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Auckland City Council

Report for Marine Parade Stormwater Project

Design Option Review

July 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

The Marine Parade stormwater project has been ongoing since 2001 and has been through a number of iterations culminating in a recommended option and then proceeding to detailed design and subsequent Resource Consent application to the Auckland Regional Council (ARC).

The ARC notified a Resource Consent application for the proposed outfall at Short Street (onto Sloanes Beach) as part of the recommended option in June 2006. A number of submissions were received from local residents.

The issues raised over the recommended option expressed concerns over the existing stormwater maintenance, boat club building stability, visual effects of the outfall, location and water quality issues.

Rather than seek to address these concerns individually or proceed to a Hearing, Auckland City Council (ACC) have directed GHD Limited (GHD), in conjunction with the residents, to undertake a review of the design options including any further options that should be considered for stormwater disposal within the catchment, taking into account the residents issues raised in the submissions.

A joint on-site meeting of representatives involved in the Marine Parade stormwater project, local community groups such as the Boat Club and local residents, was held on 13 October 2006.

Attendees at the site meeting were:
Residents: Andrew Mason, Jim Mason, Norma Griffiths (41 Marine Parade), Dianne Dodson, Dan Salmon and Ian MacDonald (39 Marine Parade).
GHD: Alastair Monro, Narendra Ganda
Beca: (Project Manager and ACC Representative) Mathew Walker, Kieren Daji
Andrew Stewart Ltd: (Planning Consultant) Aaron Andrew

A scope for this report was drawn up in answer to this site visit and subsequent meetings between affected parties. Auckland City Council signed off the scope for this report in February 2007.

This report seeks to review all of the concerns raised regarding the recommended option and options considered in previous reports and to explore feasible alternative options.

This report combines all previous technical reports to provide a complete background on the project so as to eliminate the need for reference to any previous reports.

2. Background

2.1 Site Description

Marine Parade is located in the western corner of the suburb of Herne Bay, Auckland. The street is approximately 0.8 km long and follows the cliff line between Coxs Bay and Herne Bay. The roadway slopes from either end to a low point in front of 22 Marine Parade that is approximately midway along the street. Heading eastward and away from Marine Parade the land continues to rise to a high point at Jervois Road and is bounded by Herne Bay Road. This basically forms the catchment for which stormwater runoff accumulates at the low point of Marine Parade. This area is approximately 12.4 hectares and is serviced by a combined wastewater and stormwater pipe network.

2.2 Flooding Problems

In July 2000 complaints were lodged with ACC by the owner of 22 Marine Parade with regards to the flooding of this property during heavy rainfall. Investigation has shown that the combined wastewater and stormwater network fails to discharge the catchment run off for the 10% Annual Exceedance Probability (AEP) rainfall event.

The natural topography of the local catchment has a low point at 22 Marine Parade. Before the construction of the Marine Parade carriageway and building platforms, the surface runoff was able to drain from this low point via a gully through what is now 39/41 Marine Parade. Hence, stormwater run-off now struggles to discharge through the piped network, resulting in flooding of the properties in this vicinity.

An increase in housing density in the catchment and an inadequate number of catchpits exacerbates flooding problems. Remedial works have been completed in the area, including the replacement of the kerb and channel on the western side of Marine Parade from Bella Vista Road past Short Street. These works have resulted in a reduction in reports of nuisance flooding.

2.3 Stormwater Investigations

Investigations were undertaken in 2001 to identify the connectivity of the combined wastewater and stormwater network and to assess the capacity of this network to convey the flows from the catchment.

From ACC GIS plans it was identified that the pipe networks for the Marine Parade catchment generally follows the road layout in the area and fall towards the low point of the catchment in the vicinity of 22 Marine Parade. The pipe network along Annan Street, however, is sparse and inadequate and does not fully capture the surface runoff from the road. Runoff from the catchment travels down Annan Street at high velocity towards a low point in the road alignment outside 22 Marine Parade, where it overwhelms the existing catchpit and spills over the kerb onto the adjacent lower level footpath.

The runoff is then directed into two catchpits that connect into a 225 mm diameter combined pipe that cuts across the corner of Annan Street and Marine Parade, beneath the building at 22 Marine Parade and discharges into a Watercare Services Limited (WSL) manhole (WSL MH25). See drawing 51-23678-W001 in Appendix B for the pipe layout around 22 Marine Parade. This 225 mm diameter pipe has insufficient capacity and as a result the footpath area around the two catchpits becomes flooded, this

in turn, causes flooding of the adjacent property at 22 Marine Parade. Insufficient capture of surface runoff is the primary cause of flooding at 22 Marine Parade.

The WSL manhole (MSL MH25) has a 250 mm diameter outlet pipe, which discharges flows out of the catchment area. The manhole has a high-level overflow, which operates when, during significant rainfall events, the capacity of the 225 mm outlet pipe is exceeded. As the weir is overtopped combined wastewater and stormwater discharges directly into the harbour via the outfall pipeline through 39/41 Marine Parade.

Closed circuit television (CCTV) inspections were carried out on the pipe network in the vicinity of 22 Marine Parade. It identified that a number of pipelines were blocked with sludge build up or rubble, had root intrusions or were cracked.

