ACHIEVING THE POTENTIAL OF STORMWATER PONDS BY IMPROVING THEIR OPERATION AND MAINTENANCE

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ABSTRACT

Auckland Council owns and maintains approximately 500 public stormwater management ponds and wetlands, with a total replacement value of $90 million. These assets were built to either mitigate the adverse environmental effects from new developments or as a result of Council action to improve the existing urban environment. It is expected that more stormwater ponds and wetlands will be built and vested with Council in the future.

The maintenance of these stormwater treatment facilities is critically important, as only if they are designed, built, operated and maintained correctly can they achieve their intended outcome.

This paper outlines the actions taken by Auckland Council's Stormwater Operations Group to improve the operation and maintenance of these stormwater ponds. The paper focuses on:

- Critical issues in relation to pond operation and maintenance
- The methodology and criteria used to carry out pond inspection and survey and information capture, based on best practice developed over many years of trials and acquired experience
- Actions taken to resolve identified problems
- Examples of achievements and results
- Strategies and programmes for long term maintenance, upgrading and renewal

This paper also provides recommendations for further improvements in relation to the operation and maintenance of Auckland Council's stormwater management ponds and wetlands.

KEYWORDS

Aquatic, stormwater pond, terrestrial, desilts.

PRESENTER'S PROFILE

Mohammed Sahim Razak is a senior stormwater operations engineer of Auckland Council and has led the operation and maintenance of stormwater management devices for for the last 8 years. With a background in civil and environmental engineering, Mohammed has over 28 years experience within local authorities both in New Zealand and Fiji.

1.0 INTRODUCTION

Auckland Council was formed in November 2010 from an amalgamation of 7 city and district councils, and the Auckland Regional Council. Auckland Council owns and operates approximately 500 stormwater ponds and wetlands as an integral part of its stormwater network. These ponds and wetlands, with a total replacement value of $90 million, play an important role in reducing environmental pollution and mitigating flooding risk for the Auckland region.

Each of the legacy councils had different ways of managing their ponds and wetlands. This was due to different priorities and funding regimes. The formation of Auckland Council presented an opportunity to re-think the management of these assets and provide a consistent approach across

the region. The northern part of the region was chosen as a pilot area for this new approach; however the intention is to apply the learning's across all of the Council's ponds and wetlands.

Stormwater management and treatment ponds are designed and installed to manage residual stormwater volumes and contaminants from urban runoff. The success of these devices is dependant upon correct design and construction, followed by appropriate operation and maintenance. Failure in any of these disciplines risks failure of the entire project throughout the operational life of the management device.

Many of these ponds/wetlands (particularly the older ones) are not performing as originally intended, and are not realising their full potential for improving stormwater quality and local ecological environment. The reasons for this are varied, and include:;

- Inadequate design consideration for on-going operations and maintenance (such as provision of an access way for pond maintenance and desilting), when they were constructed,

- Low amenity value due to lack of planting/landscaping planting and water quality issues, and

- Inadequate ongoing maintenance.

Over the past two years, Auckland Council's Stormwater Operations Group has been addressing these issues and, significant improvement of these ponds has been witnessed. This paper, based on the practice adopted in the northern area, outlines the actions taken to improve these ponds' performance and amenity value. It also recommends further actions to maximise the potential of these ponds.

2.0 INFORMATION COLLATION AND FIELD VALIDATION

To address the above issues, the first step was to collate and verify relevant information for the ponds and wetlands in the northern area. A good understanding of the pond assets will form the basis of future improvement programmes.

The Auckland Council Design Guideline Manual Stormwater Treatment Devices and the State of New Jersey - Department of Environmental Protection Stormwater Management Practices Manual were used, together with, the engineering knowledge and experience gained from similar projects as the basis in tailoring the field validation tool.

The methodology of information collation and validation was grouped into four main categories as follows.

2.1 The Desktop Study

A desktop study was carried out to gather all data, consents and electronic files for the ponds in the selected area. One of the early issues identified was that there were anomalies between ponds identified for maintenance by the maintenance contractor, and the ponds listed in the pond database created post amalgamation. Further investigation highlighted that important information on many of the ponds was either conflicting or missing.

Data was captured on a customised technical data sheet as shown in Table 1 below. The data sheet was aligned with existing and tested information for stormwater ponds. This study required that a fresh set of technical information for ponds be recorded and sorted into a number of broad categories:

1) Ponds captured that were included in both the amalgamated database and in the maintenance contract.
2) Ponds not captured in the maintenance contract, but included in the amalgamated database and assumed to have been vested as public assets.
3) Ponds not captured in the amalgamated database, but included in the maintenance contract.
4) Ponds not listed in any of the legacy Council databases or maintenance contract, but were potentially public assets. A number of these ponds appeared to have been constructed by a developer, inspected, certified, vested in Council and then any records relating to them appeared to have been misplaced.

