Conceptual Design for Wairoa Wastewater Treatment and Discharge

Prepared for

Wairoa District Council

Prepared by

LOWE Environmental Impact

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 1

2 INTRODUCTION 3

2.1 Background 3

2.2 Purpose 3

2.3 Scope 4

3 DEVELOPMENT OF THE DESIGN CONCEPT 5

3.1 Summary of Design Development Process 5

3.2 Existing Reporting 5

3.3 General Design and Implementation Timing 6

4 WASTEWATER SYSTEM DESIGN PARAMETERS 7

4.1 General 7

4.2 Wastewater Reticulation 7

4.3 Wastewater Flows 8

4.4 Wastewater Treatment 11

4.5 Treated Wastewater Storage 13

4.6 Treated Wastewater Discharge System 14

5 REFINEMENT OF DESIGN CONCEPT 19

5.1 Key Issues and Concerns 19

5.2 Development of Responses to Concerns 20

5.3 Design and Operation Refinements 21

6 STAGE 1 IMPLEMENTATION – FIRST 5 YEARS 26

6.1 General Description 26

6.2 Physical Changes 26

6.3 Operational Changes 27

7 STAGE 2 IMPLEMENTATION – YEARS 6-10 29

7.1 General Description 29

7.2 Physical Changes 29

7.3 Operational Changes 30

8 STAGE 3 IMPLEMENTATION – YEARS 11-20 31

8.1 General Description 31

8.2 Physical Changes 31

8.3 Operational Changes 32

9 STAGE 4 IMPLEMENTATION – YEARS 21-30 33

9.1 General Description 33

9.2 Physical Changes 33

9.3 Operational Changes 34

10 SUMMARY 35

11 REFERENCES 37

1 EXECUTIVE SUMMARY

The Wairoa wastewater treatment plant ("WWWTP") currently discharges treated wastewater into the Wairoa River during out-going tides between 6:00 pm and 6:00 am every day of every year, as has been the case since it was commissioned in 1981. The discharge consent authorising this activity expires in May 2019.

Through community consultation and with assistance from WDC's advisors, a package of changes to the existing system was developed and found to be the best practicable option (BPO) for consenting purposes. The BPO report (LEI, 2018:B4) describes how this was developed and explains why it was believed to be the BPO.

This report describes the conceptual design for the wastewater treatment system and the gradual proposed changes to its associated discharge to the river during the next 30 years; as summarised in the Package report, supported by the BPO report, and further refined within this report.

The conceptual design for the development of the future discharge system for Wairoa's treated wastewater is summarised in Table 1.1 below. While there are a range of activities proposed as part of the package, the river discharge elements relevant to the resource consents being sought are coloured in Table 1.1. It is important to note, however, that Stages 3 and 4 are **aspirational** and the ability to implement these changes is dependent upon the actual sizes of irrigation and storage that are constructed.

Early in the first stage a filtration and UV disinfection system will be installed at the outlet of the WWWTP ponds. It is also intended that the outfall pipe and discharge structure will be relocated closer to the river channel, designed to cope with the expected discharge rates and to avoid siltation blockages when idle. The outfall will be able to be readily maintained and relocated to match the migrations of the active river channel.

It is envisaged that discharges to the river will gradually occur less often and will transition over time to cease during daytime out-going tides and then cease altogether when the river is flowing less than median flow. In all cases continuous 24/7 discharges to the river of unlimited volumes (if HBRC authorise this) will occur when the river is flowing at or above 3 x median flow.

Table 1.1: Summary of Wairoa's Future Treated Wastewater Discharge System

Stage Timing	Storage Capacity#	Irrigation Area#	River Discharge Parameters*	Pump Station Overflows#
Stage 1 0-5 years	No change (5,400 m^3 within the 2nd WWWTP pond).	Develop up to 50 ha	Below ½ median river flows: <1,600 m^3/d discharge on outgoing tide at night only. ½ median to median river flows: <3,000 m^3/d discharge on **any** outgoing tide. Median to 3 x median river flows: <5,000 m^3/d discharge on **any** outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Occur less often than now (<10 events/year). Triggered during larger storms.
Stage 2 6-10 years	Increase total to about 10,000 m^3	Expanded up to 100-150 ha total	Below ½ median river flows: <1,600 m^3/d discharge on outgoing tide at night only **but limited to no more than 30 days discharge in December to March**. ½ median to median river flows: <3,000 m^3/d discharge on any outgoing tide. Median to 3 x median river flows: <5,000 m^3/d) discharge on any outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Rare (<8 events/year); only during larger storms.
Stage 3 11-20 years	Increase total to 50-100,000 m^3	Expanded up to 300 ha total	Below ½ median river flows: **no discharge at any time**. ½ median to median river flows: <3,000 m^3/d discharge **only on outgoing tide at night**. Median to 3 x median river flows: <5,000 m^3/d discharge on any outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Very rare (<4 events/year); only during very large storms.
Stage 4 21-30 years	Increase total to 200-400,000 m^3	Expanded up to 600 ha total	Below **median** river flows: no discharge at any time. Median to 3 x median river flows: <5,000 m^3/d discharge **only on outgoing tide at night**. Above 3 x median river flows: unlimited discharge at any time.	Very rare (<4 events/year); only during unusually large storms.

Notes: * bold text highlights what is changing within each stage.
\# intended changes which depend on commitments outside resource consent processes.

2 INTRODUCTION

2.1 Background

WWWTP was constructed in 1981 south of the urban area of Wairoa near Pilot Hill (Rangihoua) which is roughly opposite the river mouth into Hawke Bay. Since it was commissioned in 1981 the WWWTP has discharged treated wastewater into the Wairoa River during out-going tides between 6:00 pm and 6:00 am. The discharge consent authorising this expires on 31 May 2019.

During 2015-18 Wairoa District Council ("WDC") engaged advisors and consulted with the community to assist with understanding the existing wastewater system's constraints and design criteria, assessing options for changes, and determining how and where the future discharges should occur. This was in order to seek the appropriate resource consents from the Hawke's Bay Regional Council ("HBRC") to replace the current discharge consent upon its expiry.

Through community consultation and input from WDC's advisors, a package of changes to the existing system was developed. In February 2018 WDC agreed to:

- implement a package of wastewater irrigation to a series of farms;
- reductions of reticulation leakage and pump station overflows;
- installation of filtration and UV treatment at the WWTP outlet;
- installation of treated wastewater storage; and
- support for wider Wairoa River catchment improvement projects.

This package was subsequently found to be the best practicable option (BPO) for consenting purposes. The BPO report (LEI, 2018:B4) describes how this package was developed and explains why it was believed to be the BPO.

The BPO will require continued discharge to the Wairoa River despite reductions in the wastewater volume discharged; this being a result of the pending development of irrigation systems and reductions in wastewater flows resulting from reticulation improvements. If enough land area can be developed for irrigation and large enough storage constructed, it is possible to cease the discharges to the river for most if not all of the time except during unusually wet seasons and years.

The resource consent application for future discharges of treated wastewater will rely upon the BPO report and this Conceptual Design report for details of the various physical and operational aspects of the proposed wastewater treatment and discharge systems.

2.2 Purpose

Based on the BPO report and other background reporting, this report describes the conceptual designs for the Wairoa wastewater reticulation, treatment, storage, and discharges to the river, including changes over the next 30 years as the combined land and water discharge proposal is implemented. It describes the key design, operational features, and management requirements of the integrated systems. This report is intended to form the basis for the river discharge consent and related consent applications, and design refinement as the irrigation and storage aspects are implemented over the next 30 years or so.

2.3 Scope

This report contains:

- Brief description of the existing wastewater system, its discharges and the receiving environment;
- Description of conceptual design features consistent with the BPO for the future modifications to the reticulation, pump stations, WWTP, storage, irrigation, and discharges to the river;
- Description of the operation and management of the conceptual design as each stage is implemented;
- Indication of the implementation timing for each element;
- Description of any need for further investigations and/or negotiations, including their likely implications; and
- Description of implementation risks.

The focus of this Conceptual Design report is on the river discharge; and it excludes the irrigation system details and the wider river catchment programmes. This is because this report is intended to primarily support the applications for resource consents to discharge to the river. This report does not provide detailed designs or operational instructions for each element of the proposed treatment or river discharge systems, nor does it provide any assessments of effects of the selected designs or operational aspects.

3 DEVELOPMENT OF THE DESIGN CONCEPT

3.1 Summary of Design Development Process

The process and information used to develop The Package are described in detail in The Package report (LEI, 2017:B2A2) and the BPO report (LEI, 2018:B4).

WDC relied upon technical advisors, a targeted Stakeholder Group, hui-a-iwi, and public meetings to identify the concerns with the existing system, future design constraints, option evaluation criteria, aspirations, and ranking methodology for assessing options. A wide range of potential combinations of changes to each section of the wastewater system provided an overview of the continuum of options. The options were narrowed down by the Stakeholder Group and then refined.

An integrated system with gradual implementation over the next 30 years, known as The Package, was developed and then adopted by WDC's councillors. It has subsequently been incorporated into the 2018-28 LTP which included further public consultation. The Package has been shown to be the BPO for treating and discharging Wairoa's wastewater, and it forms the basis for this Conceptual Design report.

3.2 Existing Reporting

A programme of information gathering, consultation, data processing and evaluation, and scenario development has preceded the formation of The Package, BPO and Conceptual Design. A range of source material has been used in the development of the wastewater system's Conceptual Design. Information specific to the current and future wastewater system and relied upon for this report includes:

- EAM (2011) Investigation of groundwater infiltration of the WDC reticulated wastewater network;
- eCoast (2018:A3D3) Assessment of effects of WDC's intertidal sewage discharge on benthic sediment characteristics and ecology;
- eCoast (2018:C1.1) Wairoa WWTP Outfall: 3D Hydrodynamic Numerical Modelling;
- How (2017:A4I2) Tangata Whenua Worldviews for Wastewater Management in Wairoa;
- LEI (2015:A1I1) Wairoa Wastewater Discharge Re-Consenting Summary of Wastewater and Stormwater Overflow Issues;
- LEI (2017:A2I1) WWTP System Data and Compliance Summary;
- LEI (2017:A2I2) Current Outfall Pipe Description;
- WDC (2018:A2I3) WWTP Monitoring Update;
- LEI (2017:A3I2) Existing Environmental Data Summary;
- LEI (2018:A7I1) Wairoa Wastewater Discharge Consenting Planning Considerations;
- LEI (2017:A7D1) Discharge Options;
- LEI (2017:B2A2) Wairoa Wastewater Package – A Way Forward;
- LEI (2018:B2A3) Wastewater Polishing Options for Wairoa;
- LEI (2018:B4) Wairoa Wastewater Treatment and Discharge Best Practicable Option;
- Opus (2017) Wairoa WWTP Outfall Model Build and Assessment Report

Information sourced from the above listed reports is not repeated in full in this report and so it is recommended that the reader consults the original source reports for further information in the first instance.

3.3 General Design and Implementation Timing

The following key features are planned by WDC to be implemented over the next 30 years:

- reticulation renewals and upgrades in order to reduce flows to WWWTP;
- filtration and UV irradiation at the outlet of the WWWTP ponds to improve the discharge quality (remove pathogens and reduce algae); and
- reducing discharges (volumes and frequencies) to the Wairoa River as a direct result of progressively implementing irrigation to land and constructing additional storage facilities.

