Environment Southland:
Waituna Lagoon Diversion Scheme – Phase 1 Technical Memo

1 Summary

Environment Southland has engaged Opus to investigate the feasibility of installing a diversion channel from Waituna Lagoon to the Mataura River. The purpose of the lagoon water diversion channel is to maximise control of water levels during the summer and winter periods, as well as helping to reduce flood levels in the lagoon.

Hydraulic modelling has been undertaken for the summer and winter design scenarios, and shows the diversion channel is feasible. This is based on a channel size of 1m at the base and 13.3m at the top. The top of bank is set at 3.6m (maximum high tide level of 3.1m + 0.5m freeboard). This channel does not consider the flows from the existing channel.

There are various methods available for the control of Waituna Lagoon Diversion Channel. The varied levels required for summer and winter is feasible, however this increases the complexity of the structure. Options include:

- Adjustable weir (straight, sharp crested weir or inflatable weir)
- Control gate

We recommend further investigation into alternative solutions, such as a pump station and piped discharge to Mataura River or sea. We also recommend further investigation into the ecological effects of installing the diversion scheme.

2 Introduction

Environment Southland (ES) have asked Opus International Consultants (Opus) to investigate the feasibility of installing a diversion channel from Waituna Lagoon to the Mataura River. This channel would allow a degree of control of the lagoon water levels, and add the ability to release water from the lagoon in order to reduce the number of times the lagoon has to be opened to the sea, particularly in the summer when openings can have an adverse ecological impact. There are existing drainage channels at the east of Waituna Lagoon which drain the surrounding area and discharge into the Mataura River. ES would like to consider utilising this drain as a diversion channel for Waituna Lagoon.

The investigation has been split into 2 Phases:

- Phase 1: Assess Hydraulic Feasibility
- Phase 2: Wetlands Feasibility and Cost Estimate

This memo addresses Phase 1 of the investigation. The scope of work for Phase 1, as defined in our offer of service is as follows:

Phase 1: Assess Hydraulic Feasibility

- Topographical Survey of existing drain and discharge points

- Collate information on existing system, including rainfall information, catchment area and topography (available from ES), review and calculation of design lake inflows as well as water levels in the Mataura River.
- Undertake drainage calculations, size drain and confirm hydraulic feasibility
- Consider channel and control structure options
- Prepare brief technical memo of our findings.

3 Hydraulic Design

3.1 Design Parameters

The purpose of the lagoon water diversion channel is to maximise control of water levels during the summer and winter periods, as well as helping to reduce flood levels in the lagoon. The diversion channel design parameters are outlined in the table below.

Refer to Appendix A for a figure showing the existing and proposed drainage channels between Waituna Lagoon and the Mataura River 'big-bend'.

Parameter	Details
Existing drainage channel	A topographical survey was taken along the existing drainage proposed drainage area. This included cross sections of the main drain and side channels as well as existing culvert information. The existing drain extends from the Mataura River to the road crossing at 2,800m; with an average channel gradient of 1 in 1200. Typical channel cross-sections are: Near Mataura River (50m from outlet point): Width: 2.4m at the base, 6.7m at the top Side slopes: Approx. Grade 1 : 1 Top of bank: 1.3m Mid-point (1500m from outlet point): Width: 0.9m at the base, 4.4m at the top Side slopes: Approx. Grade 1.5 : 1 Top of bank: 3.3m At road crossing (2800m from outlet point): Width: 1.5m at the base, 6.25m at the top Side slopes: Approx. Grade 2 : 1 Top of bank: 3.6m
Existing drainage channel structures	• Several side drains into the main channel • Several farm access crossings with culverts • 300Ø PVC culvert under the road crossing • Crossing at outlet, with 600Ø steel culvert with flap gate The existing channel and structures will require significant up-sizing to accommodate the proposed design flow. As a result, we have not considered these existing structures in our model and assumed these structures will be replaced with structures of sufficient size to not influence the design flow of the channel.

Design flow	The design flow of 5m³/s is required for Waituna Lagoon diversion channel, as provided by Warren Tucky 11/12/2013.
Lagoon discharge levels	Summer Period: 1.5m Winter Period: 2.0m
Mataura River – Tidal Levels	The Mataura River 'big bend' area is known to be controlled by the tide. Based in LINZ tidal information for the period 01/01/2014-01/01/2015, we have extracted the following data: Maximum high tide: 3.1m Average high tide: 1.9m Average low tide: 1.5m
Drainage backflow	Diversion channel is to avoid water back flowing from Mataura River into Lagoon
Existing catchment flows	We have not calculated the existing flows for the existing drainage channel. We have assumed the current drains have sufficient capacity for the current catchment area. As suggested by Noel Hinton (ES catchment team), we will calculate the diversion channel size for Waituna Lagoon flows only; and increase the current drainage channel by this amount. Thus the capacity of the existing drains will not be reduced for the surrounding area. No additional runoff flows have been calculated for the extension of the drainage to Waituna Lagoon (approx. 1190m). It is assumed surface runoff drains towards the lagoon, rather than the new channel and that surface runoff will be negligible in comparison with the discharge from Waituna Lagoon.