Furthermore, a separate category of land acquisition existed, where Council had acquired land through either purchase or exchange.

a) Land vested through land development;
Some ponds, having undergone 224c certificate release and having been placed under the defects liability period (DLP, 80% occupancy or two years elapsed time since 224c certification) but after final handover to Council were found to be defective. By default, Council then became responsible for correcting any anomalies. Developers, having been released from their contractual obligations, were unable to be located.

b) Land acquired by Council;
While the process for Council to construct communal stormwater ponds, was to first acquire the land (via land purchase or exchange processes), construct the pond and to complete the sign-off process, for some reason, project files containing all communication records, design work and drawings, construction drawings and details, consents and correspondence were often unable to be located. Electronic and hard-copy file and data searches were carried out and the existing Operation and Maintenance contract was reviewed to identify all stormwater assets maintained by the current maintenance contractor.

Much of the information-conflict encountered in the existing legacy council databases involved detailed and important technical data. A substantial amount of the technical data needed for some ponds was missing, and the level of confidence in the reliability of the records was low.

2.2 Geospatial Information System (GIS) Analysis

In order to eliminate a growing lack of confidence in the available and sometimes conflicting legacy information and to formulate an accurate and reliable asset base, a Geospatial Information System (GIS) analysis and examination of databases was deemed necessary. The aim was to locate and identify all wet and dry ponds and wetlands vested to Council, to enable a definitive understanding of the total stormwater treatment and management pond asset base, in the specific geographic area under investigation.

An overview, using Auckland Council GIS and legacy Council Web Map (aerial photography) was carried out to locate any visible assets that may have been missed. This became an important validation step for pond assets which had already been identified.

A Geospatial and property-parcel search determined private or public ownership and a small number of joint venture maintenance agreements. Those ponds with a joint maintenance agreement were transferred to a separate layer in the newly constructed database, for investigation at later stage.

	Table - 1					
	STORM WATER POND /DAM MANAGEMENT SYSTEM.					
	POND DETAILS - WET/ DRY PONDS - TECHNICAL DATA					
	Description/Pond Name		**Unit**			
1	File Number					
2	Consent ID Number					
3	Pond ID from Catchment Management Plan					
4	GIS Reference (Asset ID)					
5	Combined Drainage Catchment					
6	Stormwater Catchment					
7	Pond location (Address)					
8	NZ map reference					
9	Co-ordinates (t the centre of pond from GIS)	**X**				
		Y				
10	Type of pond	Dry/Wet				
11	Levels to LINZ	i.Top of Dam				
		ii. Top of Spillway				
		iii. Toe of Dam				
12	Height of the Dam		m			
13	Contributing Catchment area		Ha			
14	Maximum pond length		m			
15	Maximum pond width		m			
17	Normal operating surface area		m^2			
16	Maximum operating surface area(estimated)		m^2			
17	Normal operating surface area		m^2			
18	Normal water depth		m			
19	Live storage volume (forebay)		m^3			
20	Live storage volume (main pond)		m^3			
20	Water quality pond volume.		m^3			
21	Total suspended solid removal percentage %		%			
22	Estimated sediment accumulation rate		tonnes/year			
23	Estimated cleaning frequency(Forebay- Main Pond)		Years			
24	Detention aquatic storage 34.5mm over 24 hrs		m^3			
25	Extended Detention 50% (2ARI)					
26	Extended Detention 10% (10ARI)					
27	Extended Detention 1% (1 ARI)					
28	Forebay present Y/N					
29	Spillways:	I. type				
		ii. width/dia.	m			
		iii.				
30	Emergency Spillway	I. type				
		ii. width/dia.	m			
31	Inlets :	I. type				
		ii. width/dia.	m			
		iii.				
		iv				
32	Outlets	I. type				
		ii. width/dia	m			
		iii.				
33	Embankment	I. Y/Other				
		ii. Crest width	m			
		iii. U/S Slope				
		iv. D/S Slope				
		v. Vegetation u/s				
		vi. Vegetation d/s				
34	Others	Completion year				
35	Compliance to TP10 (Rev 02 May 03)					

The latest and most complete legacy council database listed some 215 stormwater treatment and management ponds (including private ponds) within the northern area. Once the ponds in private ownership were confirmed as such and eliminated, only public ponds were left with which to begin detailed field investigations (refer Section 2.4).

2.3 Asset Validation

The validation exercise involved combining all the existing legacy databases and it was determined that potentially 65-stormwater treatment and management wet and dry ponds and wetlands existed that were in public ownership.

Out of this total of 65 assets, only 38 were listed as publicly maintained ponds in the then current maintenance contract. Therefore, some 27 additional ponds, all potentially vested as Council-owned and maintained assets, remained to be verified via detailed field inspections.

