Dunedin City Council

Minimum Floor Levels for Flood Vulnerable Areas

March 2015

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Purpose of this report

Dunedin City Council (DCC) is reviewing the management of natural hazards as a part of producing a second generation plan. In order to protect residents from the effects and high costs of flooding DCC is seeking to establish minimum floor levels for flood vulnerable areas across the municipality. This report has been prepared by GHD for Dunedin City Council to describe the methodology that GHD has used to establish recommended minimum floor levels. The levels provided in this report and in the digital data provisions may only be used and relied on by Dunedin City Council for informing their planning process and in accordance with the limitations set out below.

1.2 Scope and limitations

Six study areas were identified (see section 1.4) and ranked by importance: Lower Taieri Plains, Upper Taieri Plains, North East Valley, Kaikorai Valley, Waikouaiti/Karitane and Waitati. After a review of the available data and discussion with DCC about their priorities and budget, it was agreed to use the “observational method” approach based on estimated historic flood extents for all study areas beside the Upper Taieri Plains, for which a two dimensional “rain-on-grid” model of overland flow was used (see section 3). This mix of approaches was based on a pragmatic assessment of the input data, the timelines of the second-generation planning process and available budgets.

1.2.1 Observational Approach

The observational approach does not produce floor levels which are associated with a specified likelihood of flooding. Objective planning measures are often predicated on protecting against a defined flood risk (for example a 1 in 50 year average recurrent interval flood). As this method does not define a flood likelihood, any performance standards or rules based solely on this method may be challenging to defend.

The main source of data for this work is the flood hazard areas prepared by Otago Regional Council from historic flood data plus geomorphological considerations. This data is known to be incomplete and GHD has not undertaken any verification or assessment of the input data. ORC (2013) cautions that across the DCC area:

> “The mapping is incomplete because not all floods are comprehensively mapped, and some are only mapped in certain areas. … The absence of mapping does not mean that an area is flood free or affected less than areas that have been mapped.”

In addition, there is no guarantee that areas where no past flooding has been recorded were affected less than areas with detailed records. Even where previous flood observations do exist it can be difficult to determine an appropriate flood level.

Because it relies on past flood extents to set regulations for future development, this method is also inherently reactive, rather than forward thinking. Any subsequent flood protection works, or changes to the runoff characteristics of the upstream catchment are not incorporated into the analysis. The largest recorded event will differ for different catchments – leading to an inconsistent level of protection across the city.

The observation based approach also precludes an analysis of how climate change might be expected to affect flood levels. This is discussed further in Section 2.3.

1.2.2 Modelling Approach

Floor levels derived from the 2D model are shown from the sensitivity analysis to be reasonably robust, although fully theoretical as no calibration data was available. Instead, the model was parameterised with literature values and a sensitivity test conducted to determine the impact of these assumptions on the modelled flood levels. The model addresses the flood risk associated with overland runoff. The flood risk associated with inundation from the Taieri River or the Silver Stream due to failure of the flood protection works are excluded from the scope, although the risks from the Taieri were minimised by restricting the model extent to those areas higher than the stopbanks on the true right of the Taieri (and thus not vulnerable to failure of the stopbanks around the upper and lower pond).

1.3 Assumptions

1.3.1 Observational method

- Historic flood extents and geomorphological flood hazard areas were used as provided but not independently verified.
- It was assumed that the 2005 LiDAR[1] represents major landscape features, and that the terrain has not changed substantially in the 100 years of historical record.
- Flood extents chosen as input data were assumed to be sufficiently large events such that the observed flooding was driven by underlying topography rather than the built environment (stopbanks, fences, houses, etc).

1.3.2 2D Model

Hydrologic Model

- A nested storm rainfall approach has been used to in part accommodate the multiple times of concentrations at different locations of the catchment.
- Single rain pattern and intensity was used on the hills catchment.
- Single rain pattern (lower intensity) was used on the floodplains.
- Hills catchment rain HIRDS (High Intensity Rainfall System) calculation on the North range) is slightly more intense than the floodplain rain (HIRDS calculation in Mosgiel).
- Rain on grid method on the floodplain assumes a 100% runoff and no infiltration losses.

Hydraulic Model

- Rain on grid method assumes a 100% runoff and no losses.
- Ground data relies on LiDAR definition and may differ from real data in some areas.
- No structures (such as road or railway culverts) have been added in the model; full blockage of all structures is hence schematised.
- The stormwater pipe network in Mosgiel is not modelled, so all flow is modelled across the land surface.
- Floodplain roughness is based on National Database land cover (LRIS, or Land Resource Information Systems) and hasn’t been checked with field reconnaissance.

[1] LiDAR is a remote sensing technology that measures distance by illuminating a target with a laser and analysing the reflected light.

1.4 Study Areas

The study areas for this project are as follows and as illustrated in Figure 1.

1. Lower Taieri Plains: area of the Taieri plains below Mosgiel
2. Upper Taieri Plain : area of the Taieri plains above Mosgiel (including Mosgiel). This area is shown in green in Figure 1 below.
3. North East Valley
4. Kaikorai Valley
5. Waikouaiti and Karitane Rivers
6. Waitati River

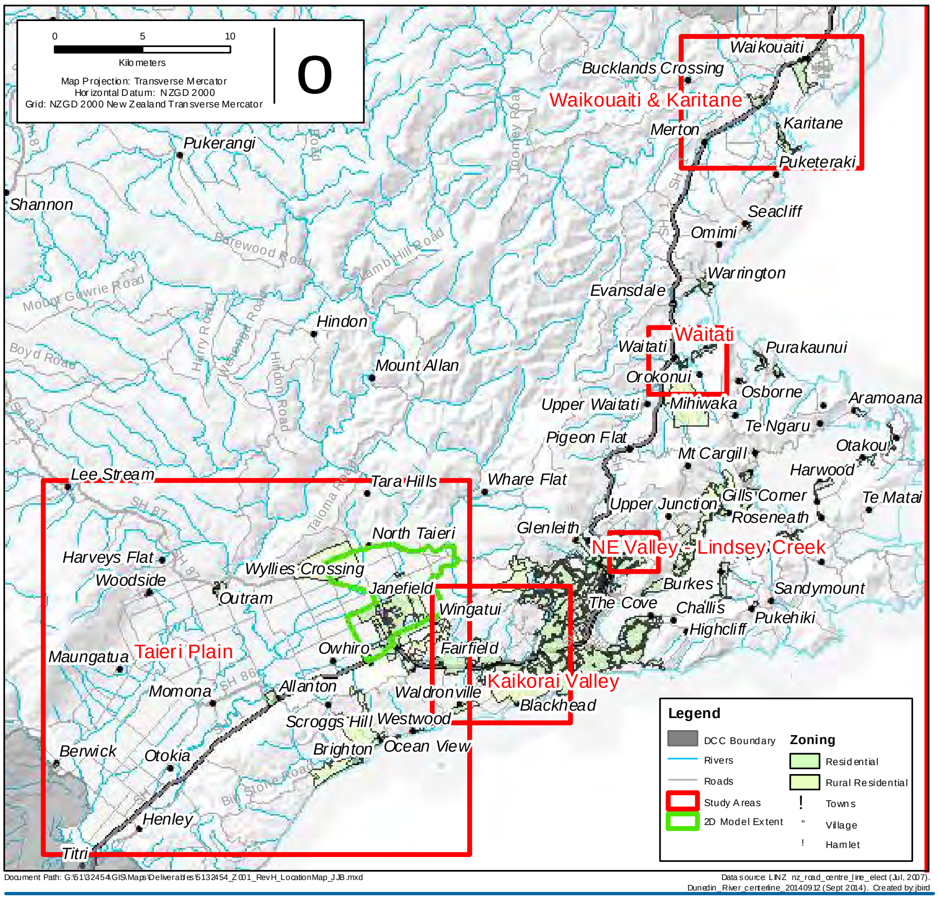


Figure 1: Location of study areas

- Lower and Upper Taieri Plains – from the Council boundary at the Waipori River, through the airport, Outram and Mosgiel as far as Silverstream Valley Road. This a rural area with residential areas at Mosgiel, Outram, Allanton and Berwick.

  Minimum floor levels for the Lower Taieri Plains have been recommended based on the observational method. For the Upper Taieri Plains, GHD built a 2D rain-on-grid model (see section 3).

  Setting minimum floor levels for the Taieri Plains (Upper and Lower) is challenging as the flood risk is heavily modified (mitigated) by a series of engineering projects including multiple level stopbanks, road and rail embankments, spillways, engineered detention basins, use of the western lakes and natural detention areas, and reliance on pumping to maintain normal dry weather lake levels. Most of these mitigation measures were put in place after the extensive floods which have been used as the input data for the observational method. The upper Taieri River has several gorges which create natural detention effects and can result in multiple peaks in flows from a single rain event, complicating assessment of the return interval of the historic flood. In addition to the extensive Taieri catchment there are significant incoming side catchments, most notably the Silver Stream and Waipori catchments and the runoff from the Maungatua foothills and the coastal ranges (see *Natural Hazards on the Taieri Plains (ORC, 2013) for further detail).*

- North East Valley – the Lindsay Creek floodplain between the confluence with Leith River and Bonnington Street in Normanby.

  Lindsay Creek is a montane stream capable of high flood velocities and there are several places where the floodplain slopes away from the creek, so small changes in the location where spilling first occurs could produce large changes in flood extent and level. Additionally the overland flow paths are densely settled, which means any floodwaters spilling from Lindsay Creek will be guided by the many built structures in the overland flow path (roads, houses, sheds, fences, etc.).

  Combined, these factors complicate the task of creating a synthetic flood surface, as there is substantial risk that the extent and location of the historic floods was driven by factors that are not determinable from the recent (2005) LiDAR.

- Kaikorai Valley – from Brighton Road bounded upstream by Stuart Street with the lateral extent set by the extent of the flood hazard area as provided by ORC. There are significant areas of industrial and other non-residential land in the Kaikorai Valley, so the analysis has been explicitly restricted to the residential portions.

- Waikouaiti River – between Karitane and Waikouaiti as far as approximately 3 km upstream of McGrath Road.

  The supplied LiDAR data does not cover the entire flood hazard area (See Appendix E). GHD confirmed with DCC that no additional datasets existed that could be used instead (email 15 September 2014 from Jack Tang). Therefore, it was agreed to restrict the study area to that portion of the flood hazard area covered by the LiDAR, which includes the community of Karitane. The community of Karitane is vulnerable to both flooding from the Waikouaiti River and costal inundation. The proposed minimum floor levels were adjusted to account for the multiple hazards (see section 2.5).

- Waitati River – to just upstream of the Motorway.

  In Waitati various approaches were used to recommend minimum floor levels, depending on whether or not an area was at risk of inundation from pondage behind the railway embankment.

Table 1 below summarises the approach used for each area. The following two sections describe these approaches in detail.

Table 1 Method by study area

Study Area	Method
Taieri Plains - Upper	2D rain-on-grid model
Taieri Plains - Lower	Observational method – historic flood extents
North East Valley	Observational method – historic flood extent
Kaikorai Valley	Observational method – geomorphological extent
Waikouaiti River	Observational method – historic flood extent
Waitati River	Observational method – terrain analysis (by GHD)

1.5 Definitions

This section defines a number of terms that are used consistently throughout this report. A number of the terms defined below are illustrated graphically in Figure 2 below.

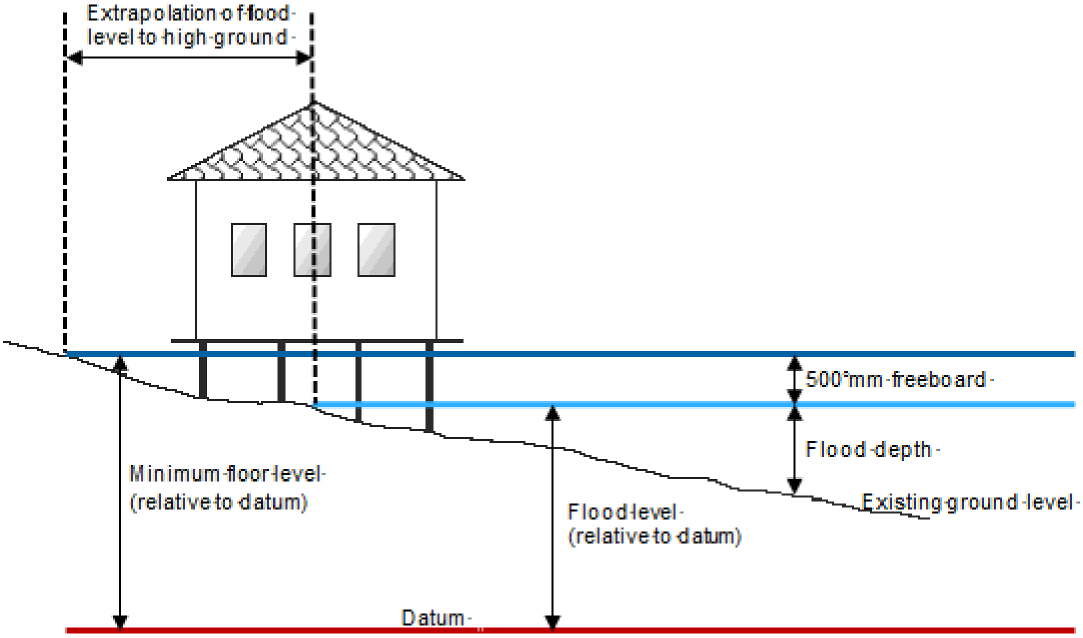


Figure 2: Key terms illustrated

Existing ground level: the level of the ground above mean sea level, determined using LiDAR.

Flood depth: the difference between the predicted flood level and the existing ground level at any given point on the land. In simple terms this is the predicted depth of flooding that a person standing on the ground would be expected to observe.

Flood extent: is the maximum extent of flooding for a given historical or predicted flood event. It is equivalent to the boundary of the flood surface.

Flood likelihood: generally expressed as an average recurrence interval (ARI), is the expected period between flood events of a certain magnitude. It is a method of describing the magnitude of a flood event based on how often such a flood is statistically likely to occur.

Flood surface: is a notional surface of the flooding which represents the peak of flooding at each flooded point. A synthetic flood surface is a flood surface that has been derived using the methods outlined in Sections 2 and 3 of this report.

Freeboard: is an allowance for flood impacts above the predicted flood level, used to take into account local effects (such as wave action from passing vehicles) and uncertainty in the method used to derive the predicted flood level. Further discussion on freeboard can be found in Section 2.2.

LiDAR: see definition in Section 1.3.1.

Minimum floor level: is the predicted flood level plus freeboard, measured in metres above the vertical datum / mean sea level.

Predicted flood level (generally referred to in this report as simply "flood level"): the level of flood waters above the vertical datum / mean sea level, as determined using the methods outlined in Sections 2 and 3 of this report.

Vertical datum: is a unified basis for determining relative heights. The datum used in this report has mean sea level at 0 m, hence the terms "above datum" and "above mean sea level" have identical meanings.

2. Methodology – Observational Method

This section describes the Observational Method used to recommend minimum floor levels.

2.1 Source information

Spatial flood-risk data used to inform the observational method falls into two categories: historic flood extents and floodplain extents determined using a geomorphological approach. The geomorphological method of flood hazard identification results in hazard areas that are more extensive than areas obtained using the historical flood analysis method. This is because the geomorphological approach encompasses all areas that are likely to have been impacted by fluvial processes over a timeframe that substantially pre-dates human record. As such, the likelihood of some areas within this wider extent being impacted in any given flood event may be very low.

The observational approach to setting floor levels was initially trialled using geomorphologically derived flood hazard extents. It was assumed that the floodplain was filled with flood waters sufficiently deep to match the hazard extent. However, generally this resulted in unrealistically high floor levels, often several metres above the existing ground surface. When the source of the hazard extent being matched is considered, it is unsurprising that unrealistic flood depths result when it is assumed that the entire area floods at the same time. This is because the geomorphological flood hazard extent represents all areas that have previously flooded at some time, but these areas most probably didn’t flood at the same time.

Because of this limitation and the unrealistic flood levels that resulted, it was decided to use historic extents where available to inform the observational approach. This creates a different limitation, as floor levels can only be determined for areas where historical floods have been documented (and the immediate vicinity), though these are the same areas that can be considered to be subject to the most substantial flood risk.

2.2 Freeboard

Clause 4.3.1 of Verification Method E1/VM1 (which is supplemental to the New Zealand Building Code) recommends 500 mm freeboard for residential floor levels above the 50 year average recurrence interval flood level. Although it is not possible to strictly comply with the Building Code when setting floor levels, as the recurrence interval of the estimated flood levels produced by analysis of historic flood extents cannot be established, 500 mm freeboard has been applied.

2.3 Climate Change

The recent release of the IPCCs (Intergovernmental Panel on Climate Change) Fifth Assessment Working Group 2 report has highlighted the ongoing challenge of planning for climate change. However, as the return interval of the historic floods cannot be estimated reliably, it is difficult to define a quantitative adjustment to the estimated flood levels to reflect current predictions of climate change. A floor level equal to the estimated flood level + 500 mm freeboard will provide some mitigation of the risks of climate change, but the precise level of mitigation cannot be quantified.

2.4 Generating Synthetic Flood Surfaces

In order to generate locally consistent minimum floor levels across each study area it was necessary to generate synthetic flood surfaces that replicate the flood hazard extents (compiled and provided by ORC) as best as possible. The approach to generating these flood surfaces is described in detail below, however in summary it involves the use of GIS software to trial various flood levels and compare these trials with the historic flood extents. Once a synthetic flood surface was selected, 500 mm of freeboard was added, and the flood surface extended to show where that higher surface intersects the ground. Note this method does not allow for any effects from flow constrictions like culverts (other than to the extent that their effect is recorded in the historic flood records).

To fit a synthetic flood surface for each study area a set of 'breaklines' were drawn across the river valley perpendicular to the presumed direction of flow based on visual assessment of the LiDAR. The density of the breaklines varied according to the valley topography and complexity of historic flood extent. The flood surface level was set at each break line equal to the highest edge of the relative flat section of the floodplain (so as to create a floodplain that was fully flooded except for any "island" or high spots in the floodplain). In some cases the edge of the floodplain was the crest of a road. A synthetic flood surface was then generated by interpolating between the breaklines. The extent of this surface was compared to ORC's flood hazard polygons and historical flood extents, and the assumed flood levels and hydraulic grades adjusted iteratively until an acceptable match was reached.

In some regions the hazard areas and historical flood extents could be matched, whilst other regions could not be replicated even with extreme assumptions about hydraulic grade. Particularly for the steeper North East Valley and Kaikorai Valley the initial synthetic flood surface estimation produced very high flood levels near the centre of the floodplain. This result is not surprising given the nature of the flood risk scenario represented by the geomorphological flood risk extents. The overall method used in this study was adjusted slightly for each study area to take into account the variable level of risk inherent in the geomorphological risk extents.

The final surface for each study area was selected based on balancing the overall match of the total flooded area, the spatial pattern of flooding and the depth of flooding relative to assumptions about the type of event that produced the input data. Deep sections were interrogated to make sure they were in reasonable locations i.e. they were in the main stream channel. A coarse cell size was applied obscuring some aspects of the channel and reducing the resolution of the flood extent edge, but better reflecting the coarseness of the input data. In addition some sections of floodplain protected by stop banks and other features that would prevent river/stream flow were included in the analysis and flood surface extent. These sections are included in the flood mapping based on the assumed risk of overtopping of stopbanks.

Often one side of the floodplain, which had a hard edge such as a road or defined river terrace, would be matched well, however the other side of the floodplain which was more gently sloping would be either under or overestimated when compared to the input data. In most cases where this occurred there was less development on the gently sloping side and the validity of observations used as input data was assumed to be less reliable.