The improved quality of the treated wastewater resulting from UV treatment can allow discharges to the river to occur continuously outside of the irrigation seasons when storage is full. Its quality and reduced rates of discharge will protect the river from public health effects and address cultural values to the most practicable extent possible for the urban Wairoa community. The key details agreed with the community in 2017 and the timing for implementing each stage of the future treatment and discharge system are summarised below:

Within 5 Years	Within 10 years	Within 20 years	Within 30 years
•Improvement of sections of the reticulation system (i.e. pipe relining) •Improve treatment of effluent discharging from the WWTP to the estuary, allowing for 24 hour discharge •Add an area of irrigation (<50 ha) close to treatment ponds •WDC to advocate for Wairoa River Catchment initiatives	•Expand wastewater irrigation area to WDC forestry block (landfill area) and neighbouring land •Continue reticulation improvements •Develop storage capacity to make treatment more effective and irrigation options more viable •Catchment projects underway (i.e. riparian planting and retirement of grazing land in priority sub-catchments)	•Further irrigation areas identified and infrastructure put in place (i.e. up to 300 ha of irrigation) •Catchment project works have covered a significant portion (to be determined) of the catchment area	•Removal of a significant portion(to be determined) of the wastewater discharge to the river •Further irrigation areas identified (i.e. up to 600 ha of irrigation) •The catchment area has had project works established over much of its area and maintenance of these areas will be ongoing

This report provides Conceptual Design details for each of these implementation stage timeframes so that the integrated system can be better understood as each stage is implemented. It also refines the proposed river discharge regime from the initial proposal that a continuous 24-hour discharge regime could be implemented. The timing of implementing each of these stages needs to be viewed with some caution, as they are aspirational targets that depend upon the willingness of local farmers and the wider community to implement the proposed features.

4 WASTEWATER SYSTEM DESIGN PARAMETERS

4.1 General

The conceptual design for the future wastewater system must be suited to a range of parameters of the current system and the anticipated ranges of future changes to those design parameters. It is therefore important to identify and quantify those parameters and explain any assumptions relied upon for predicting any future changes.

The accuracy of the daily flows, storage volumes, and river discharge regime presented in this Conceptual Design report has not been refined to a narrow and precise range for each of those components. Instead, in places it relies on generalisations and wide ranges of possible flow, storage, and discharge parameters for each stage of development of the future discharge systems. The lesser precision of these parameters is expected (and intended) to be flexible to allow for successful implementation of each stage of the proposed conceptual design, as described below, while also allowing for refinement of its final design and operation as each stage is nearing its implementation date.

A number of aspects of the future system are aspirational and challenging for WDC to achieve. Some aspects rely upon the goodwill and willingness of other parties to collaborate with WDC and the wider community; WDC may struggle to gain the desired level of collaboration and may not wish to be in a position of either failing to implement the long-term design or being forced to compel third parties to participate. WDC can use the Public Works Act and other legislation to purchase land or acquire rights over land in order to successfully implement the future systems, but this is very much a last resort.

4.2 Wastewater Reticulation

4.2.1 Current Reticulation

Wairoa's urban wastewater system is reticulated and mainly relies on gravity flow to four pump stations which lift each catchment's wastewater into the next section of gravity mains. The final pump station (Fitzroy Street) receives all of Wairoa's wastewater and pumps it via a rising main to the inlet of the WWTP.

The majority of the reticulation is more than 30 years old and it is known to be prone to excessive volumes of groundwater infiltration and stormwater ingress (I & I) which elevate the base flow and peak wet weather flow volumes. The Kopu Road pump station catchment has been identified by EAM (2011) and LEI (2015:A1I1) as the most leaky and the main contributor of excessive I & I inflows. WDC have investigated this catchment to identify its main faults and have commenced a more intensive reticulation repair and renewal programme to resolve the issues.

During storm events the pump stations can be overwhelmed with inflows which discharge directly to the river via emergency overflow bypass pipelines. At times the pumps have also become blocked which has compounded the overflow problem. In addition to the reticulation renewal works, WDC has reconfigured their pumps and repaired or replaced some pumps in order to better match the pump capacities to the inflows. These changes have reduced the frequency of blockages and storm overflows, and in some cases eliminated them since making changes.

New generation chopper pumps that break up solids have been installed at the Fitzroy Street pump station; this has eliminated blockages and overflows occurring at this location.

4.2.2 Future Reticulation

Reticulation repairs and renewals will continue to be undertaken in the Kopu Road pump station's catchment and elsewhere in order to reduce I & I contributions. A drinking water supply leakage detection and repair programme will also occur, and this is hoped to reduce the amount of water held in the water table which can subsequently leak into the reticulated sewers. A new main line will be installed as a dedicated main pipeline from Kopu Road pump station to Fitzroy Street pump station. This will enable the existing main pipeline to service only the flows from the rest of Wairoa's urban area and avoid surcharging caused by Kopu Road flows sharing the capacity of that pipeline.

New generation chopper pumps will be installed at every pump station in order to prevent blockages and reduce maintenance costs. Emergency power generators (or with the capacity to have generators connected) will also be installed at every pump station to prevent pump stoppages and any resultant overflows occurring during power outages (power cuts often coincide with storm events when wastewater flows are also elevated).

The rising main pipeline from Fitzroy Street pump station up to the WWWTP inlet will be duplicated in order to double its capacity. This will ensure that all flows entering Fitzroy Street pump station will be pumped into the WWWTP for treatment instead of some large storm flows occasionally overflowing the wet well and discharging to the river via the main WWWTP outfall without treatment in a similar manner to what occurs with the overflows from other pump stations.

Possible future changes include extension of reticulation to the western side of North Clyde and south along Kopu Road between urban Wairoa and Fitzroy Street (these dwellings are currently using septic tanks). Additional reticulation connections will be incorporated into the network as Wairoa's urban area expands and intensifies (through construction of dwellings on currently empty sections and subdivisions creating in-filled housing).

4.3 Wastewater Flows

4.3.1 Current Flows

LEI (2017:A2I1) presents details of the wastewater flow variations while WDC (2018:A2I3) presents more recent monitoring data. Figure 4.1 below presents a graph of the monthly average daily inflow to WWWTP (as recorded at the Fitzroy Street pump station) during 2009-18. Inflows are important to understand because they determine the time taken for wastewater to pass through the WWWTP and thus affect its treatment performance.

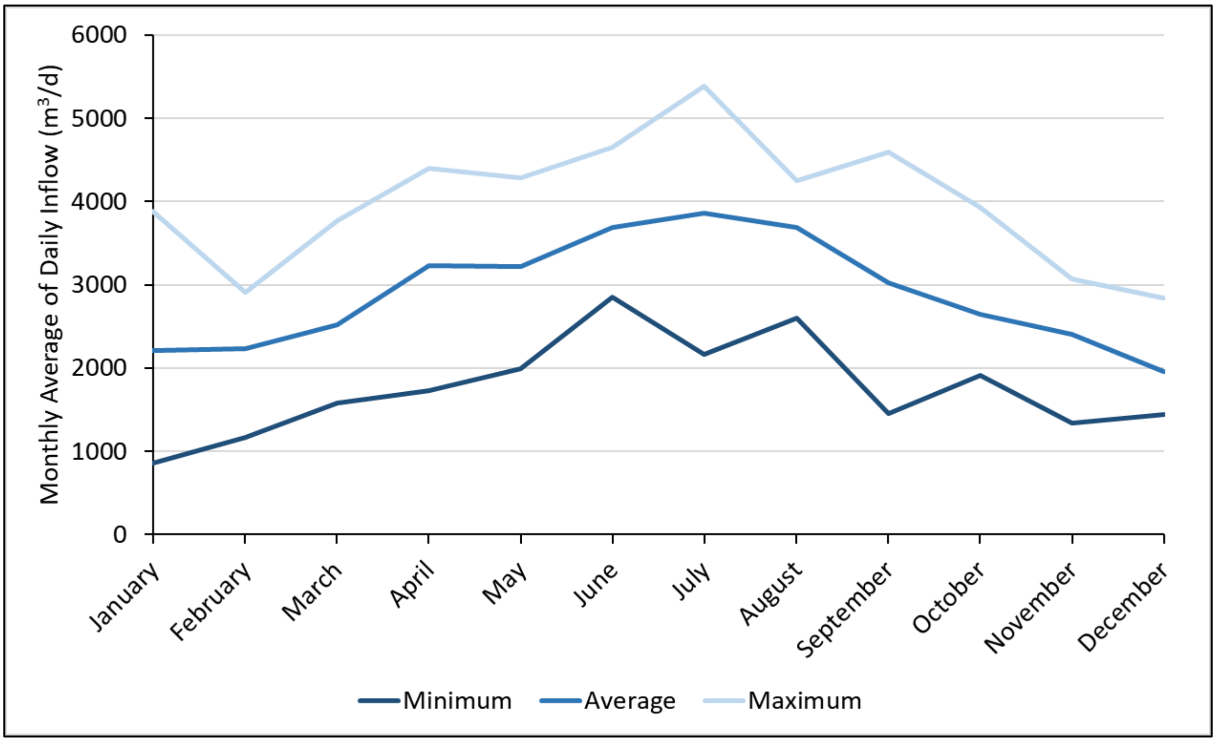

Figure 4.1: Monthly Average Daily Inflows for Wairoa WWTP for 2009-18

Figure 4.1 clearly shows the seasonal variations (elevated in winter months and generally lower in summer) caused mainly by I & I from variable groundwater levels and storm events. Annual flow totals during 2009-17 were 1.0 – 1.2 Mm^3/y, with an average of 1.13 Mm^3/y. Statistics for the daily inflows to WWWTP during 2009-18 are presented below in Table 4.1.

Table 4.1: Daily Wastewater Inflows (m^3/d)

Timeframe	Overall Mean	Summer Mean	Winter Mean	90th Percentile
2009-18	2,868	2.134	3,908	5,050
2009-12	2,824	2.358	3,987	5,232
2013-14	2,549	1,677	3,833	4,417
2016-18	2,852	2,147	3,812	5,082
2018 (Jan-Sep)	2,617	1,742	2,856	4,228

Improvements and renewals of the reticulation (mainly in the Kopu Road catchment) and pump station upgrades during 2016-18 have anecdotally reduced frequencies of pump station blockages and overflows, but the variations in seasonal rainfall over recent years have made it more difficult to identify whether the improvements are related to general weather conditions, the sizes of storm events, and/or reticulation improvements.

2013 and 2014 were generally drier than usual, and this reduced the daily wastewater flow rates from what would have occurred during more normal years. Daily flow data for the first 9 ½ months of 2018 indicates reductions of 10-20 % from previous years when adjusted for rainfall variations (this adjustment was important given that July 2018 was the driest July during the last 21 years).

A graph of the cumulative distribution of daily wastewater inflow volumes to WWWTP during 1 January 2009 to 14 June 2018 is presented below in Figure 4.2. It shows that the 10th to 90th percentile daily wastewater flows are between 1,500 and 5,000 m^3/d and that the median daily flow is 2,450 m^3/d.

