

Ref: GL 17-08-31 GMD Q000356.docx

31 August 2017

By Email: kurt.bowen@ppgroup.co.nz

Paterson Pitts Group
DUNEDIN

Attention: Kurt Bowen – Director

Dear Kurt

**Balmoral Developments (Outram) Ltd Subdivision Consent Application
Stormwater Management – 21 July 2017 Flood Event**

1.0 Introduction

Fluent Solutions has been engaged by Balmoral Developments (Outram) Limited to develop a preliminary stormwater management plan for the proposed subdivision at 94 Holyhead Street, Outram. The stormwater plan is set out in the Fluent Solutions letter dated 29 May 2017.

The purpose of this letter is to comment on the effects of the flood event that occurred on 22 July 2017 in the relation to the proposed stormwater management plan.

2.0 Background

2.1 Site Location

The location of the site and the key elements of the proposed stormwater management plan is set out in the attached Fluent Solutions letter dated 22 July 2017 referred to above.

2.2 Flood Information

Photographs of the 22 July 2017 provided under emails from Kurt Bowen dated 8 August 2017 and information relating to the flooding on the western side of State Highway 87 reported in the Otago Daily Times have been reviewed and comments are provided below.

The flood extent predicted by the preliminary 2D model results in Figure 2.1 used to develop the preliminary stormwater management plan matches well with the observations of the 22 July 2017 – see figures 2.2 and 2.3 below.