2.5 Study Area Specific Adjustments

2.5.1 Lower Taieri

Extents of multiple historic floods are available for the Taieri Plain. The 2006 flood extent was set aside because of its limited inundation area. The 1868, 1924 and 1980 floods covered extensive portions of the floodplain, but we were concerned about the reliability of the 1868 data. Separate synthetic flood surfaces were calculated for both the 1924 and 1980 events. In order to achieve acceptable results the hydraulic grade was adjusted sharply from the true right to the true left bank, which is consistent with the profile of the floodplain. In order to establish floor levels, the common characteristics of the two floods were considered and a combined flood surface generated.

In generating the combined surface, consideration was also given to the description of flood hazards provided in ORC's *Flood Hazard on the Taieri Plains and Strath Taieri* (2014). On the West Taieri Plains below the high tide level the flood level from the ORC report was adopted. Near the centre of the Plain there are areas that were inundated in the 1923 but not in 1980. These areas were analysed for basin low points to show the depths that would be reached before overtopping and flowing into the lower areas. This methodology was also incorporated in the setting of break lines around some of the stopbanks north of Allanton. The results from this analysis were compared against the ORC report and found to be consistent.

The effects of flood mitigation works such as floodbanks, topography, and other de facto flood retention measures (such as road embankments) were only taken into account where these conditions were in place at the time of the historical floods used to inform this study.

To show more local effects the area surrounding Berwick and east of the state highway was analysed in greater detail than the rest of the floodplain.

Outram

The community at Outram is located on a debris fan cut through by paleo channels of the Taieri River. This means that the local flooding is not driven wholly by the hydraulic gradient of the valley. The hydraulic connectivity between the paleo channels, the current stormwater network and potential flood-driven runoff is unknown. Attempts were made to apply the observational method to the historic flood extents provided for the Outram area, but the method was found to be ineffective. As such, flooding extents and depth predicted for Outram using this method were removed from the study area for the combined Taieri map.

Allanton

Allanton sits on the edge of the historic flood extent and DCC's hazard 1 overlay encompasses part of the community (Figure 3). As there are known uncertainties in the precise edge of the historic flood extents, additional analysis may be required to understand the level of risk for this community.

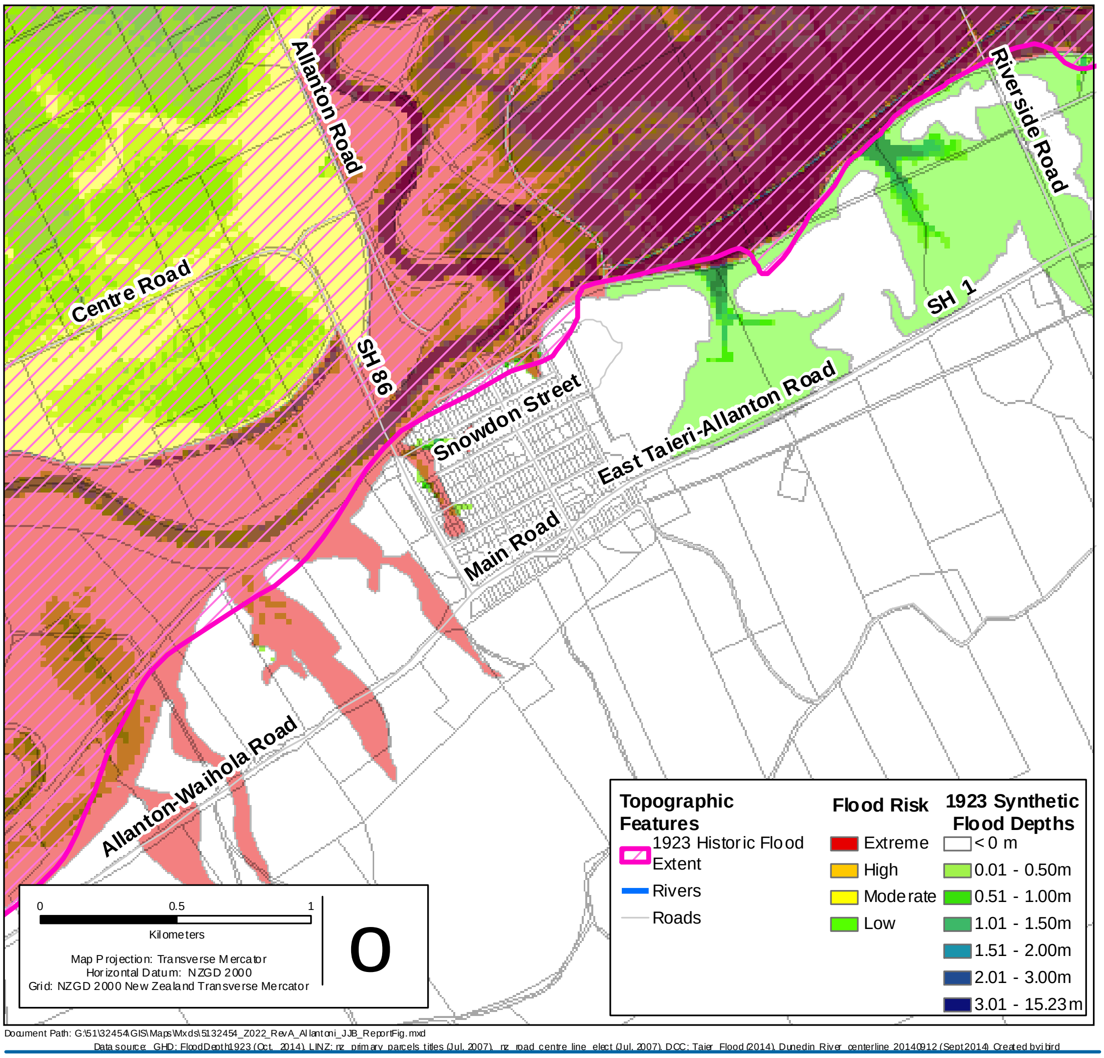


Figure 3: Comparison of 1923 Flood extent, Synthetic flood extent and DCC Hazard Overlay for Allanton

Berwick

The small residential zoned area in Berwick is vulnerable to flooding both from the Taieri and the Waipori Rivers. The local influence of the Waipori River has been accounted for in the method through separate fitting of hydraulic grade represented by additional break lines. The addition of these lines gives more confidence in the levels around Berwick. The inundation and events used to produce the synthetic surface means the surface is only valid for similar localised interactions of the catchments at this point.

Mosgiel

The community of Mosgiel is included in the 2D model extent, and the more robust results from that approach have been used to set minimum floor levels in this area. Refer to Section 3 for more information.

2.5.2 North East Valley

Two sources of input data are available for North East Valley: the 1924 estimated flood extent, which is known to be of lower quality and a flood risk area based on a geomorphological analysis (both provided by ORC).

Initial attempts to fit a flood surface to the geomophologically derived flood extent for North East Valley resulted in very deep flood depths. As the spatial extent of the historic flood event was not recorded with great precision, it was decided to select a synthetic flood surface that filled the floodplain to the edge of the flood terrace; resulting in a slight under-prediction of flood extent relative to the historic flood extent. The edge of the flood terrace was defined as the crest of North Road, except for north of Birchfield Avenue and the lower section of North Road (from Opoho Road to Craigleith Street), where the floodplain edge moved away from the road.

2.5.3 Kaikorai

For Kaikorai Valley the geomorphological extent was used because the available historic event only inundated the estuary. The initial hydraulic gradient approach did not suit the steep terrain of the upper Kaikorai. It did however give a reasonable approximation of the lower more tidal areas. As a pragmatic solution, and in recognition that the geomorphological extent combines multiple event types, effort was focussed on refining the synthetic surface in residentially zoned areas.

2.5.4 Waitati

A digital estimated flood hazard area was provided by ORC. The flood hazard area was created in December 2004 based on floods in 1923, March 1929, May 1957, June 1980 and October 1982 (data collected in Floodplain management Report Dunedin District – Rural Areas (March 1993)). This floodplain extent indicates very limited flooding over residentially zoned parts of the floodplain.

However, the residentially zoned portion of the floodplain is bounded on one side by Blueskin Bay estuary. The combined hazard area (which includes the coastal hazard) covers all of this area. Furthermore, the slope of the land is such that if the river breaks its banks to the north flows could break away toward the bay. Therefore it was considered appropriate to consider minimum floor levels beyond the 2004 hazard map.

The railway embankment runs across the floodplain mouth, where a number of bridge and culvert structures allow passage of flows to the estuary. However during a flood, pondage of water behind the embankment could be expected. Therefore, rather than fit a synthetic flood surface, we instead considered likely ponding depths behind the railway embankment with additional considerations for bank overtopping of the Waitati River.

2.5.5 Waikouaiti and Karitane

The supplied LiDAR data does not cover the entire flood hazard area (See Appendix E). GHD confirmed with DCC that no additional datasets existed that could be used (email 15 September 2014 from Jack Tang). Therefore, it was agreed to restrict the study area to the portion of the flood hazard area covered by the LiDAR, which includes the community of Karitane.

A flat synthetic flood surface was found to match well with the observed flood extent around Karitane. As minimum floor levels are likely to be primarily applied to residential dwellings, no attempt was made to extend the flood surface into adjacent non-residential areas.

3. Methodology – Upper Taieri 2D Model

3.1 Hydrologic Approach

The Upper Taieri Plain collects runoff from the steep surrounding hills in addition to the rain that falls directly on it. The hydrology was therefore schematised as 23 source catchments representing the hill catchment runoff applied at points on the floodplain margin and rain on grid with zero infiltration within the floodplain. The modelled scenario is a nested-100 year event as agreed with DCC and ORC during project inception. The design level for the Silver Stream stopbanks is 100 years. Therefore the Silver Stream catchment and the channel itself were excluded from the model schematisation.

The runoff from the hill catchments was calculated using the unit hydrograph method (UHM) as implemented in the HEC-HMS software package[2]. This method is a combination of the SCS (Soil Conservation Service) curve number method to calculate the infiltration loss and the Clark UHM for simulation of the transformation of the runoff.

Hydrological parameters required for the model built, such as the initial losses, land cover, imperviousness, time of concentration, have been established based on physical parameters (catchment area, slope) and geographical information (soil, land cover) by adaptation of the NZ available data into SCS method equivalent measures.

Rainfall data was obtained from HIRDS (Version 3) for two locations covering the catchment in order to account for the variability of rainfall across the catchment. Location 1 is on the north range and rain data is used for the hills catchment runoff model. Location 2 is located in Mosgiel and is applied on the floodplain on the rain on grid approach.

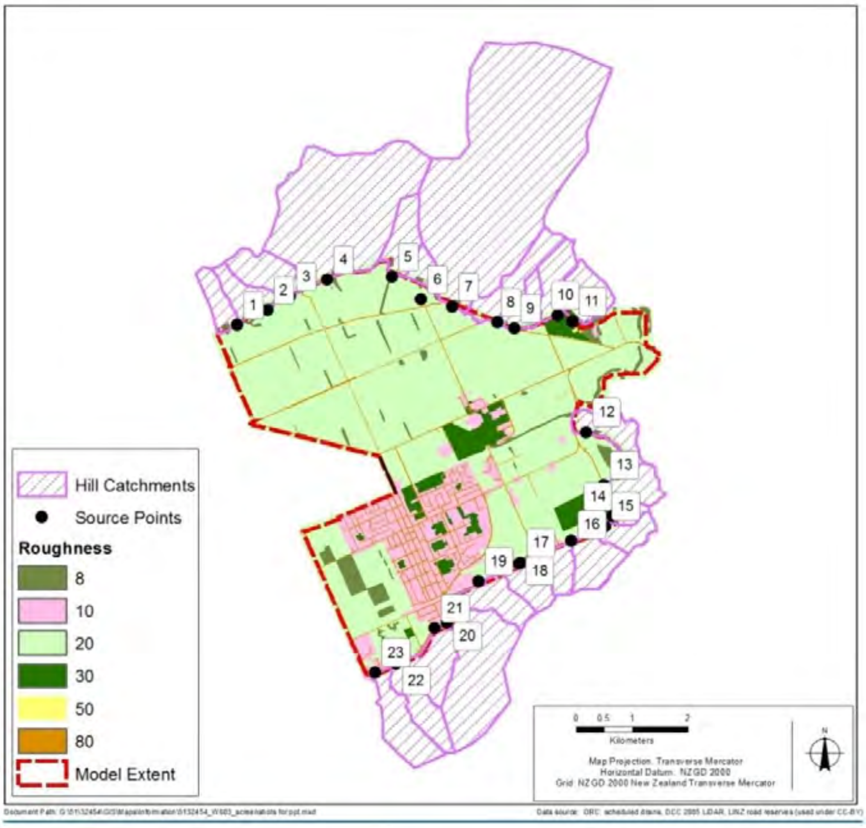


Figure 4: Upper Taieri Plains model: Hill catchment extent and roughness

[2] HEC-HMS stands for Hydrologic Engineering Center, Hydrologic Modelling System (HEC-HMS). HEC-HMS is a software package developed by the U.S. Army Corps of Engineers

3.1.1 Climate Change

Based on Dunedin City Council – Climate Change Projections (2011), the model adopted the following climate change projections:

- Projection to 2090
- +2.5°C mean Temperature increase / +20% extreme rainfall intensity increase

3.1.2 Sensitivity of hydrologic model to choice of antecedent conditions

The HEC-HMS hydrological model sensitivity has been assessed by changing its main parameter called Curve Number (CN). The curve number is a unique physical parameter based on the soil type and land cover, it varies between 23 and 53.9 in the model.

To test the model sensitivity, wet antecedent conditions have been used instead of average conditions (CN vary from +14% to +30% between average antecedent condition and wet antecedent conditions). The wet antecedent condition increases the peak flow by 47% in average, which shows that the hydrological part of the model is sensitive to variation of its main parameter.

This was considered when selecting the change of 50% increase in runoff for sensitivity testing of the hydraulic model (see below).

3.2 Hydraulic Model

The hydraulic model used is the DHI 2D hydrodynamic module for inland flooding and overland flows. The model uses a flexible grid where different areas are defined with a different level of detail or resolution. The grid is composed primarily of two different areas:

1. a fine grid resolution around the drains network (elements no larger than $7m^2$),
2. a medium grid resolution on the area of interest network (elements no larger than $35m^2$),

There is also a very coarse grid resolution network downstream of the area of interest to allow water to drain freely away from the modelled area. An open boundary was created at the foot of this slope to allow water to exit the model. This was deemed acceptable for the modelled event because the modelled region is above the Taieri River stopbank height, hence even if the Taieri River level exceeds the stopbank height these waters will spill across the lower (western) floodplain.

Land Cover and Roughness

The modelled floodplain is mostly covered with farmland (high producing exotic grassland). Built-up areas concentrate around Mosgiel. There are a few large parks and scattered shelterbelts (nearly all running Northwest\Southeast).

The hills catchments are a mix of high producing exotic grassland, exotic forest and some patches of Manuka/Kanuka and Gorse/Broom cover.

Floodplain roughness was modelled as a spatially-varying manning M surface, using existing land cover data (LCDB4, downloaded via LRIS portal). Manning's M for each landcover surface was derived from literature values (WDC 2014).

Table 2 Manning values used in model

Manning's value	Area	Area (%)
8	1.4 km^2	3.75%
10	4.4 km^2	11.38%
20	28.9 km^2	75.39%
30	1.8 km^2	4.75%
50	0.01 km^2	0.03%
80	1.8 km^2	4.70%
Total area	38.4 km^2	100%

Sensitivity of hydraulic model to hydrologic model

The response of the 2D model to the assumptions made about the hydrology was tested by increasing runoff by 50% for both the hill catchments and the rain-on-grid.

Comparison of flood levels across the floodplain shows that the results are in most areas within the 500mm freeboard allowance despite the severe increase of runoff. In some areas as shown in Figure 6 of Section 4.2.1, the increase is greater than 500mm and therefore the model is less reliable in these areas – this is mostly in localised ponds or depressions, in which development should be avoided or subject to more specific considerations.

3.2.1 Floor Level Estimation

Floor level estimation is based on the following assumptions:

- A 500mm freeboard has been applied on modelled results
- The minimum floor level, which includes freeboard, has been extrapolated to the point where it intersects the ground level (labelled "high ground", Appendix B)

3.3 Otago Datum

Modelling calculations and results are in NZGO 2000 datum, where zero is mean sea level. To convert the model results to Otago Datum it is necessary to add 100 metres.

4. Results and Recommendations

Table 3 below summarises the recommendations from this study. In some cases it was not possible to determine predicted flood levels with sufficient confidence to allow performance standards based on the resulting minimum floor levels. The table summarises where minimum floor levels should be used as a performance standard or as a recommendation only. The subsequent sections contain further details regarding the results, recommendations, basis for recommendations and potential options for increasing confidence regarding flood levels.

Minimum floor levels have been established by adding 500 mm freeboard to the predicted flood level. Where no predicted flood level could be determined but a flood risk is expected to be present the minimum floor level is the existing ground level plus 500 mm freeboard. The basis for the 500 mm freeboard is discussed in Section 2.2.

Table 3 Summary of Recommendations

	Minimum Floor Level	Basis
Lower Taieri	Recommendation only.	Insufficient confidence to set levels, but sufficient to inform development.
Upper Taieri [1]	Yes – performance standard.	Good confidence based on modelling.
North East Valley	Yes – 500mm above existing ground. Higher minimum floor levels within historical flood extent areas are recommendations only.	500mm minimum level based on ORC hazard mapping.
Kaikorai Valley	Yes – 500mm above existing ground. No recommended levels.	As above for 500mm minimum level. High level of uncertainty associated with flood levels provided.
Karitane	Yes – performance standard.	Good confidence based on historical flood record.
Waitati – lower area	Yes – performance standard.	Good confidence based on analysis of existing terrain.
Waitati – higher area	Yes – 500mm above existing ground.	Based on risk of flood bank failure or overtopping.

[1] Includes the area of overlap between Lower Taeri and Upper Taieri investigations.

4.1 Lower Taieri

Appendix A shows four portions of the Taieri Plain: the upper basins west of Mosgiel, the area around Outram, the lower plain and the section linking the lower and upper areas along the State Highway. Over the whole Plain the flood surface generated ranges from 1.50 m to 18.2 m above mean sea level. The flood depths ranged from 0 to 12.2 m deep (without freeboard), with the majority of the Plain less than 3 m deep apart from the upper basin and the river channels.

The analysis gives a broad overview of the flood risk on the Taieri Plain and the impact of other waterways and local topography that may influence flood levels in ways which are not taken into account by this analysis. Furthermore, in some areas it was only possible to achieve an approximate fit of the synthetic flood surface extent against observed flood extents. It should also be noted that the synthetic floods used to recommend minimum floor levels fill the floodplain from the bottom. Or in other words, the effects of floodbanks, topography or other de facto flood retention measures such as road embankments may not be taken into account, especially if such measures were not in place in 1924. On the basis of these limitations it is not considered that the analysis of the Lower Taieri has produced floor levels of sufficient confidence to be used as performance standards. The data provided does have significant capacity to inform DCC and developers.

The analysis used to develop the floor levels provided with this report did not take into account risk of flooding from alluvial fan activity or from residual risks such as floodbank failure. As such, the nature of these additional flooding risks should be taken into account when making planning decisions. This is especially true around Outram, where alluvial fan activity and flood bank failure risks are present. There is definite flood risk in Outram, however the nature of these risks make a minimum floor level approach inappropriate. DCC should take into account risk from alluvial fan activity and flood bank failure when determining the planning approach for Outram.

In the small area of overlap between the Lower Taieri and Upper Taieri where floor level data is provided for both, the Upper Taieri floor levels should be used (i.e. for recommendations regarding this overlap area refer to the Upper Taieri section below).