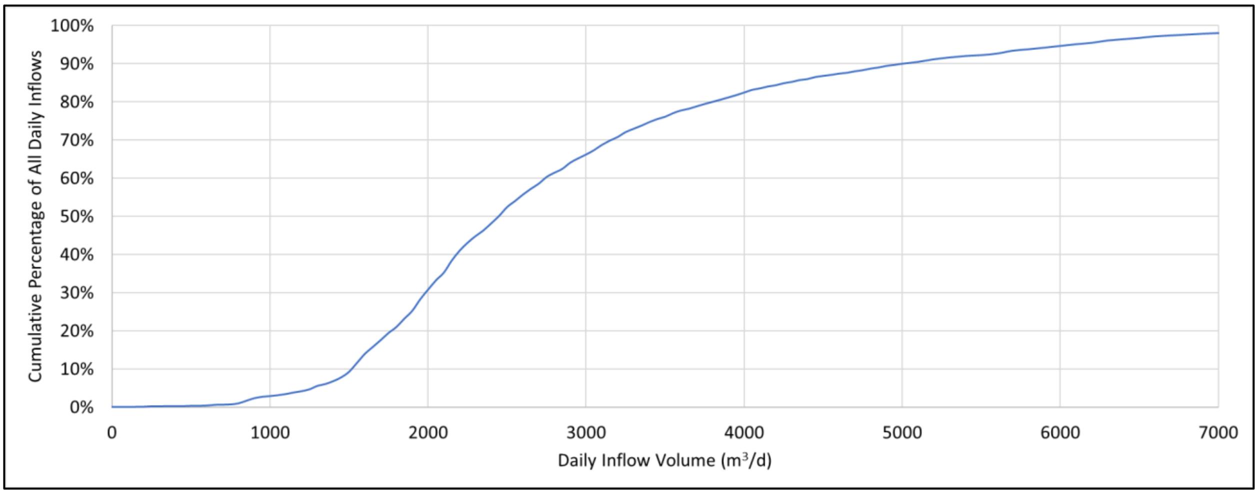

Figure 4.2: Cumulative Distribution of Daily Inflows for Wairoa WWTP for 2009-18

4.3.2 Future Flows

The original WWTP design flow rates were 1,800 m^3/d average for dry weather, 3,600 m^3/d for the annual average, and 7,200 m^3/d for peak wet weather flow. In 1992-97 the actual flow rates were 800 m^3/d for dry weather average, 1,600 m^3/d for the annual average, and 2,400 m^3/d for winter average flow. Wairoa's population has declined over the years but it may increase again over the next 30 years and it is uncertain whether future reticulation improvements could achieve a return to the relatively low daily flow rates of the 1970's-90's.

LEI's estimates of anticipated future flows based on planned reticulation improvements occurring over specific timeframes are presented in Table 4.2.

Table 4.2: Anticipated Future Daily Wastewater Inflows

Milestone Year	Overall Mean	Summer Mean	Winter Mean	90th Percentile
2009-18 (current)	2,870	2,100	3,900	5,050
2024 (5 year stage)	2,600	2,000	3,500	4,000
2040	2,100	1,800	2,800	3,500
2050	1,800	1,500	2,100	3,000

It is important to note that these flows are indicative only and are aspirational for the purposes of describing the design constraints for the future development of WWWTP's treatment and discharge systems and for calculating the likely scale of effects of the discharges on the receiving environments. These estimated flow reduction aspirations are potentially very challenging for WDC to achieve, as widespread sources of I & I across the reticulation will be difficult to identify and potentially also physically challenging and very expensive to resolve. The flows are also highly driven by prevailing weather conditions, so a series of storms or unusually wet seasons could easily mask the actual scale of wastewater flow reductions that would have been more apparent during normal or drier seasons.

If flows do not reduce to the extent indicated in Table 4.2 then the storage volume and/or the frequency of discharges to the river will need to increase to accommodate the higher flows. The changes in flows (particularly winter and wet weather flows) are important for estimating the storage volume requirements for the future discharge system, because the higher wet weather flows can't be immediately irrigated (because soils are too wet) and are instead generally stored or discharged into the river.

4.4 Wastewater Treatment

4.4.1 Current Treatment

The current design of the WWWTP consists of an inlet screen, an aerated lagoon, and an oxidation pond. The two aerators on the surface of the aerated lagoon were replaced in April 2018 with a submerged sparge for air injection near the lagoon's inlet. The aerated lagoon was also partially de-sludged in 2018. The treated wastewater quality currently achieved by WWWTP (based on 2008-16 monitoring data) is presented in Table 4.3 below. Further details on WWWTP's design and performance are presented in LEI (2017:A2I1) and WDC (2018:A2I3).

Table 4.3: Treated Wastewater Quality During 2008-16

Parameter	Range	Mean	Median
COD (g/m^3)	34 – 620	158	126
CBOD (g/m^3)	6 – 190	31	23
NH_3-N (g/m^3)	4.0 – 36	16.1	15.6
TSS (g/m^3)	7 – 290	64	52
E. coli (cfu/100 ml)	8 – 470,000	5,250	5,200

4.4.2 Future Treatment

The current design of the WWWTP is not likely to require changes because its performance has been adequate and future reductions in wastewater flows will improve its consistency of performance. As wastewater flows reduce, the hydraulic residence time of wastewater within the WWWTP ponds will increase. This will allow a longer time for sunlight and biological processes to reduce the concentrations of BOD, nutrients, and pathogens, thus improving the WWWTP's treated effluent quality.

Consultation feedback and an independent review of the WWWTP performance indicated that reductions in pathogen concentrations were the only aspect of treatment that required attention for improvement of wastewater quality and suitability for discharge to the land or water receiving environments. No other wastewater quality parameters were seen as requiring attention in order to be acceptable for discharge to the river or irrigation. The background to this view is outlined in the Package report (LEI, 2018:B2A2) and the earlier reports that were considered during the Stakeholder Group process.

There is a wide range of possible additional treatment options at each stage of treatment to effectively achieve the desired reductions in pathogen concentrations. The Polishing Options report (LEI, 2018:B2A3) reviewed the available disinfection treatments for their appropriateness and likely costs at Wairoa. The polishing or tertiary treatment system comprising ultraviolet (UV) light irradiation with pre-filtration was selected as being the most appropriate technology and BPO for WWWTP. This system is best located at the outlet of the existing WWWTP pond (not earlier in the treatment system). No other disinfection or treatment technologies were seen as necessary or more effective than UV.

Filtration (probably a sand filter) will primarily remove algae from the treated wastewater. This is important for UV light penetration efficiency, for avoiding river discolouration effects upon discharge to the river, and for avoiding blockages of irrigation sprinklers. UV irradiation will target pathogens which is important for protection of public health and cultural values in the river, and for health protection of stock and neighbours to the irrigated farms.

The filtration system will be capable of being regularly back-flushed (with flushed wastewater fed back into the facultative pond inlet) and having its filter media occasionally replaced when it becomes too heavily clogged. The UV lamps will be readily accessible so that they can be regularly cleaned and replaced in order to remain effective.

Based on previous project experience, **indicative** statistics for the anticipated future treated wastewater quality after filtration and UV irradiation are presented in Table 4.4 below.

Table 4.4: Potential Future Treated Wastewater Quality

Parameter	Range	Mean	Median
COD (g/m^3)	20 – 60	40	35
CBOD (g/m^3)	3 – 30	20	17
NH_3-N (g/m^3)	2.5 – 25	12	10
TSS (g/m^3)	2 – 50	15	10
E. coli (cfu/100 ml)	0 – 5,000	60	50

The exact characteristics of the future discharge system need to be clarified and will only be known more confidently once filtration and UV have been commissioned in combination with I&I reductions. This is primarily due to ongoing I&I improvements modifying the quality of the effluent and volume to be managed, and uncertainty of design and performance capability of the treatment processes. In addition, further discussion with equipment suppliers and the community is needed to balance the need for improvement in discharge quality against the expense of such improvements; with the key issue being the upgrade costs could be spent on other aspects of the Package that may have a more tangible benefit.

The installation of filtration will assist with reducing CBOD and COD concentrations in addition to its primary role of reducing TSS and pathogens; this is because solids and pathogens are key factors in driving oxygen demand. UV treatment is only capable of reducing pathogen numbers; it is not able to reduce any other wastewater quality parameters. Filtration and UV are not capable of significantly reducing ammoniacal-nitrogen concentrations.

The anticipated improved quality of the treated wastewater is intended to primarily address pathogens in order to make it more suitable for discharging directly to the river. Its *E. coli* and suspended solids concentrations will be better than the river's water quality, and, based on hydrodynamic modelling of the discharge (eCoast, 2018:C1.1), dispersion of the discharge plume is expected to rapidly mix the discharge with the river water to achieve 100-fold dilution within 100 m downstream of the discharge under most river flow conditions. The combination of improved treated wastewater quality and rapid dilution is aiming to ensure that the WWWTP's contributions to the river's poor water quality do not exacerbate any breaches of water quality limits.

Reductions in volumes needing discharge to the river will also assist with reducing effects on the river as storage and irrigation are implemented. The treated wastewater quality is also suitable for irrigation while protecting stock and people (farm workers and neighbours) from health concerns and odour nuisance.

A grit trap is likely to be installed at the inlet to the aerated lagoon in order to catch stormwater-derived sediments and sand that are unable to be treated by the WWWTP processes. This trap will reduce the rate of settled sediment build-up in the aerated lagoon and improve the quality of the sludge so that it is entirely composed of organic material from wastewater treatment. This will result in reduced frequencies of desludging, improved maintenance of adequate hydraulic residence times, and improved treatment performance for the aerated lagoon.

Additional aeration or flow modifications such as baffles may be installed in the aerated lagoon and/or facultative pond if they are expected to be beneficial to the treatment effectiveness of the WWWTP system. The frequency of de-sludging may increase from historic frequencies to prevent sludge accumulations reaching levels that can adversely affect treatment performance and/or carry over into the facultative pond as has occurred at times in the past.

4.5 Treated Wastewater Storage

4.5.1 Current Storage

WWWTP currently has about 5,400 m^3 of storage capacity which is created by the outlet control weir and varying the water level of the main facultative pond by 500 mm. It is roughly equal to two days of average inflows, but during some storm events this has not been sufficient storage volume for a single day of elevated inflows.

4.5.2 Future Storage

Storage will be expanded as irrigation schemes are implemented over the next 20-30 years. The exact volume of storage to be provided has not yet been determined but it is likely to start small (about 10,000 m^3) and ultimately become quite substantial. The total land area needed for storing large volumes could easily exceed 10 ha, so the development of storage is a very important aspect to build into a plan, including allocating appropriately large land areas and funding for construction.

The size of storage will need to be based on the number of days of wet weather flows which need to be stored and are able to be fully discharged to irrigation and/or the river later (dry weather flows will generally be discharged instead of being stored). There is no advantage in providing storage if the entire stored volume cannot be discharged over the coming months, as it will either overflow or force a breach of discharge consent conditions in the long run.

The size of storage also needs to account for reducing wastewater flows resulting from reticulation improvements; it would be economically inefficient to provide storage for larger flows than are actually likely to pass through the system in future years, as the spare storage capacity would never be used despite the large cost of constructing it. Unusually wet seasons will result in unusually high river flow rates and the river can therefore more readily receive discharges, so larger storage for such periods of time is not necessary and would also be economically inefficient to construct.

The storage requirements will be refined based upon the actual observed scale of reductions in future flow rates resulting from reticulation renewals and the storage implications resulting from the combined land and water discharge regime constraints. As irrigation is developed, the storage requirements for the expanded irrigation areas will be able to be determined based on the land area, irrigation controls, and wastewater flow rates. Where constraints are applied to the timing and volume of discharges to the river, storage requirements for complying with those constraints can be determined based on wastewater flow rates.

Another important factor in determining the size of storage is rainfall that falls directly onto the storage ponds. As storage surface area increases, the volume of rainfall added to the volume of treated wastewater also increases. Rainfall can be a large contributor, particularly during winter when evaporation is also less (often negligible). Summer evaporation can exceed rainfall inputs but intense summer storms may still require a week or two to evaporate or need to be factored into the irrigation volumes.