In addressing the 38 ponds listed in the maintenance contract, it was found that some were situated on public land but involved long-term lease arrangements for water take, including drainage/irrigation channels. Some ponds were situated on private land, under private ownership, yet partially maintained by Council. For the purposes of this exercise, elimination of the drainage channels in the maintenance contract was necessary in order to differentiate between the functional and financial considerations of stormwater management ponds and drainage channels. Each has its own particular operational characteristics, function and maintenance-cost implications.

2.4 Field Investigation

Field investigations of the 65 ponds were carried out to visually inspect all sites and confirm compliance with consent conditions and thus deemed fit for purpose as public stormwater management assets.

Site inspections and investigations for these ponds was undertaken to compare them with those recorded in the as-built technical data. An asset condition appraisal, operational assessment and a record of ‘hard’ assets for each of the ponds was completed. All field information obtained for each of these ponds was then collated from customised field record sheets. A series of information sheets relating to structural, geotechnical and flora and fauna for each pond were developed for field investigation use. These components included (but were not restricted to);

1) Headwalls and wing walls
2) Apron slabs
3) Outlet manhole riser structures (shape, size and condition)
4) Inlet and outlet pipe-work
5) Condition of water retaining bunds
6) Fore-bay
7) Rock erosion protection
8) Spillway condition
9) Embankment stability and integrity
10) Gabion retaining structures
11) Extent of aquatic and terrestrial weed infestation
12) Condition and general health of the landscape planting.

A record of all fences, walls and pond signage present on each site was obtained. In addition, it was necessary to appraise and record both aquatic and embankment weed control requirements and the overall condition of the existing (designated) planting associated with each pond. To achieve the desired results, a field analysis matrix was developed for the investigation team. Refer to Tables 2 to 4 below:

Table 2 -Field Analysis Matrix – Structural

	1 (Excellent)	2 (Very good)	3 (Average)	4 (Poor)	5 (Failed)	Comments
Inlet pipework						
Outlet pipework						
Riser condition						
Headwall						
Wingwall						
Apron Slab and erosion protection						
Bathymetric Bunding						
Gabion retained structures						
De-watering and drain valves						
Spillway condition						
Maintenance access						
Fencing/Walls						

Table 3.Field Analysis Matrix – Geotechnical

	1 (Excellent)	**2 (Very good)**	**3 (Average)**	**4 (Poor)**	**5 (Failed)**	**Comments**
Embankment slope						
Cavities, tomos, rabbit borrows						
Landslip						
Sledging						
Erosion						
Shrinkage and tension-cracking						
Spillway embankment						

Table 4. Field Analysis Matrix - Flora and Fauna

	1 (Excellent)	2 (Very good)	3 (Average)	4 (Poor)	5 (Failed)	Comments
Flora						
1. Terrestrial						
(a) Desirable:						
Density						
Health						
Adaptability (appropriate species)						
Maintenance required						
(b)Undesirable or invasive						
Density						
Dominant Species						
Actions required						
2. Aquatic						
(a) Desirable						
Density						
Health						
Adaptability						
Maintenance required						
(b)Undesirable or invasive						
Density						
Dominant species						
Actions required						
Fauna						
1. Terrestrial						
(a) Desirable (e.g. native birds, insect, frogs)						
(b) Undesirable (e.g. possums)						
2. Aquatic:						
(a) Desirable						
e.g native fish/eels						
Waterfowl						
(b) Undesirable						
Pest fish (e.g. mosquito fish/koi carp)						

3.0 IMPROVEMENT PROGRAMMES

3.1 Issues Identified during Information Collation and Validation

Through the above mentioned processes, a much greater understanding and appreciation of the physical location and property ownership (public versus private) was gained. A finalised table of public ponds, after analysing all of the attributes and criteria, was compiled. The following issues in relation to pond structure, formation, surrounding planting and vegetation and sedimentation were also identified during this process:

1) Many ponds and their associated structures were over 70% obscured by invasive weed species.

2) Several ponds were lacking in formal maintenance access ways and defined emergency spillways; and issues regarding the design and construction of these ponds remained to be resolved.

3) Of the 65 ponds investigated, 36 had no dewatering devices installed, and 39 ponds had serious invasive terrestrial and aquatic weed issues. At this stage, the full extent of the pond desilting requirements had yet to be ascertained.

3.2 Development of Improvement Plans

The above identified issues indicated an urgent need to develop programmes for immediate to short term management across the following disciplines: weed management and control, minor asset repairs, embankment planting and pond desilting programmes.

1) Weed management and control

An immediate to short term Weed Management and Control Plan was prepared based on the field assessment. This Plan focuses on the requirement to regain control of the terrestrial (embankment) and aquatic sectors of the ponds, to the design and implementation of formal landscape planting plans, followed by infill planting.