An approximate check of the capacity of the existing 300 – 600 mm diameter pipe beneath 22 Marine Parade showed that it has less than half the required capacity for the catchment that it is serving for the 10% AEP rainfall event (1 in 10 year rainfall event). This would cause the upstream pipelines to surcharge under heavy rainfall and cause backflow through surrounding catchpits and overflow onto the property at 22 Marine Parade with potential of flooding of the basement.

The recommendations following this work was to carry out cleaning of the combined wastewater and stormwater pipelines in the vicinity of 22 Marine Parade and to design for the construction of a new pipeline which would run beneath 22 Marine Parade, then along Marine Parade to connect new catchpits and to discharge via the existing overflow pipeline. This existing overflow pipeline would also require further CCTV inspection to assess its condition. It was recommended that this new pipeline allow for future separation of the stormwater network and have adequate capacity for the 10% AEP rainfall event.

2.4 Remedial Options

Following the above stormwater investigations and recommendations it was decided that a more thorough assessment of solutions be undertaken. Four possible solutions were investigated:

1. Piping the catchment stormwater runoff for 10% AEP rainfall event through Short Street. In addition, the extra stormwater runoff for a 2% AEP rainfall event (1 in 50 year rainfall event) will be provided for by regrading of roads to create an overland flowpath through Short Street.
2. Piping all the catchment stormwater runoff for a 2% AEP event through Short Street by providing larger pipes and no regrading of roads.
3. No change to the current stormwater system.
4. Increasing the capacity of the current stormwater system.

The existing combined network is in poor condition and under capacity. Therefore, Option 3 (i.e. no change to the current stormwater system) was not recommended.

Due to the ongoing difficulties in obtaining Private Property Owner Consent and the liability issues associated with constructing a new pipeline beneath 22 Marine Parade, the option of upgrading the existing network was also not recommended.

Options 1 and 2 will address the flooding experienced at 22 Marine Parade during a 2% AEP rainfall event.

Option 1, which involved providing an overland flowpath (by regrading of the roads), was deemed a technically preferable option as pipe systems are prone to blockage. However, there is a substantial cost saving in the pipe-only system, as there is no need to carry out the expensive regrading of the road. Regrading of roads can also cause other difficulties such as clashes with existing services and possible vehicle access difficulties as a result of road and driveway level changes.

It was concluded that piping the catchment stormwater runoff via Short Street i.e. Option 2, was the most practical and economical solution and it was therefore identified as the recommended design option.

2.5 Recommended Option

Option 2 was the recommended option and was progressed to Detailed Design. A pipe network was designed to capture surface runoff from Marine Parade, Annan Street and Upton Street, in the vicinity of 22 Marine Parade. This involved a number of pipelines along these streets meeting at a manhole at the entrance to Short Street. An outlet pipe was proposed down Short Street to an outfall structure on Sloanes Beach.

2.6 Resource Consent

The proposed outfall structure required Resource Consent for which ACC applied to ARC in 2005. The ARC notified the Resource Consent application in June 2006.

A total of 90 submissions were received from local residents and interested parties. A total of 89 submissions opposed the proposed outfall on Sloanes Beach.

The main objections were that the options assessment was insufficient and that other outfalls were more suitable. Concerns regarding boathouse stability, visual effects of the outfall, location and water quality issues were also raised. A summary of these consent submissions is provided in Section 5.

3. Existing Catchment and Network

3.1 Catchment and Flows

Marine Parade, Jervois Road and Herne Bay Road bound the area that contributes stormwater runoff to the low point at 22 Marine Parade (See Figure 1 in Appendix A for sub-catchment boundaries). This area is approximately 12.4 hectares and is serviced by a combined wastewater and stormwater network.

In terms of the overland flow in larger storm events, the overall catchment drains to three points. The first is to the bottom end of Bella Vista Road where runoff from properties along Jervois Road and Marine Parade drain out onto the road and flow down to this point. This sub-catchment is designated as Catchment A and has a total area of 4.1 hectares.

The next overland flow path drainage point is at the bottom end of Herne Bay Road. Property and road runoff flow down the street and exit through a low driveway on the corner of Herne Bay Road and Marine Parade. A small area bounded by Upton Street and Galatea Terrace also drains to this point resulting in a total contributing area of 1.9 hectares. These sub-catchments are designated as Catchments C and D.

Runoff from approximately 6.4 hectares (sub-catchment B) flows to this point via Bella Vista Road, Galatea Terrace, Upton and Annan Streets and Marine Parade. This overland flow contributes to flooding at 22 Marine Parade and surrounding properties.

3.2 Combined Wastewater and Stormwater Network

The Marine Parade catchment is serviced by a combined drainage network, which carries both wastewater and stormwater. (Refer to Figure 1 for a layout of the existing combined network and drawing 51-23578-W001 in Appendix B for details on the manhole arrangement in front of 39 Marine Parade.)

The southern end of Marine Parade is serviced by dual 225 mm diameter lines, which drain towards manhole NN7715 at the bottom of Bella Vista Road. Bella Vista Road and Wolseley Avenue are serviced by a single 225 mm diameter line also connecting to manhole NN7715. Manhole NN7715 has a an overflow pipe which allows flow in excess of the capacity of the network to discharge into the harbour at 53 Marine Parade via a 225 mm outfall pipe.

From manhole NN7715 the combined system continues down Marine Parade to manhole AA020 at 39 Marine Parade.