4.6 Treated Wastewater Discharge System

4.6.1 Current Receiving Environment – Wairoa River

The Wairoa River's water quality is currently one of the worst in the Hawke's Bay region for recreational contact (pathogens), clarity and suspended solids; but has low (good water quality) nutrient concentrations. Table 4.5 below summarises the river's existing water quality upstream of Wairoa, based on HBRC's state of the environment monitoring data for 2004-13. The river's water quality is important to understand because it is the receiving environment for WWWTP's current and future discharge.

Table 4.5: Wairoa River Water Quality During 2004-13 Upstream of Wairoa

Parameter	Range	Median	Water Quality Limit
TP (g/m^3)	0.004 – 2.2	0.026	0.033 maximum (ANZECC 2000)
DRP (g/m^3)	0.002 – 0.043	0.006	0.015 maximum at or below median flows (RRMP)
NO_3-N (g/m^3)	0.001 – 0.373	0.040	1.0 maximum for annual median (NPS-FM for Attribute State A)
NH_3-N (g/m^3)	0.005 – 0.119	0.010	0.1 maximum at or below median flows (RRMP)
TSS (g/m^3)	1.5 – 2,900	20	25 maximum for all river flows (RRMP)
Turbidity (NTU)	1.8 – 1,510	19	N/A
Clarity – black disc (m)	0.0 – 2.1	0.6	1.6 minimum at or below median flows (RRMP)
E. coli (cfu/100 ml)	1 – 14,000	85	No more than 10-20% of results exceeding 540 cfu/100 ml, 20-34% exceeding 260 cfu/100 ml, median 130 cfu/100 ml, and 95th percentile 1,200 cfu/100 ml (NPS-FM for Attribute State C)

The river water quality currently fails to meet the RRMP limit for DRP and ammoniacal-nitrogen some of the time, and often fails to meet the RRMP limit for suspended solids and clarity before passing urban Wairoa. During 2010-18 the river water quality at the Ski Club (upstream of most of the urban area) has generally been in the NPS-FM Attribute State C criteria for *E. coli*. It is classed as Attribute State C despite its median *E. coli* meeting the Attribute State A limit for the median value because of its high 95th percentile and high frequency of results exceeding 260 and 540 cfu/100 ml. These statistics mean that it is overall a high-risk site for contact recreation due to its generally poor water quality for pathogen numbers. It should be noted, however, that the RRMP standards only apply upstream of the coastal marine area (CMA) and, apart from the limit for suspended solids, only apply at or below median river flows. Within the CMA the RCEP sets more generalised standards for discharges.

The key flow statistics for the Wairoa River are shown in Table 4.6. It is apparent that the river flows through urban Wairoa are approximately twice the Marumaru flows and are influenced by flows from several major tributaries, including the Waiau and Waikaretaheke Rivers with their hydroelectric power stations which regulate daily river flows and mask seasonal and storm variations. Due to the tidal nature of the lower Wairoa River it is not possible to accurately measure flows downstream of all these tributaries joining the Wairoa River, so HBRC calculate the flows based on the Marumaru and Waiau measurements. Based on these calculations, the median flow for the Lower Wairoa River is estimated to be about 60 m^3/s.

Table 4.6: Key Wairoa River Flow Statistics (m^3/s) (Sources: LAWA & HBRC)

Statistic	Marumaru	Waikaretaheke	Waiau	Lower Wairoa
Lowest Record	2.2	0.11	3.4	7.6
7-day MALF	5.8	-	14	19
Median	31	17	38	60
Mean	65	21	49	119
Mean Annual Flood	1,600	86	560	2,200
Highest Record	2,600	130	1,300	4,015

The Wairoa River estuary is tidal with a neap[1] tide and a spring[2] tide range of 1.2 m and 1.4 m respectively. Table 4.7 outlines the tidal ranges and gives an estimation of the tidal prism volumes[3]. The tidal cycle of the Wairoa River estuary is not sinusoidal due to a high river flow rate whereby there is a 5.2-hour inflow and a 7-hour outflow (Argo Environmental, 2010).

Table 4.7: Tidal ranges in Wairoa River (Source: Argo Environmental, 2010)

Tidal Condition	Neap Tides	Spring Tides
Mean high water	1.5 m amsl	1.6 m amsl
Mean low water	0.3 m amsl	0.2 m amsl
Range	1.2 m	1.4 m
Tidal Prism	3,500,000 m^3	4,100,000 m^3

There is an inverse relationship between river flow rates and the flow rate of the tidal prism of seawater entering the Wairoa River. As river flow increases, the in-coming tide and subsequent ebb tide[4] flow rate decreases. At low river flow rates the in-coming and ebb tides can have an equal or greater flow rate of marine water than the river flow rate, resulting in stratified and brackish estuarine conditions which can then migrate up river for several kilometres. River flow rates of ~200 m^3/s or greater result in zero in-coming and ebb tide flow rates of seawater at the mouth of the river; the entire flow is terrestrial and has no marine component.

The river's mouth to Hawke Bay is controlled by a natural gravel dune which is redistributed by coastal currents that occasionally close off the estuary from the sea, forcing the river flows to pass through the gravel dune instead of through a defined channel. During these river mouth closures the river forms eddies and has difficulty dispersing the wastewater discharge, even during out-going tides, and river water levels back up for several kilometres upstream. Closure of the mouth also elevates flood levels so that smaller rainfall events cause worse flooding than would have been the case when the mouth is open. Sometimes the river naturally breaks through the dune to form a new mouth but usually HBRC use excavators to re-open the channel through the dune when necessary and safe to do so.

Further details of the river environment are provided in LEI (2017:A3I2) and LEI (2018:A3I4).

4.6.2 Current Discharge System

The resource consent conditions limit the maximum daily (24 hour) discharge volume to 5,400 m^3/d and restrict the timing of discharges to out-going tides between 6:00 pm and 6:00 am (ie. overnight). When the river mouth is closed and affecting river flows the discharges are required to cease until storage at WWWTP is full; at this point discharges may resume but WDC are required to issue public health warning notices until the river mouth is opened again.

[1] Neap tide - a tide just after the first or third quarters of the moon when there is least difference between the high and low tides.
[2] Spring tide - a tide just after new or full moon when there is greatest difference between the high and low tides.
[3] Tidal prism - the volume of water in an estuary between mean high tide and mean low tide
[4] Ebb Tide – the period between high tide and low tide during which water flows out to sea.

Discharges are controlled by a weir and valve at the WWWTP outlet. The 20 m elevation of the WWWTP above the river allows the gravity-driven flows to generate a strong hydrostatic head pressure that ensures that the discharge flows quickly into the river.

During large storm events the WWWTP ponds have insufficient storage for retaining the inflows until the next overnight out-going tide which results in discharges occurring outside of the consented timeframes. A bypass system allows a portion of high flows to discharge to the river during storm events when inflows exceed the capacity of the pipe connecting the aerated lagoon to the facultative pond and/or when storage is insufficient to retain the volume until the next authorised discharge timeframe and it overflows its weir instead. During some storm events the total daily volumes discharged can also exceed the 5,400 m^3/d limit.

The WWWTP currently discharges by gravity via a 360 mm ID HDPE pipe to the river which terminates at a location about 150 m from the shore. During recent years the migration of the main river channel eastwards has allowed silt to build up a wider mudflat than previously. The depth of silt above and around the outfall was more than 3 m in 2016. This silt had blocked the outfall pipeline which the flow of wastewater had had difficulty clearing during each discharge event. In addition to silt blocking the outlet, a "bird's nest" of sticks, branches, and small logs were buried in the silt, and a large log was also discovered to have been deposited across the outlet.

In order to address these issues, a snorkel was fitted to the end of the outlet to lift it above the silt and log. It now terminates just above the low tide water level and reduces the head difference in elevation between the WWWTP outlet and the outfall, thus reducing the pressure and velocity of discharge flows. The snorkel is also a slightly smaller diameter than the main pipeline which restricts the outfall's flow capacity and exacerbates surcharging of the pipeline back towards the WWWTP.

In 2017 it was discovered that above average discharge rates were causing the outfall pipeline to surcharge and overflow to an adjacent stormwater drain near the riverbank. It is unknown how long this had been occurring but it may have been exacerbated by the modifications to the outlet which had been implemented to raise the outlet above the silt and buried tree log.

4.6.3 Future Discharge Systems

River Discharge System Design

As the Package is implemented, the river's water quality may improve somewhat, but the extent and timing of this is difficult to predict. For the purposes of this report, the current river water quality is assumed to be similar to current conditions even at the end of the 30-year period.

The existing discharge pipeline is likely to be retained but its outfall structure needs to be modified to resolve the siltation, flow capacity, and back-pressure concerns. Depending on the authorised limitations on the daily maximum volume and duration for the future discharge regime, the pipeline capacity may need to be increased by installing a larger diameter pipeline or a duplicate pipeline to the outfall diffuser location. However, wastewater flow reductions resulting from reticulation improvements may overcome these pipeline capacity issues, particularly when combined with increased storage capacity and more consistent discharge volumes.

The current pipeline would probably have sufficient capacity if the discharge regime was changed to include daytime out-going tides or 24-hour continuous discharges were allowed for elevated winter wastewater flow rates unless WDC intend to discharge several days' inflows during a single 24-hour period (for example to regain storage capacity while the river is flooding).

The outfall needs to be designed so that it can be idle for some months without silting up or becoming obstructed by tree debris and then reliably able to open and flow freely as soon as the discharge to the river needs to commence again. The current daily discharge helps to keep the outfall clear of silt by flushing it out, but even these daily discharges have not always prevented siltation blockages. Future long periods of idleness due to irrigation and storage prioritisation could result in considerable blockage of the outfall that might ultimately rupture the pipeline or cause surcharging and overflows occurrences along the pipeline. The risk of this occurring will be increased if the pressure of discharging wastewater cannot clear the siltation and/or could force the storage to overflow.

WDC needs to ensure that there is minimal need for maintenance of the outfall to keep it clear of silt and tree debris. WDC also needs to be able to freely carry out maintenance of the pipeline without triggering the need to gain resource consents or other authorisations prior to each time that maintenance is required. Some maintenance may need to be urgently attended to, so any delays in undertaking such works could have serious adverse consequences and delays therefore need to be minimised or avoided.

River Discharge Regime

The Package proposed a change from overnight out-going tide restrictions to potentially allowing continuous 24-hour and 7-day river discharges during certain flow conditions. The current daily discharge volume limit of 5,400 m^3 could also be increased or perhaps even become unrestricted during elevated river flow conditions so that the entire volume of any storm-induced flow and some of the previously stored wastewater volumes can be discharged to the river.

These changes to the timing, duration, and volume of discharges are believed to be potentially acceptable because the addition of filtration and UV treatment at the outlet of WWWTP will ensure that pathogens are no longer a public health concern upon discharging the treated wastewater to the river. A continuous 24/7 discharge was considered to have some advantages, as it will disperse the wastewater more slowly into the river and allow better dilution rates than is achieved by the current 5-6 hour discharge events. It will also relieve the surcharging pressure on the outfall pipeline so that the discharge flow rates are within the capacity of the pipeline and the overflows to the stormwater drain near the riverbank no longer occur.

However, during the refinement of the future discharge regimes, the implementation of 24/7 discharges and increased or unlimited volumes was restricted to elevated river flow conditions in order to ensure that the river was able to assimilate such discharges. It was also a conservative measure to ensure that the wastewater contaminants had no chance of travelling upstream. In any case, the proposed storage and irrigation regime also enables more flexibility for discharge management and helps to reduce the need for 24/7 discharges of large volumes.

