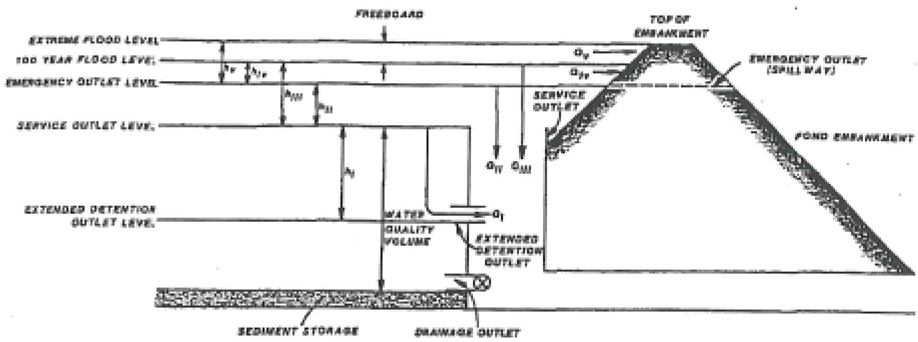


Figure 4-3
Schematic of Wetpond Showing Storm Storages and Elevations

4.2.1.3 Sand Filters

The sand filter configuration that was used for the ALPURT project is essentially the same as required by the NZTA Standard; the filters in fact exceed the NZTA Standard required for vault sand filters. The filter used on ALPURT offers comprehensive treatment of stormwater by having an initial sedimentation chamber and two filtration chambers and having an overflow pipe to convey flows that exceed the designed storm parameters. The sand filter at ALPURT is designed to treat flows from 10% AEP storm events.

Below are schematics for vault sand filters. Figure 4-4 illustrates the NZTA requirement for a vault sand filter. Figures 4-5, 4-6and 4-7 illustrate the vault sand filters for ALPURT.

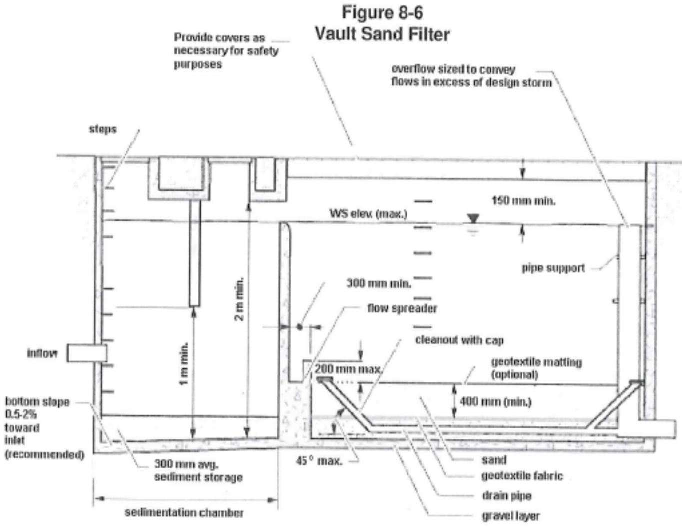


Figure 4-4
Schematic of Vault Sand Filter Derived from NZTA Standard Document

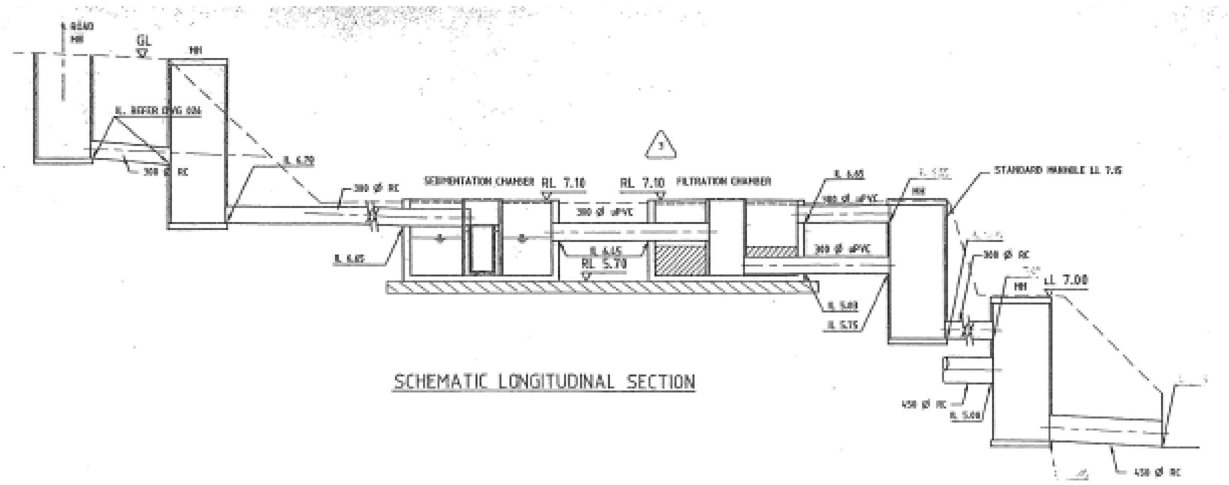
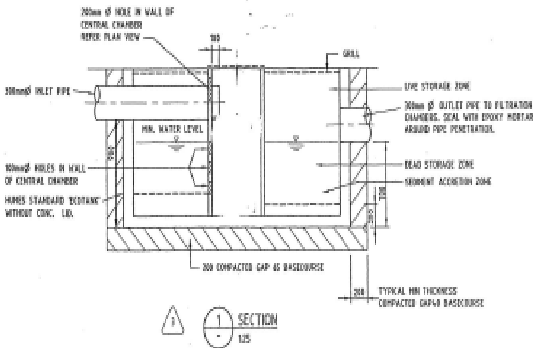