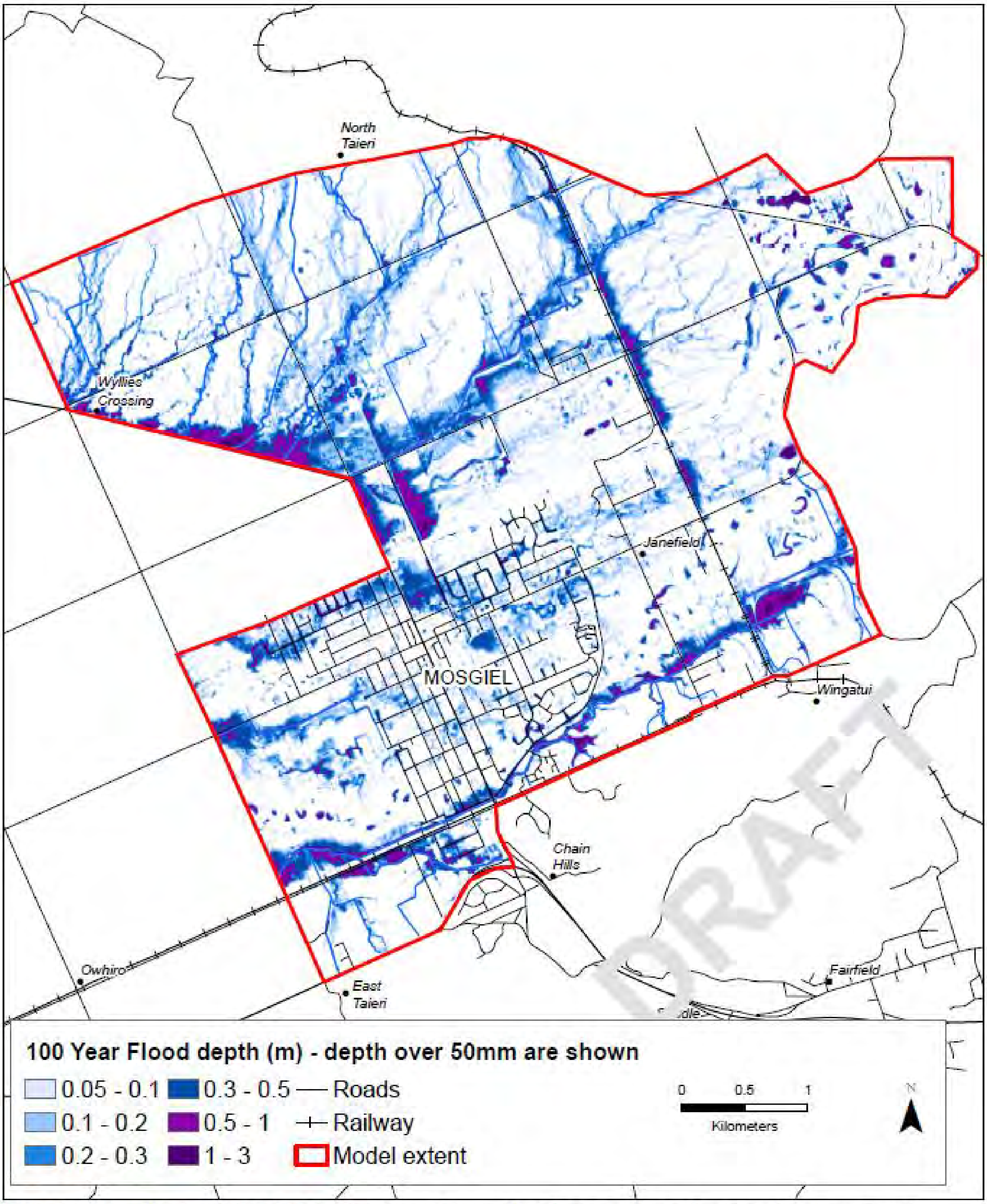
If DCC wished to increase the level of confidence in the Lower Taieri minimum floor levels there would be a few options. Field verification of flood marks, completed by a surveyor, would allow comparison of the synthetic levels with recorded levels. It would also be possible in some cases to increase the resolution of the analysis completed in this project. This would require field survey of significant floodplain features such as road crest levels and culverts. This information could be used to verify the ponding assumptions made and/or confirm the existence of pockets of land which are isolated from the floodplain (i.e. protected by floodbanks, topography or other de facto flood retention measures such as road embankments).

For the Lower Taieri Plains, the size, flatness and complexity of the floodplain (in terms of contributing catchments and flood diversion measures) are such that development of a model would be challenging and potentially costly. For this reason, a cost-benefit analysis would need to be undertaken prior to embarking on any modelling exercise. This analysis would need to consider whether uncertainty around flood extents and depths could be adequately reduced to improve the developability of land and/or better manage land that is already developed.

More refined modelling exercises might be justified in special circumstance, for example to test floodbank failure scenarios for Outram.

4.2 Upper Taieri

The model indicates that some areas of the Upper Taieri Plain are vulnerable to deep (>0.5 m) flooding in extreme events (Figure 5 and Appendix B) and that large areas can expect shallow flooding. Some flooding is adjacent to the ORC scheduled drains, but a substantial portion of the floodwater is carried by overland flow paths that are dry in fine weather. Some of the roadways on the outskirts of Mosgiel sit below the adjacent properties and serve as drainage channels, rather than hydraulic barriers.



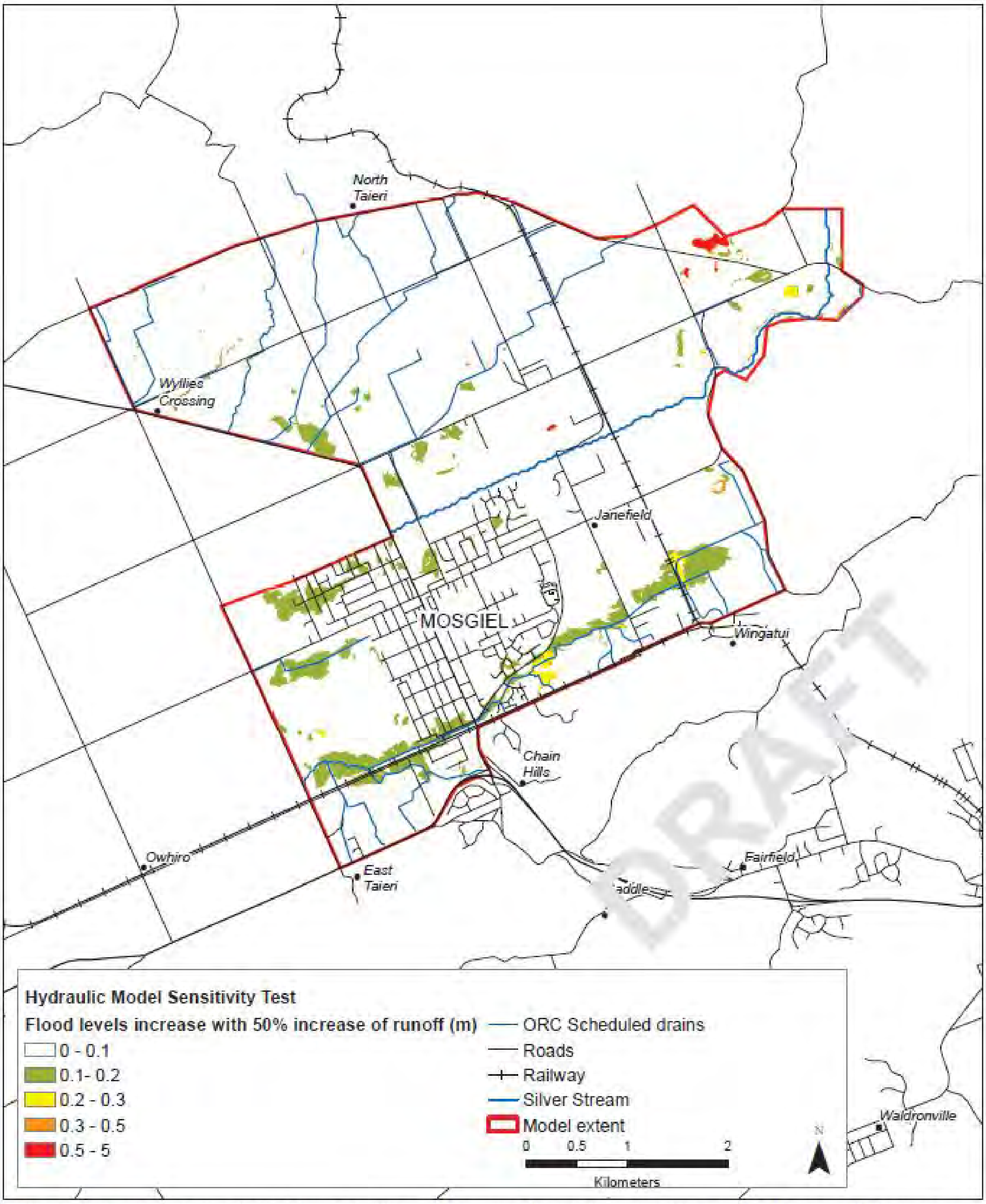
N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Report Figures\5132454_ReportFig3_MapofFloodDepth_revC.mxd

Figure 5: Map of Upper Taieri flood depths

4.2.1 Areas of High Uncertainty

Areas of high uncertainty are based on the sensitivity test with an increased runoff of 50% as described in section 3.2. In most areas, increasing runoff by 50% does not increase the predicted flood levels by more than 100mm. The figure below shows where higher uncertainty areas are located. In these areas the model shows the flood risk is less predictable using the adopted methodology and more specific detailed (and/or conservative) assessments and planning rules could be adopted in these small areas.

Red areas (>500mm) are existing wet ponds or local land dips which basically fill up with no drainage and are therefore very responsive to change in runoff volume.



N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Report Figures\5132454_ReportFig4_HydraulicModelSensitivity_revD.mxd

Figure 6: Map of Upper Taieri's high uncertainty areas

Except for the areas marked in red on Figure 6, there is sufficient confidence in the minimum floor levels provided to allow them to be used as performance standards. A 500 mm freeboard has been included in the minimum floor levels provided, as discussed in Section 2.2.

In some areas as shown in Figure 6, the level of uncertainty in the modelled flood levels is greater than 500mm. This is mostly in localised ponds or depressions, in which development should be avoided or subject to more specific considerations.

4.3 North East Valley

The flood surface graded smoothly from 23.00 to 55.92 m over the 2.4 km study reach. The flood depths ranged from 0 to 5.32 m (Appendix C) and where outside of the defined channel the majority of flood depths were 0 to 1.50 m. Areas of lesser confidence were (1) where North Road becomes a poor indicator of the floodplain extent at Birchfield Avenue, and (2) north of North Road between Calder Ave and Baldwin Street where the river channel is too small to be shown due to the large cell size.

Due to the coarse resolution of the historical flood extents used to generate the synthetic flood surface and complex developed nature of the floodplain, only a moderate level of confidence can be applied to the minimum floor levels provided. Given this level of confidence DCC should adopt the levels provided as recommended minimum floor levels rather than as performance standards. A 500 mm freeboard has been included in the minimum floor levels provided, as discussed in Section 2.2.

There are portions of the floodplain which are covered by the ORC flood hazard area (geomorphologically derived) but for which minimum floor levels have not been established by this study (because minimum floor levels were generated based on historical data which doesn’t cover the whole hazard area). In these portions of the floodplain it would be appropriate for DCC to establish a performance standard requiring new residential developments to be constructed at least 500 mm above the ground.

If DCC wanted to increase the level of confidence in the minimum floor levels in the North East Valley there are a couple of options. Field verification of flood marks, completed by a surveyor, would allow comparison of the synthetic levels with recorded levels. Some effort was made as a part of this project to compare provided flood levels with the synthetic flood surface, but this approach was limited by inconsistencies in the levels provided to GHD.

This area may also lend itself to a two dimensional flood modelling project. A major limitation is that there are several places where the floodplain slopes away from the creek, so small changes in model predictions of where spilling first occurs could produce large changes in flood extent and level. Any reasonable modelling effort would therefore have to manually assess likelihoods and consider combinations of multiple possible points of riverbank breaching. Additionally, the overland flow path of any floodwaters spilling from Lindsay Creek would be guided by the many built structures in the overland flow path (roads, houses, sheds, fences, etc.). Data for fences in particular would be expensive to gather and significant untestable assumptions would also be required with regard to roughness of various surfaces.

4.4 Kaikorai Valley

The flood surface (without freeboard) varies from 1.52 to 140.55 m above sea level and is linked to the steepness of the whole valley. The flood depths ranged from 0 to 9.07 m, and outside of the defined channel the majority of flood depths were 0 to 2.00 m.

This area is particularly susceptible to the limitations inherent in the source data (as discussed in Section 2.1). A very low level of confidence should be applied to the flood level maps presented on the maps in Appendix D. The maps are provided for completeness, but should not be relied upon to inform the planning process. The flood levels provided should not be used as a minimum floor level, either as a performance standard, or a recommendation. .

The ORC flood hazard area provides an indication of areas where the possibility of flooding is highest. In this hazard area it would be appropriate for DCC to establish a performance standard requiring new residential developments to be constructed at least 500 mm above the ground.

Options for improving confidence regarding flood hazard in Kaikorai Valley are somewhat limited. As discussed in ORC's 2001 *Kaikorai Stream Flood Hazard Report*, there is very little historic flood information available for Kaikorai Stream. In the event of future flooding, efforts should be made to capture flood extents and depth. A pre-prepared plan to capture this data would increase the likelihood of data being collected and the quality of the data when a flood event does occur.

This area may also lend itself to a two dimensional flood modelling project. However more would need to be understood regarding available data and residential development potential in order to determine order of magnitude costs and benefits.

4.5 Karitane

The flood surface found to best match the 1980 flood event was consistent at 2.00 m above mean sea level. The flood depths ranged from 0 to 2.77 m where this was mainly estuary or low lying land around the settlement (Appendix E).

The numerical likelihood of the 1980 flood event has not been established. However, given the extent of flooding in comparison to other flood events on record, it can be assumed that the 1980 flood is representative of the severity of flood for which setting planning regulations is appropriate. On this basis it is recommended that DCC adopt minimum floor levels for Karitane based on the interpretation of flood depths in this report. A 500 mm freeboard has been included in the minimum floor levels provided, as discussed in Section 2.2.

Given the uncertainty surrounding the likelihood of the 1980 event, DCC should bear in mind that a higher level of protection from flood risk may be appropriate. This is especially true given the likely interaction of terrestrial flood hazard with sea level (storm surge and/or climate change) in Karitane. DCC should consider raising the minimum floor levels in Karitane in line with any adopted sea level rise allowances.

4.6 Waitati

The minimum crest level of the railway embankment is approximately 3.0m above mean sea level. Allowing for 300mm depth of flow over the embankment, plus 500mm freeboard results in a minimum floor level of 3.8m above mean sea level to protect against pondage from the embankment. This minimum floor level should be adopted, though it only protects the very low lying areas around Foyle Street and Killarney Street.

Given the history of channel avulsion in the area, the higher part of the residentially zoned floodplain (around Harvey Street and Pitt Street) is more likely to be affected by concentrated flows that have overtopped the bank, rather than pondage. Minimum floor levels at least 500mm above the surrounding ground surface should be recommended in this area (Appendix F).

5. References

Dunedin City Council – Climate Change Projections (2011): 6 September 2011

Field, C. B., Barros, V. R., Mach, K., and Mastrandrea, M., 2014. 'Climate change 2014: impacts, adaptation, and vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report-Technical Summary, pp 1-76.

HEC-HMS Technical Reference Manual, US Army Corps of Engineers, March 2000

Macleod, R. Cocks, J., December 2011. Methodology for Determining Minimum Floor Levels 2011, Dunedin, MWH.

NIWA (2011). HIRDS Version 3.0 High Intensity Rainfall Design System. New Zealand: National Institute of Atmospheric Research

O'Sullivan, K. Goldsmith, M. and Palmer, G., 2013, Natural Hazards on the Taieri Plains, Otago, Dunedin, Otago Regional Council.

Otago Regional Council, August 2001, Kaikorai Stream Flood Hazard Report. Dunedin, Otago Regional Council.

Otago Regional Council, June 2014, Flood Hazard on the Taieri Plain and Strath Taieri, Otago Regional Council.

Otago Regional Council, April 2014, Waikouaiti Catchment Information Sheet. Dunedin, Otago Regional Council.

Project Delivery Unit, Waimakariri District Council. April 2014. Localised Flood Hazard Assessment 2014. Waimakariri District Council. Document Number 140331032427, file number DRA-20-10

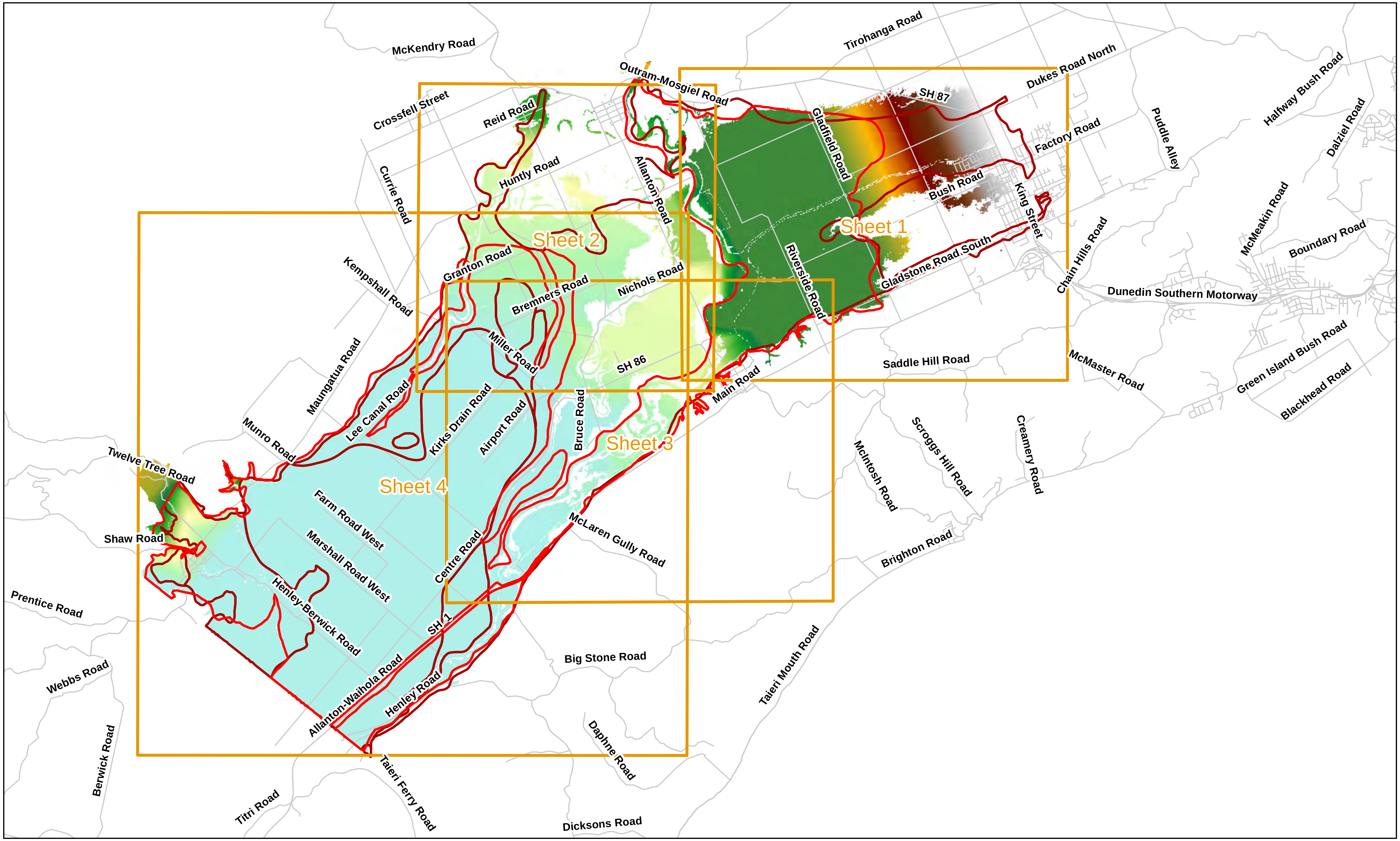
Skinner, R., March 1993, Floodplain Management Report Dunedin District- Rural Areas. Dunedin, Otago Regional Council.