The ultimate aspiration is for river discharges to cease altogether, but it is acknowledged that the very large irrigation area (perhaps 600 ha) and storage volume (perhaps 400,000 m^3) required to achieve this goal may not be achievable or affordable for Wairoa within the next 30 years. During unusually wet years it is likely that a river discharge will be unavoidable for at least part of the year (late winter and/or spring), but a compensating factor for this would be that the river would also be flowing faster than average and could readily accommodate the discharge.

This discharge regime will be phased in over time as irrigation and storage are developed. The available volume of storage has a strong influence on the seasonality of discharges to the river, as the time taken each autumn to winter to fill the storage will determine when river discharges must recommence. Initially the small area of irrigation and lack of storage will mean that a portion of each day's wastewater flows during summer will still need to discharge to the river. During the middle stages when moderate land areas are irrigated and more storage is available, the discharges to the river will cease during summer (November to February) but will still need to occur daily during autumn to spring. As irrigation and storage are further expanded the length of the season for river discharges will reduce to late winter and early spring.

Irrigation Discharge System

WDC will implement deficit irrigation across as much farm land as possible, starting near WWWTP and potentially including the landfill forest. Large areas of farm land which could be irrigated exist to the north and west of WWWTP, but the terrain is challenging for installing storage and connecting pipelines. Negotiations with the property owners also need to provide permission for this area to be irrigated. Irrigation and storage will be prioritised over discharges to the river so that the various irrigation areas ultimately take the majority of the annual wastewater volumes.

Irrigation will initially be less than 50 ha and only capable of taking a portion of the summer flows of wastewater. Over the 30-year timeframe of implementation, it is hoped that up to 600 ha could be developed for irrigation. As irrigation is developed, storage will also be developed to carry wastewater volumes over from autumn and winter to the next irrigation season.

Limiting irrigation to deficit rates[5] is necessary to match the poor drainage rates of the soils and to avoid causing instability and/or erosion of the hilly slopes. As experience is gained with irrigation in the local area it may be possible to demonstrate that non-deficit irrigation[6] is acceptable without causing adverse effects. If this is found to be the case the irrigation across all land areas could be adjusted to extend the irrigation season into the shoulder seasons (spring and autumn) and to force a small amount of drainage to groundwater following each irrigation event. This would assist with discharging the annual wastewater volumes to a smaller area of land and over a longer portion of each year. If non-deficit irrigation is implemented during early stages, it may be possible to reduce and ultimately cease the river discharges more rapidly than originally anticipated for the 30-year package.

[5] Deficit rates are those when following irrigation there is no drainage to groundwater.

[6] Non-deficit rates are those that allow irrigation to be applied in excess of what plants use and result in some drainage to groundwater.

5 REFINEMENT OF DESIGN CONCEPT

5.1 Key Issues and Concerns

The key issues and concerns raised throughout consultation related to the perceived adverse effects of the existing discharge of treated wastewater on the cultural, recreational, and public health values of the Wairoa River. Discharges while the river mouth is closed exacerbated the community's concerns. Storm-induced overflow discharges from the pump stations and breaches of the consented discharge constraints were also a concern for some parties. The primary wastewater contaminant of concern that was in common for all of these values was pathogens. Cultural concerns relate to all human-derived contamination of the river, not just pathogens.

The community feedback consistently identified a strong preference for ceasing the discharges to the river and implementing 100 % discharges to land (irrigation) but also strongly advised that all future changes must be affordable for the economically-challenged urban ratepayers. They also acknowledged that the entire rural catchment upstream of Wairoa is responsible for much of the river's poor water quality and health, and that resources should be contributed to rural efforts to improve the river's water quality in addition to the wastewater discharge improvements.

Hawke's Bay District Health Board (HBDHB) have expressed concerns about contact recreation and consumption of shellfish that may have elevated risks of causing illness, but they have no evidence that implicates the discharge in any historic outbreaks of individual or community illnesses. Despite this, WDC and members of the public acknowledge that improved treatment and/or changes to the discharge regime would reduce the public health risks posed by the treated wastewater discharge.

Closure of the river mouth causing river levels to rise and preventing flushing of the estuary out to sea is a key concern affecting the public health risks and WDC's ability to discharge to the river at times. HBRC are responsible for keeping the river mouth open but this is a hazardous activity for personnel and earthmoving equipment to undertake. It is also unpredictable as to when the mouth will close and how long it will take for HBRC to re-open it or for the river flows to naturally force a new opening to the sea.

River water quality targets (minimum standards) for a range of parameters upstream of the coastal marine area (CMA) are set by the NPS-FM and RRMP, while the RCEP sets generalised effects-based limits for the CMA. As noted above, the river water quality is in poor condition (mainly pathogens and suspended solids/clarity/colour) due to upstream rural sources of contaminants. There appears to be no strong evidence of the WWWTP discharge directly or measurably adversely affecting river water quality in a cumulative manner beyond the poor upstream water quality. The discharge timing restriction to out-going overnight tides combined with the outfall's location near the river mouth minimises the length of river that could be affected. Ecological studies of the estuary's sediments have also been unable to attribute any variations in sediment grain size distribution, sediment chemistry, ecological diversity, benthic fauna population sizes, or ecosystem health to the discharge, partly due to effects from the natural variations in the morphology and sedimentation patterns of the area as the river channel migrates over time. Despite these features, the discharge quality can be improved so that it is close to or better than the river water quality, and the daily discharge volumes and rates could be reduced or managed to reflect river flow rate variations. Such changes can further reduce the potential risks of causing any adverse effects.

The capacity of the outfall to discharge all of the daily wastewater volumes is a concern for WDC and the community's expectations of a single reliable discharge location within the riverbed. The restricted outfall capacity has contributed to surcharging of the outfall pipeline causing overflows at the manhole adjacent to the riverbank since late 2017. This overflow has been an issue which WDC have sought to manage and resolve in collaboration with the community, HBRC, and HBDHB. Siltation of the riverbed has caused blockage and burial of the pipe outlet which has restricted its capacity to discharge. WDC have cleared silt and debris and then sought to improve the outlet location and design for improved capacity and on-going reliability of discharge.

Storm flows of wastewater have caused discharges via the main outfall to occur outside of the consented overnight out-going tide restrictions and to occasionally exceed the daily volume limit of 5,400 m^3/d. Pump station and manhole overflows to land and the river have also occurred during storm events. These discharge concerns are directly related to the poor condition of some of the reticulation and illegal stormwater connections which drive up I & I contributions to the wastewater flows during wet weather.

5.2 Development of Responses to Concerns

Community consultation and the Tangata Whenua Worldviews report (How, 2017:A4I2) identified 100 % discharge to land (irrigation) as the preferred option to fully address cultural, social, and environmental values, but How (2017:A4I2) also promoted the use of improved treatment processes to ideally achieve drinking water standards if discharge to the river was to continue. WDC and the community do not believe that the high-tech and very expensive treatment systems to achieve drinking water quality are affordable as part of the solution. Rather, their preference was to invest those funds instead into irrigation which will avoid the need for high levels of treatment and avoids causing redundancy within a few years of installing new treatment systems.

Disinfection treatment of the treated wastewater will address the pathogen concerns that are directly related to the cultural, recreational, and public health concerns. In order to achieve high rates of disinfection, filtration of the treated wastewater is required immediately prior to the inlet to the disinfection unit. Filtration will reduce suspended solids and colour/clarity as its primary purpose, but it will also remove some nutrients and BOD from the wastewater which contribute to adverse effects on the water quality and ecological health of the river. The most appropriate disinfection technology was found to be UV irradiation. As noted in Section 4.4 above, the combined treatment performance of filtration and UV disinfection will remove 90-99 % of the suspended solids and pathogens from the treated wastewater. It will not achieve drinking water standards but will be a significant step towards meeting those standards and it will generally be cleaner than the river water ultimately receiving the discharge.

Storage and irrigation facilities will divert wastewater away from the river discharge system, which will directly reduce the effects of the discharge on the river. As noted above, the ultimate solution to avoid effects on the river is to discharge all treated wastewater to land. While irrigation is being developed across expanding areas of land, the discharges to the river can be gradually reduced in annual volume and timing (daily and seasonally). Storage also provides opportunities for managing wastewater flows so that discharges to the river can vary to reflect the river flow conditions and its assimilative capacity or sensitivity to receiving the discharge. Low river flows and summer seasons are the most sensitive times for discharges, so discharges are likely to be more restricted during these times. Irrigation coincides with summer and will, in combination with storage, prevent river discharges throughout summer months and eventually all year round.

Reticulation improvements will address the wet weather wastewater flow and storm overflow issues. The level of annual investment and rate of improvements in reticulation condition and reductions in wastewater flows need to be affordable and optimised for achieving the best balance of outcomes. WDC's LTP provides for the on-going reticulation improvement programme which WDC believed would be affordable and was endorsed through consultation with the community.

Duplicating the outfall pipeline would address the capacity and surcharging issues but may not be necessary if discharge flow rates are to reduce in future as a result of combined reticulation improvements and diversion of treated wastewater flows to irrigation. Allowing the outfall to be relocated within a defined area of the riverbed so that it is kept close to the active river channel would assist with keeping it clear of silt and debris.

5.3 Design and Operation Refinements

5.3.1 Disinfection Treatment Details

A balance needs to be struck for sizing of the filter and UV chamber to reflect the normal range of wastewater flows in the future integrated system. The anticipated reductions in flows resulting from reticulation improvements need to be factored into their sizing (it should not be designed for current flows) which will help reduce the size of the disinfection system. The diversion of flows to the river, storage, or irrigation also needs to be factored into the outlet design for the disinfection system. If all treated wastewater flows into storage after disinfection, then the flows through the filter and UV system can occur continuously every day instead of only matching any river or irrigation discharge timing. This helps reduce the size of the disinfection system.

The capacity of the filter and UV chamber need to allow high flows to partially bypass the system directly to the river discharge outfall. The bypass of UV treatment for flows above a specific threshold is necessary to prevent overflows or pressurising of the filter and UV chamber, and for ensuring that treatment performance is kept within the design range. The bypassing of a proportion of these high flows will mean that pathogens and suspended solids in the final effluent will be higher, but this untreated volume will be diluted into the fully treated wastewater stream prior to discharge to the river. It will also be readily assimilated by the faster flowing and more heavily contaminated river which is less likely to be used at such times for recreation or fishing.

The filter and UV lights will both be duplicated. The duplication of filters enables one filter to be back-flushing while the other filter is in use. The duplication of UV light banks ensures that they can be cycled between duty and standby, and also allows more UV lamps to be turned on for treatment of higher flow rates which will help to maintain consistent treatment performance at a wide range of flow rates.

5.3.2 Storage Details

There are a number of options for storage designs and locations. The existing facultative pond could have its bunds raised so that its operating level can be varied more than the current 500 mm. Some care would be required to ensure that this did not adversely affect the treatment performance when it is operating near its new maximum water levels. Alternatively, this pond could be converted to a much deeper and dedicated storage pond (varying between empty and a higher bund level without intentionally providing treatment) and a new treatment system could be constructed on the elevated bare land near the entrance to the WWWTP site to provide the treatment lost by converting the facultative pond into a storage pond.

Another storage configuration alternative is to construct a new storage facility on the elevated bare land near the entrance to the WWWTP site and pump treated wastewater from the outlet of the facultative pond up to the new storage facility. This storage facility could be a pond formed by excavation and bund construction or it could be a large steel or timber tank. There is space for a series of ponds and/or tanks to be constructed in this area of the WWWTP site, and this might be a useful way of staging the expansion of storage over time to match the development of the discharge systems.