Figure 4-5
Longitudinal Schematic of Sand filter used at ALPURT



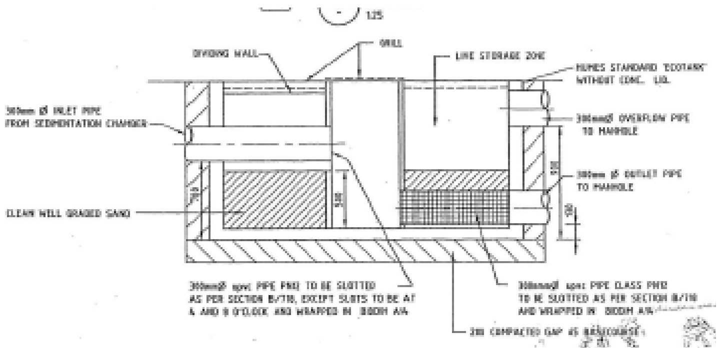


Figure 4-6
Schematic of Sedimentation Chamber for ALPURT Sand Filter

Figure 4-7
Schematic of Sedimentation Chamber for ALPURT Sand Filter

4.3 Maintenance of Treatment Devices

This section identifies the maintenance requirements of the treatment devices located in sectors A2 and B1. The maintenance of these devices ensures that they continue to provide effective treatment of the stormwater.

The maintenance guidelines for the treatment devices for ALPURT draw largely upon an updated version of the TP2 document referred to as TP10 – Auckland Regional Council Technical Publication No.10 "Design Guideline Manual Stormwater Treatment Devices". In terms of maintenance, the TP10 document provides different parameters for the maintenance of treatment devices with the aim of enhancing the efficiency of the stormwater treatment devices, but provides only general guidelines on maintenance activities. The maintenance document created by Serco provides a more detailed maintenance schedule which is specific to the ALPURT treatment ponds.

The NZTA Stormwater Standard also provides general guidelines on when maintenance should be undertaken on treatment devices, but also identifies that maintenance plans developed by designers and engineers are perhaps a more appropriate way of maintaining treatment devices. The NZTA Standard does not address every functional aspect of the treatment devices for ALPURT so comment on the Standard will be made where possible in the following section.

It should be noted that the NZTA Standard for maintenance draws heavily from the TP10 Standard, the inspection checklists are also identical to those derived from the ARC's TP10 document.

The maintenance audit checklists for the A2 and B1 sectors are attached in the appendices.

4.3.1 Wet Ponds

The information regarding the maintenance of wetponds is derived from the Serco maintenance document which outlines specific maintenance requirements for the ALPURT ponds. The Serco maintenance schedule adheres to the maintenance standards outlined in ARC's TP10, 2003 document.

Sediments

Of all the treatment devices ponds are most effective at removing sediments from run-off. They remove sediment by detaining the water long enough for the sediment to settle out. The NZTA Standard notes that performance of the pond will suffer if sediment is introduced in large amounts over a lengthy period of time as the sediments reduce the volume and subsequently the extended detention time resulting in impaired treatment performance. As a result, ponds need periodic maintenance to remove sediments deposited on the bottom. The rate of sedimentation should be measured and compared with data from previous inspection reports to assist in scheduling periodic sediment removal. In a stabilised watershed, the rates of accretion should be consistent. If there is an increase in the rate of sedimentation, then areas contributing stormwater to the facility should be inspected for erosion problems or sediment sources and corrective steps taken.

Accumulated sediments should be removed on a periodic basis before they reduce the detention time. Coarser sediments can be expected to be found close to the pond inlet, with finer sediments deposited closer to the pond outfall. In terms of volume, the coarser sediments occupy a greater volume and removal of these sediments may need to be undertaken more frequently than the removal of finer sediments.

Removing the sediment from the wet ponds involves draining the water down to the lowest possible elevation. If possible, a small pool of water is left to provide a habitat for any resident fish populations. Removing sediment from the dry ponds is done when they are dry and cracked and thereby separated from the vegetation. In both cases, this is achieved by sitting an excavator on top of the pond embankment and excavating the wet material using a swamp bucket. Alternatively, the sediment is removed using a sucker truck similar to those used to clean catchpits.

The NZTA Standard stipulates that the sediment forebay of the pond is to be cleaned out when sediment reaches 50% of the design volume and the main pond is to be cleaned out when the accumulated sediment deposition is within 400mm of the pond water surface.

Toxic Materials and Heavy Metals

Wet ponds are very effective at removing toxic materials and heavy metals when they are attached to sediments, but only wet ponds remove soluble toxics and metals. Pollutant removal effectiveness increases with residence time. Ponds are especially effective at reducing the release of toxic substances that are inadvertently spilled during an accident and function as a holding area until the cleanup is accomplished provided the outlet is blocked off.