Galatea Terrace, Upton Street and the upper half of Marine Parade drain towards the corner of Marine Parade and Upton Street and then to manhole MHA at 39 Marine Parade. Manhole MHA is connected to manhole AA020.

Annan Street is serviced by a combined pipe system and a single stormwater line. Both these lines cut across 22 Marine Parade to the manhole arrangement in front of 39 Marine Parade. The stormwater line connects to manhole AA020 and the combined pipe connects to the WSL manhole MH25.

Manhole AA020 also connects into this WSL manhole. All catchpits along these routes discharge into the combined system.

During low flows, a 225 mm diameter WSL wastewater line discharges wastewater and stormwater flows out of the system. During high flows, the combined flow is allowed to spill over a high-level weir and discharge to the harbour via the existing pipe and outfall in the vicinity of 39/41 Marine Parade.

Metrowater are currently undertaking a study to prioritise the separation of the combined systems throughout the city. However, anecdotal evidence suggests that ACC has not planned for separation of this combined network within the next 10 years. As a result any option considered or implemented as part of this project will need to retain the existing combined system.

3.3 Existing Overflow Pipes

3.3.1 39/41 Marine Parade Outfall

From manhole AA020 situated in the roadway adjacent to 22 Marine Parade the overflow pipe system runs beneath 39 and 41 Marine Parade to an outlet structure at the low tide mark.

The overflow system begins as a 600 mm diameter pipe which runs approximately 13m from manhole AA020 directly into the property at 39 Marine Parade. At this point the 600 mm diameter pipe splits into a 500 x 500 mm box culvert and a 450 mm diameter pipe.

The 500 x 500 box culvert veers across to a manhole within the property at 41 Marine Parade. From this manhole it then runs to manhole BA030 at the rear of the property. From here the single outfall pipe continues to the low tide mark. The 450 mm diameter pipe runs directly from the junction with the 500 x 500 mm box culvert to manhole BA030 at the rear of 41 Marine Parade.

The condition of these pipes is discussed in Section 4 of this report.

3.3.2 Bella Vista Road Outfall

The overflow at the western end of Bella Vista Road consists of a single 225 mm diameter outfall pipe. The pipe originates at manhole NN7715 on the corner of Marine Parade and Bella Vista Road. From this manhole the pipe runs underneath the dwelling at 53 Marine Parade to a manhole NN7731 located in the back of the property, from this manhole the pipe discharges to the sea.

The condition of these pipes is unknown, as they were not inspected during previous CCTV investigations.

4. CCTV Inspections

CCTV inspections were carried out in 2001 and again in 2007. The investigation assessed the condition of the existing outfall pipes and box culvert at 39/41 Marine Parade. The following table summarises the results from these investigations. Drawing 51-23678-W001 in Appendix B also provides a visual representation of the results. The overall conclusion of the 2007 CCTV inspection was that there was no significant deterioration of these pipes over the past 6 years.

Table 1 Summary of CCTV inspections

Year of Survey	Pipe Line Details	Pipe Diameter	Project Summary	Cause of Problem	Recommended Works	Notes
2001	MHBA020-MHBA030. No's 39- 41 Marine Parade Length: 55.3 Material: CP	500 mm x 500 mm box culvert	Inspection abandoned at 55.3m downstream of MH BA020 due to root intrusions. Line full of encrustations (due to infiltration), several root intrusions of small- medium severity. Surface damage of similar severity was observed during the inspection with exposed aggregated sections.	Surface damage, root intrusions, encrustations.	Lining with grouting of box culvert edges	
2007	MHBA010-MHBA030. No's 39-41 Marine Parade Length: 55.8 Material: CP	500 mm x 500 mm box culvert	Line full of encrustations (due to infiltration), root intrusions of medium to large severity. Exposed aggregate sections could be observed during the inspection. No lateral connections observed in line.	Surface damage, root intrusions, encrustations.	Lining with grouting of box culvert edges	1. Extent of surface damage could not be verified by CCTV inspection. Profiling of the stormwater line will allow a better assessment and indicate any deterioration of line from previous inspection above. 2. Site investigation required to assess accessibility of appropriate lining option. (Spiral wound, CIPP).
2001	MHBA020-Junction on line (MHAA020-MHBA030). No's 39- 41 Marine Parade Length: 7.2 Material: CP	500 mm x 500 mm box culvert	Line full of encrustations (due to infiltration), of small-medium severity. Exposed aggregate sections could be observed during the inspection. No lateral connections observed in line.	Surface damage, root intrusions, encrustations.	Lining with grouting of box culvert edges	
2007	MHBA010-MHBA030. No's 39-41 Marine Parade Length: 9.0 Material: CP	500 mm x 500 mm box culvert	Line full of encrustations (due to infiltration), of small-medium severity. Exposed aggregate sections could be observed during the inspection. No lateral connections observed in line.	Surface damage, encrustations.	Lining with grouting of box culvert edges	1. Extent of surface damage could not be verified by CCTV inspection. Profiling of the stormwater line will allow a better assessment and indicate any deterioration of line from previous inspection above. 2. Site investigation required to assess accessibility of appropriate lining option (Spiral wound, CIPP)
2001	MHAA020-outlet (MHBA030). No's 39 (O/S)- 41 Marine Parade Length: 13.2 Material: EW	600 mm Φ	Line with several cracks of medium to large severity. One broken pipe section at 11.2m downstream of MHAA020 nearly collapsing requiring urgent attention. One chamber located at 1.2m downstream of MHAA020 that need to be exposed during rehabilitation work. No lateral connection observed.	Cracks, collapsed pipe section.	Lining	
2007	MHAA020-outlet (MHBA030). No's 39 (O/S)- 41 Marine Parade Length: 12.0 Material: CP	600 mm Φ	Line with several cracks of medium to large severity. One broken pipe section at 10m downstream of MHAA020 nearly collapsing requiring urgent attention. No lateral connections observed.	Cracks, collapsed pipe section.	Lining	No significant further deterioration from first survey in 2001, however the status of the pipe requires urgent attention.
2001	Junction (Line AA020-outlet (MHBA030). No's 41 Marine Parade Length: 60.2 Material: EW	450 mm Φ	Line with several cracks located between of medium to large severity. One broken pipe section at 27.7m downstream of Junction of large severity. Root intrusions were observed between 57.0-60.0m downstream of Junction. Two blank lateral connections at 43.7m(9) and 60.0m(9) the latter with root intruding in the main pipe.	Cracks, collapsed pipe section.	Lining	
2007	Junction (Line AA020-outlet (MHBA030). No's 41 Marine Parade Length: 65.1 Material: CP	450 mm Φ	Line with several cracks located between of medium to large severity. One broken pipe section at 27.7m downstream of Junction of large severity. Root intrusions were observed between 57.0-60.0m downstream of Junction. Two blank lateral connections at 43.7m(9) and 60.0m(9) the latter with root intruding in the main pipe.	Cracks, collapsed pipe section.	Lining	Survey indicates no further deterioration from first survey in 2001, however the status of the pipe requires attention.