Another option is to install tanks and/or ponds that are more conveniently located for the irrigation system. An obvious possibility is to install storage on the top of the ridge to the west of WWWTP so that it is central to farm land on both sides of the ridge (the coastal area and Tawhara Valley). A centralised storage facility could help to minimise reticulation to the various irrigated farm areas and it would keep storage management simple. Its height could be an advantage for gravity feed to the various irrigation areas at lower altitudes, thus saving on irrigation pumping costs to create the correct pressure for adequate spray irrigation coverage.

As irrigation is developed further away from WWWTP it may be desirable for some farmers to have some storage dedicated to their farm instead of relying on a shared centralised facility. These will need to be lined and engineered for stability and have their floors above groundwater levels when empty.

A series of storage facilities could provide a very large total storage volume while not dominating a single farm's land area. It would spread the risk of storage or reticulation failures and natural disaster disruptions, thus providing greater resilience than a single storage facility would provide. However, it also would generate more complex storage management issues and might incur some conflict between farmers over whose storage should have priority over others' storage for topping up during dry seasons.

The storage locations are also likely to occupy flatter terrain which means that the farmers will need to determine the appropriate balance between the proportion of use of their flat land for irrigation and storage. A trade-off will need to be applied so that sufficient storage is provided while not losing too much valuable productive land that could have been irrigated. The rate of irrigation (mm/d) and extent (ha) of irrigated land will also be a high consideration in determining the appropriate balance of storage facilities within their farm land.

5.3.3 Discharge System Details

The future pipeline could be designed so that it is able to be relocated rapidly within a specific area of the riverbed so that its outfall can be maintained within a short distance of the active deeper river channel. This would ensure that the discharge entered faster-flowing river water for more rapid dispersion and it would generally avoid siltation accumulations. It should be able to be shortened, lengthened, re-levelled, and realigned as necessary to match the on-going migrations of the river channel and its mouth through the coastal dune. However, this discharge location envelope needs to be kept as small as practicable so as to minimise the potential area of disturbance when relocating the outfall.

Its potential for obstruction of the navigable waterway will also need to be minimised and acceptable to the Harbour Master. The outfall may potentially need a surface marker to indicate its current location so that river users can be clearly warned of its location and navigational hazard.

Ideally WDC will have advance authorisation to be able to freely and rapidly relocate the outfall within the designated envelope area without triggering the need to gain resource consents or other authorisations prior to each time that relocation is required. There may be occasions when relocation of the outfall is required to occur urgently in order to avoid structural damage to the outfall pipeline or to address its obstruction of the river channel or obstruction from deposited flood debris.

5.3.4 Discharge Regime Development

As storage is expanded, discharges to the river can be managed so that the timing, duration, flow rate, and total daily volume of the discharge increase with increasing river flow rates. This type of flow management can ensure that the discharge is kept well within the assimilative capacity of the river and is assured of being dispersed and flushed out to sea without any risk of being carried back upstream towards or past the urban area.

As noted in Section 4.6.1 above, the RRMP limits only apply upstream of the CMA and when river flows are below median flows. The RCEP imposes more generalised limits on the downstream changes in water quality that are attributable to a discharge within the coastal environment. In order to apply a conservative and simplified approach to the WWWTP's discharges, calculations have been undertaken to determine the dilution rates that would be necessary to achieve the RRMP or NPS-FM limits at all river flows. This would also indicate that the cumulative effects of the WWWTP discharge would be acceptable after reasonable mixing. The rationale is that if the required dilution rates are readily achievable then the scale of effects under the RCEP regime should be acceptable. Based on wastewater quality data for the current discharge and the potential future discharge following installation of filtration and UV disinfection, the dilution rates for acceptable river water quality are presented in Table 5.1 below.

Table 5.1: Treated Wastewater Dilution Targets

Parameter	Discharge Quality		Dilution Requirement		River Water Quality Limit
	Range	Median	Range	Median	
Current Discharge Quality					
NH_3-N (g/m^3)	4.0 – 36	15.6	40 – 360	156	0.1 maximum (RRMP)
TSS (g/m^3)	7 – 290	52	0 – 12	2	25 maximum (RRMP)
E. coli (cfu/100 ml)	8 – 470,000	5,200	0 - 400	4.3	Median 130 cfu/100 ml, 95th percentile 1,200 cfu/100 ml (NPS-FM for Attribute State C)
Potential Future Discharge Quality					
NH_3-N (g/m^3)	2.5 – 25	10	25 – 250	100	0.1 maximum (RRMP)
TSS (g/m^3)	2 – 50	10	0 – 2	0	25 maximum (RRMP)
E. coli (cfu/100 ml)	0 – 5,000	50	0 – 5	0	Median 130 cfu/100 ml, 95th percentile 1,200 cfu/100 ml (NPS-FM for Attribute State C)

Table 5.1 indicates that future discharges will potentially require little or no dilution in order to meet the RRMP's river water quality targets/limits for suspended solids and *E. coli* and will only require 100-fold dilution to meet the river water quality target/limit for ammoniacal-nitrogen. The discharge concentrations of suspended solids and *E. coli* will be lower (better) than the river water quality receiving the discharge. Achieving 100-fold dilutions would ensure that the contributions of wastewater-derived contaminants are undetectable in the river and therefore unlikely to cause adverse effects on the environment. Applying these dilution limitations to discharges only when river flows at or less than median flows would reflect the RRMP limits and this could allow discharges above median river flows to have less (or even no) consideration for its contribution to poor water quality. However, the community may not be comfortable with endorsing this for a wastewater discharge.

It is acknowledged that in-coming tides during lower river flows (less than about 3 x median) will transport any discharged contaminants upstream and this may be perceived by the public as an unacceptably negative effect on the river despite the very low pathogen concentrations in the discharge following installation of filtration and UV treatment. In order to address this perception concern, it is proposed that ultimately (in the future) the discharge only occurs during out-going tides (both during daylight hours and overnight) when river flows are below 3 x median.

The river does not allow in-coming tides to enter the estuary when it is flowing at or above about 3 x median flow. Under these conditions the river is continuously flowing into the sea at a rate of about 180-200 m^3/s and this river flow rate is readily able to assimilate a large discharge of treated wastewater. Storm-induced elevated river flow rates carry higher loads of silt and pathogens from upstream sources, can readily assimilate treated wastewater discharges (which may be of better quality than the river at such times), and are accompanied by an absence of recreational and food-gathering activities. Under these river flow conditions the discharge can occur 24/7 and there may be no need for a discharge volume limit or at least with a higher discharge volume limit (perhaps 20,000 m^3/d); the physical capacity constraints of the discharge pipeline would provide the limit for the daily 24-hour discharge volume.

Hydrodynamic modelling of various discharge scenarios (eCoast, 2018:C1.1) has assisted with determining and refining appropriate discharge parameters for river flow bands. Scenarios were developed by LEI for fixed river flow rates, daily total discharge volumes, and discharge durations (either out-going tides or continuous 24-hour durations). The river flow bands were selected to represent changes in the river's assimilative capacity and water quality. The highest river flow band of 3 x median was selected to represent periods when the river flows prevent in-coming tides entering the mouth. The discharge flows were selected to represent the lowest 10 % through to the highest 10 % of daily wastewater flows with increasing discharge flows as river flows increase. The scenario parameters are shown below in Table 5.2.

Table 5.2: River Flow and Discharge Scenarios for Hydrodynamic Modelling

Scenarios	River Flow	Discharge Flow (m^3/d)	Discharge Timing
1 and 2	MALF (15 m^3/s)	800 and 1,600	Out-going tides
3 and 4	½ Median (30 m^3/s)	1,600 and 2,400	Out-going tides
5 and 6	Median (60 m^3/s)	2,400 and 3,200	Out-going tides
7 and 8	2 x Median (120 m^3/s)	4,000 and 6,000	Out-going tides
9 and 10	3 x Median (180 m^3/s)	6,000 and 10,000	Continuous 24-hour

The modelling predicted that the 90-99th percentile extents of plumes would be diluted 100-fold from the original discharge concentration within 50-100 m of the outfall location under all of these scenarios. The extent of the plume at 1,000-fold dilution varied considerably for the various scenarios and tended to extend towards or through the river mouth and also westwards towards Whakamahi Lagoon.

Based on Table 5.1 and the hydrodynamic modelling, the discharge scenarios give confidence that the target of a 100-fold dilution of the median discharge quality is readily achievable within 100 m of the outfall location. A 100 m mixing zone is small compared with the RRMP's allowance of 200 m for reasonable mixing and compliance assessments in a river of this width.

Once a large storage and irrigation system has been established the river discharge could be avoided during low river flows (initially below half median flow, but ultimately perhaps avoided somewhere between median and 2 x median river flows). The availability of large-scale irrigation and storage will ensure that this restriction can be readily complied with because the wastewater will have alternative destinations to the river. The low river flows generally occur during summer months which is when irrigation is needed the most often, and this means that the irrigation regime provides a complementary timing for avoiding discharges to the river during low river flow conditions.

Once the irrigation and storage have been commissioned on a large scale the daily discharges at or above 2 x median river flows may be allowed to increase in order to relieve pressure on storage. It may be necessary at this stage to duplicate the outfall pipeline or increase its diameter to cope with these higher daily discharges, as the current pipeline does not have the capacity to allow such flows, even continuously on a 24/7 basis, without surcharging and overflowing the pipeline and its manholes.

Storage will also enable WDC to cease discharges to the river while the river mouth is closed. Ideally the storage will be sufficient to wait until HBRC or the river flows re-open the mouth.

During initial stages of development of the storage and irrigation systems it is possible that there will not be sufficient storage available to cease the river discharges for the entire duration of a river mouth closure, and this must be developed into an implementation sequence.

6 STAGE 1 IMPLEMENTATION – FIRST 5 YEARS

6.1 General Description

During the first 5 years of implementation, the following features will be developed:

- some reticulation and pump station improvements will limit flows into WWWTP and reduce the frequency and volume of pump station overflows so that they only occur during larger storm events (targeted to less than 10 times per year from each pump station);
- filtration and UV treatment system will be installed at the WWWTP facultative pond's outlet for algae and pathogen reductions but with a partial bypass for elevated flows;
- existing storage of 5,400 m^3 within the WWWTP ponds will remain unchanged;
- the river discharge pipeline and outfall will be relocated closer to the river channel;
- the daily discharge volumes will continue to reflect the daily inflows and limited storage until irrigation has been commissioned;
- a small area (<50 ha) of farm land and perhaps the landfill forest near WWWTP will be developed to receive summer irrigation of some treated wastewater and the subsequent discharges to the river during will be able to occur as follows:
    - summer discharges to the river will reduce in volume, duration, and frequency due to irrigation taking some of the flows;
    - during summer storms and every day throughout autumn, winter, and spring discharges to the river will be changed to reflect the assimilative capacity of river flows (if that is accepted by HBRC) as follows:

River Flow Rate	Maximum Daily Discharge Volume	Discharge Timing Restrictions
Below ½ median	1,600 m^3/d	Only overnight out-going tides
½ median to median	3,000 m^3/d	All out-going tides
Median to 3 x median	5,000 m^3/d	All out-going tides
Above 3 x median	No limit	Continuous 24-hour

These river discharge limits are intended to reflect the modelled discharge scenarios and improved storage management.