To ensure that toxics, especially heavy metals, remain sequestered in the sediment at the bottom of the ponds, it is essential that the bottom environment remains aerobic and that the pH remain neutral. Failure to do this will lead to a release of the pollutants from the sediments and the reintroduction of these contaminants into the run-off.

Nutrients

Nutrients, such as nitrogen and phosphorus, in stormwater come in either particulate or soluble forms. The particulate form of phosphorus is effectively removed through adsorption and sedimentation. The soluble form is not removed by sedimentation but through the processes that occur during the nitrogen cycle.

Ponds only remain effective at removing particulate nutrients if the bottom sediments and water remain aerobic with a pH near 7. To ensure that nutrients remain sequestered in the pond it is important that the [pond bottom remains aerobic. If the pond becomes anaerobic or pH rises or falls, phosphorus that has been previously captured can then be converted to a soluble form and re-enter the run-off.

Oils and Greases

Ponds allow the reduction in oils, greases and other hydrocarbons to occur through vaporization. The effectiveness of this process depends on air and water temperatures, winds, and surface turbulence. Any spills must be cleaned up, contaminated areas removed, and the device appropriately reinstated.

Trash and Debris

The inlet and outlet of the ponds becomes, on occasions, clogged by debris. This must be removed to ensure that all components are operating as required. The removal of trash and debris also prevents possible damage to vegetated areas and eliminate potential mosquito breeding habitats.

Mechanical Components

Valves, gates, locks and access grills should remain functional at all times. All mechanical components should be operated during the annual maintenance inspection to ensure continued performance.

Structural Repairs

Periodic maintenance of structural components are undertaken to ensure their continued operation. This includes inspecting overflow weirs, inlet and outlet pipes and joints for possible leakage or seepage. Areas should also be checked for corrosion; valves should be manipulated and lubricated when needed, and all moving parts inspected for wear and tear. Leakage around the barrel and riser assembly should be checked as it can cause piping of water that adversely affects the structural strength of the facility.

Dam, Embankment and Slope Repairs

Damage to dams and embankments from settlement, scouring, cracking, sloughing, seepage and rutting must be repaired quickly to maintain the integrity and safety of the facility.

Erosion Repair

Where factors have created conditions where erosion will potentially occur corrective steps are taken to prevent the loss of soil and any subsequent risk to the performance of the facility. This is usually mitigated using erosion control blankets, or rip-rap.

Control of Weeds

Undesirable aquatic plants invade littoral zones. These smother other plants and adversely affect the operation of the pond. These undesirable plants must be removed through mechanical or chemical means. If chemicals are used, the chemical should be used as directed and left over chemicals disposed of properly. The chemicals that are used for the control of weeds are low in toxicity and residue.

Grass Maintenance

Grass areas require limited periodic fertilizing, de-thatching, and soil conditioning in order to maintain healthy growth. Where grass cover is damaged by sediment accumulation, stormwater flow, or other causes it will be necessary to re-seed and re-establish the grass. Any grass cutting that is created because of ‘mowing’ within 10m of a watercourse or within the 20% AEP flood plain is collected immediately to ensure that organic material is not washed into the watercourse.

Vegetation Maintenance

Planting within the stormwater treatment devices is maintained and replaced as necessary. Such maintenance ensures the proper functioning of the device. This maintenance also occurs after sediment is removed from the dead storage zone.

4.3.2 Sand Filters

The information regarding the maintenance of sand filters is derived from the Serco maintenance document which outlines specific maintenance requirements for the ALPURT ponds. The Serco maintenance schedule adheres to the maintenance standards outlined in ARC’s TP10, 2003 document.

Sediments

Filters are very effective at removing sediments from stormwater through settling and filtration. Coarser sediments are generally removed in the sedimentation chamber and finer sediment in the sand filter. Generally, the sediment will only penetrate a small distance into a filter made of fine sands. However, the coarser the sand, the further the sediment will penetrate and the more filter media that will need to be removed or replaced. The sand can be scraped off when it becomes contaminated and new sand added to restore the depth to 500mm to restore desired infiltration rates.

If standing water is present after rain, partial clogging has occurred and the sediment must be removed once the filter has dried out. If the filter is totally clogged, it will have to be drained and allowed to dry out before removing the sediment. If sediment removal is attempted while water is standing in the filter tank, the finer sediments will become suspended and will remain in the tank.

The NZTA Standard stipulates that when the permeability rate of the sand filter drops below 300mm/day the filter must be cleaned.

Toxic Materials and Metals

Toxic materials and metals are removed in filters when they attach to sediments or when they pass through organic materials. This occurs in most sand filters where the surface of the filter becomes highly organic due to the trapping of fine sediments, oils and greases. The organic material enhances the ability of the sand filter material to remove toxics and metals. The addition of up to 20% potash can enhance the ability of filters in removing toxic materials.

Nutrients

Filtration systems only remove particulate nutrients and remove phosphorus from stormwater. However, they are limited in their ability to remove nitrogen.