Table 1: Design Parameters

3.2 Model Inputs and Assumptions

The following inputs and assumptions have been used in our hydraulic model:

- We have based our design on a separate proposed drainage channel along the same alignment at the existing drain. We have used the levels from our topographical survey for the existing drain.
- For the purpose of the model, we assumed 1 critical culvert structure with flap gates near the outlet point. We assume any other structures required along the drainage channel will be of sufficient size to not influence the design flow of the channel.
- We have assumed drainage channel side slopes to have a gradient of 1.5 :1
- The lagoon outlet control structure is not considered in the model. It is assumed 5m³/s is achievable over the control structure.
- We have assumed a Manning's n value of 0.027, which is a normal value for an "*Excavated or Dredged Channel; Earth straight and uniform clean; with short grass, few weeds*". (Refer to HECRAS user manual, Table 3.1)

- We have assumed a culvert roughness Manning's n value as 0.013, which is a normal value for a "*Concrete culvert with bends, connections and some debris*" (Refer to HECRAS user manual, Table 6.1)

3.3 Model Results

The limiting factors in the diversion channel design are:

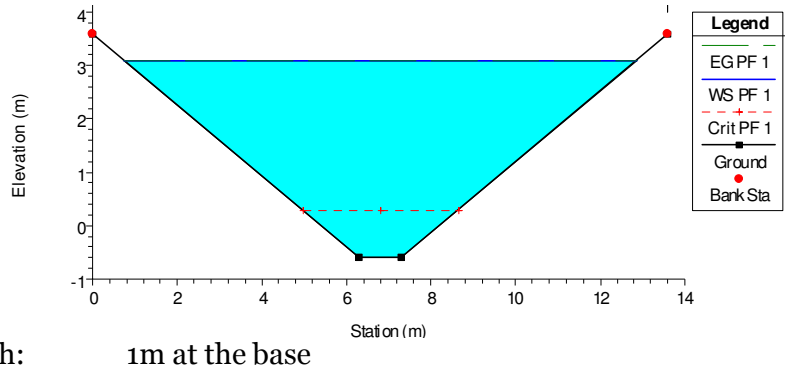
a) Level of the Mataura River;

b) Level of Waituna Lagoon;

c) Size of the diversion channel.

For each design scenario, the level of Waituna lagoon must be higher than the receiving water in the Mataura River, in order to create a hydraulic head. The difference in heads must be greater that the friction losses in the channel and through the culverts.

The following results were generated for the diversion channel to achieve a flow rate of 5m³/s.

Item	Details
Channel dimensions*	 Width: 1m at the base 13.3m at the top Side slopes: Grade 1.5 : 1 Top of bank: 3.6m (3.1m high tide + 0.5m freeboard)
Culvert	5 x 1.8Ø pipes with flap gates (located 50m from Mataura River)

*Channel dimensions are based on the flows from Waituna Lagoon only (5m³/s), and do not include the current channel flows.

Table 2: Proposed diversion channel dimensions

Mataura River Tide Level*	Minimum required level at Lagoon Outlet Structure to achieve 5m³/s flow rate	
	Summer Period (Weir Level = 1.5m)	Winter Period (Weir Level = 2m)
Ave low tide (1.5m)	1.9m	2.4m
Ave high tide (1.9m)	2.1m	2.4m
Max high tide (3.1m)	3.2m	3.2m

*Based in LINZ tidal information for the period 01/01/2014-01/01/2015

Table 3: HEC-RAS model results for the proposed channel

Based on these results the diversion channel is feasible, however the level of service achieved (ie. the flow rate through the channel) is dependent on the hydraulic head between the lagoon and receiving waters. If the tide is higher than the lagoon, no flow will occur.

3.4 Lagoon Outlet Control Structure Options

There are various methods available for the control of Waituna Lagoon Diversion Channel. The varied levels required for summer and winter is feasible, however this increases the complexity of the structure. Options include:

- Adjustable weir (such as straight, sharp crested weir or inflatable weir)
- Control gate

The structure selected depends on the required Lagoon level control, ie. how fast do we want to lower the lagoon. The allowable time to reduce the water levels and the flow volume into the lagoon will determine the size of the structure.

For all options, water level monitoring and adjustment for summer/winter periods is required. This could be done manually, however this would require significant control, in particular when Mataura River experiences maximum high tides. There is the ability to control automatically, based on the lagoon and/or outfall tide levels, which would allow more accurate discharge control and reduce the risk of flooding the surrounding area.

4 Recommendations

We recommend the following issues should be considered as part of the Phase 2 works:

4.1 Alternative solutions

Based only our calculations the diversion channel concept is hydraulically feasible, however it may not be economically feasible. We suggest that ES consider alternative diversion schemes, such as the installation of a pump station and pipework which discharges to the sea or Mataura River.

4.2 Ecology effects

The proposed diversion scheme will have considerable ecological effects on the Lagoon, Mataura River and surrounding area. We recommend consideration into the following:

- The effects of a flap gate installation (ie. restriction of fish life migrating upstream)
- If no flap gate installed, the effect of saline water in the drain
- Effect on ecology if structures/flap gates are installed on the side drains
- Effect of any flooding upstream

4.3 Other considerations

- Corrosion issues with saline water on flap gates
- Control requirements at the weir (eg. accuracy of control requirements, monitoring requirements, remote or manual control requirements)
- Cost analyses of new drain and control structures, including O+M cost

Legend:

Existing drainage channel

Proposed drainage channel

Appendix A: Existing and proposed drainage channels between Waituna Lagoon and Mataura River “Big Bend”

Figure not to scale.