6.2 Physical Changes

WDC will continue to implement their CCTV and other inspections of the reticulation, enforce stormwater disconnections on urban properties, and renew or repair leaky reticulation. Modern chopper pumps will be installed at all pump stations with back-up power generators for electrical outages. These will ensure that blockages will become rare events, and overflows during storm events will also reduce as pumps will be able to continue operating even when the local power supply is down.

A new pipeline will link directly from Kopu Road pump station to Fitzroy Street pump station so that flows from all of the other catchments can be accommodated by the existing gravity main, even during storm events. A new duplicate rising main pipeline will also be installed from Fitzroy Street pump station to WWWTP inlet to ensure that the Fitzroy Street pump station is not overwhelmed by storm flows and causing raw wastewater to back up within the sewer main towards Wairoa (which can then cause surcharging and overflows within the urban reticulation network).

A grit trap may be installed after the WWWTP's screen and prior to the aerated lagoon. The outlet of the WWWTP will be modified to divert all non-storm event flows of treated wastewater through the filtration unit and UV light chamber prior to a valve which selects the pipelines leading to irrigation or the river outfall. Flow meters will be installed in each discharge pipeline to record daily volumes for management and compliance purposes.

The majority of higher storm flows of treated wastewater will be distributed across several banks of filters and UV chambers by a manifold. Additionally, higher flows than a specified threshold (perhaps 3,500 m^3/d) will bypass the filter and UV chamber directly to the river discharge pipeline. This would be acceptable because the river will be flooding and/or contain urban run-off during such times and the wastewater would not need to be as well-treated as would be required for normal river flow conditions.

The river outfall will be modified to ensure that it is located close to the edge of the active river channel so that siltation and tree debris are less likely to affect its operation. Its design will also ensure that it is suitable for the discharge flow rates without surcharging the pipeline, less prone to blockages from silt, and able to be relocated rapidly when necessary. The pipeline's surcharge overflow structure will remain in place to protect the main pipeline from excessive pressure but it is anticipated that the riverbank overflows from the main discharge pipeline will also reduce in frequency and will generally only occur during storm events and elevated winter flows.

The irrigation system during this stage may be of a design that is modular and able to be readily dismantled, moved, and reassembled. This would enable the designs and locations of sprinklers to be refined and optimised over time, allow flexibility for farm management, and help to minimise the investment costs during the first few years of irrigation development. Some farmers may wish to trial irrigation instead of making a definite long-term commitment, and temporary modular systems can also be replaced later with permanent infrastructure while the modular systems can then be deployed to the next area of new irrigation development or trials elsewhere.

6.3 Operational Changes

Once filtration and UV irradiation have been installed at the outlet of the WWWTP, river discharges will be changed from their overnight out-going tide restriction to including daytime out-going tides for river flows between ½ median and 3 x median river flows and allowing 24/7 discharges at or above 3 x median river flows. The current daily discharge volume limit of 5,400 m^3 may also become unrestricted (if that is accepted by HBRC) above 3 x median river flows to cope with storm events that elevate wastewater flows beyond what the WWWTP's limited storage is able to retain. Reductions in I & I combined with active storage management during winter months should mean that the highest daily discharges to the river only occasionally exceed 5,400 m^3/d during large winter storm events.

As irrigation is commissioned, storage within the WWWTP pond will be managed during the summer irrigation season (normally November to March) so that, as much as possible, river discharges are avoided and storm inflows can mostly be retained in storage for later irrigation (instead of being immediately discharged to the river). However, the limited storage volume and inability of the irrigated land areas to discharge all incoming wastewater flows mean that there will still be daily or almost daily discharges to the river during summer, albeit at reduced volumes. These discharges will mostly occur during overnight out-going tides because daytime irrigation and storage will generally avoid the need to discharge to the river during summer mornings and afternoons.

Outside of irrigation seasons, the treated wastewater will discharge to the river during all out-going tides when the river flows are between ½ median and 3 x median. Storm-induced wastewater flows will discharge to the river on a continuous basis while the river is flowing at or above 3 x median. A portion of storm flows will bypass the filter and UV system which will be sized to suit future reduced wastewater flows.

Irrigation will occur on the farm land at deficit rates on every day possible during spring to autumn months (but primarily summer). During and after summer storm events irrigation will not be possible until soils dry out sufficiently for deficit irrigation to resume.

7 STAGE 2 IMPLEMENTATION – YEARS 6-10

7.1 General Description

During years 6-10 of implementation, the following features will be developed:

- further reticulation improvements will reduce flows into the WWWTP and will reduce the frequency and volume of pump station overflows so that they only occur rarely during larger storm events (targeted to less than 8 times per year from each pump station);
- filtration and UV treatment will continue to operate but partial bypasses of storm flows will reduce in volume and frequency due to reticulation improvements;
- the river discharge outfall will be maintained close to the river channel and modified to prevent siltation during summer periods of zero discharges;
- some additional storage capacity of up to 10,000 m^3 (in addition to the existing 5,400 m^3 within the WWWTP ponds) will be constructed outside the existing the WWWTP ponds for irrigation;
- additional areas of farm land near WWWTP (up to a total of about 100-150 ha including the previous stage) will be developed to receive summer irrigation of treated wastewater and the subsequent discharges to the river will be able to occur as follows:
  - summer discharges to the river will reduce in volume, duration, and frequency (and may cease at times such as when the river is at or below half median flow) due to reduced inflows, increased storage, and expanded irrigation taking more of the flows;
  - discharges to the river will remain as follows when irrigation can't receive flows (during summer storms and every day throughout autumn, winter, and spring):

River Flow Rate	Maximum Daily Discharge Volume	Discharge Timing Restrictions
Below ½ median	1,600 m^3/d	Overnight out-going tides
½ median to median	3,000 m^3/d	All out-going tides
Median to 3 x median	5,000 m^3/d	All out-going tides
Above 3 x median	No limit	Continuous 24-hour

Discharges to the river when it is flowing below ½ median during summer months should be rare, as the combination of irrigation and increased storage should usually be able to handle all wastewater flows while the river is flowing so slowly. Despite this, it is proposed that discharges when the river is below ½ median flow to be limited to **no more than 30 days of discharge in the months of December through to March** (with no limit on the numbers of days of discharge when the river is below ½ median outside of those months).

7.2 Physical Changes

Further reticulation improvements will reduce I & I which will reduce the frequencies and volumes of pump station overflow events and will help WDC to manage the treatment and storage of wastewater. WDC will be better able to avoid discharges to the river during lower river flow conditions (at least below half median flows). Reticulation improvements will also reduce the volumes of treated wastewater that need to be stored and/or discharged to the river.

Storage of up to 10,000 m^3 in addition to the existing the WWWTP freeboard, most likely in the form of tanks, will be constructed outside of the WWWTP ponds. This storage may be constructed within the WWWTP property and/or near the top of the ridge between the WWWTP and Tawhara valley. Storage level monitors and alarms for high and low levels will be installed at each storage facility. Flow meters will be installed in each discharge pipeline to record daily volumes for management and compliance purposes.

The outlet of the WWWTP's filtration unit and UV light chamber will be modified to enable a valve to select a pipeline leading to the expanded storage. Despite the UV treatment prior to pumping to storage, it is possible that pathogens could re-populate the stored wastewater, so either the risk is accepted, or each storage facility's outlet may require a UV system to operate immediately prior to each irrigation event. The wastewater flow from the storage outlet to irrigation could readily pass through the WWWTP's UV system prior to irrigation if the storage is located within the WWWTP land area.

More irrigation will be constructed with separate controls and meters for each irrigation unit. The irrigation design may be a mixture of permanent and temporary modular systems.

7.3 Operational Changes

Discharges to the river will continue to include daytime out-going tides for river flows between ½ median and 3 x median and allowing 24/7 discharges for river flows at or above 3 x median. It should be possible to generally avoid discharges to the river when it is flowing at or below its half median flow because these low river flows generally occur during summer and inflows during such times will usually be able to be irrigated or stored. However, there needs to still be some allowance for summer discharges when river flows are less than ½ median, and it is proposed that this be limited to no more than 30 days of discharge during December to March each year. The expanded irrigation and storage will ensure that summer (normally November to March) discharges to the river will only occur occasionally (usually during wet periods and large storms) and generally irrigation during daylight hours will restrict river discharges to overnight out-going tides.

Summer storm events during wet summer seasons that cause flows to exceed the available storage capacity will need to discharge the excess volume to the river. Where possible these discharges will be managed to occur during all out-going tides when river flows are below 3 x median, but will be allowed to occur continuously and with unrestricted daily discharge volumes (if that is accepted by HBRC) when the river is flowing at or above 3 x median.

Outside of irrigation seasons, storage will be actively managed to smooth out storm peak flows prior to discharge to the river. However, even with active storage management, the limited storage capacity will mean that discharges to the river will occur daily during most of autumn to spring. During these seasons the discharge to the river will operate during all out-going tides for river flows less than 3 x median and continuously for river flows at or above 3 x median. There will be limited ability for WDC to reduce daily discharge volumes during lower river flow conditions but it should be possible to draw down the stored volume to some extent when the river is flowing at or above 3 x median.

Reticulation improvements will ensure that a smaller portion of storm flows will overflow any of the pump stations and/or bypass the filter and UV system and less often than was previously the case. Reductions in I & I combined with active storage management should mean that the daily discharges to the river during autumn to spring months only rarely exceed 5,000 m^3/d during large storm events and should be able to be timed to coincide with river flows above 3 x median flows or have the excess stored to spread the discharge over an extra day or two.

8 STAGE 3 IMPLEMENTATION – YEARS 11-20

8.1 General Description

During years 11-20 of implementation, the following features will be developed:

- further reticulation improvements will further reduce flows into WWWTP and reduce the frequency and volume of pump station overflows so that they only occur very rarely during very large storm events (targeted to less than 4 times per year from each pump station);
- filtration and UV treatment will continue to operate with less frequent and smaller volume partial bypass of storm flows;
- the river discharge outfall will be maintained close to the river channel and modified if necessary to prevent siltation during extended periods of zero discharges;
- additional storage capacity (up to a total of 50-100,000 m^3) will be constructed outside the existing WWWTP ponds and/or on irrigated farms;
- additional areas of farm land (up to a total of about 300 ha including the previous stages) near WWWTP will receive summer irrigation of treated wastewater from the expanded storage facilities and the subsequent discharges to the river will be able to occur as follows:
    - summer discharges to the river will cease except during long wet periods due to increased storage and irrigation taking all of the flows almost all the time;
    - discharges to the river will continue to occur as follows when irrigation and storage can't receive flows (during winter and parts of autumn and spring):

River Flow Rate	Maximum Daily Discharge Volume	Discharge Timing Restrictions
Below ½ median	No discharge	No discharge at any time
½ median to median	3,000 m^3/d	Only overnight out-going tides
Median to 3 x median	5,000 m^3/d	All out-going tides
Above 3 x median	No limit	Continuous 24-hour

Discharges to the river when it is flowing between ½ median and median during summer months should cease and during autumn months will be rare, as the combination of irrigation and increased storage should usually be able to handle all wastewater flows while the river is flowing at or below its median flow.

8.2 Physical Changes

Further reticulation improvements will reduce I & I which will reduce the frequencies and volumes of pump station overflow events and will help WDC to manage the treatment and storage of wastewater. These improvements, combined with expanded storage, mean that WDC will be able to avoid discharges to the river during low summer river flow conditions (at least below median flows). Reticulation improvements will also reduce the volumes of treated wastewater that need to be stored and/or discharged to the river during autumn to spring. The wastewater flows will remain within the treatment capacity of the filtration and UV system most of the time, and only occasionally bypass to storage or the river discharge.