Oils and Greases

Sand filters are very effective at removing oils and greases. The sedimentation chamber is important in removing hydrocarbons due to the fact that oil adheres to solids. The filter chamber removes oils and greases, which penetrate 25mm to 75mm into the filter media (depending on the gradation of the filter media) before being bound up in the sand. Clogging can occur from excess oils and greases entering the facility. Clogging can also occur from algae growth when water is allowed to stand too long in the filter tank. Clogging will cause failure of the sand filter and create a long-term problem.

Structural

Periodic maintenance is done of structural components to ensure their continued operation. This includes inspecting any joints for possible leakage or damage and cleaning pipelines, and replacement. Other maintenance concerns such as spalling of concrete, cracks in concrete or damage to grates are addressed when they are discovered.

4.3.3 Swales

The information regarding the maintenance of swales is derived from the Serco maintenance document which outlines specific maintenance requirements for the ALPURT ponds. The Serco maintenance schedule adheres to the maintenance standards outlined in ARC's TP10, 2003 document.

Sediment

Sediment accumulation in swales is a long-term process. Sediment is trapped around the roots of grass and is slowly be buried by the grass. Where sediment build-up occurs this is removed during the summer by scraping once the sediment is dry.

The NZTA Standard stipulates that all obvious sediment is to be removed from swales.

Trash and Debris

Following each storm event the swales are briefly inspected with the trash and debris that is caught in the swales removed. This is critical in maintaining the effectiveness of the swales as treatment and conveyance devices.

The NZTA Standard stipulates that all obvious trash and debris is to be removed from swales.

Vegetation

Mowing is needed up to three times a year but no mowing is done in the winter. The grass is kept at least 100mm high. Mowing the grass too short will damage the grass, increase run-off flow velocities, increase erosion and decrease pollutant removal effectiveness. If the grass grows too tall, it is prone to lying down in a storm event instead of filtering run-off, thus decreasing treatment effectiveness. Any grass cutting created because of ‘mowing’ must be collected immediately to ensure the organic material is not washed into the treatment pond.

The invasion of undesired vegetation can occur. In some situations it is necessary to remove weeds by chemical means and either resow the grass or replace it with grasses and sedges. In autumn it is sometimes necessary to apply fertiliser to promote a dense growth of vegetation.

The NZTA Standard stipulates that the minimum height for grass within swales is to be 50mm with the desired height being 100mm and that there is to be dense uniform vegetation within swales.

5.0 COST

Resource Consents

Costs for the resource consents are not available for this report. However, the cost is estimated at $20,000-30,000 (1996 rates).

Professional Services

The cost of the geotechnical investigation was estimated at $342,000 for sectors A2 and B1.

Building Consents

No building consents were required.

Final Design

The design costs for the stormwater system for sectors A2 and B1 were approximately $600,000.

Construction

(i) Collection

The primary collection device for ALPURT stormwater is the swales. The total swale landscaping cost for sectors A2 and B1 is approximately $750,000.

(ii) Conveyance

The total costs for subsoil drains for sectors A2 and B1 is approximately $500,000.

The total cost for pavement drains for sectors A2 and B1 is approximately $100,000.

The total cost for stormwater drains and culverts for sectors A2 and B1 is approximately $2,500,000.

(iii) Attenuation

The ponds act as both an attenuation and treatment device so the presented cost is for both actions.

The wetpond construction costs for sectors A2 and B1 is approximately $2,100,000.

(iv) Treatment

For wetponds see above.

The cost of the sand filter is $100,000

Monitoring Costs

(i) Construction

Monitoring costs during the construction phase for sectors A2 and B1 are approximately $200,000

(ii) Operational

Monitoring costs during the operational phase for sectors A2 and B1 are approximately $50,000.

Operation and Maintenance

The estimated annual cost of maintaining the stormwater system is approximately $12,000. The activities primarily associated with maintaining the stormwater treatment devices include:

- Spraying of undesirable vegetation within swales and ponds;
- Cutting of grass within the swales;
- Removal of trash and debris;
- Removal of oils and greases; and
- Removal of sediment from ponds.

6.0 TIME

Resource Consents

The resource consent application was received by the ARC on the 28th of August 1996. The applicants were formally notified of consent approval on the 24th of March 1997.

Building Consents

No building consents were required.

Final Design Time

The final design and construction drawings for ALPURT took approximately 14 months. The stormwater treatment system design was part of that design process.

Construction

The construction time for sector A2 was approximately 30 months (start of 1997 – end of 1999).

Construction time for sector B1 was approximately 18 months (start of 1998- end of 1999)

Operation and Maintenance

(i) Life Expectancy Prior to Major Works

The ponds require the sediment to be cleaned out approximately every 10 years for them to remain effective.

(ii) Life Expectancy for Renewal

Life expectancy for the stormwater system is 50 years.

7.0 Conclusion

The stormwater system for ALPURT was built in accordance with the Auckland Regional Councils guidelines for designing stormwater treatment devices (TP2,1992). The NZTA Draft Stormwater Standard is largely drawn from this standard. When testing the NZTA standard against the standard applied to ALPURT we essentially end up with the same stormwater treatment system built to the same specifications. Only minor deviations in design parameters exist between the two standards and these have no implications in terms affecting the cost of design and construction for ALPURT.