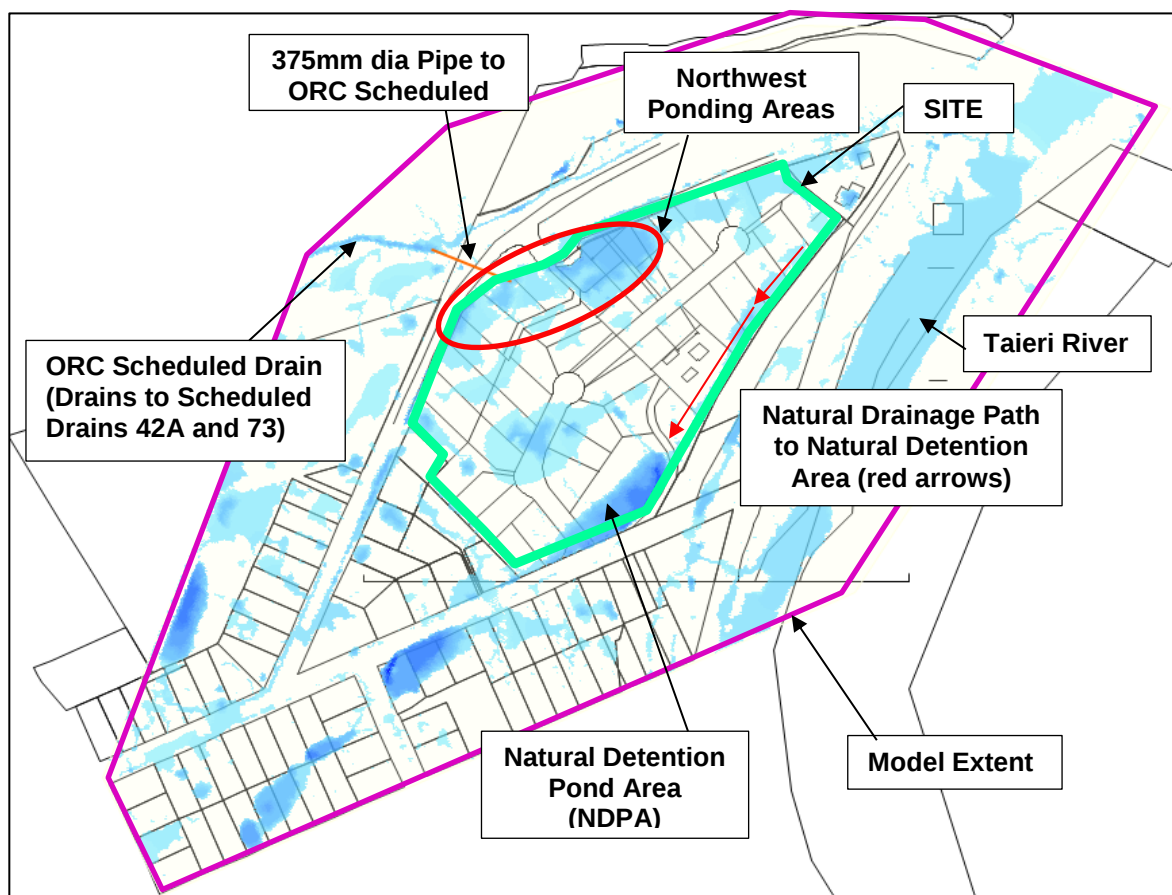


Figure 2.1: Pre-development Model Results
100 year Average Return Interval 2 hr duration storm rainfall event.



Figure 2.2: Natural Detention Pond Area 22 July 2017 – (See Figure 2.1)



Figure 2.3: Northwest Ponding Areas 22 July 2017 – (See Figure 2.1)

2.3 Flood Observations

The area adjacent to the site to the west of SH87 that drains to Schedule Drains 42A and 73 is confined by the SH87 at the site, the town centre of Outram and SH87 further to the west. The confined area receives storm runoff from elevated land to the north and is the location of “ANZAC Court”, a recent residential subdivision. It was observed that a culvert under SH87 to the west of the town centre had at least partially blocked and was likely to have elevated flood levels in the ANZAC Court locality and had potentially also slowed drainage from the Balmoral site via the existing 375mm diameter pipe under SH87. Anecdotal comments suggested that the flooding on the site in July 2017 was worse than that during in the June 2015 flood.

No attempt has been made at this point to calibrate the flood observations with the model flow distribution pattern. The model used for the preliminary Stormwater Management Plan did not include topography of the confined area west of the site or the hill country to the north and therefore assumed that flood flows would not significantly impede flow out of the site.

2. There is a question mark on the capability of the 375mm dia drainage culvert to drain water from the site to the confined area to the west that includes ANZAC Court. Consideration should be given to placing a flap gate on the western end of the 375mm dia pipe to prevent stormwater flowing into the site, especially if there is a blockage to the to the culvert under SH87 west of ANZAC Court. The flap gate would prevent the potential for flood water to flow into the site from the confined area containing ANZAC Court and hence the potential for surcharging the SDP and pump station.
3. The proposed SDP and pump station has the potential to benefit the confined area to the west and flooding to the south of Holyhead Street. Any additional cost for serving areas outside the site however should fall to the Dunedin City Council as an improvement to the stormwater network in Outram.
4. Further stormwater modelling is required to understand the effects of the proposed SMP on the wider area, and vice versa, and to confirm the capacity of the pump station and the size of the SDP. The further modelling would be an important part of firming up the detailed design of the SMP components.

For example, without a flap gate on the western end of the 375mm dia pipe under SH87, the size of the pipe draining the areas along the western boundary of the site to the SDP and the required capacity of the pump station is likely to be different to that identified for the preliminary SMP.

The extent of the existing stormwater model should be increased to include the confined area catchment to the west and include a calibration step using the 22 July 2017 flood if practical. The calibration step is likely to be a valuable test of the accuracy of the model.

4.0 Conclusion

The flood observations for the 22 July 2017 flood event has confirmed both the necessity for the proposed SMP and the benefits of a pumped stormwater discharge from the SDP to the Taieri River.

Reliance on stormwater disposal from the site to the west under SH87 may be misplaced. Further stormwater modelling is required to quantify the effects of the confined ANZAC Court area to the west on the proposed SMP for the Balmoral site.