Scarf, I. M., Johnstone, N. P. and Stevenson, M. K., January 1999, Water of Leith Flood Hazard Report. Dunedin, Otago Regional Council.

Appendices

Appendix A - (Maps of Advisory Floor Levels – Lower Taieri Plains)

- Figure A1: Lower Taieri – Synthetic Flood Level with 500mm Freeboard
  - Sheet 0: Overview
  - Sheet 1: Mid Taieri Plain
  - Sheet 2: Outram
  - Sheet 3: Allanton – SH 1
  - Sheet 4: Lower Taieri
- Figure A2: Lower Taieri – Synthetic Flood Depth with 500mm Freeboard
  - Sheet 0: Overview
  - Sheet 1: Mid Taieri Plain
  - Sheet 2: Outram
  - Sheet 3: Allanton – SH 1
  - Sheet 4: Lower Taieri
- Figure A3: Lower Taieri – Synthetic Flood Level without Freeboard
  - Sheet 0: Overview
  - Sheet 1: Mid Taieri Plain
  - Sheet 2: Outram
  - Sheet 3: Allanton – SH 1
  - Sheet 4: Lower Taieri
- Figure A4: Lower Taieri – Synthetic Flood Depth without Freeboard
  - Sheet 0: Overview
  - Sheet 1: Mid Taieri Plain
  - Sheet 2: Outram
  - Sheet 3: Allanton – SH 1
  - Sheet 4: Lower Taieri



Paper Size A3 (At Scale: 1: 80000)

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Levels (with 500mm freeboard).

High : 18.70

10.3

Low : 2

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	C
Date	22 Dec 2014

Taieri Synthesised

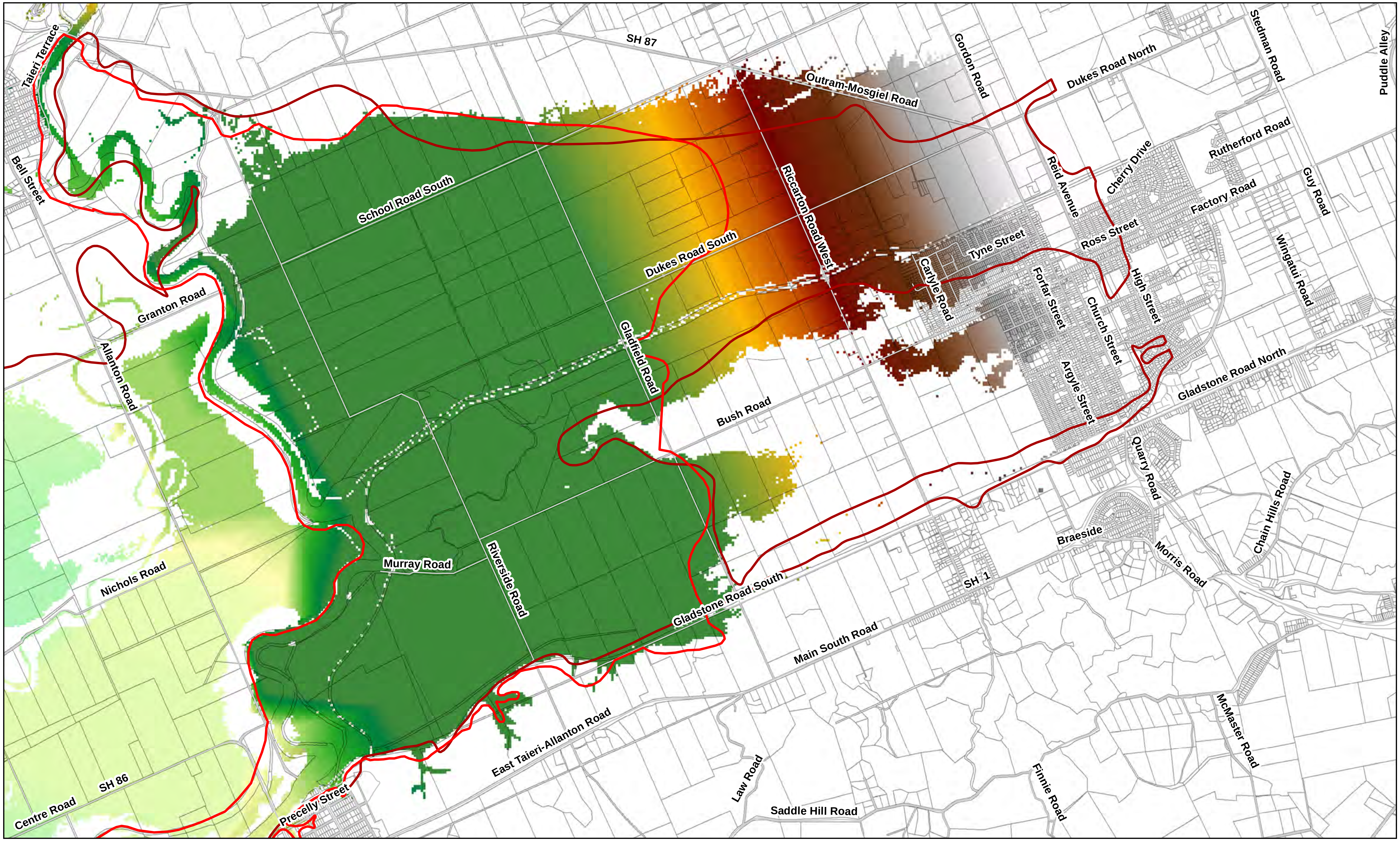
A-1 Overview

Synthetic Flood Level with 500mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z025_RevC_TaieriComposite_CR_LevelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with 500mm freeboard).

High : 18.70

10.3

Low : 2

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Taieri Synthesised
Synthetic Flood Level with 500mm Freeboard

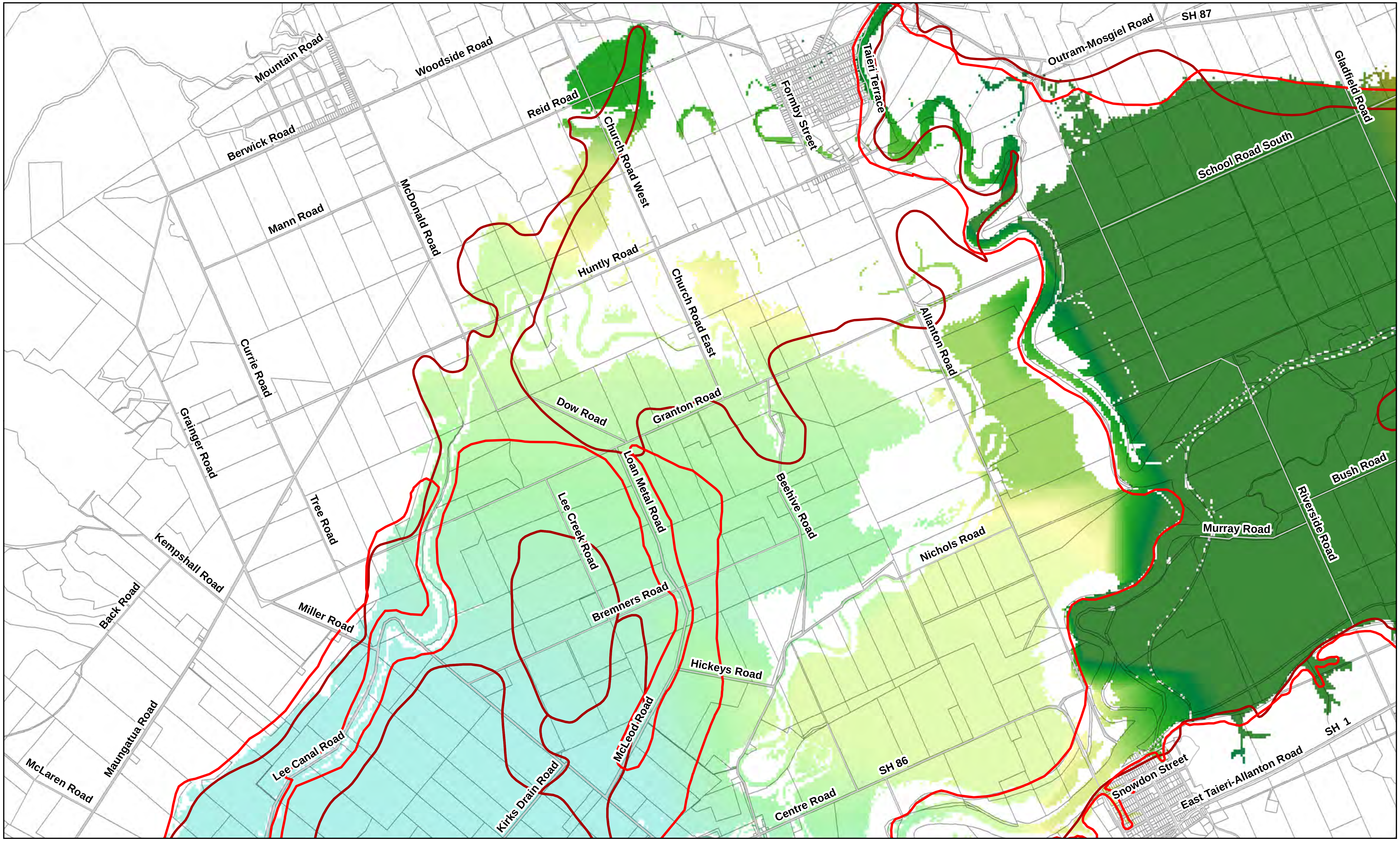
Job Number	51-32454
Revision	C
Date	22 Dec 2014

A-1 Sheet 1

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z025_RevC_TaieriComposite_CR_LevelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with 500mm freeboard).

High : 18.70

10.3

Low : 2

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	C
Date	22 Dec 2014

Taieri Synthesised

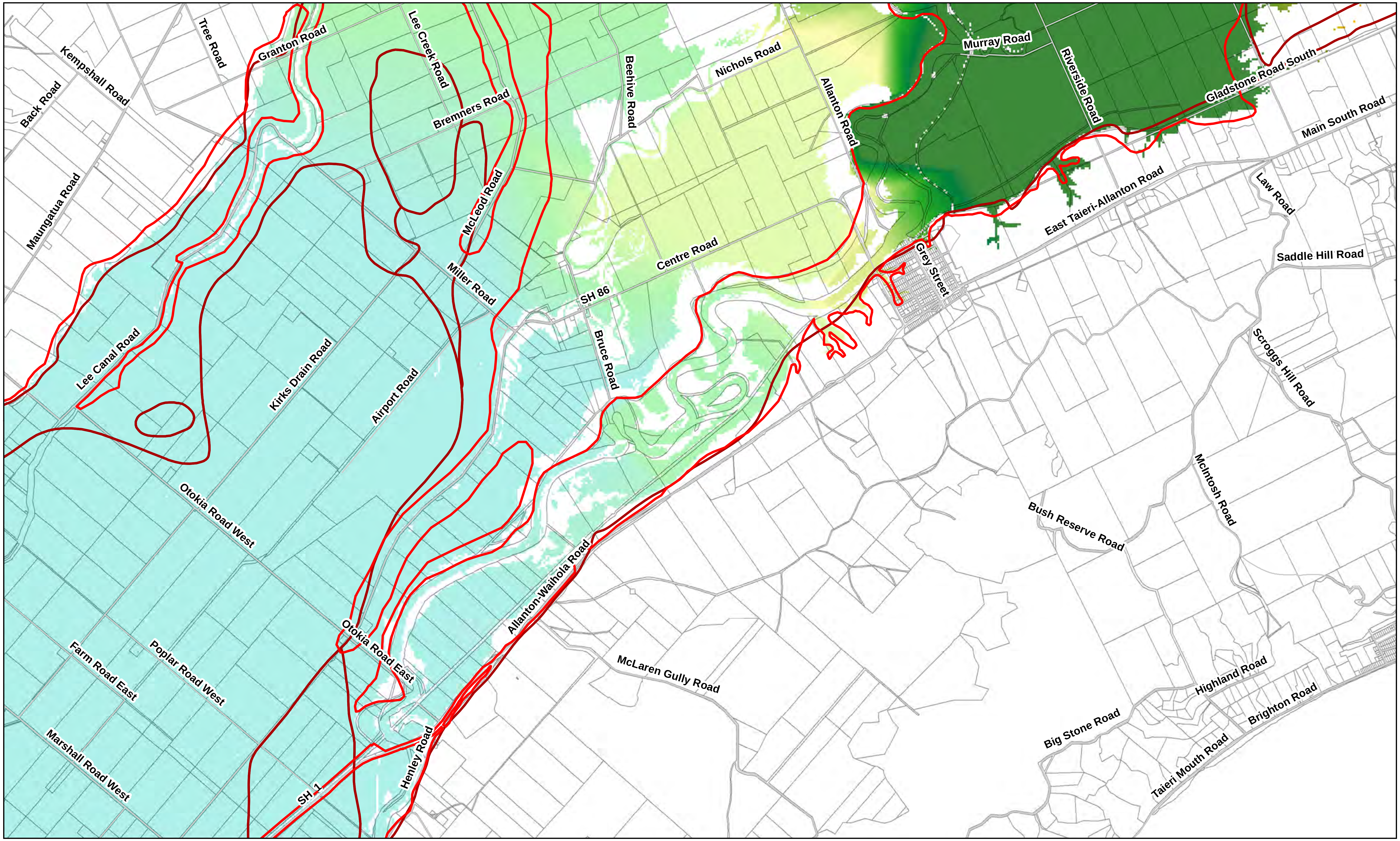
A-1 Sheet 2

Synthetic Flood Level with 500mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z025_RevC_TaieriComposite_CR_LevelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 35000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with 500mm freeboard).

High : 18.70
10.3
Low : 2

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Ōtepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Taieri Synthesised
Synthetic Flood Level with 500mm Freeboard

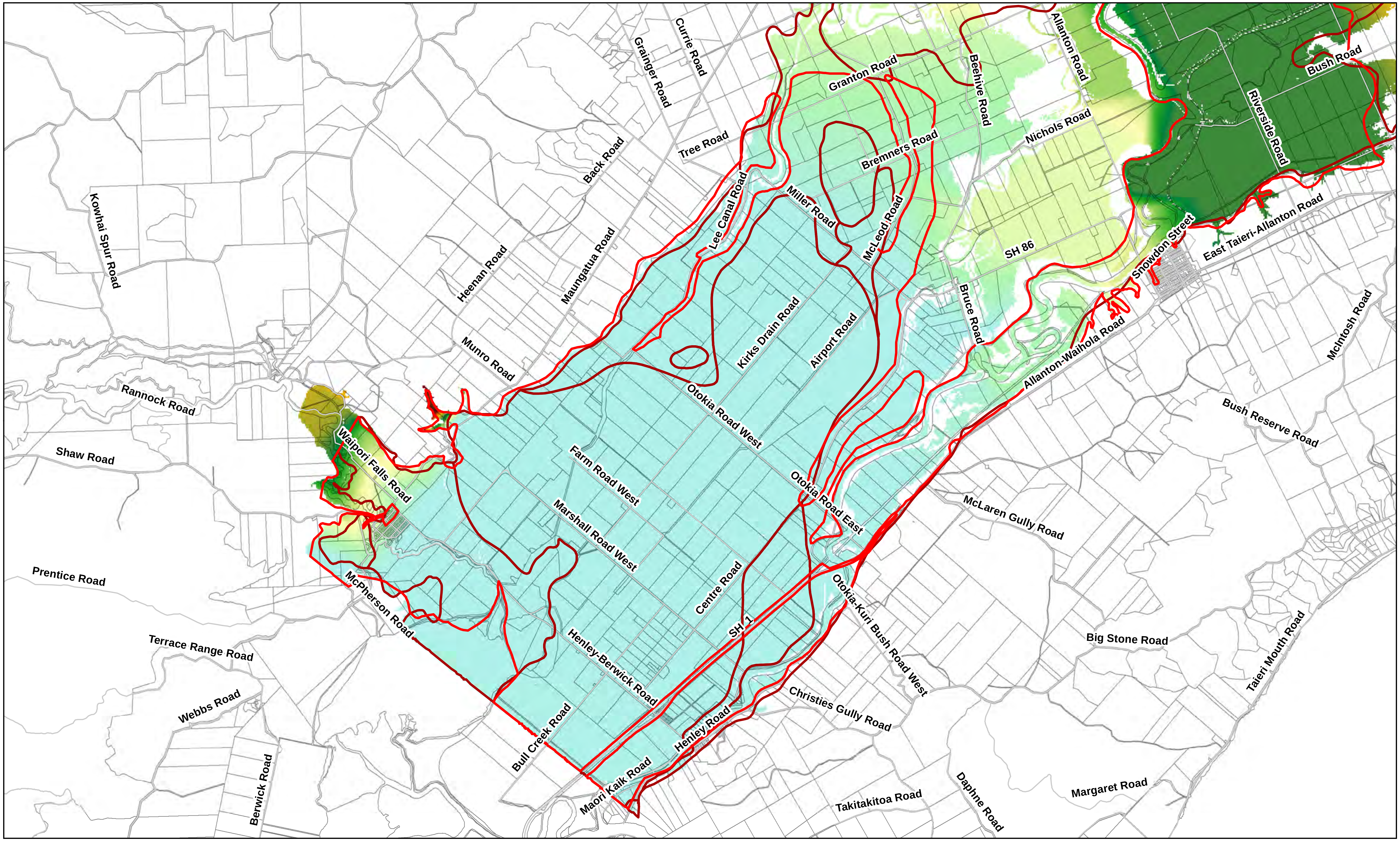
Job Number	51-32454
Revision	C
Date	22 Dec 2014

A-1 Sheet 3

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z025_RevC_TaieriComposite_CR_LevelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 55000)

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with 500mm freeboard).