8.0 References

"Design Guideline Manual Stormwater Treatment Devices"- Auckland Regional Council (ARC) Technical Publication No.2 (TP2), 1992

ALPURT – Project Management Plan June 1996

SH1 Realignment Albany to Puhoi: Sector B1 – Pine Valley Road to Orewa Link Road – Application for Resource Consent, July 1997.

ALPURT – Project Management Plan Volume II "Environmental Guidelines", November 1997

Independent Review of ALPURT Resource Consent Processes, October 1997, Hill Young Cooper Ltd

ALPURT – State Highway 1: Albany to Puhoi Realignment, Efficiency of Stormwater Ponds September 2000

ALPURT – State Highway 1: Albany to Puhoi Realignment, Sectors A and B1 Stormwater Treatment Devices, Maintenance and operation Guidelines, July 2001, Serco

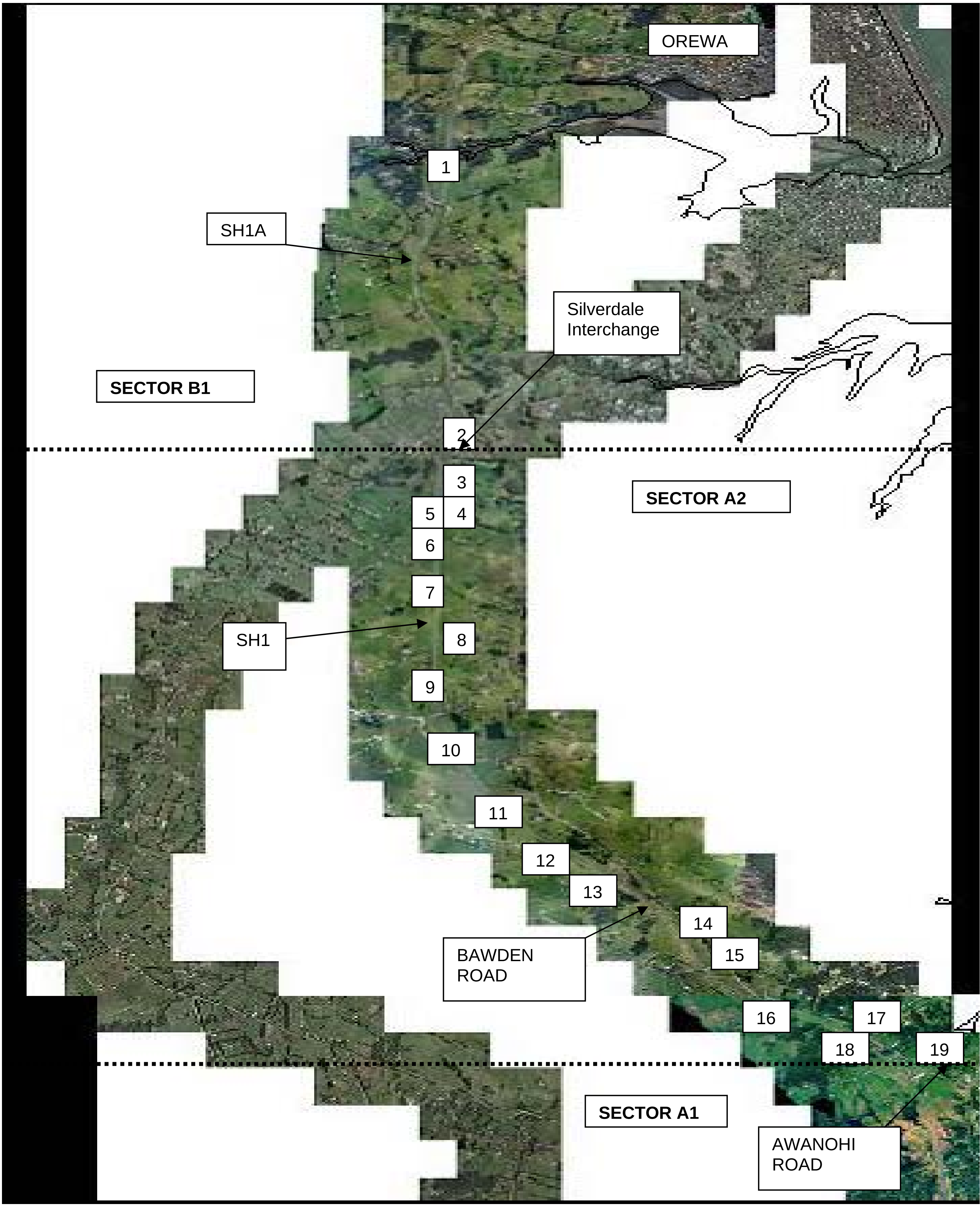
ALPURT – Sector A: SH1, Post-Construction Review of Environmental Treatments, 26-27 April 2006, Transit New Zealand

ALPURT – A2 and B1 Pond Stability Study, Beca Infrastructure, February 2007

Draft Stormwater Treatment Standard for Road Infrastructure, July 2008, NZ Transport Agency (NZTA)