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For further clarification on the matters above please contact the writer.

Yours faithfully

FLUENT INFRASTRUCTURE SOLUTIONS LTD

Per:



Gary Dent
Director / Senior Environmental Engineer

Enclosure:

- Fluent Solutions letter to Paterson Pitts Partners Limited (Paterson Pitts Group) for the attention of Kurt Bowen dated 29 May 2017.

Ref: GL 17-05-25 AOP Q000356.Docx

29 May 2017

By Email: kurt.bowen@ppgroup.co.nz

Paterson Pitts Partners Limited
DUNEDIN

Attention: Kurt Bowen - Director

Dear Kurt

**Balmoral Developments (Outram) Ltd Subdivision Consent Application
Preliminary Stormwater Management Plan**

1.0 Introduction

Fluent Solutions has been engaged by Balmoral Developments (Outram) Limited to develop a stormwater management plan for the proposed subdivision at 94 Holyhead Street, Outram. This report presents a preliminary stormwater management plan assessment for the site as support for an application for resource consent.

2.0 Background

2.1 Site Location

The proposed subdivision site is located between Holyhead Street and SH 87 in Outram. For the location of the site and related features refer to Figure 2.1 below. To the west of the site, and west of SH87, is an Otago Regional Council (ORC) scheduled drain which conveys water to the West Taieri drainage network. On the southeastern boundary of the site a flood bank separates the proposed development from the Taieri River.