High : 18.70

10.3

Low : 2

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	C
Date	22 Dec 2014

Taieri Synthesised

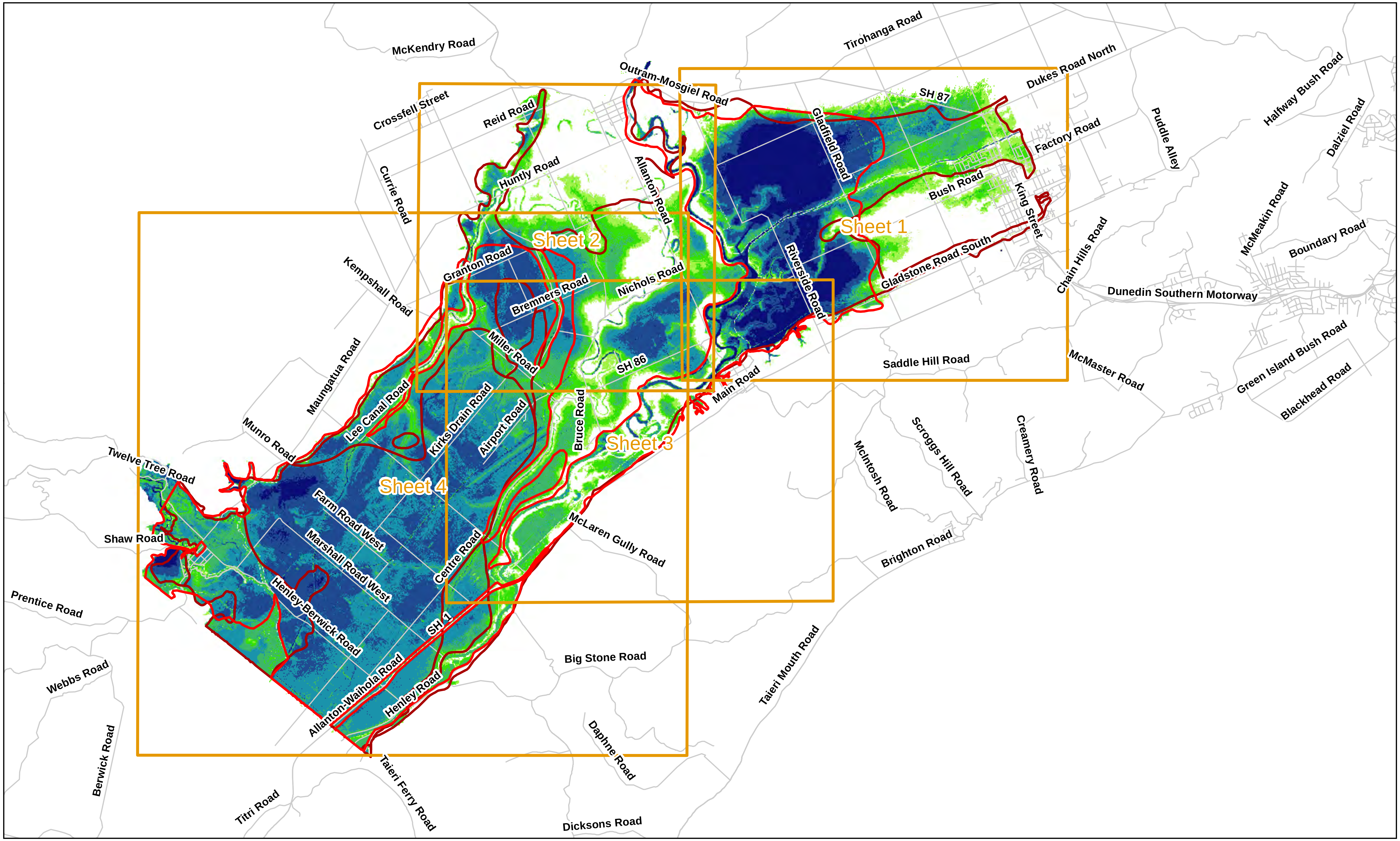
A-1 Sheet 4

Synthetic Flood Level with 500mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z025_RevC_TaieriComposite_CR_LevelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 80000)

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.50m
- 0.51 - 1.00m
- 1.01 - 1.50m
- 1.51 - 2.00m
- 2.01 - 3.00m
- 3.01 - 15.73m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

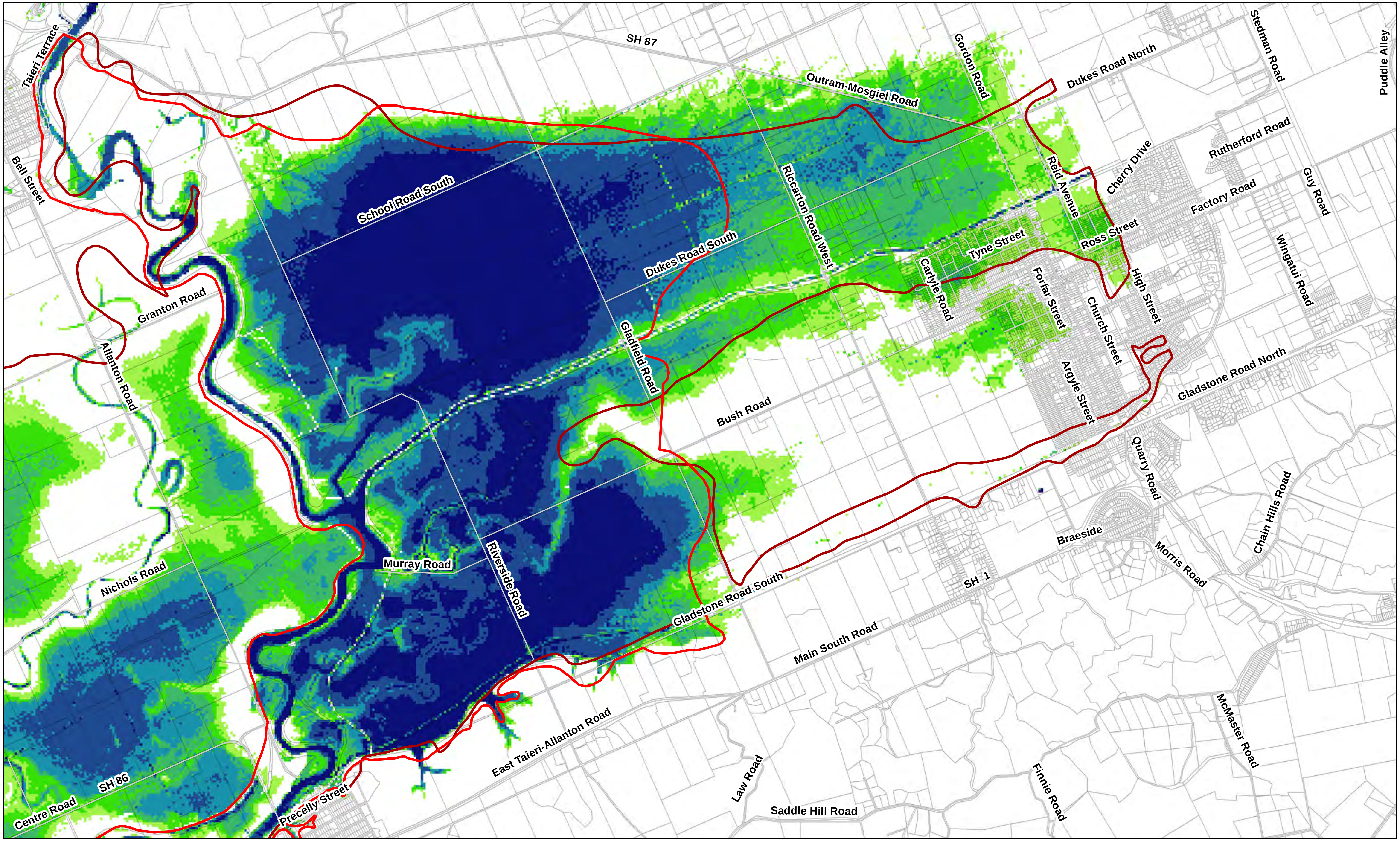
A-2 Overview

Synthetic Flood Depth with 500 mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z026_RevA_TaieriComposite_CR_DepthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_with500mmFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.50m
- 0.51 - 1.00m
- 1.01 - 1.50m
- 1.51 - 2.00m
- 2.01 - 3.00m
- 3.01 - 15.73m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Ōtepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

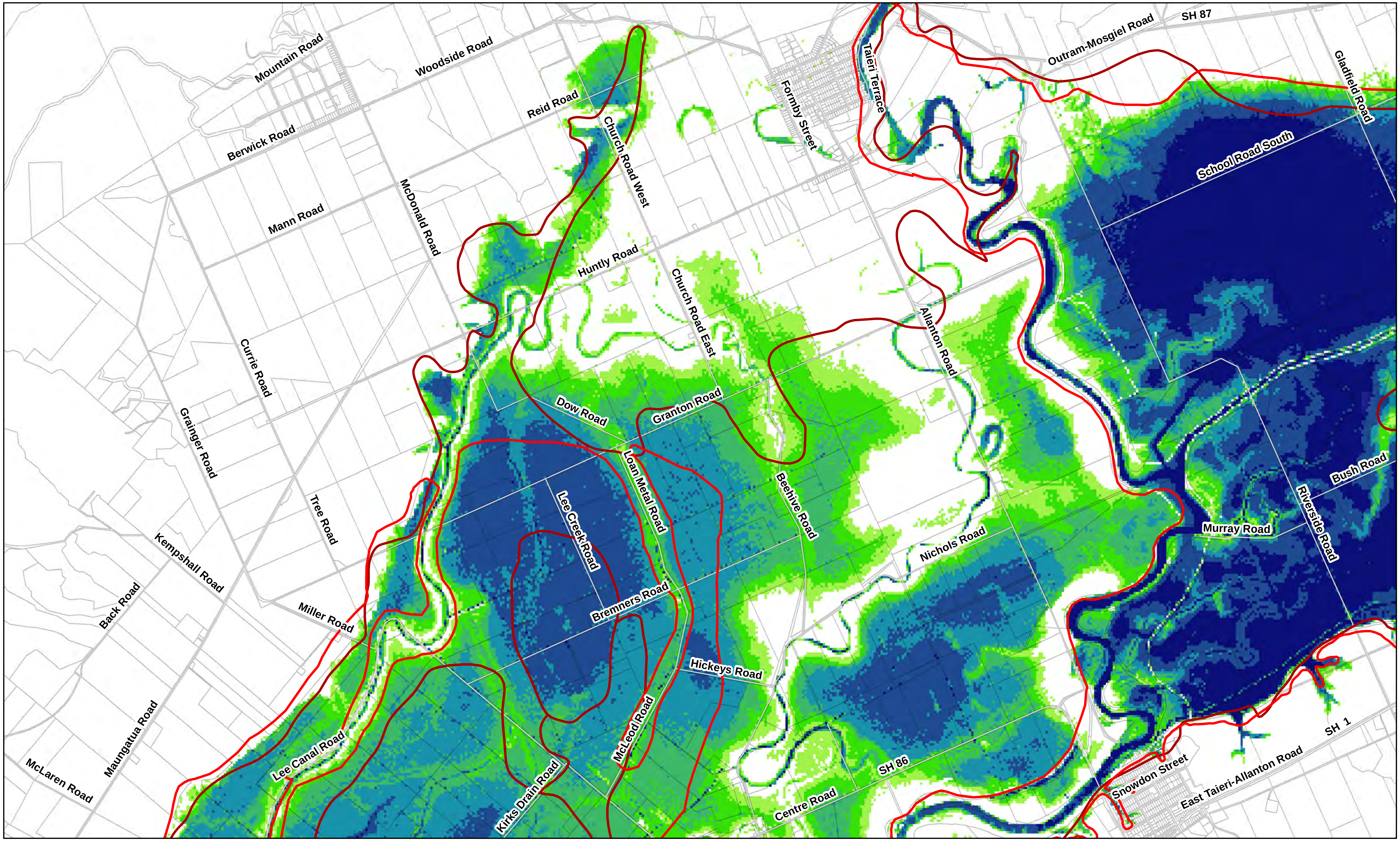
A-2 Sheet 1

Synthetic Flood Depth with 500 mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z026_RevA_TaieriComposite_CR_DepthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_with500mmFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Depths (with 500mm Freeboard)

< 0 m	0.51 - 1.00m
0.01 - 0.50m	1.01 - 1.50m
1.51 - 2.00m	2.01 - 3.00m
3.01 - 15.73m	

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

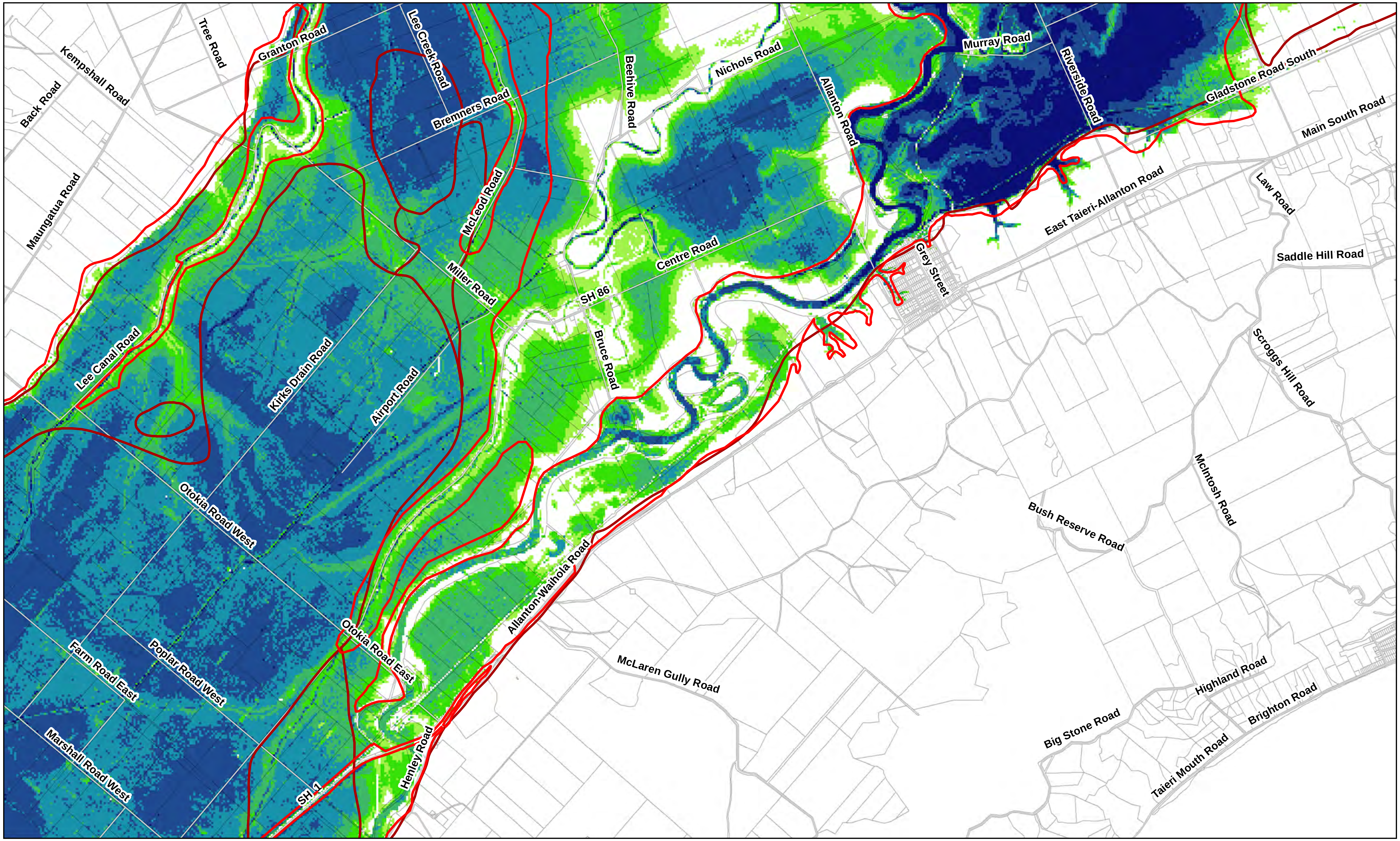
A-2 Sheet 2

Synthetic Flood Depth with 500 mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z026_RevA_TaieriComposite_CR_DepthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_with500mmFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 35000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Depths (with 500mm Freeboard)

< 0 m
0.01 - 0.50m
0.51 - 1.00m
1.01 - 1.50m
1.51 - 2.00m
2.01 - 3.00m
3.01 - 15.73m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Taieri Synthesised
Synthetic Flood Depth with 500 mm Freeboard

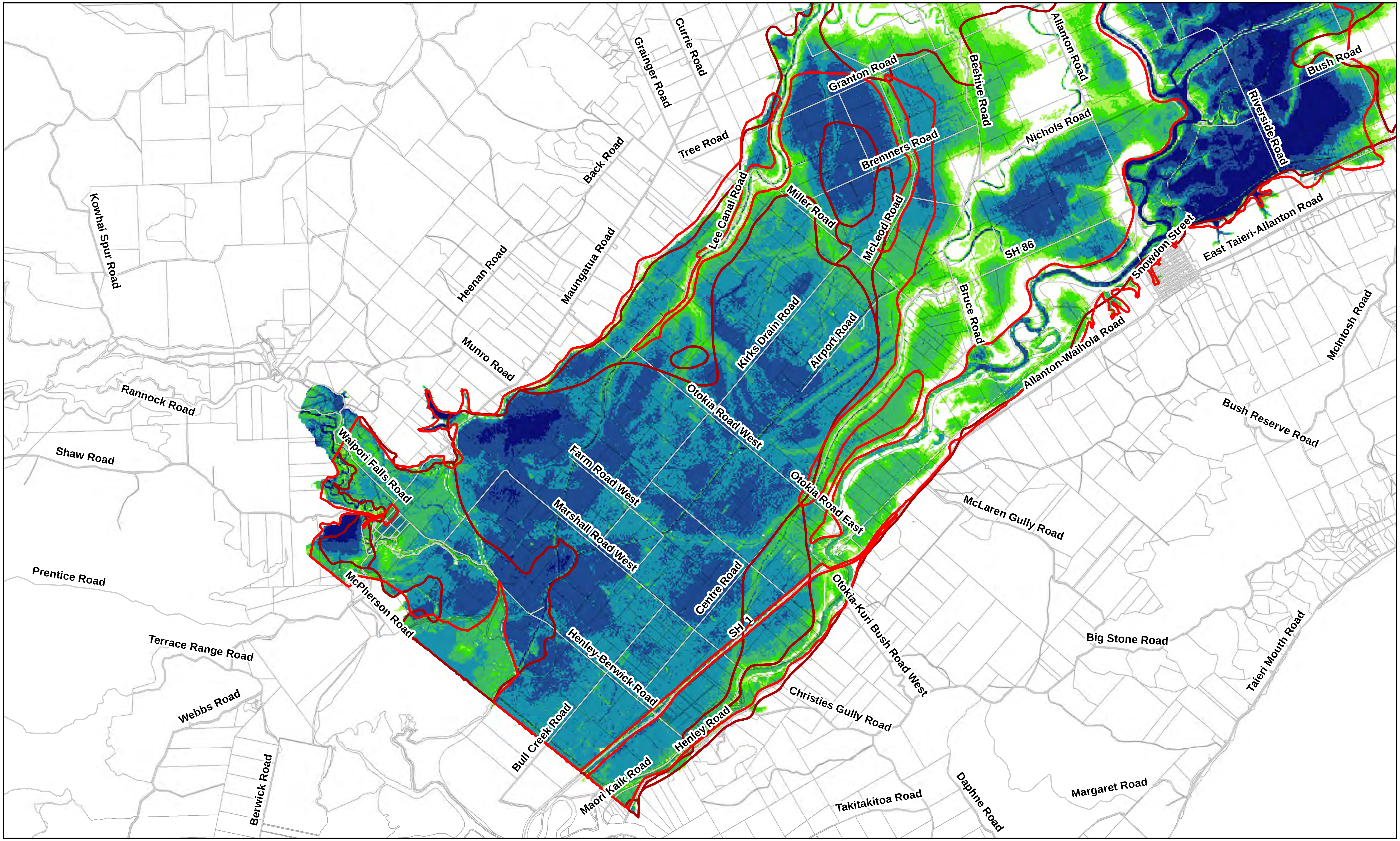
Job Number 51-32454
Revision A
Date 22 Dec 2014

A-2 Sheet 3

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z026_RevA_TaieriComposite_CR_DepthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_with500mmFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 55000)

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.50m
- 0.51 - 1.00m
- 1.01 - 1.50m
- 1.51 - 2.00m
- 2.01 - 3.00m
- 3.01 - 15.73m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