5. Geotechnical Investigations

The following investigations have been conducted to assess the ground conditions surrounding the area of investigation:

» Geotechnical Investigation, City Design, 27 June 2001.

» Geotechnical Investigation and Assessment (39 Marine Parade), Tonkin and Taylor, 16 November 2001.

» Geotechnical Investigation, Soil Engineering, 30 January 2004.

From the above listed investigations, the following conclusions are drawn:

» The information is adequate for initial cost estimates, but will need further evaluation once the route for Detailed Design has been agreed.

» There is no clear evidence of a major instability in the vicinity of 39/41 Marine Parade, however the settlement observed indicates some historical movement and that significant further investigation and analysis would be required before new pipework was considered further here.

» The Herne Bay region has a history of instability, typically involving movements of the weaker Pleistocene subsoils on the contact with the Waitemata Group materials at depth (Tonkin&Taylor, November 2001). This again needs to be considered in the context of installing new pipelines, particularly underneath buildings.

Borehole logs are attached in Appendix C.

6. Review of Consent Submissions

The Resource Consent application was facilitated by Andrew Stewart Ltd. The following table summarises the submissions made during this process:

Table 2 Resource Consent Submission Summary

Position on Project	**Total Submissions**
Support	1
Oppose	89
Wish to be heard	57
Refuse consents in entirety	83
Will consider a joint case at hearing if others make a similar submission	67
Reasons for Objection	**Total Submissions**
AEE and supporting documents insufficient or absent	78
Thorough hydrological study of impact of uncontrolled stormwater required	77
Discharge will adversely affect coastal processes/cause erosion	82
Outfall will adversely affect boat club building	83
Options assessment insufficient/other outlet locations more suitable	80
Proposal will adversely affect foreshore amenity	81
Proposal is contrary to ARC coastal plan	79
Fails to meet RMA as proposal does not achieve sustainable management	77
Stormwater discharge will pollute the beach	10
Discharge will produce algal blooms/adversely affect marine life	1
Proposal contradicts city and regional policies to achieve clean waterways	1
Proposal will restrict recreation/access to beach/rocky foreshore	6
Rock scaping increases the impact of proposal/is ugly	4
Further stormwater treatment should be provided before discharge	2
Scale of proposal is excessive	2
Pipe should be below ground and discharge at low tide mark	4

7. Consideration of Additional Options

7.1 Option 1: Increase capacity of existing Outfall at Bella Vista Road. Upgrade part of existing outfall at 39/41 Marine Parade.

Please refer to drawing 51-23678-W011 in Appendix A.

Option 1 involves increasing the capacity of the existing outfall at Bella Vista Road to discharge stormwater runoff generated by Catchment A and the area south of Bella Vista Road, which comprises approximately $^1/_3$ of Catchment B. This will effectively "cut-off" the runoff from this sub-catchment and reduce the loading on the existing outfall at 39/41 Marine Parade.

The existing drainage system consists of 225 mm diameter combined pipes, including the outfall pipe, and does not have sufficient capacity to accommodate the runoff from the above-mentioned catchment. Thus the whole drainage system of the sub-catchment will need upgrading.

When upgrading the system, it would be sensible in terms of construction and cost effectiveness to separate the stormwater and wastewater system for the sub-catchment, rather than just upgrading the existing combined system. This approach will better align with Auckland City's aim to separate the wastewater and stormwater systems throughout Auckland and will save future separation expenditure.

Separating the drainage system will also require additional work on either the private drainage connections in the catchment, or alternatively new stormwater and catchpits to be constructed.

It should be noted that agreement would need to be reached between Auckland City Council and Metrowater to fund these separation works.