Appendix A: Location of ALPURT Sector A2 and B1 Stormwater Treatment Devices

Treatment Devices Location					
Device No	**Route Position**	**Structure type**	**Outlet Type**	**Pond Volume m^3 (Live)**	**Pond Volume m^3 (Dead)**
1	00/ 2.96 West	Sand filter	N/A	N/A	N/A
2	00/ 0.60 East	Wet pond	Manhole	N/A	N/A
3	00/ 0.08 East	Wet pond	Weir	125	60
4	296/ 0.28 East	Wet pond	Weir	525	85
5	296/ 0.36 West	Wet pond	Weir	1290	830
6	296/ 0.46 West	Wet pond	Weir	395	270
7	296/ 0.96 West	Wet pond	Weir	305	160
8	296/ 1.66 East	Wet pond	Weir	710	210
9	296/ 2.82 West	Wet pond	Manhole	240	N/A
10	296/ 3.36 West	Wet pond	Weir	185	130
11	296/ 4.00 West	Wet pond	Weir	1290	N/A
12	296/ 4.48 West	Wet pond	Weir	550	170
13	296/ 4.85 East	Wet pond	Weir	1895	250
14	296/ 6.68 East	Wet pond	Manhole	885	785
15	296/ 6.88 East	Wet pond	Weir	415	N/A
16	296/ 7.04 West	Wet pond	Manhole	200	125
17	296/ 7.70 East	Wet pond	Weir	980	290
18	296/ 7.75 West	Wet pond	Weir	420	285
19	296/ 7.88 East	Wet pond	Weir	365	250


OREWA
1
SH1A
Silverdale
Interchange
SECTOR B1
2
3
SECTOR A2
5
4
6
7
SH1
8
9
10
11
12
13
14
BAWDEN
ROAD
15
16
17
18
19
SECTOR A1
AWANOHI
ROAD

Appendix B: Maintenance Auditing Checklists for Sand filters, Swales and ponds

Sand Filter Audit Checklist

TRANSFIELD SERVICES
PSMC005

ALPURT SAND FILTER AUDIT FORM

Auditor:____

Date:____

DESCRIPTION	FREQUENCY	ACCEPTALBE	UNACCEPTABLE	COMMENTS
Inlets				
Debris and litter removal required	S			
Sediment accumulation	B			
Evidence of erosion	S			
Sediment Trap				
Signs of petroleum contamination	B,A			
Sediment level	B			
Sediment trap requires cleaning (within 300mm of storage level)	B			
Floating or floatable debris removal required	B			
Filter sock requires cleaning	B			
Filter Sock damaged	B,L			
Riser and pipes				
• Cracks or displacement	A			
• Minor spalling >25mm	A			
• Major spalling (rebar exposed)	A			
• Joint failure	A			
• Water tightness of riser	A			
• Inlet pipe clear	A			
• Outlet pipe clear	A			
Grill				
• Damage	A			
• Corrosion	A			
• Secure	A			

S = Standard Maintenance Items; B = Bi Annual Maintenance Items; A = Annual Maintenance Items; L = Long Term Maintenance (5 year revolving schedule)

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PSMC005

ALPURT SAND FILTER AUDIT FORM

DESCRIPTION Sandfilter	FREQUENCY	ACCEPTALBE	UNACCEPTABLE	COMMENTS
Visible pollution	B,A			
Sediment or trash accumulation	S			
Sand filter dewaters within 48hours	B			
Water ponding 72hrs after storm	A			
Evidence of short circuiting	B,A			
Sand requires aerating	A			
Top 50 to 75 of sand filter requires replacement	A			
Sand filter requires replacement				
Filter Fabric				
• Clogging	A			
• Damage	A			
• Requires replacement	A.L			
Riser and barrels				
• Cracks or displacement	A			
• Minor spalling <25mm	A			
• Major spalling (rebar exposed)	A			
• Joint failure	A			
• Water tightness of riser	A			
Grill				
• Damage	A			
• Corrosion	A			
• Secure	A			

S = Standard Maintenance Items; B = BI Annual Maintenance Items; A = Annual Maintenance Items; L = Long Term Maintenance (5 year revolving schedule)

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PSMC005

ALPURT SAND FILTER AUDIT FORM

DESCRIPTION	FREQUENCY	ACCEPTALBE	UNACCEPTABLE	COMMENTS
Outlet Pipe				
• Cracks or displacement	L			
• Pipe clear	L			
• Joint failure	L			
• Requires cleaning	B			
Outfall				
Outfall pipe clear	B,A			
Concrete or rip rap failure	A			
Maintenance access condition	B			
Comments				

S = Standard Maintenance Items; B = Bi Annual Maintenance Items; A = Annual Maintenance Items; L = Long Term Maintenance (5 year revolving schedule)

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Swale Audit Checklist

TRANSFIELD SERVICES
PSMC005

ALPURT SWALE AUDIT FORM

Auditor:____

Date:____

DESCRIPTION	FREQUENCY	ACCEPTALBE	UNACCEPTABLE	COMMENTS
Debris				
Swales clean of debris	S			
Contributing catchment clean of debris	S			
Vegetation				
Mowed when needed	S			
Minimum mowing depth not exceeded	S			
Dead or dying grass evident	B			
Swale requires dethatching	S			
Invasive or undesirable vegetation growth	S			
Evidence of erosion	S			
Animal burrows	S			
Fertilised as required	A			
Other				
Dewatering				
Swale dewaters between storms	A			
Standing water or wet spots after dry weather	A			
Other				
Sediment				
Sediment build up evident	A			
Visible pollution	B			
Swale needs scraping	L			
Other				