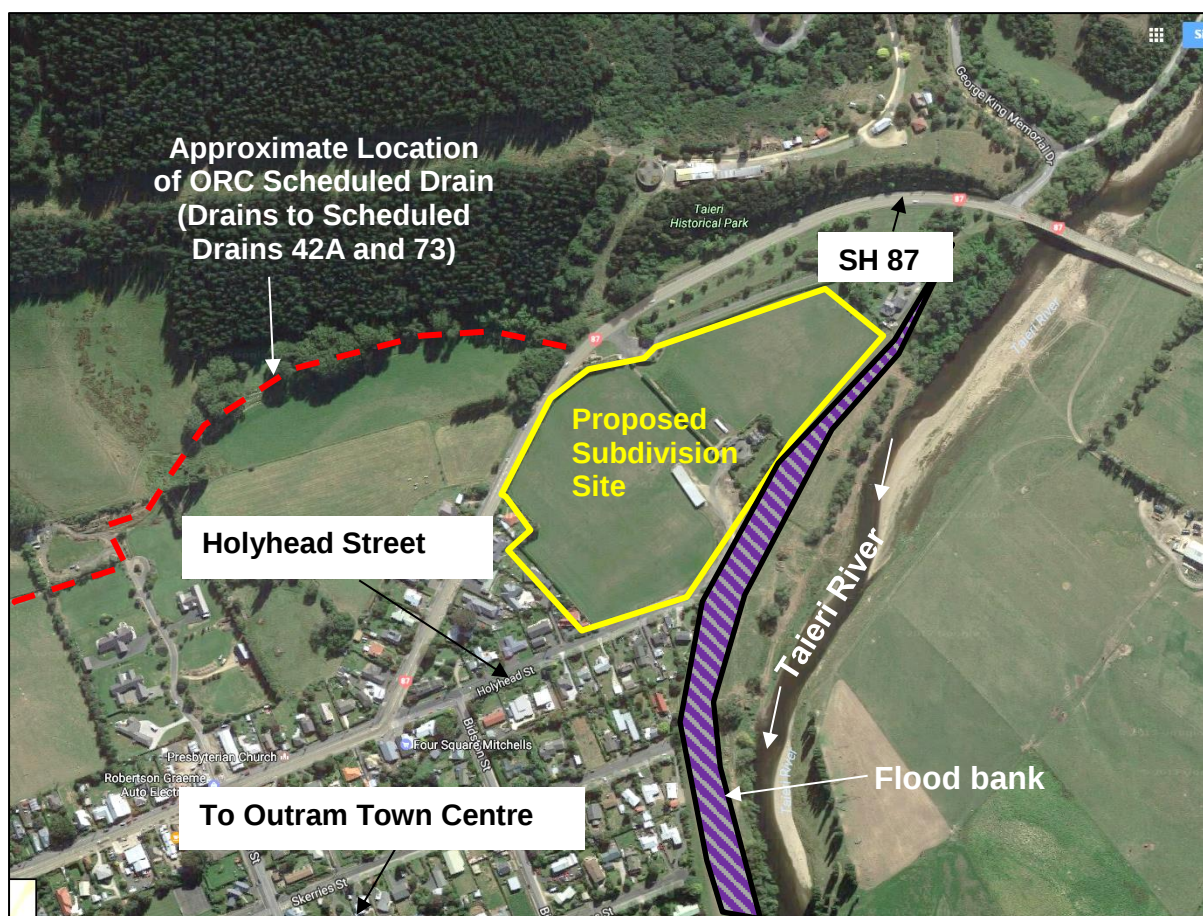


Figure 2.1: Locality and Features Plan

2.2 Proposed Development Plan

We have based our proposed stormwater management concept on Paterson Pitts Group (PPG) drawing dated 24 April 2017 (PPG Ref. D15829 / Sheet 1, Rev B). The development provides for a total of approximately 39 residential lots plus a main access way lot off of Holyhead Street at the southeastern corner of the site.

Note that the development plan includes a building restriction area which is in reference to the 2nd Schedule plan of Lower Taieri Defences Against Water included in the ORC "Flood Protection Management Bylaw 2012" (Bylaw) which refers to these zones as excavation sensitive areas.

2.3 Existing Stormwater Drainage

Stormwater drainage from the eastern area of the site drains to a natural depression adjacent to the flood bank at the southeast corner of the site. Stormwater that enters the depression infiltrates the ground surface and flows under the flood bank to the Taieri River. Lot 31 in the PPG subdivision layout plan is the current location of an existing natural detention area. The natural detention pond area would be retained and used as part of the stormwater management for the eastern area of the site.

The western area of the site drains under SH87 to the ORC schedule drain network.

3.0 Stormwater Flow Analysis

3.1 Flow Assessment Methodology

To establish the basis for stormwater management planning, the hydraulic and hydrological modelling software Infoworks ICM (ICM) was used to estimate stormwater runoff flows and detention volumes.

Within ICM, a 2-dimensional hydraulic model was developed using 3D LiDAR data representing the pre-development topography for the site, see Figure 3.1 below. Rainfall and soil characteristics were applied to the 2D grid to provide an estimate of the runoff across the ground surface. The resulting flow pattern from the model was used to estimate the design flows and provide an indication of detention volumes for the site.