The proposed stormwater system for the sub-catchment is shown on the above referenced drawing. It will have dual drainage pipes along Jervois Road, starting with 225 mm diameter pipes at the top and will increase in size to 300 mm diameter towards the end of Bella Vista Road. A single pipeline will run along Bella Vista Road and Wolseley Avenue, increasing in size to 450 mm diameter down to the end of Bella Vista Road.

The system will discharge to the sea via a new 450 mm diameter outfall pipe at the end of Bella Vista Road. The existing 225 mm diameter combined outfall pipe runs underneath a residential dwelling at 53 Marine Parade. The risk of damaging the property when upgrading the pipe is high; therefore, a new route will have to be established for the upgraded outfall.

The new stormwater system will reduce the loading on the existing overflow outfall at 39/41 Marine Parade. However, the 600 mm diameter pipe at the upstream end of this outfall (Marine Parade roadway to 39 Marine Parade) will have to be upgraded to 675 mm diameter.

CCTV inspections revealed that the existing outfall pipes and box culvert in the vicinity of 41 Marine Parade are in poor condition and any option utilising this outfall will have to include the lining of the existing 450 mm diameter outfall pipe and 550 x 550 mm box culvert.

The existing 450 mm diameter stormwater line discharging to Sloanes Beach would remain under Option 1.

7.2 Option 2: Construct new stormwater pipe system for Annan Street and discharge point at Short Street. Keep existing outfall at 39/41 Marine Parade.

Please refer to drawing 51-23678-W012 in Appendix A.

Option 2 involves the construction of a new stormwater network at the intersection of Marine Parade and Upton and Annan Streets. The network will connect to a new manhole in 39 Marine Parade and discharge through the existing 550 x 550 mm box culvert and 450 mm diameter outfalls.

This option also includes a high-level overflow, which will discharge via a new pipeline constructed down Short Street Reserve. The final outfall location for this 525 mm diameter overflow pipeline is yet to be determined. Options exist to disguise the outfall with a landscaped energy dissipation structure discharging to the beach. Alternatively, the outfall could be extended past the private boat ramp of 33 Marine Parade.

The collection of stormwater runoff from Annan and Upton Streets and Marine parade will directly reduce flooding at 22 Marine Parade. The existing pipelines beneath 39/41 Marine Parade will remain operational and will be rehabilitated.

The new stormwater network will commence at 1 Annan Street with three new catchpits connecting into a 375 mm diameter pipe running down Annan Street. A new manhole will be placed on top of the existing 300 mm diameter stormwater pipe exiting from 2 Annan Street. This will re-direct this pipeline into the new system.

Existing catchpits draining the low-point in the footpath east of 22 Marine Parade, and those draining the carriageway, will be upgraded to high-capacity catchpits and will connect to the new line. From here a 675 mm diameter line will run down to the intersection of Annan and Upton Streets and pick up the two catchpits at the bottom of Upton Street. The system will then discharge through a new 900 mm diameter line, which will be connected to a new manhole in 39 Marine Parade.

The high-level overflow weir in the manhole at the intersection of Upton and Annan Streets will discharge via a 525 mm diameter pipeline down Short Street Reserve. This line can be directionally drilled from a set-up at the location of the manhole. The line could be drilled in one continuous string and the pipe pulled from the outfall location. This methodology would have minimal impact on Shore Street Reserve.

Two additional high-capacity catchpits will be constructed in front of 24 and 41 Marine Parade and connected to the upstream end of the existing outfall at 39/41 Marine Parade.

The existing 500 x 500 mm box culvert and 450 mm diameter culverts will have to be rehabilitated. The 600 mm diameter line upstream of this junction is also in poor condition and would be replaced under Option 2.

The existing 300 mm – 600 mm diameter stormwater line between Annan Street and Marine Parade, crossing 22 Marine Parade, is currently in a very poor state and will be abandoned.

There is an opportunity to connect the existing 450 mm diameter stormwater pipe, which currently discharges to Sloanes Beach, to the proposed 525 mm diameter overflow pipe. However, this would result in the outlet pipe flowing during all storm events. This would need to be investigated further.

7.2.1 Modelling of Option 2

Option 2 was modelled by amending the existing Metrowater Herne Bay Integrated Catchment Study (ICS) MOUSE model. The existing model was updated with the proposed pipe arrangement to determine the spill frequency and volume of flow over the proposed high-level overflow weir (525 mm diameter pipeline). Model results show that the overflow will not spill during the 1 in 10 year event, but will spill 105 ℓ/s during the 1 in 20 year event and 195 ℓ/s during the 1 in 50 year event.

7.3 Option 3: Construct new stormwater pipe system for Annan Street and connect to existing outfall at 39/41 Marine Parade. Replace the existing outfall pipe system.

Please refer to drawing 51-23678-W013 in Appendix A.

Option 3 is a derivative of Option 2. Option 3 varies from Option 2 in that it does not involve a secondary discharge in Short Street. Rather, Option 3 utilises the same route as the existing outfall in the vicinity of 39/41 Marine Parade.

This option therefore involves the construction of a new stormwater system for Annan Street, which would then connect to manhole AA020 using a new 750 mm diameter line.

In order to connect to manhole AA020, it will have to be deepened by approximately 1.6 m. The existing outfall pipe arrangement will need to be upgraded to increase capacity. A single 825 mm diameter pipe will replace the existing 600 mm pipe and culverts. The 825 mm pipe connecting into existing manhole BA030 and then discharging via the existing outfall pipe.