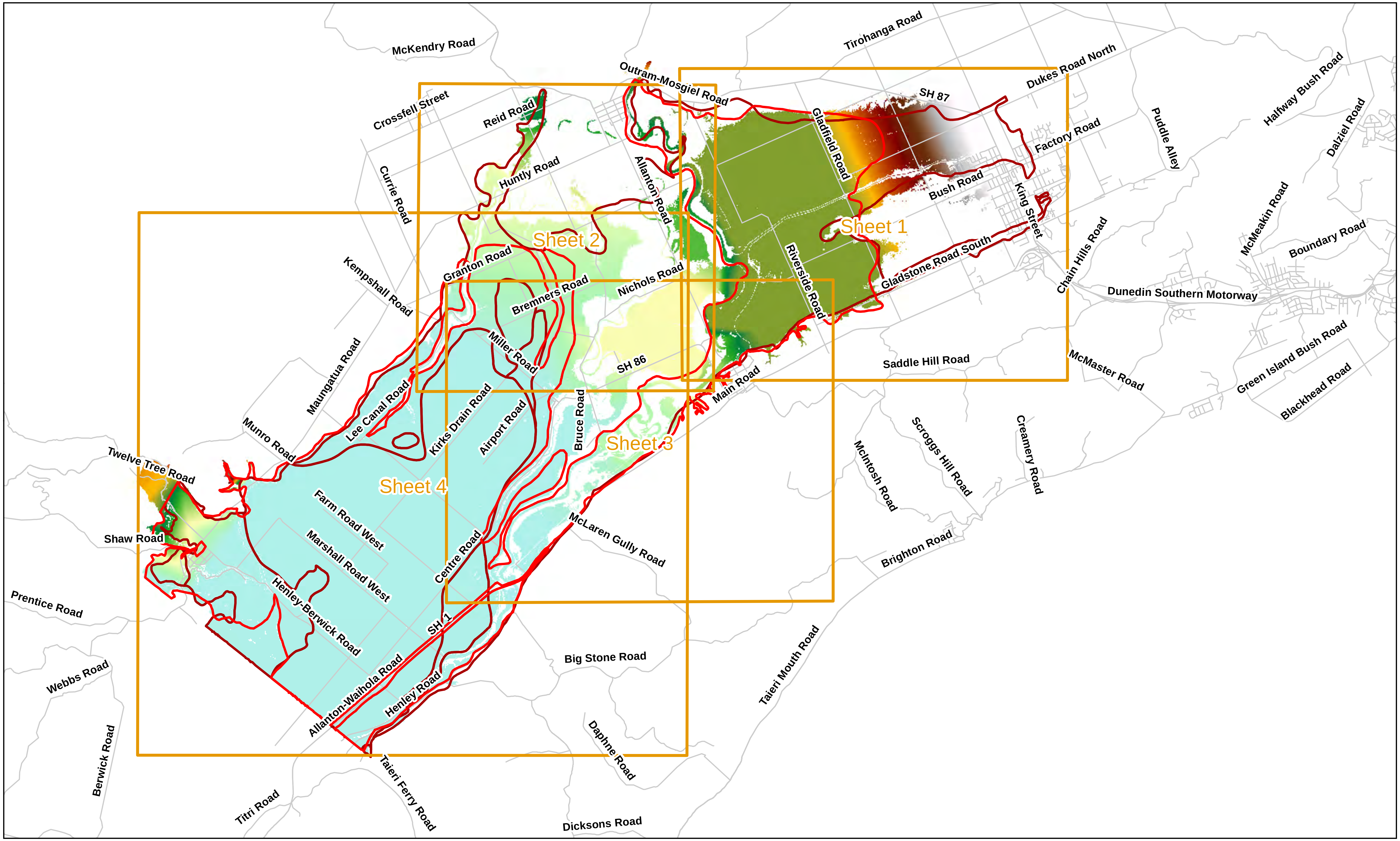
A-2 Sheet 4

Synthetic Flood Depth with 500 mm Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z026_RevA_TaieriComposite_CR_DepthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_with500mmFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 80000)

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Levels (with no freeboard).

High : 18.1994

Low : 1.5

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

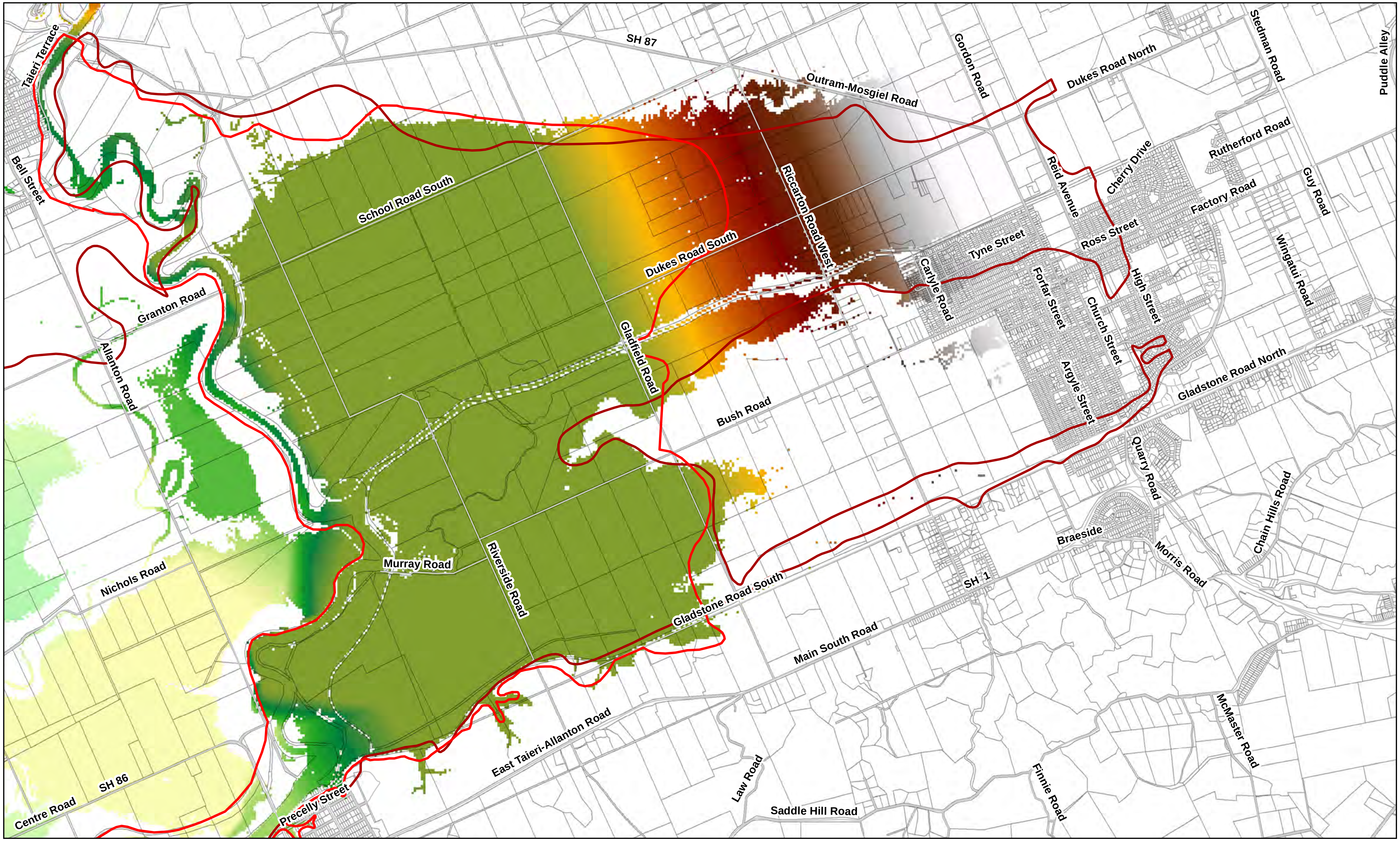
A-3 Overview

Synthetic Flood Level with no Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z027_RevA_TaieriComposite_CR_Level_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with no freeboard).

High : 18.1994

Low : 1.5

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Taieri Synthesised
Synthetic Flood Level with no Freeboard

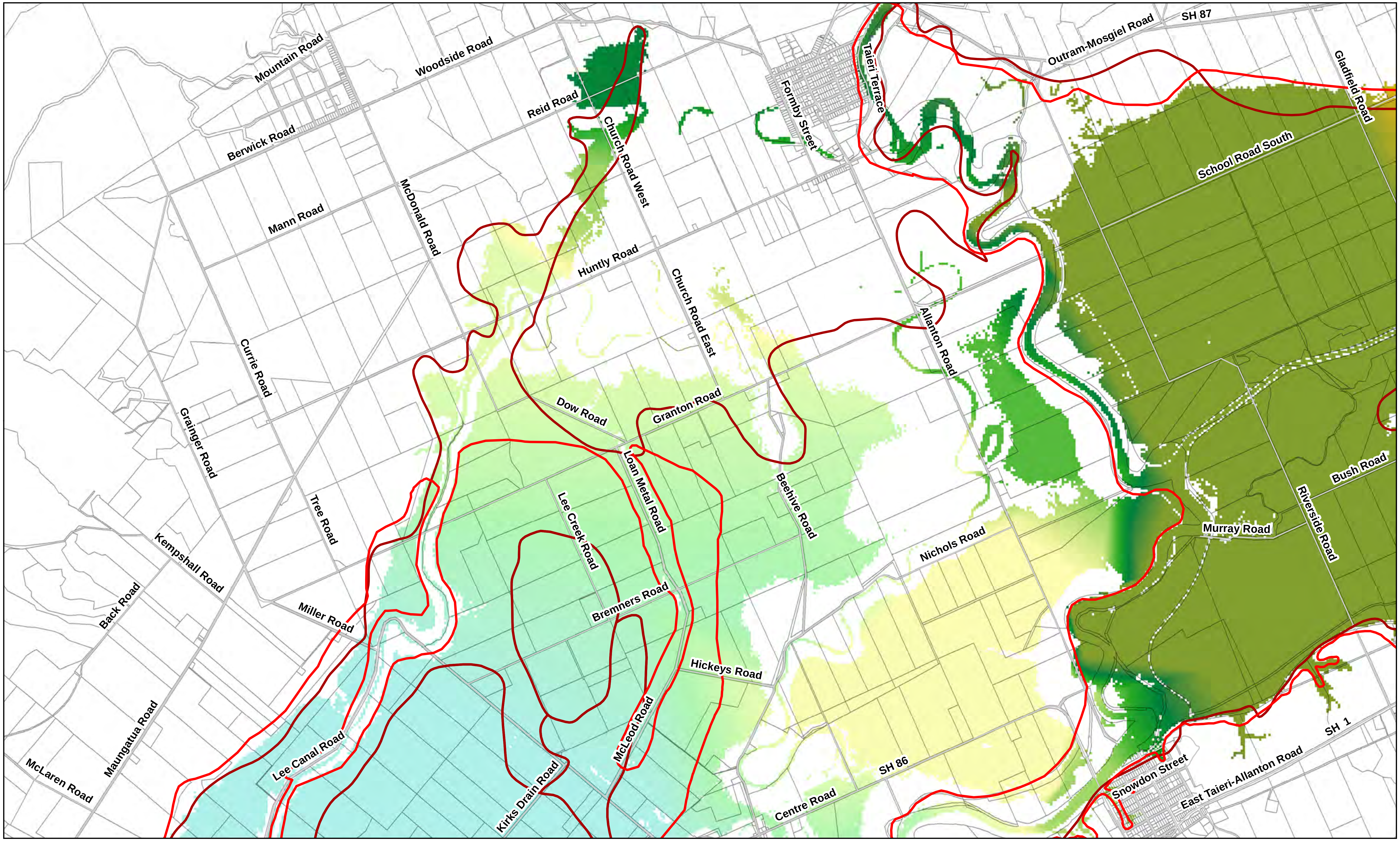
Job Number	51-32454
Revision	A
Date	22 Dec 2014

A-3 Sheet 1

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z027_RevA_TaieriComposite_CR_Level_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with no freeboard).

High : 18.1994

Low : 1.5

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 22 Dec 2014

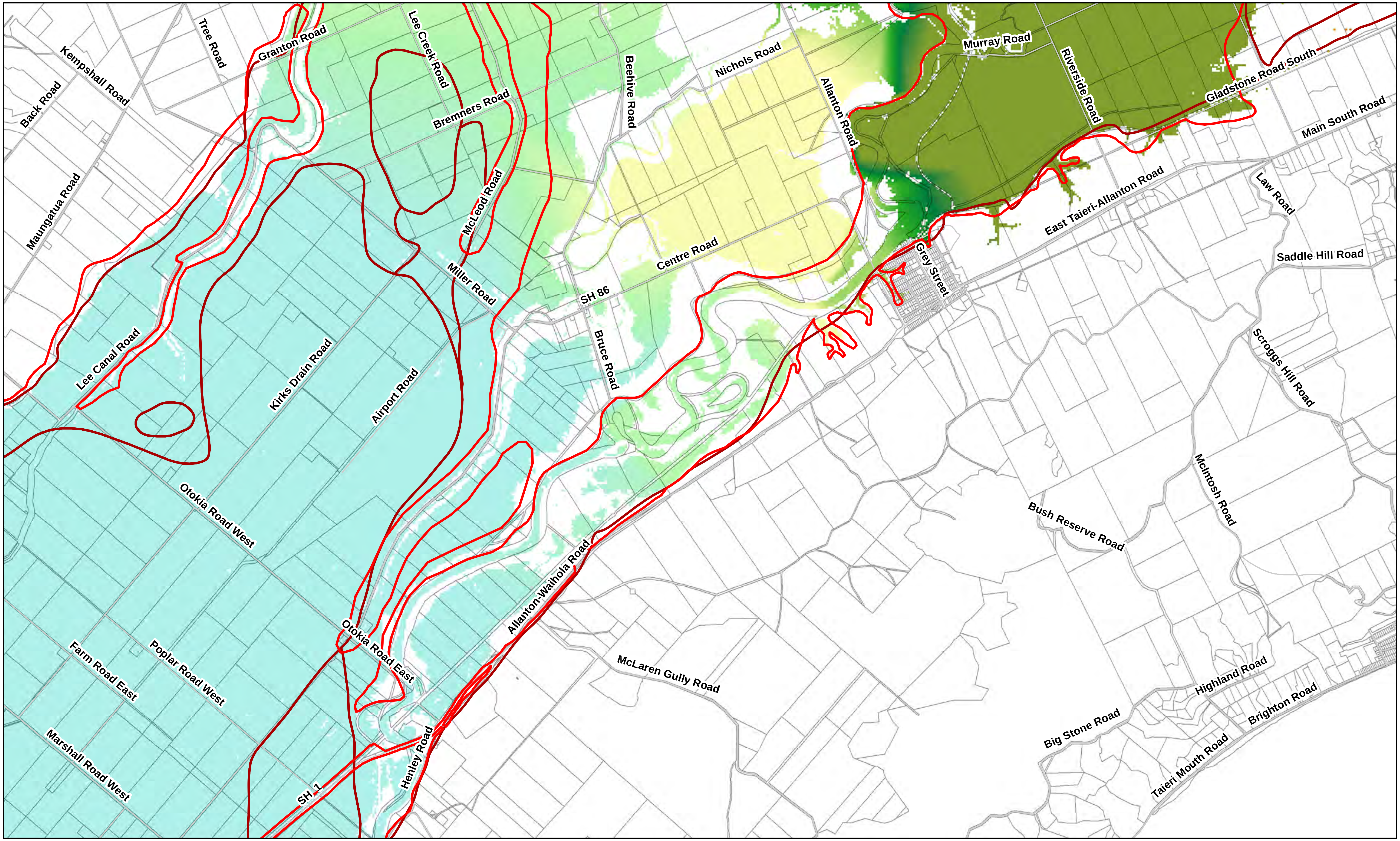
Taieri Synthesised
Synthetic Flood Level with no Freeboard

A-3 Sheet 2

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z027_RevA_TaieriComposite_CR_Level_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 35000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with no freeboard).

High : 18.1994

Low : 1.5

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Taieri Synthesised
Synthetic Flood Level with no Freeboard

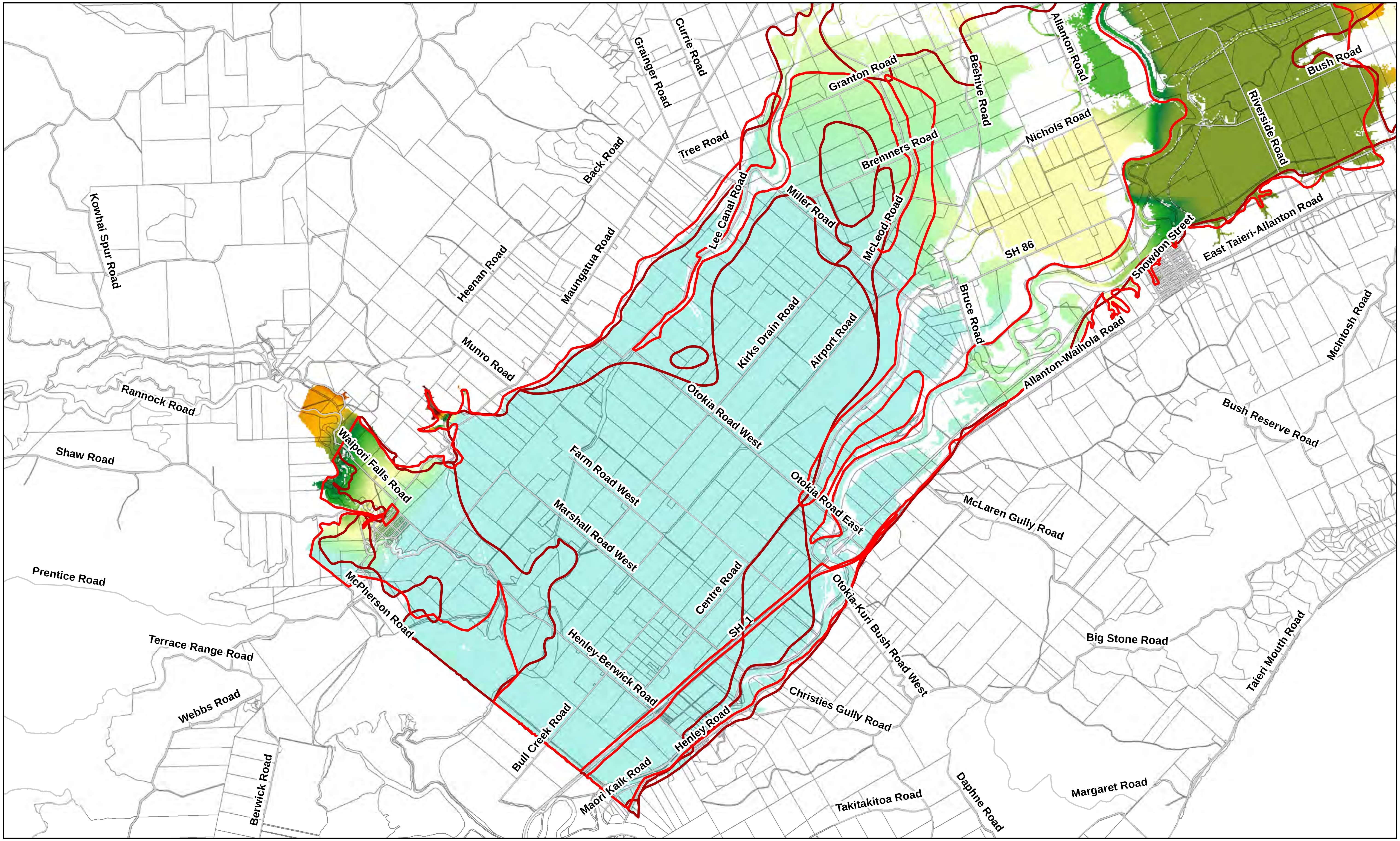
Job Number	51-32454
Revision	A
Date	22 Dec 2014

A-3 Sheet 3

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z027_RevA_TaieriComposite_CR_Level_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 55000)

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Levels (with no freeboard).