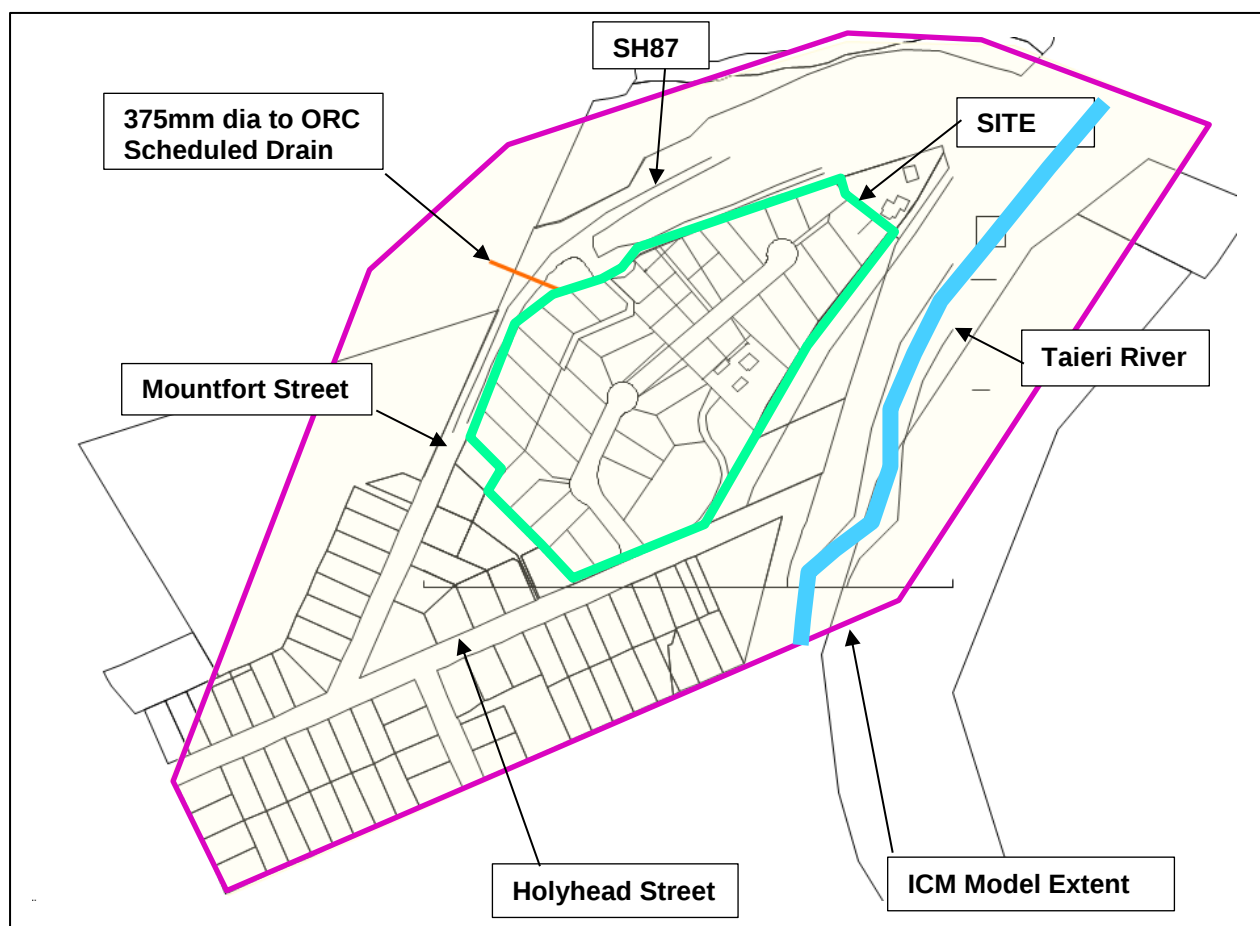


Figure 3.1: Model Area

The ICM model includes an allowance for a pipe the under SH 87 at the existing entrance to the site that discharges into the ORC scheduled drain on the opposite side of SH87. According to the DCC Water and Waste Services online maps, there is a 375mm diameter pipe along Mountfort Street. For the purposes of this preliminary model assessment, the size of the pipe under SH 87 is assumed to be 375mm diameter. This will need to be confirmed at the detailed design stage.

3.2 Rainfall Hyetographs

Flows were calculated based on the Dunedin Integrated Catchment Management Plans, Rainfall and Tidal Analysis Report, prepared by URS (August 2011) used for stormwater management planning by the DCC. Rainfall information for the site was derived from rainfall depth-duration-frequency data specified for Dunedin. A series of rainfall hyetographs (rainfall intensity versus time graph) were developed for a range of storm durations for the 10yr and 100yr ARI events. Included in the hyetographs is an 11% increase in rainfall depth to allow for climate change. Triangular rainfall hyetographs were developed and imported to the Infoworks ICM modeling program, and runoff flows and volumes were calculated.