Construction of the 825 mm diameter pipe introduces risk due to the close proximity of the pipeline to the dwelling at 39 Marine Parade. This risk is heightened given the inherent risks of excavating in close proximity to the cliff edge.

The existing 450 mm diameter stormwater line discharging to Sloanes Beach would remain under Option 3.

The main risks associated with replacing the existing outfall pipe are the close proximity of the house structure and the inherent unstable nature of the cliff edge ground.

7.4 Option 4: Construct new stormwater pipe system for Marine Parade and Annan Street and discharge at Sloanes Beach via outfall structure.

Please refer to drawing 51-23678-W014 in Appendix A.

Option 4 is the original preferred option as presented for Resource Consent application to the ARC in 2006. It is not an additional option, but is discussed here for the sake of completeness.

This option comprises the construction of a new stormwater system for Marine Parade and Annan Street. The new stormwater pipe system will start at 1 Annan Street with three new catchpits connecting into a 375 mm diameter pipe running down Annan Street. A new manhole will be placed on top of the existing 300 mm diameter stormwater pipe exiting from 2 Annan Street. This will re-direct this pipeline into the new system. The existing catchpits located in the footpath to the back of 22 Marine Parade and in the carriageway will be upgraded to high-capacity catchpits and connected into the new manhole.

In Marine Parade two new manholes will be constructed in the carriageway in front of 37 and 39 Marine Parade. The existing five surrounding catchpits will be upgraded and re-connected into one of the manholes. Two additional high-capacity catchpits will be constructed in front of 41 and 24 Marine Parade and connected to the same manhole.

A pipe-jacking pit will be formed at the corner of Annan and Upton Streets from where 1050 mm diameter pipes will be jacked towards a new manhole in Annan Street, a new manhole in Marine Parade and a new manhole midway along Short Street. The 1050 mm diameter pipeline in Short Street will continue towards Sloanes Beach where the system will discharge via a concrete outfall structure, constructed and camouflaged to blend in with the surrounding rocks.

Under Option 4 the final location for the outfall structure would need to be determined. There is potential to extend the outfall in a seaward direction, approximately 50 m offshore where there is a natural rock shelf. Extending the outfall to this location would bring about a number of potential complications i.e. “silting-up” of the outfall and this would need to be investigated further. However, there are means of addressing this issue. The option to extend the outfall is likely to be very costly and gaining Resource Consent for the extended outfall may prove to be difficult.

These issues would need to be investigated fully in a detailed assessment of this option, should Option 4 be progressed to Detailed Design.

The existing 450 mm diameter stormwater line, which currently discharges to Sloanes Beach, is proposed to be connected to the new system under this option.

For Option 4 the existing overflow at 39/41 Marine Parade would be abandoned.

7.5 Option 5: Construct new stormwater pipe system for Annan Street and discharge point at bottom of Bella Vista Road. Abandon existing outfall at 39/41 Marine Parade.

Please refer to drawing 51-23678-W015 in Appendix A.

Option 5 incorporates an upgrades stormwater network at the intersection of Marine Parade and Annan/Upton Streets, similar to Options 2 – 4. The discharge pipe however, extends to a new outfall between 53 and 57 Marine Parade. This pipeline could only be feasibly constructed using a pipe-jacking methodology.

In order to connect to the existing catchpits in Annan Street, avoid clashes with existing services and get a positive fall in the outfall pipe, the proposed stormwater pipes will have to be installed at considerable depth.

Two 6 m square jacking pits will have to be constructed to accommodate the direction changes of the pipes, one at the corner of Annan and Upton Street and a second at the corner of Bella Vista Road and Marine Parade. The jacking pit at Annan Street will be approximately 9m in depth and the pit at Bella Vista Road will be approximately 18 m deep.

Constructing pipes at this depth is very expensive and poses a multitude of construction and future maintenance difficulties.

The existing overflow at 39/41 Marine Parade would be abandoned.

The existing 450 mm diameter stormwater line discharging to Sloanes Beach would remain under Option 3.

8. Assessment of Additional Options

The following table summarises the option assessment for the additional options presented in the previous section.

Table 3 Assessment of Additional Options

OPTION 1	
General Comments and Risks Identified	Option 1 will reduce the loading on the existing outfall pipe system at 39/41 Marine Parade by approximately 40%, however, it will not remove the risk of flooding at 22 Marine Parade, which is mainly due to the poor interception of the catchment runoff along Annan Street and the property's low elevation relative to the surrounding road level. Option 1 will also involve the separation of the public and private drainage systems in the contributing catchment, which will be very costly. Metrowater are currently undertaking a study to prioritise the separation of the combined systems throughout the city. This study is due for completion in early 2008, and will set the timing of separation in this catchment.
Construction Cost	$1.8 M - $2.2 M *Note: Range indicates preliminary nature of cost estimate* *Private drainage separation costs are excluded.*
Staging	N/A
Constructability	Construction of the main collector pipe system will be straightforward. The outfall pipe could be directionally drilled, but due to the nature of cliff faces there might be stability issues. *(Note: The option of constructing the new outfall pipe along the same route as the existing pipeline i.e. beneath the dwelling at 53 Marine Parade, was considered to be unacceptable due to the elevated construction risks.)*
Affected Parties	All residents within the contributing catchment area. 53 & 57 Marine Parade will be affected by the construction of the new outfall pipeline. 46 & 48 Marine Parade will have access to their properties affected during the works.
Environmental & Amenity Considerations	The quality of discharge at the Bella Vista Road outfall will be greatly improved, as the outfall will now discharge stormwater only. The overflow volume at 39/41 Marine Parade will be reduced, but the discharge will remain combined.
Level of Service	Capacity of the Bella Vista Road outfall will be increased to discharge the runoff from a 10% AEP event without surcharge. By upgrading the top end of the 39/41 Marine Parade outfall pipe, the capacity of the outfall will be increased to accommodate runoff from a 2% AEP event without surcharge.