High : 18.1994

Low : 1.5

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

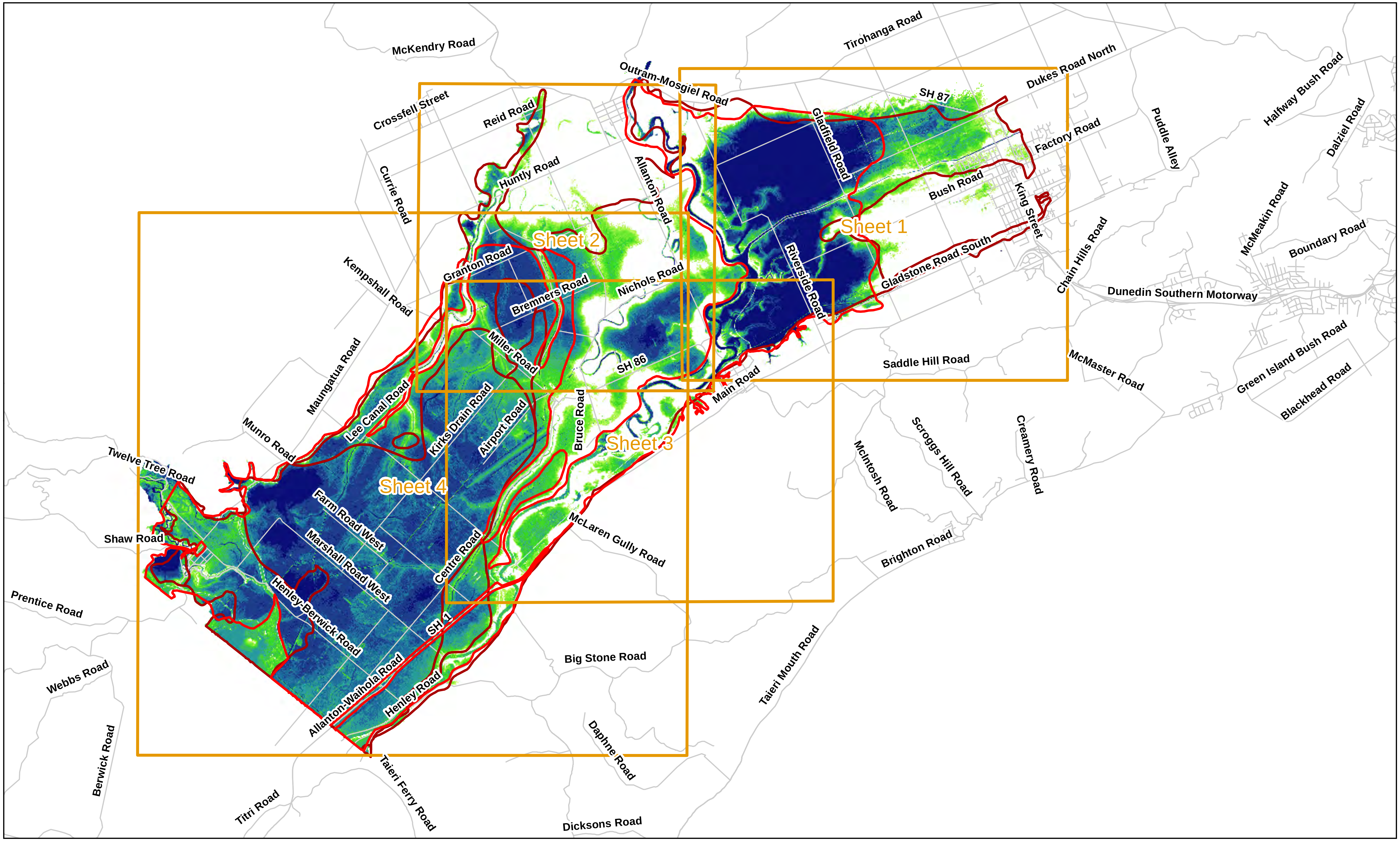
A-3 Sheet 4

Synthetic Flood Level with no Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z027_RevA_TaieriComposite_CR_Level_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite WaterSurface1923-1980 (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 80000)

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with no Freeboard)

- < 0 m
- 0.01 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- > 2m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

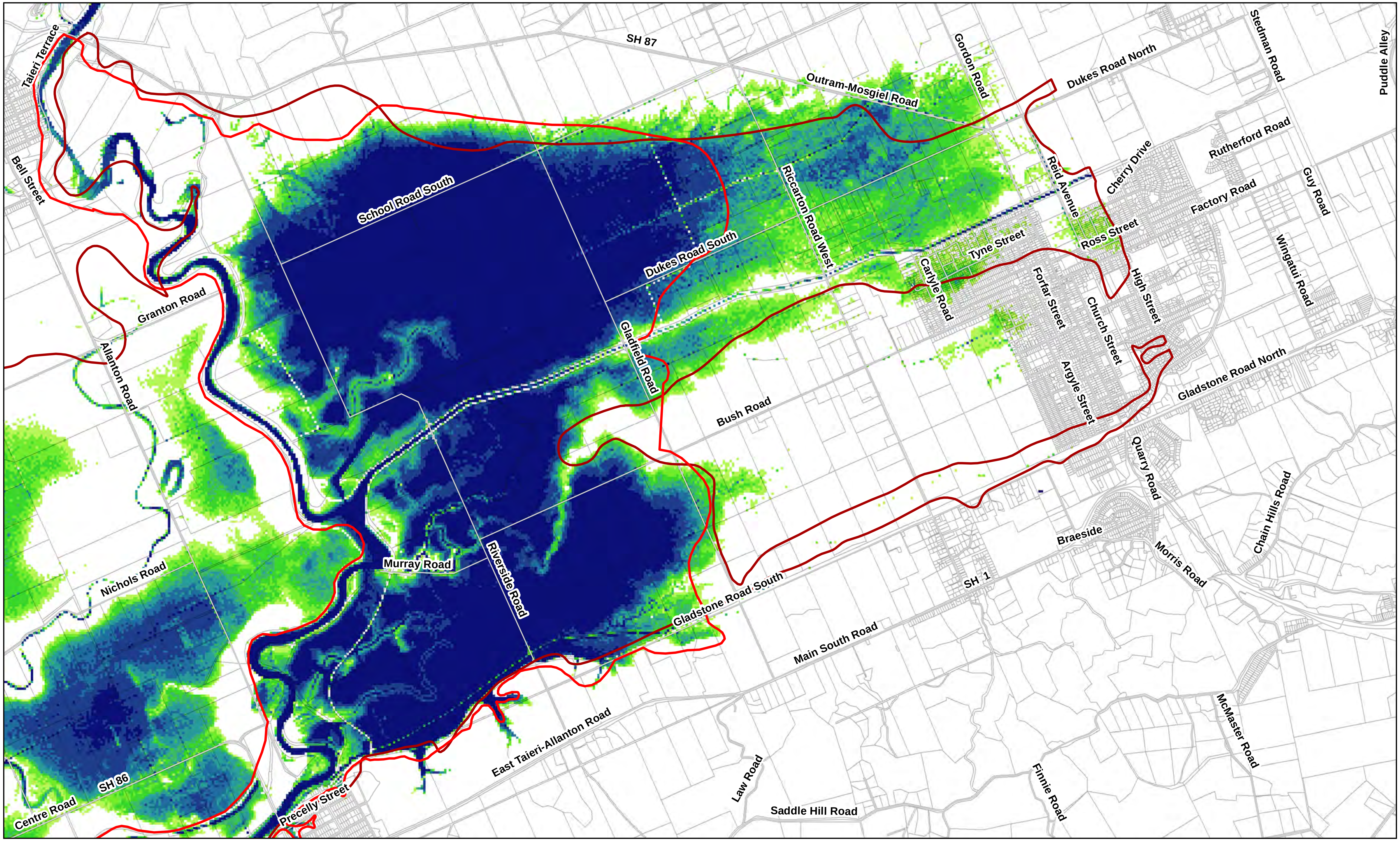
A-4 Overview

Synthetic Flood Depth with no Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z028_RevA_TaieriComposite_CR_Depth_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; Composite FloodDepth_withnoFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with no Freeboard)

- < 0 m
- 0.01 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- > 2m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

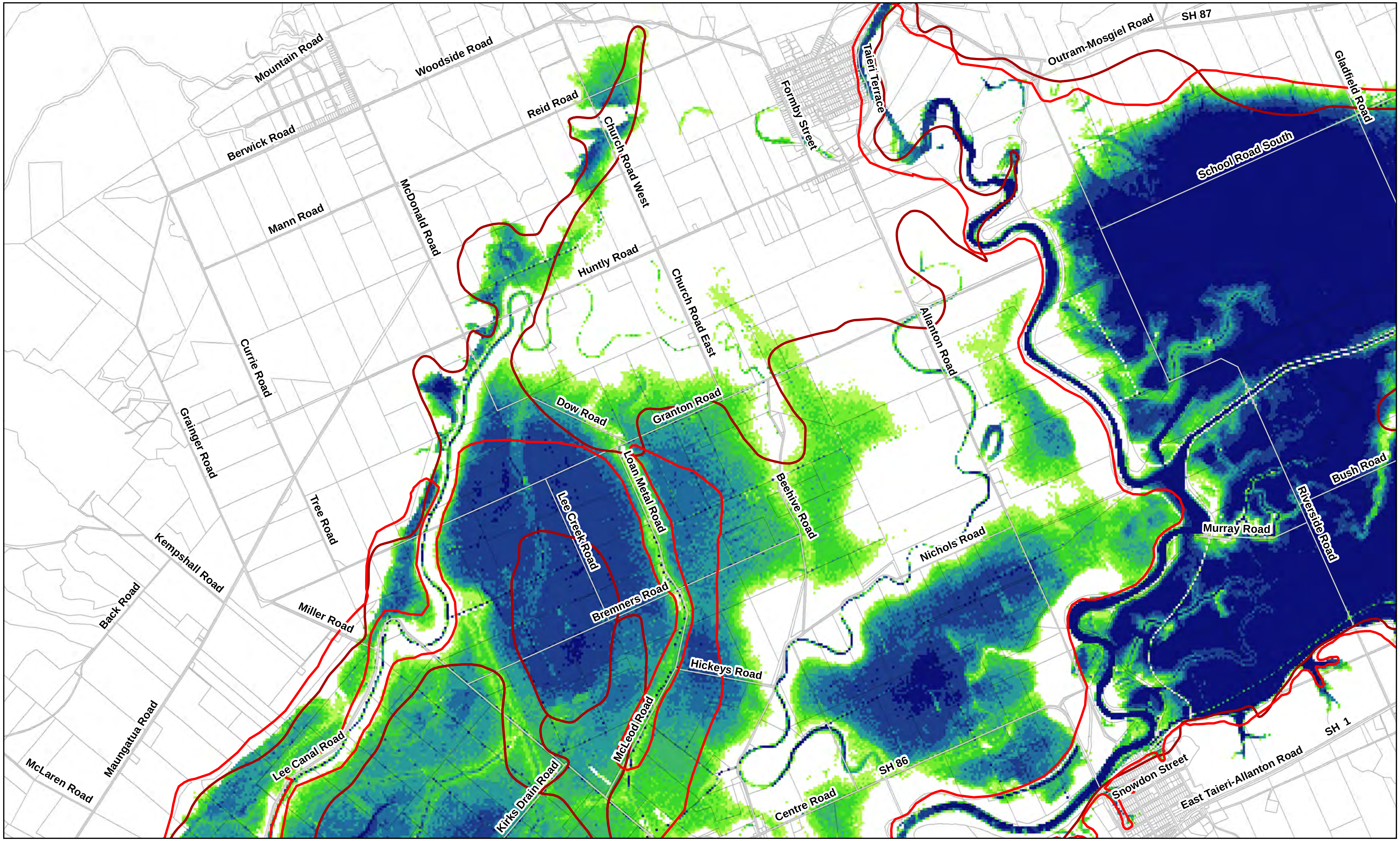
A-4 Sheet 1

Taieri Synthesised
Synthetic Flood Depth with no Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z028_RevA_TaieriComposite_CR_Depth_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_withnoFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 30000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with no Freeboard)

- < 0 m
- 0.01 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- > 2m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised

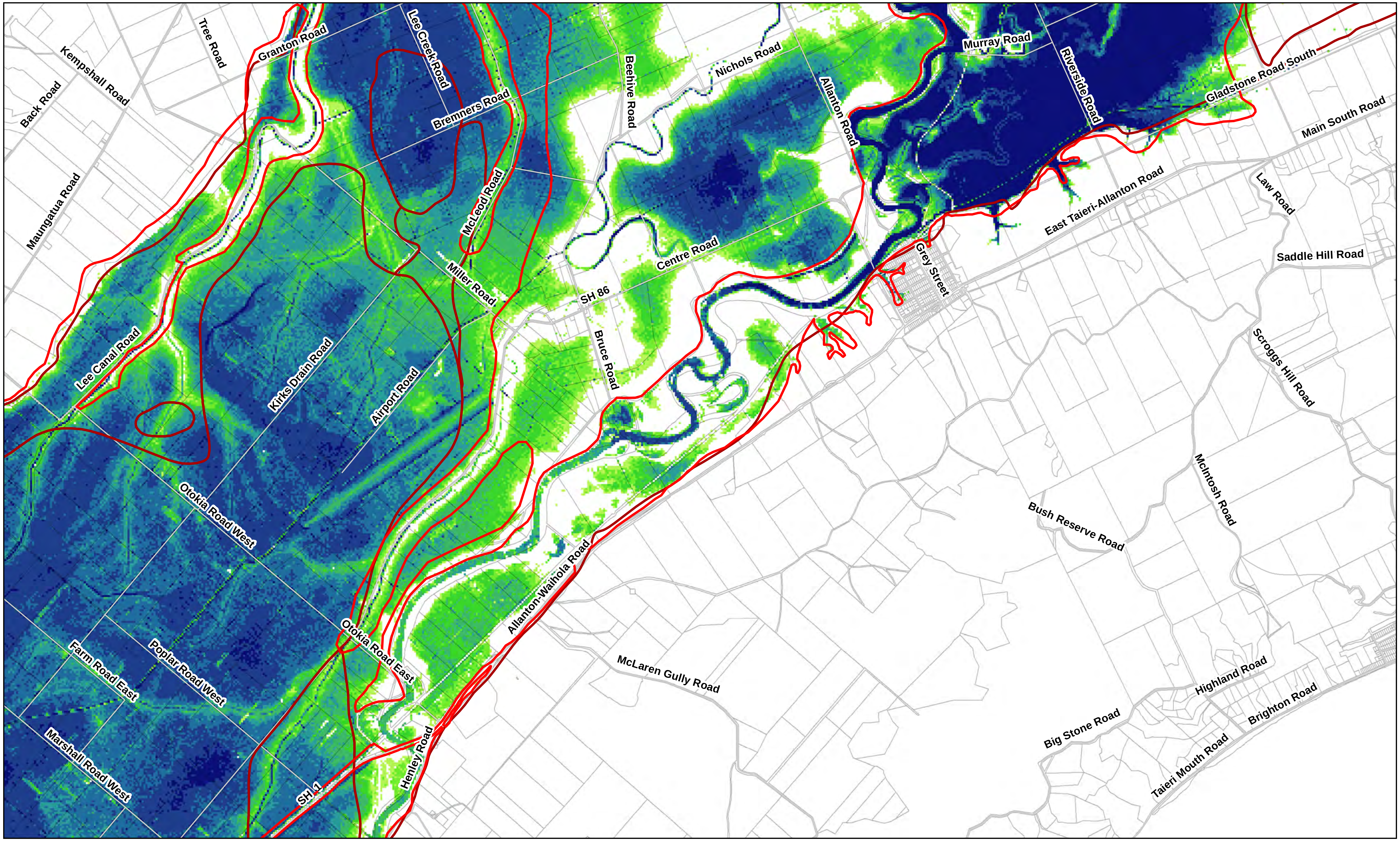
A-4 Sheet 2

Synthetic Flood Depth with no Freeboard

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z028_RevA_TaieriComposite_CR_Depth_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; Composite FloodDepth_withnoFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 35000)

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max Historic Flood Extent 1980

Max Historical flood Extent 1923

Rivers

Roads

Flood Depths (with no Freeboard)

< 0 m
0.01 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.25
1.25 - 1.5
1.5 - 2
> 2m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 22 Dec 2014

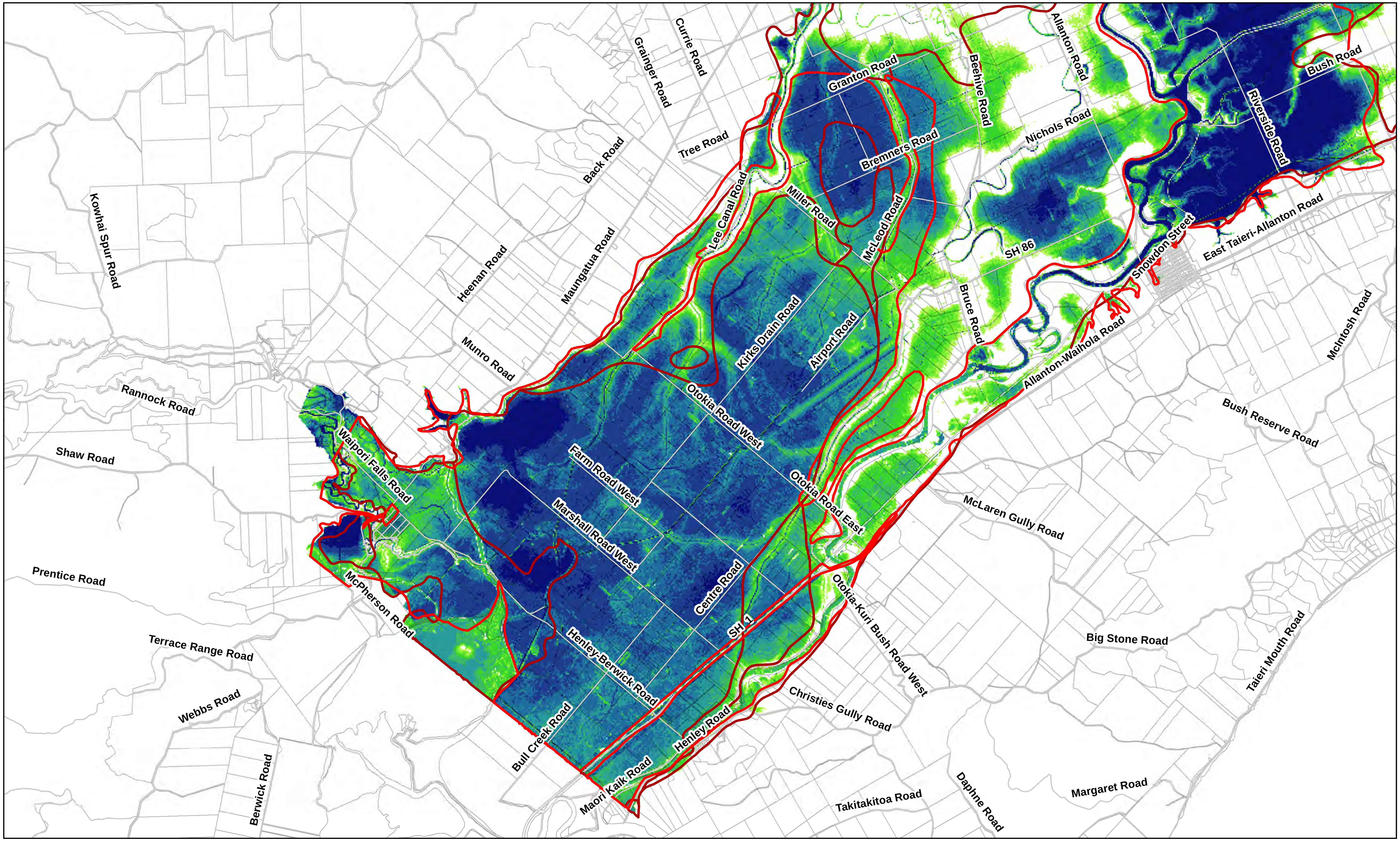
Taieri Synthesised
Synthetic Flood Depth with no Freeboard