Due to the degree of the invasive weed infestation at many of the ponds, and the identification of “pest” weeds falling under The Bio-security Act category of ‘nuisance weed species’, the need for specialist contractual input was identified and implemented.,

2) Landscape and planting plan

An immediate to short term Landscape Planting Plan was prepared. This Plan aimed to improve the landscaping and planting around selected ponds so that amenity and ecological value of these ponds is enhanced. The understanding and support to stormwater management from the public is critically important. The improved amenity and ecological value of stormwater ponds will attract public attention and get community support for the long term operation and maintenance programmes of the Council.

3) Pond de-silting programme

As previously discussed, there was an urgent need to develop a pond desilting programme, as sedimentation in some ponds has reduced the pond treatment efficiency significantly. Based on the field investigation results, a 15 year pond desilting programme was prepared.

3.3 Improvement Plan Implementation

Over the past two years, the weed management and control plan has been implemented. This resulted in 43 ponds/wetlands being brought under a formal maintenance contract.

Between 2011 and 2013, a formal contract for landscape planting was implemented and working in close collaboration with the Stormwater Group Project team, 37 ponds were greatly enhanced through implementation of major planting programmes. 50,000 trees and shrubs were planted around 37 ponds across the northern area. As a result, this has greatly enhanced the amenity and ecological value of these ponds.

A total of 10 ponds with significant sedimentation were de-silted over the past two years.

Typical examples of progressive improvements made are illustrated in the photographs below:

Site 1 Before and after silt removal

Site 2 - Before and after silt removal

Site 3 - Before and after silt removal

Site 4 - Before and after landscape restoration

In summary, after nearly two years of design, planning and implementation of the above mentioned plans and programmes, the treatment potential of these stormwater management ponds has significantly increased. The enhancement of these sites as public amenities has, without doubt, improved.

From both an aesthetic and practical access viewpoint, the positive changes in many of these ponds have been very notable.

From an ecological perspective, much-improved aquatic and terrestrial planting has greatly enhanced the wildlife habitat, making a major difference to the attractiveness of these ponds across the region.

The overall pond improvements implemented have been summarised in Table 5 (below):

Table 5 Asset Validation and Maintenance Overview

Category	Validation year			Value ($000)
	1 (2010/11)	2 (2011/12)	3 (2012/13)	
(A) Asset ownership				
(i) Wet ponds	48	43	40	
(ii) Dry ponds	13	13	13	
(iii) Wetlands	4	5	5	
Total	**65**	**61**	**58**	
(B) Weed control				
Stage 1 programme	Minimum as per maintenance contract	Programme designed & implemented		
Number of ponds		28		90
Stage 2 programme	N/A		Programme designed & implemented	
Number of ponds			43	75
(C) Landscape Planting				
Stage 1 programme	N/A	30*		150
Stage 2 programme			25*	200
(D) Pond de-silting				
Number of Ponds		4		115
			6	578

Note: The number of ponds planted overlap in Stages 1 and 2. (A total of 37 individual ponds were planted in the 2011/12 and 2012/13 financial year.

4.0 FUTURE WORK

1) Compile the long-term pond renewal (de-silting) programme. This needs to be implemented with urgency.

2) Streamline the procedures to be followed by internal and external stakeholders when vesting assets from 224c stage through to final handover to the respective Stormwater Asset and Operations Groups.

3) Conduct site surveys to compile as-built information and collate this through ‘Best Practice’.

4) Initiate medium to long-term remedial actions and any major upgrading or improvement works required. The aim of this exercise is to compare calculated data for water quality and quantity with theoretical treatment requirements in order to quantify each pond's capacity and the likelihood of these ponds/dams being breached.

5) Digitise the catchment boundaries to calculate water volume discharging into these ponds/ dams. This will provide Council with accurate details enabling informed decision making for any future works. However, the requirement to comply with consent conditions and other relevant regulations is binding upon Auckland Council.

5.0 CONCLUSIONS

1. A greater understanding of the stormwater ponds and wetlands was obtained.

2. A much improved management methodology has been established that in future will be conducted across the whole region.

3. Based on the field and technical information and programmed initiatives, weed management, landscape planting, minor capital works and renewal (de-silting) programmes have been developed and partially implemented.

4. Those ponds and wetlands which have been replanted, landscaped or de-silted, are demonstrating higher treatment efficiency, better amenity and ecological value. These improvements make the future maintenance works easier.

5. Long term major technical and pond improvement works required for these assets has been programmed, including capital asset (CAPEX) enhancement opportunities.

6. The identification of the need for greater collaboration and information sharing between departments within the wider Stormwater Group was identified.

7. Further specialised works requirements were identified.

6.0 ACKNOWLEDGEMENT

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7.0 REFERENCES

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