OPTION 2	
General Comments and Risks Identified	This option will greatly reduce the amount of flooding experienced by 22 Marine Parade by effectively capturing the surface runoff along Annan Street. Though this option still discharges along Short Street, it differs from the preferred option presented for Resource Consent (June, 2006) in that it is a secondary flowpath, the size of the outfall pipe is significantly reduced and it would not require the large concrete outfall structure on the beach. The location of the outfall onto Sloanes Beach has yet to be determined. Options exist to landscape the outfall with the incorporation of energy dissipation structures. Alternatively, an option exists which looks to divert the outfall past the front of 33 Marine Parade. However, this option will still utilise the existing outfall structure, which will require remedial work.
Construction Cost	$1 M - $1.2 M *Note: Range indicates preliminary nature of cost estimate.*
Staging	N/A
Constructability	The new outfall towards Short Street could either be pipe-jacked or directionally drilled as will the section between 2 Annan Street and the manhole at the corner of Annan and Upton Streets. The flow dissipation zone at the outfall pipe end will require input from a Landscape Architect.
Affected Parties	Properties along Annan Street and the bottom part of Upton Street. Properties adjacent to Short Street and along Marine Parade in the vicinity of the existing outfall. Approval will be required from ACC Arts, Community, and Recreation (ACR) Services.
Environmental & Amenity Considerations	Frequent or large events may cause erosion down Short Street.
Level of Service	The new stormwater system will have sufficient capacity to discharge stormwater flows from a 2% AEP event without surcharge. The capacity of the existing outfall remains unchanged.

OPTION 3	
General Comments and Risks Identified	This option will greatly reduce instances of flooding inundation at 22 Marine Parade by effectively capturing the surface runoff along Annan Street. Construction of the 825 mm diameter pipe introduces risk due to the close proximity of the pipeline to the dwelling at 39 Marine Parade. This risk is heightened given the inherent risks of excavating in close proximity to the cliff edge.
Construction Cost	$800k - $1.1 M *Note: Range indicates preliminary nature of cost estimate*
Staging	N/A
Constructability	It will be difficult and risky to drill or pipe-jack a new outfall pipeline in close proximity to the dwelling at 39 Marine Parade, through ground that shows signs of movement. Connecting another pipe to the existing manhole cluster in Marine Parade will be difficult to construct and will complicate an already complex pipe connection arrangement.
Affected Parties	Construction of the new outfall pipe will directly affect the owners and occupants of 39 and 41 Marine Parade. Properties along Annan Street, the bottom end of Upton Street and Marine Parade between the outfall and Short Street will also be affected by construction. The owner of 41 Marine Parade has previously indicated her opposition to any works in her property.
Environmental & Amenity Considerations	The discharge quality at the outfall will be greatly improved, since the outfall will now only contain stormwater and not a combination of stormwater and wastewater.
Level of Service	The new stormwater system will have sufficient capacity to discharge stormwater flows from a 2% AEP event without surcharge.

OPTION 4	
General Comments and Risks Identified	This option will significantly improve the stormwater network along Marine Parade and Annan Street. It effectively separates the stormwater and wastewater system for this area, greatly improving the quality of the discharge water. One of the main issues property owners had with this option was the outfall structure on the beach. Even though it would be constructed in such a way as to blend in with the surrounding rocks, it was perceived to be excessive in size.
Construction Cost	$1.1 M
Staging	N/A
Constructability	The proposed methodology is to construct the bulk of the pipeline by jacking. This will require a jacking pit at the corer of Annan Street and Upton Street. There is sufficient room at this intersection for this pit. There may also be potential issues with construction in the coastal marine area and in the vicinity of the existing boat shed. Careful consideration will need to be given to all works in this area.
Affected Parties	Identified during resource consent process.
Environmental & Amenity Considerations	Having a separate stormwater system will greatly improve the quality of the discharge water, since it will now only contain stormwater and not a combination of storm and wastewater. The outfall structure will be constructed to blend in with the surrounding rocks.
Level of Service	The new stormwater system will have sufficient capacity to discharge stormwater flows from a 2% AEP event without surcharge.