S = Standard Maintenance Items; B = Bi Annual Maintenance Items; A = Annual Maintenance Items; L = Long Term Maintenance (5 year revolving schedule)

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TRANSFIELD SERVICES
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ALPURT SWALE AUDIT FORM

DESCRIPTION	FREQUENCY	ACCEPTALBE	UNACCEPTABLE	COMMENTS
Rock Check Dam				
Evidence of short circuiting	A			
Erosion	S,A			
Damage	A			
Outlets and Culverts				
Erosion evident	S,A			
Good condition	S,A			
Other				
Comment				

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Pond Audit Checklist

TRANSFIELD SERVICES
PSMC005

ALPURT STORMWATER POND AUDIT FORM

Auditor: ____________________________

Date: ____________________________

DESCRIPTION	FREQUENCY	0.25LI	1.67LI	4.88LI	6.65LI	8.06LI	9.25LI	9.45LI	11.3LI	11.08LI	0.95RI	3.2RD	4.47RD	7.04RD	7.73RD	8.65RD	9.85RD	10.2RD
Embankment and Vegetation cover																		
Vegetation and ground cover	B,A																	
Embankment erosion	S																	
Animal burrows	S																	
Litter and debris	S																	
Weeds	A																	
Cracking, bulging or slips																		
• Upstream face	A																	
• Downstream face	A																	
• At or beyond toe downstream	A																	
• At or beyond toe upstream	A																	
• Emergency spillway	A																	
Pond toe	A																	
Seeps or leaks on downstream face	A																	
Slope protection or rip rap failures	A																	
Emergency spillway clear of obstructions	A																	
Other																		
Wet Pond																		
Vegetation healthy and growing	A																	
Invasive vegetation growth	B,A																	
Vegetation harvesting required	A																	
Floating or floatable debris removal required	A																	
Visible pollution (slick) or eutrophication	A																	
Shoreline problems	S																	
Other																		

S = Standard Maintenance Items; B = Bi Annual Maintenance Items; A = Annual Maintenance Items; L = Long Term Maintenance (5 year revolving schedule)

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PSMC005

ALPURT STORMWATER POND AUDIT FORM

DESCRIPTION	FREQUENCY	0.25LI	1.67LI	4.88LI	6.65LI	8.06LI	9.25LI	9.45LI	11.3LI	11.08LI	0.95RI	3.2RD	4.47RD	7.04RD	7.73RD	8.65RD	9.85RD	10.2RD
Sediment																		
Fore Bay or entrance depth	A																	
Pond depth	A																	
Excessive sedimentation evident	A																	
Outlet																		
Outlet type																		
• Reinforced concrete manhole riser	A																	
• Timber weir	A																	
Outlet weir																		
• Debris removal required	M																	
• Corrosion control	A																	
• Timber damage	A																	
• Excessive sediment accumulation	A																	
Outlet Riser and barrels																		
• Cracks or displacement	A																	
• Minor spalling <25mm	A																	
• Major spalling (rebar exposed)	A																	
• Joint failure	A																	
• Water tightness or riser	A																	
• Pond drain valve	A																	
• Pond drain valve operational	A																	
• Pond drain valve chained and locked	A																	
• Outfall pipe clear	A																	
• Head and end walls	A																	
• Outfall clear	A																	

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TRANSFIELD SERVICES
PSMC005

ALPURT STORMWATER POND AUDIT FORM

DESCRIPTION	FREQUENCY	0.25LI	1.67LI	4.88LI	6.65LI	8.06LI	9.25LI	9.45LI	11.3LI	11.08LI	0.95RD	3.2RD	4.47RD	7.04RD	7.73RD	8.65RD	9.85RD	10.2RD
Spillway																		
Type																		
• Reinforced concrete	A																	
• Rip rap	A																	
• Other	A																	
Spillway clear	A																	
Concrete rip rap failure	A																	
Slope erosion	S																	
Other																		
Other																		
Grass mowing required on unplanted areas	B																	
Maintenance access condition	A																	
Other																		
Overall condition (A=acceptable/U=unacceptable)																		

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PSMC005

ALPURT STORMWATER POND AUDIT FORM

Comments	
0.25LI	0.95RD
1.67LI	3.2RD
4.88LI	4.47RD
6.65LI	7.04RD
8.06LI	7.73RD
9.25LI	8.65RD
9.45LI	9.85RD
11.3LI	10.2RD
11.08LI	