3.3 Soil Characteristics

The general classification of soils within the site are moderately well drained silty loam soils with grass cover. This soil classification provided the basis for choosing the Horton soil loss values used for the preliminary pre- and post-development runoff flow analysis.

As described above, the pre-development flow (and preliminary post-development results) were modelled using a 2D surface based on LiDAR information.

In order to provide a preliminary assessment of the post-development condition an approximation of the ratio of pervious to impervious area was used. Based on the proposed average lot area a 50% / 50% pervious and impervious ratio was used to estimate runoff.

4.0 Pre- and Post-Development Stormwater Management Scenarios

Pre- and post-development stormwater management scenarios were defined and modelled using ICM.

4.1 Pre-development Stormwater Management

Figure 4.1 below illustrates the pre-development stormwater runoff scenario and illustrates the pre-development model results for the 100yr, 12hr storm (critical storm). Note that other than the flow through the pipe discharging to the ORC Scheduled Drain, the runoff flows within the site are largely contained. The results show ponding on the northwestern boundary and the southeastern corner of the site. As noted above, the latter is an existing natural depression. There is an internal flow path from the northeast corner of the site which drains to the natural depression.

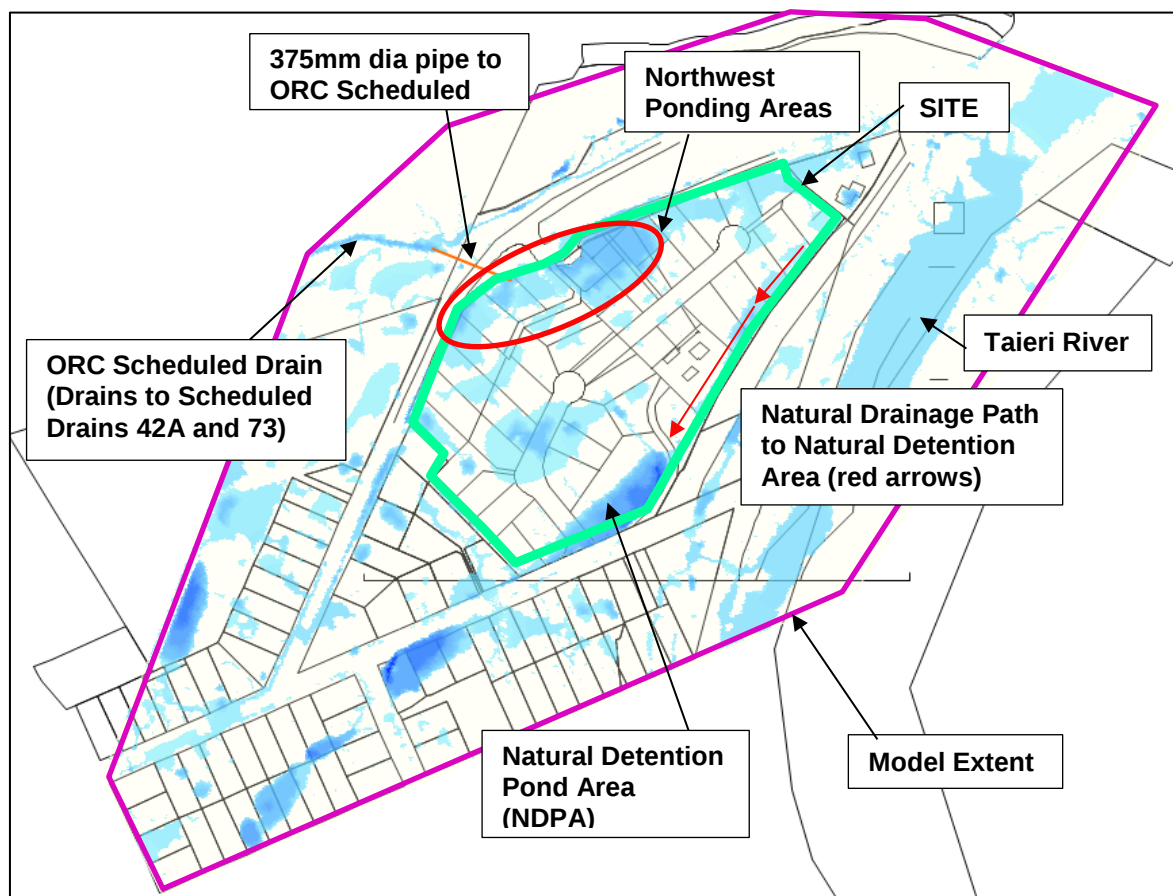


Figure 4.1: Pre-development Model Results

The model confirms the primary flow path from the site is the pipe draining the western part of the site to the ORC scheduled drain. The flow discharged through this pipe was estimated to be 185 l/s for the pre-development stormwater management scenario. Further confirmation of pipe sizes and levels for the existing pipe alignments remain to be confirmed before the pre-development discharge estimate(s) can be confirmed.

4.2 Proposed Post Development Model Scenario

Figure 4.2 shows the proposed preliminary post-development stormwater management plan.

The proposed post-development stormwater management concept relies on provision of the following:

- The site is designed to drain to a stormwater detention facility at the southeastern corner of the site at Lot 31. To manage the flood level in the detention pond, stormwater would be pumped over the flood bank to the Taieri River. The pump station would include a diesel generator as a back-up power source for the normal mains power supply.
- The collection system in the site would be a combination of swales, natural overland flow and conventional stormwater pipe reticulation.

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- Subject to subdivision consent approval, a final Stormwater Management Plan would be prepared to define stormwater detention volumes and pumping rates necessary for the site.