Storage will be expanded up to a total of 50-100,000 m^3 in the form of one or several large ponds and perhaps some smaller tanks located within the WWWTP site and the farms for individual and decentralised storage management. It is unlikely that the entire storage volume can be provided within the WWWTP's limited available land area, since some of the storage that was constructed during the previous stage may occupy some of the available land area.

Storage level monitors and alarms for high and low levels will be installed at each new storage facility. Flow meters will be installed in each of the new storage and irrigation discharge pipelines to record daily volumes for management and compliance purposes.

New areas of irrigation will have separate controls and meters for each irrigation unit. Irrigation will become permanent across more farm land, hopefully covering up to 300 ha in total area.

8.3 Operational Changes

Reticulation improvements will ensure that only occasionally a small portion of storm flows will overflow any of the pump stations and/or bypass the filter and UV system; this will be less often than was previously the case.

As irrigation and expanded storage are commissioned, it should be possible to avoid discharges to the river during late spring, summer and most of autumn because all inflows during such times will usually be able to be irrigated or stored. Irrigation will ensure that the expanded storage will be maintained as empty as possible during the irrigation season (normally November to February) so that any storm inflows can be retained as much as possible for later irrigation. As early spring approaches, storage will be maintained as full as possible to maximise the available volume for irrigation upon commencement of the next irrigation season.

During late autumn to early spring, storage will be actively managed to smooth out storm peak flows and adjust discharge rates to the river flow conditions. However, even with active storage management, the limited storage capacity will mean that discharges to the river will occur daily during late autumn to early spring. During these seasons the discharge to the river will operate during all out-going tides for river flows between median and 3 x median and continuously for river flows at or above 3 x median. With good storage management WDC will be able to reduce daily discharge volumes during lower river flow conditions by discharging larger daily volumes to the river in order to regain storage capacity when the river is flowing at or above 2 or 3 x median. It may be possible for WDC to manage storage so that discharges to the river only occur when the river flows are at or above median flow, but provision has been retained for some discharges to occur during ½ median to median river flows with discharge limits of up to 3,000 m^3/d during overnight out-going tides. This is necessary to ensure that storage can be managed to avoid any risks of overflowing in the event that discharges during river flows above median are unable to maintain enough spare capacity as spring and the next irrigation season approach.

Irrigation will occur on the expanded farm land areas at deficit rates on every day possible from late spring to early autumn. It may be found to be possible to irrigate some areas at non-deficit rates to allow irrigation during the shoulder seasons (spring and autumn).

Allocation of wastewater volumes to each of the storage and irrigation areas will become more complex as more land areas and landowners join the scheme. There may be times when storage has been emptied and the daily flow of wastewater through WWWTP is insufficient to irrigate all of the available land. This may also coincide with the driest or latter part of summer when farmers will want to irrigate the most. Consequently, it is likely that rationing will need to be implemented, and a fair allocation system will need to be developed by WDC and the farmers.

9 STAGE 4 IMPLEMENTATION – YEARS 21-30

9.1 General Description

During years 21-30 of implementation, the following features will be developed:

- further reticulation improvements will further reduce flows into WWWTP and reduce the frequency and volume of pump station overflows so that they only occur very rarely during unusually large storms (targeted to less than 4 times per year from each pump station);
- filtration and UV treatment will continue to operate and storm flows will rarely bypass it;
- the river discharge outfall will be maintained close to the river channel and modified if necessary to prevent siltation during extended periods of zero discharges;
- additional storage capacity (up to a total of 200-400,000 m^3) will be constructed within irrigated farms;
- additional areas of farm land (up to a total of about 600 ha including the previous stages) may be identified and developed to receive summer irrigation of treated wastewater from the expanded storage facilities and the subsequent discharges to the river during will be able to occur as follows:
  - discharges to the river may cease during summer, autumn, and some or all of winter due to increased storage and irrigation taking all of the flows;
  - discharges to the river during late winter and maybe parts of spring when irrigation and storage can't receive flows will continue to occur as follows:

River Flow Rate	Maximum Daily Discharge Volume	Discharge Timing Restrictions
Below ½ median	No discharge	No discharge at any time
½ median to median	No discharge	No discharge at any time
Median to 3 x median	5,000 m^3/d	Only overnight out-going tides
Above 3 x median	No limit	Continuous 24-hour

Discharges to the river when it is flowing between median and 3 x median during summer months should cease and during winter and spring months will be rare, as the combination of irrigation and increased storage should usually be able to handle all wastewater flows while the river is flowing at or below its 3 x median flow. The ability to discharge during river flows above median is necessary to ensure that wastewater flows during winter and spring months do not risk overflowing the storage facilities before the next irrigation season commences.

9.2 Physical Changes

Further reticulation improvements will continue to reduce I & I which will almost eliminate the pump station overflow events and will improve WDC's management of the treatment and storage of wastewater. These improvements, combined with expanded storage, mean that WDC will be able to avoid discharges to the river during all summer river flow conditions and much of winter and spring (at least below median flows). Reticulation improvements will also reduce the volumes of treated wastewater that need to be stored and/or discharged to the river during winter to spring. The wastewater flows will remain within the treatment capacity of the filtration and UV system almost all of the time, and only rarely bypass it to storage or the river discharge.

Storage up to a total of perhaps 200-400,000 m^3 may be provided in the form of one or several additional large ponds within the irrigated farms. It will not be possible to develop further storage within the WWWTP site at this stage, as earlier stages of storage development will have occupied all of the available land within the WWWTP site.

Irrigation will become permanent across more farm land, hopefully covering up to 600 ha in total area. Each irrigation system will have its own controls and metering of flows.

In the event that 600 ha cannot be attained across the farm land near Wairoa, the storage volume will also be reduced accordingly. The storage volume required will be calculated as the irrigation scheme is developed, as storage needs to match the volume that can be realistically expected to be irrigated during the next irrigation season.

9.3 Operational Changes

Reticulation improvements will ensure that only rarely a small portion of storm flows will overflow any of the pump stations.

Once the expanded irrigation and storage are commissioned, it should be possible to avoid discharges to the river at all times except late winter and early spring during unusually wet years because all inflows during late spring to winter will usually be able to be stored or irrigated. Irrigation will ensure that the expanded storage will be maintained as empty as possible during the irrigation season (mainly November to February) so that any storm inflows can be retained as much as possible for later irrigation. As winter ends and early spring approaches, storage will be maintained as full as possible to maximise the available volume for irrigation upon commencement of the next irrigation season.

Storm events during wet winter or spring seasons that cause flows to exceed the available storage capacity will force discharges of the excess volumes to the river. During autumn and winter WDC could discharge some of the stored wastewater on each occasion that the river is flowing at or above 3 x median, even if the storage is not yet full, as this would help to retain storage capacity and assist management of future inflows and river discharge events later in the winter and spring seasons. With good storage management WDC will be able to avoid daily discharge volumes during winter and spring when river flows are below median flow. The large storage capacity means that WDC should be able to manage winter and spring discharges to occur during overnight out-going tides when river flows are between median and 3 x median and to occur continuously and with unrestricted daily discharge volumes (if that is accepted by HBRC) when the river is flowing at or above 3 x median.

Irrigation will occur on the expanded farm land areas at deficit rates on every day possible from late spring to early autumn. It may be found to be possible to irrigate some areas at non-deficit rates to allow irrigation during the shoulder seasons (spring and autumn).

Allocation of wastewater volumes to each of the storage and irrigation areas will continue to become more complex as more land areas and landowners join the scheme. There will be times when storage has been emptied and the daily flow of wastewater through the WWWTP is insufficient to irrigate all of the available land. This will also coincide with the driest or latter part of summer when farmers will want to irrigate the most. Consequently, it is likely that rationing will continue to be required using a fair system that was developed during the previous stages and modified as necessary to incorporate the new irrigators.

10 SUMMARY

The conceptual design for the development of the future discharge system for Wairoa's treated wastewater is summarised in Table 10.1 below.

Table 10.1: Summary of Wairoa's Future Treated Wastewater Discharge System

Stage Timing	Storage Capacity#	Irrigation Area#	River Discharge Parameters*	Pump Station Overflows#
Stage 1 0-5 years	No change (5,400 m^3 within the 2nd WWWTP pond).	Develop up to 50 ha	Below ½ median river flows: <1,600 m^3/d discharge on outgoing tide at night only. ½ median to median river flows: <3,000 m^3/d discharge on **any** outgoing tide. Median to 3 x median river flows: <5,000 m^3/d discharge on **any** outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Occur less often than now (<10 events/year). Triggered during larger storms.
Stage 2 6-10 years	Increase total to about 10,000 m^3	Expanded up to 100-150 ha total	Below ½ median river flows: <1,600 m^3/d discharge on outgoing tide at night only **but limited to no more than 30 days discharge in December to March**. ½ median to median river flows: <3,000 m^3/d discharge on any outgoing tide. Median to 3 x median river flows: <5,000 m^3/d) discharge on any outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Rare (<8 events/year); only during larger storms.
Stage 3 11-20 years	Increase total to 50-100,000 m^3	Expanded up to 300 ha total	Below ½ median river flows: **no discharge at any time**. ½ median to median river flows: <3,000 m^3/d discharge **only on outgoing tide at night**. Median to 3 x median river flows: <5,000 m^3/d discharge on any outgoing tide. Above 3 x median river flows: unlimited discharge at any time.	Very rare (<4 events/year); only during very large storms.
Stage 4 21-30 years	Increase total to 200-400,000 m^3	Expanded up to 600 ha total	Below **median** river flows: no discharge at any time. Median to 3 x median river flows: <5,000 m^3/d discharge **only on outgoing tide at night**. Above 3 x median river flows: unlimited discharge at any time.	Very rare (<4 events/year); only during unusually large storms.

Notes: * bold text highlights what is changing within each stage.
intended changes which depend on commitments outside resource consent processes.

While there are a range of activities proposed as part of the package, the river discharge elements relevant to the resource consents being sought are coloured in Table 10.1 above. It is important to note, however, that Stages 3 and 4 are **aspirational** and the ability to implement these changes is dependent upon the actual sizes of irrigation and storage that are constructed.

Early in the first stage a filtration and UV disinfection system will be installed at the outlet of the WWWTP ponds. Early in the first stage the outfall pipe and discharge structure will also be relocated closer to the river channel, designed to cope with the expected discharge rates and to avoid siltation blockages when idle. The outfall will be able to be readily maintained and relocated to match the migrations of the active river channel.

Discharges to the river will gradually occur less often and will transition to cease daytime out-going tides and then cease altogether when the river is flowing less than median flow. In all cases continuous 24/7 discharges to the river of unlimited volumes (if HBRC authorise this) will occur when the river is flowing at or above 3 x median flow.

11REFERENCES

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Lowe Environmental Impact (2017:A2I2) Current Outfall Pipe Description.

Lowe Environmental Impact (2017:A3I2) Existing Environmental Data Summary.

Lowe Environmental Impact (2018:A7I1) Wairoa Wastewater Discharge Consenting Planning Considerations.

Lowe Environmental Impact (2017:A7D1) Discharge Options.

Lowe Environmental Impact (2017:B2A2) Wairoa Wastewater Package – A Way Forward.

Lowe Environmental Impact (2018:B2A3) Wastewater Polishing Options for Wairoa.

Lowe Environmental Impact (2018:B4) Wairoa Wastewater Treatment and Discharge Best Practicable Option.

Opus (2017) Wairoa WWTP Outfall Model Build and Assessment Report.

Wairoa District Council (2018:A3I2) WWTP Monitoring Update.