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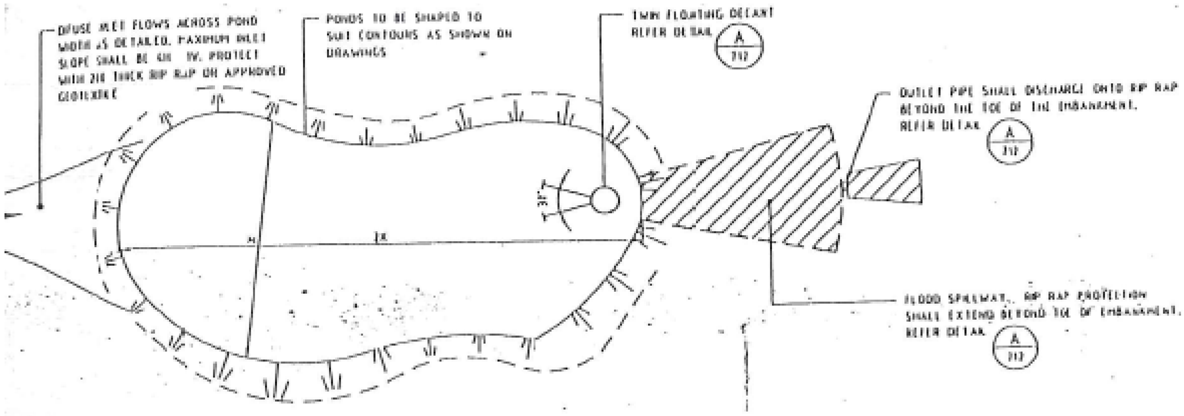
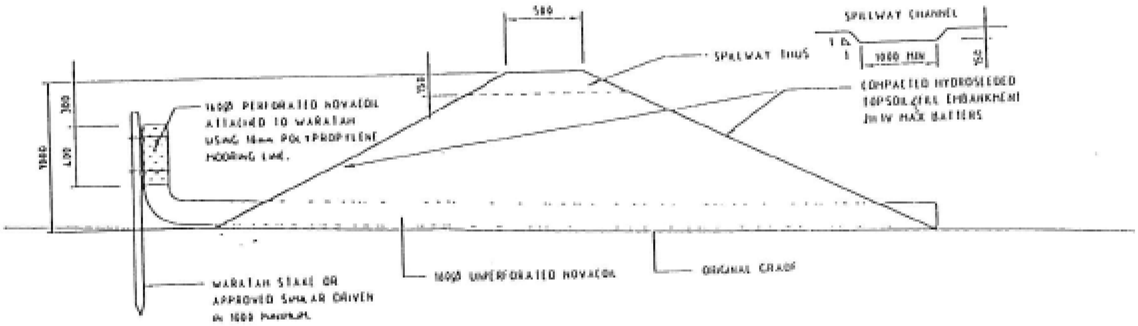
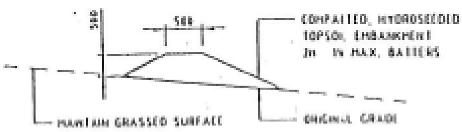
Appendix C: Schematics of Temporary Erosion and Sediment Control Devices



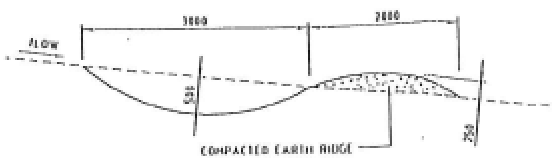
A TYPICAL SINGLE INLET POND
NTS



H BUND WITH DECANT
SCALE 1:5 NOTE
THE PERFORATED AND UNPERFORATED SECTIONS OF NOVACOIL ARE TO BE SOLVENT JOINTED.

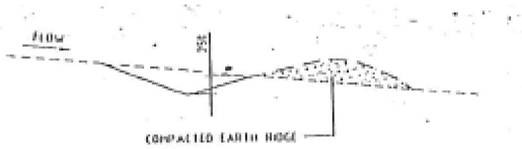


B TYPICAL EARTH BUND
SCALE 1:50

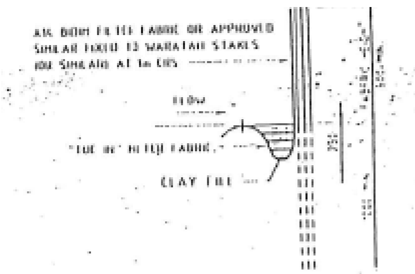


C TYPICAL CUT OFF DRAIN
SCALE 1:50
NOTE:
CUTOFF DRAIN SIMILAR, LINE CUTOFF DRAIN WITH APPROVED GEOTEXTILE AND FIXED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. GEOTEXTILE TO BE "TUCKED IN" ON UP HILL INLET EDGE OF DRAIN.

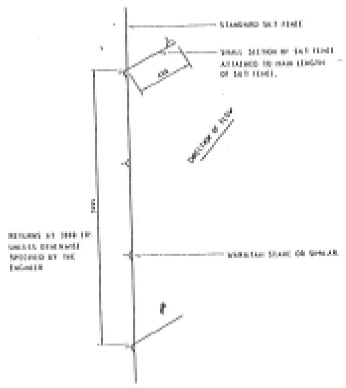
D CUT OFF DRAIN CHECKS
SCALE 1:50



E TYPICAL CONTOUR DRAIN
SCALE 1:50
NOTE:
CONTOUR DRAIN CUT INTO EARTH USING DIGGER BLADE (OR APPROVED SIMILAR METHOD). EXCAVATED MATERIAL IS TO BE PLACED ON THE DOWNSLOPE SIDE OF THE DRAIN.



F TYPICAL SILT FENCE
SCALE 1:25



G SILT FENCE WITH RETURNS

TRANSFIELD
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