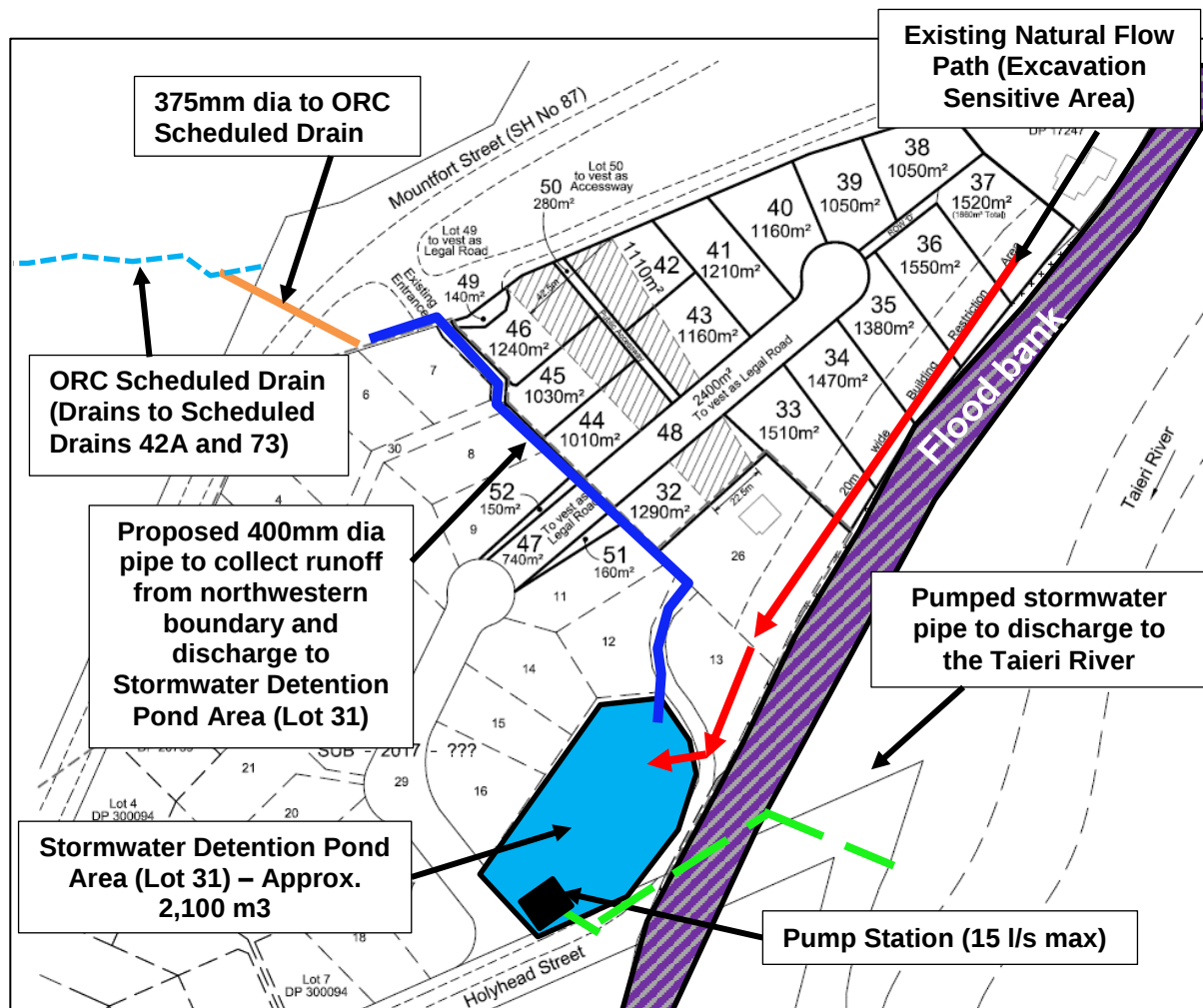


Figure 4.2: Preliminary Stormwater Management Plan

It was assumed that for the post-development situation, flows leaving the site would need to be mitigated to pre-development levels. From the preliminary model results, with drainage to the Natural Detention Pond Area (NDPA), the flow leaving the site was estimated to be 174l/s compared to 185l/s for the pre-development scenario.

The post-development model was also used to provide an indicative volume required in the NDPA assuming a pumping capacity from the NDPA to the Taieri River of 15 litres per second (l/s). The preliminary model results indicate that the NDPA can be further developed to comfortably accommodate the stormwater detention volume required for the development within the assumed predevelopment discharge to the Scheduled Drain to the west and the assumed pump discharge to the Taieri River.

The site is relatively flat and therefore there is flexibility to adjust the sub-catchment boundaries draining either to the northwest ORC Scheduled Drain or Natural Detention Pond

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Area (Lot 31) to ensure that an optimal solution is identified for implementation at the engineering approval and building consent stages of the subdivision development.

The proposed plan would not require significant earthworks in the excavation sensitive area along the toe of the flood bank on the eastern boundary shown in Figure 4.2.

4.3 Alternative Post Development Scenario

As considered previously for this site, another stormwater management option is to use individual lot stormwater detention systems for the western portion of the site. The individual lot systems would be designed to collect runoff from the roof and other impervious areas and store it to limit the rate of runoff to the Schedule Drain to the west under SH87. The post-development runoff flow rate would be limited to the pre-development flow rate (with allowance for climate change). The alternative post-development scenario may have a benefit for staging the development.

5.0 Recommended Stormwater Management Plan

Based on the preliminary stormwater management assessment work completed for this report it is recommended that the proposed stormwater management plan scenario with capability directing stormwater from the western portion of the site to the natural ponding area on Holyhead Street with pumping to the Taieri River be pursued.

For further clarification on matters presented in this report please contact the undersigned.

Yours faithfully

FLUENT INFRASTRUCTURE SOLUTIONS LTD

Per:



Gary Dent
Director / Senior Environmental Engineer