OPTION 5	
General Comments and Risks Identified	This option will greatly reduce instances of flooding experienced at 22 Marine Parade by effectively capturing the surface runoff along Annan Street. Option 5 effectively separates the stormwater and wastewater system for this area, greatly improving the quality of the discharge water. No pipelines or outfall structures will be constructed along Short Street or Sloane's Beach and the existing combined system outfall at 39/41 Marine Parade will be abandoned. A new outfall structure will be constructed between 53 and 57 Marine Parade and will require Resource Consent. The existing 450 mm diameter stormwater pipe down Short Street will not be redirected and will continue to discharge directly onto Sloane's Beach.
Construction Cost	$2.1 M - $2.7 M *Note: Range indicates preliminary nature of cost estimate*
Staging	N/A
Constructability	The proposed methodology is to construct the bulk of the pipeline by jacking. The pipeline makes two directional changes and thus two jacking pits are required to accommodate these changes in direction. This methodology would require a jacking pit at the corer of Annan and Upton Street and another at the corner of Bella Vista Road and Marine Parade. There is sufficient room at both intersections for these pits. The jacking pits and subsequent manholes are very deep (9m and 18m), which poses various construction and future maintenance difficulties.
Affected Parties	Identified during Resource Consent process.
Environmental & Amenity Considerations	Having a separate stormwater system will greatly improve the quality of the discharge water, since it will now only contain stormwater and not a combination of stormwater and wastewater. The new outfall structure will be constructed to blend in with the surrounding rocks.
Level of Service	The new stormwater system will have sufficient capacity to discharge stormwater flows from a 2% AEP event without surcharge.

9. Summary of Outfalls for all Options

The following table summarises the status of the two existing combined outfalls at 39/41 Marine Parade and Bella Vista under each of the five proposed options.

Table 4 Summary of Existing Outfall

OPTION	39/41 MARINE PARADE OUTFALL		BELLA VISTA OUTFALL	
	Outfall	**Flow**	**Outfall**	**Flow**
1	Remains in operation. Existing 600 mm dia. pipe upgraded to 675 mm dia.	Combined.	Abandoned. New 450 mm dia. SW only outfall constructed.	SW only.
2	Remains in operation. Existing 450 mm pipe and 550 square box culvert lined.	Combined.	Remains in operation.	Combined.
3	Abandoned. New 825 mm dia. outfall constructed through 39/41 Marine Parade.	Combined.	Remains in operation.	Combined.
4	Remains in operation. To be abandoned following wastewater separation.	Combined.	Remains in operation. To be abandoned following wastewater separation.	Combined.
5	Remains in operation. To be abandoned following wastewater separation.	Combined.	Abandoned. New 10505 mm dia. outfall constructed at end of Bella Vista Road.	Combined.

10. Conclusions and Recommendations

10.1 Option 1

- Option 1 will reduce the loading on the existing outfall pipe system at 39/41 Marine Parade.
- Option 1 will not directly relieve flooding at 22 Marine Parade.
- Option 1 will also involve the separation of the wastewater and stormwater drainage systems in the contributing catchment, which will be costly.
- **Option 1 is not recommended**, as it does not sufficiently relieve the flooding at 22 Marine Parade and will be very costly with marginal benefits.

10.2 Option 2

- Option 2 will significantly reduce flooding at 22 Marine Parade.
- Instances of combined discharge will be significantly reduced under this option as a separate stormwater network is provided.
- The overflow pipeline down Shore Street Reserve and the location of energy dissipation structures at the outfall will need to be determined. An option exists to direct the outfall north crossing the private boat ramp of 33 Marine Parade. This requires further investigation.
- Option 2 is deemed a cost effective option.
- **Option 2 is the preferred option.**

10.3 Option 3

- Option 3 will significantly reduce flooding at 22 Marine Parade.
- Difficulties in obtaining property owner consent and the risks associated with constructing a new pipeline beneath 39 Marine Parade, which involves the upgrading of the existing outfall pipe arrangement.
- **Option 3 is not recommended.**

10.4 Option 4

- Option 4 will significantly reduce flooding at 22 Marine Parade.
- Option 4 has that advantage of resulting in a single stormwater outfall structure in the long-term, post separation.
- Option 4 will significantly reduce instances of combined discharge by providing a separated stormwater network.
- The proposal to construct an outfall structure on the beach received considerable public opposition during the first Resource Consent application (2006).
- **Option 4 is the original preferred option.**

10.5 Option 5

» Option 5 will significantly reduce flooding at 22 Marine Parade.

» Construction of this option will, however, be very costly. Deep manholes (9 m and 18 m) will cause future maintenance difficulties.

» The new outfall between 53 and 57 Marine Parade will require a new Resource Consent.

» **Option 5 is not recommended**.

11. Option 2 Discussion

Option 2 is the preferred option and provides the following benefits:

- Option 2 presents a cost effective option that fully addresses flooding at 22 Marine Parade.
- The 525 mm diameter overflow pipeline down Short Street Reserve can be constructed using a directional drill methodology, which will have minimal impact on the Shore Street Reserve.
- The outfall structure required onto Sloanes Beach is significantly smaller than that proposed under the original option and will have much less of an impact on the beach environment. Furthermore, an option exists to divert the overflow pipe past the front of 33 Marine Parade minimising the visual impact of the outfall. This option requires further investigation.
- Option 2 allows for the effective future separation of the stormwater and wastewater networks, improving discharge water quality and network performance.

Option 2 retains the existing 500 x 500 mm box culvert and 450 mm diameter pipe outlets through 39/41 Marine Parade. CCTV investigation of these lines has shown that they require rehabilitation. Successful rehabilitation of these lines can be achieved using non-dig techniques.

The 600 mm diameter stormwater line, connecting manhole AA020 to the junction within 39 Marine Parade is also in need of repair. This line will be replaced as part of the works under Option 2.

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