A-4 Sheet 3

N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z028_RevA_TaieriComposite_CR_Depth_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Composite FloodDepth_withnoFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild



Paper Size A3 (At Scale: 1: 55000)

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max Historic Flood Extent 1980
- Max Historical flood Extent 1923
- Rivers
- Roads

Flood Depths (with no Freeboard)

- < 0 m
- 0.01 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 2
- > 2m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	22 Dec 2014

Taieri Synthesised
Synthetic Flood Depth with no Freeboard

A-4 Sheet 4

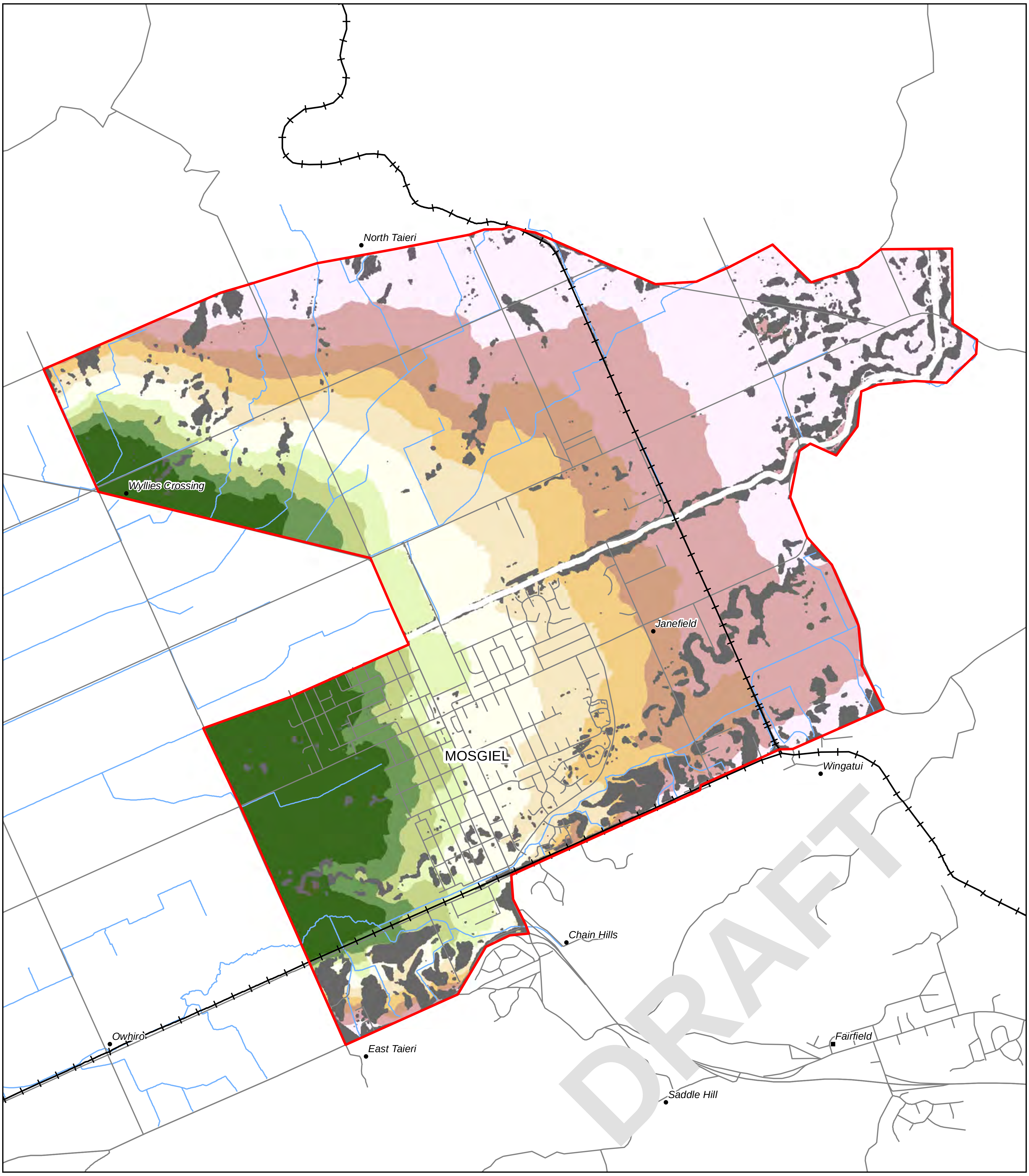
N:\NZ\Christchurch\Projects\51\32454\GIS\Maps\Mxds\5132454_Z028_RevA_TaieriComposite_CR_Depth_noFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; Composite FloodDepth_withnoFB (Dec, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:cwild

Appendix B - (Maps of Proposed Floor Levels – Upper Taieri Plains)

- Figure B1: Upper Taieri – Proposed Minimum Floor Levels including 500 mm Freeboard
- Figure B2: Upper Taieri – Proposed Depths to Minimum Floor Level including Freeboard



Proposed minimum floor level (m), including 500mm freeboard

High Ground	16.1 - 17	20.1 - 22	26.1 - 30
10.1 - 15	17.1 - 18	22.1 - 24	30.1 - 50
15.1 - 16	18.1 - 20	24.1 - 26	

Railway
Roads
ORC Scheduled Drains

Paper Size A3 1:30,000
0 250 500 1,000
Metres
Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Proposed Minimum Floor Levels
Upper Taieri Plain

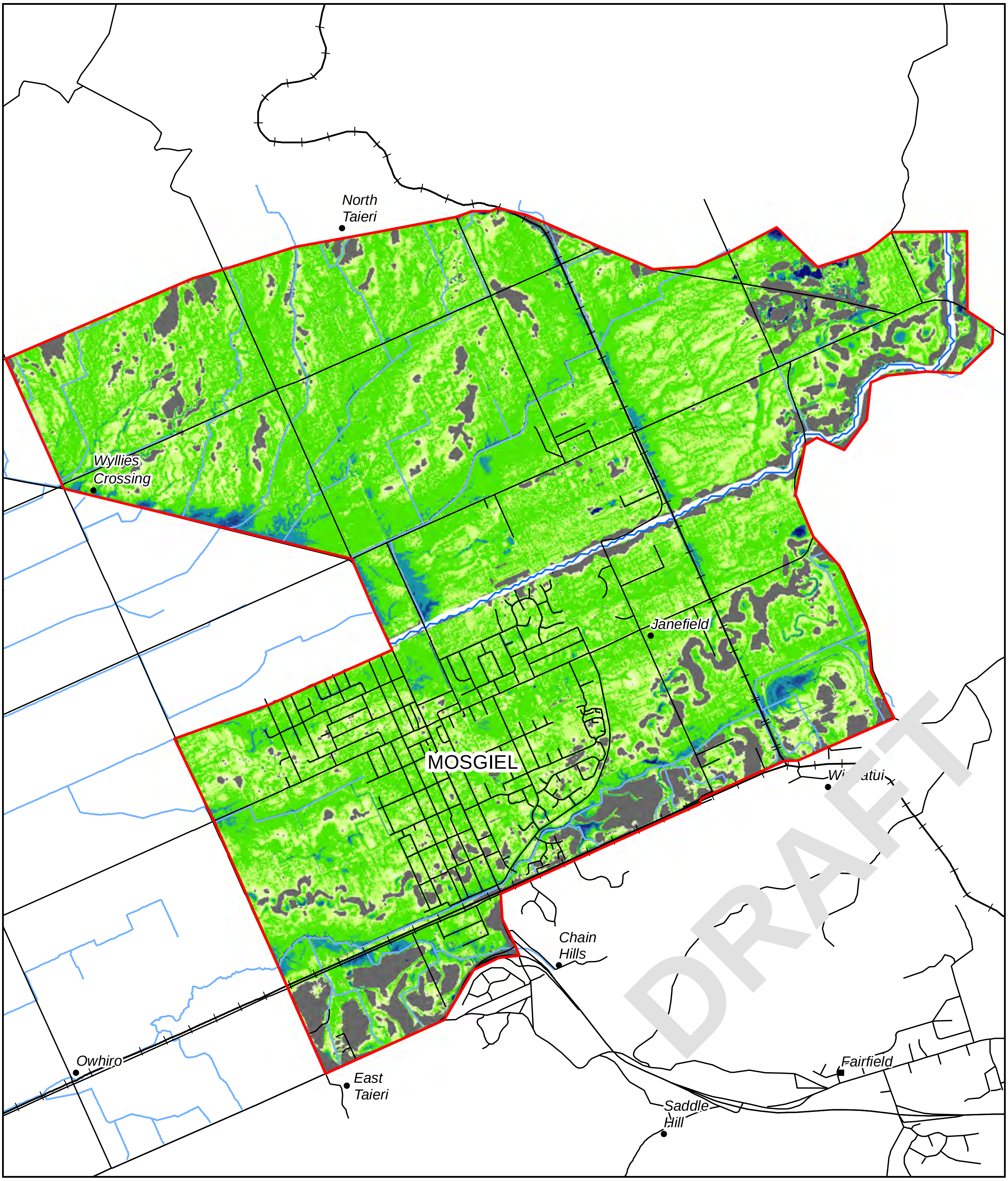
Job Number 51-32454
Revision B
Date 16 Dec 2014

Appendix B

G:\51\32454\GIS\Maps\Mxds\5132454_AppendixB_UpperTaieriFloorLevel_revD.mxd

226 Antigua Street, PO Box 13 468, Christchurch 8141, New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.com W www.ghd.com

Data source: DCC, DCC_Urban_Imagery_2013 (Dec 2013). LINZ; nz_road_centre_line_elect (July 2014), nz_railway_centre_lines (July 2014). GHD, process model results v131/ras_500_fin, October 2014 Created by:crolin



100 Year Flood depth (m) + freeboard 500mm

High Ground	0.25 - 0.5	1.00 - 1.50	Model extent	Roads
0.00 - 0.25	0.50 - 1.00	1.50 - 2.00	ORC Scheduled Drains	Railway
		> 2.00 m		

Paper Size A3
at scale 1:40,000

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision B

Date 19 Dec 2014

Flood depth with freeboard 500mm
Upper Taieri Plain

Appendix B-2

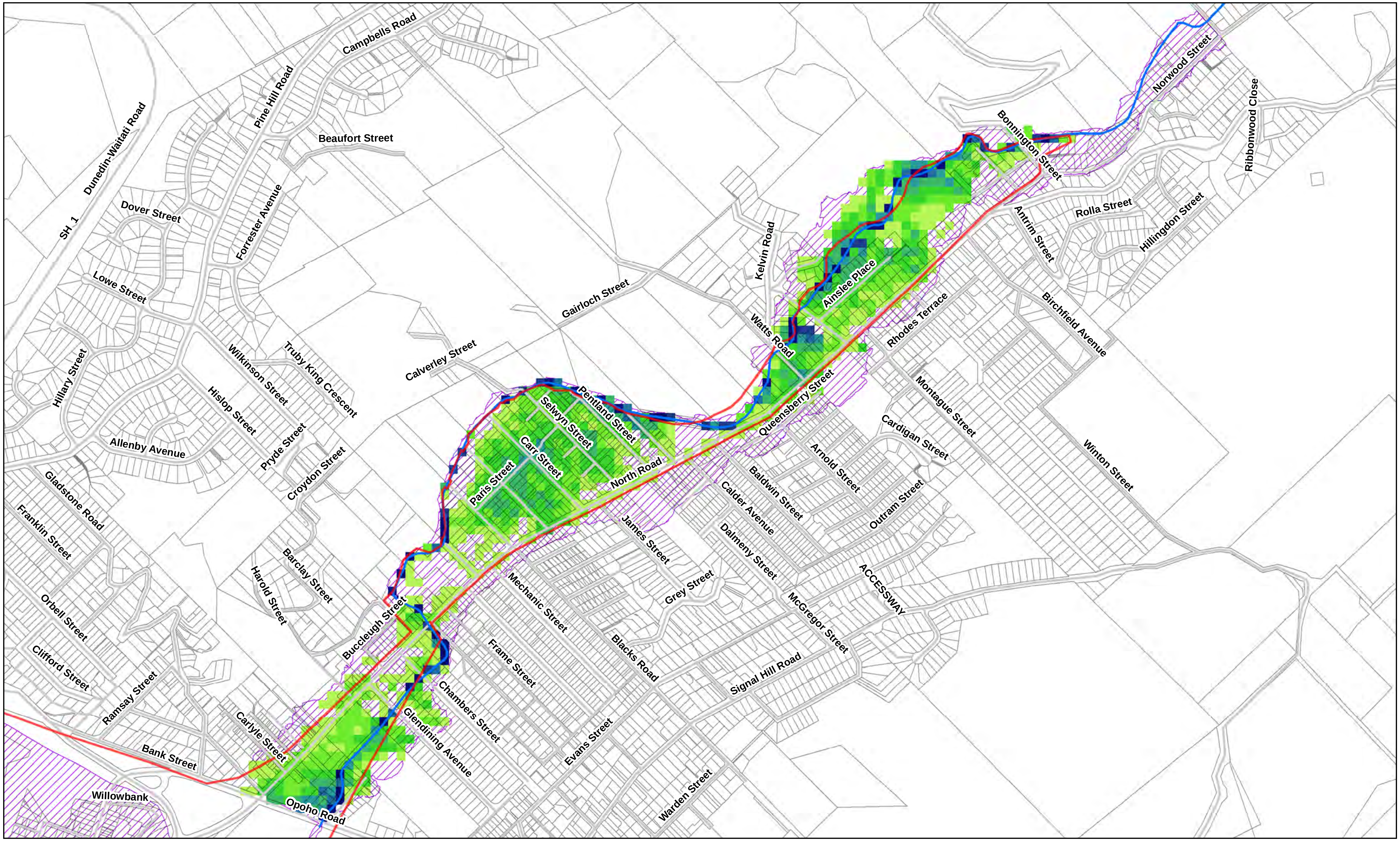
G:\51\32454\GIS\Maps\Mxds\5132454_AppendixB_UpperTaieri100yDepth_fb500mm_revD.mxd

226 Antigua Street, PO Box 13 468, Christchurch 8141, New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.com W www.ghd.com

Data source: DCC, DCC_Urban_Imagery_2013 (Dec 2013). LINZ; nz_road_centre_line_elect (July 2014), nz_railway_centre_lines (July 2014). GHD, process model results UpperTaieri Depth, December 2014 Created by:crolin

Appendix C - (Maps of Advisory Floor Levels – North East Valley)

- Figure C1: North East Valley – Synthetic Flood Depth without Freeboard
- Figure C2: North East Valley – Synthetic Flood Depth with 500 mm Freeboard
- Figure C3: North East Valley – Synthetic Flood Level without Freeboard
- Figure C4: North East Valley – Synthetic Flood Level with 500 mm Freeboard



Paper Size A3 (At Scale: 1:8,000)

0 50 100 200 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Rivers
- Roads
- Max historic Flood extent
- Geomorpho-logical extent*

Flood Depths (without Freeboard)

- < 0 m
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 5.5

* The geomorphology of this area suggests that it is at risk of flooding, although the flood risk cannot currently be quantified. 500 mm clearance between finished floor levels and the ground would be advisable

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	B
Date	16 Dec 2014

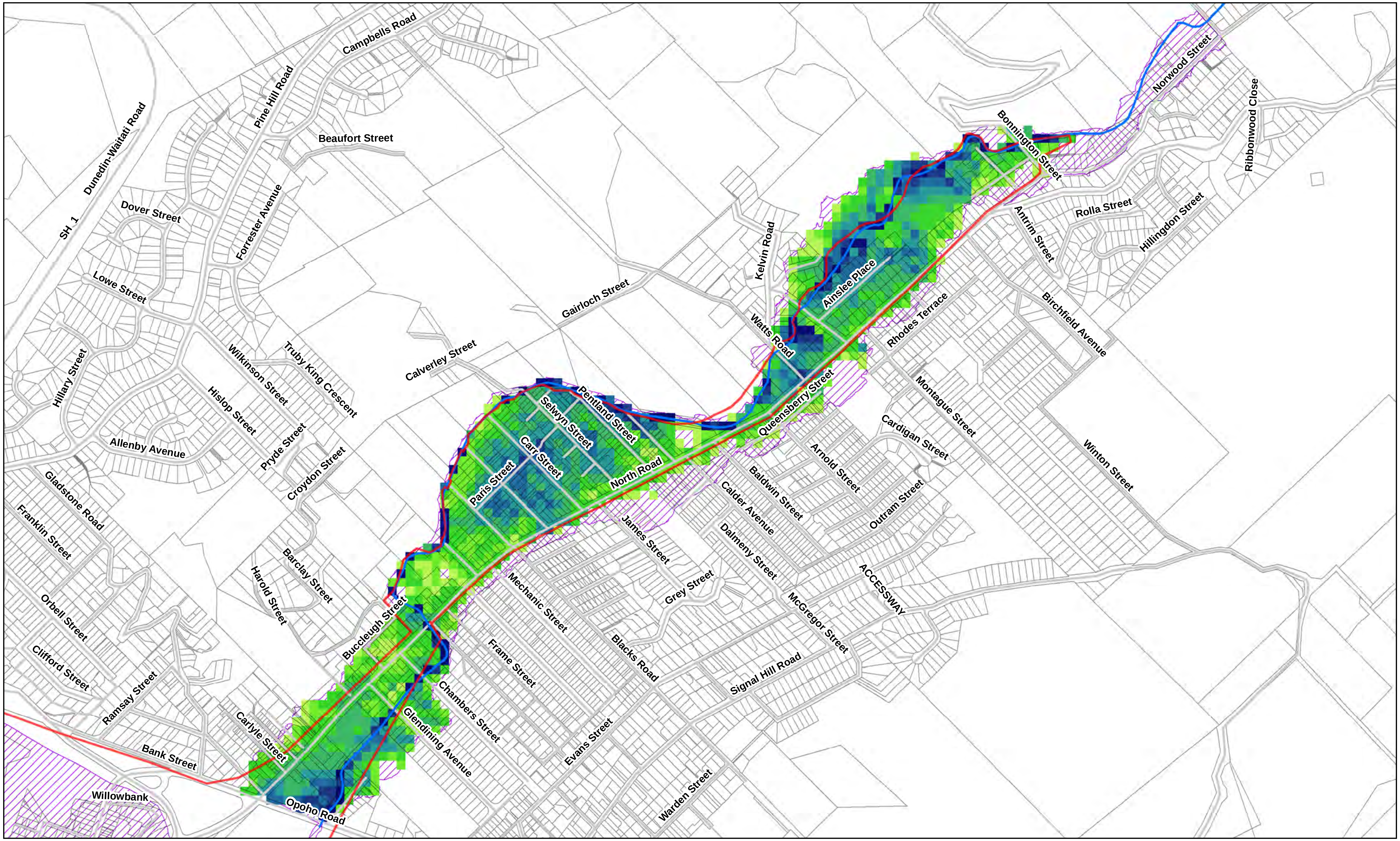
Synthetic Flood Depth without Freeboard NE Valley

Figure C-1

G:\51\32454\GIS\Maps\Mxds\5132454_Z001_RevB_LindsayIterations_GP_FigC-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; Depths20141023 (Oct, 2014), Geomorphological extent (). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:crolin



Paper Size A3 (At Scale: 1:8,000)

0 50 100 200 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Rivers
- Roads
- Max historic Flood extent
- Geomorphological extent*

Flood Depths (with 500mm Freeboard)

- < 0 m
- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 5.5

* The geomorphology of this area suggests that it is at risk of flooding, although the flood risk cannot currently be quantified. 500 mm clearance between finished floor levels and the ground would be advisable

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	B
Date	16 Dec 2014

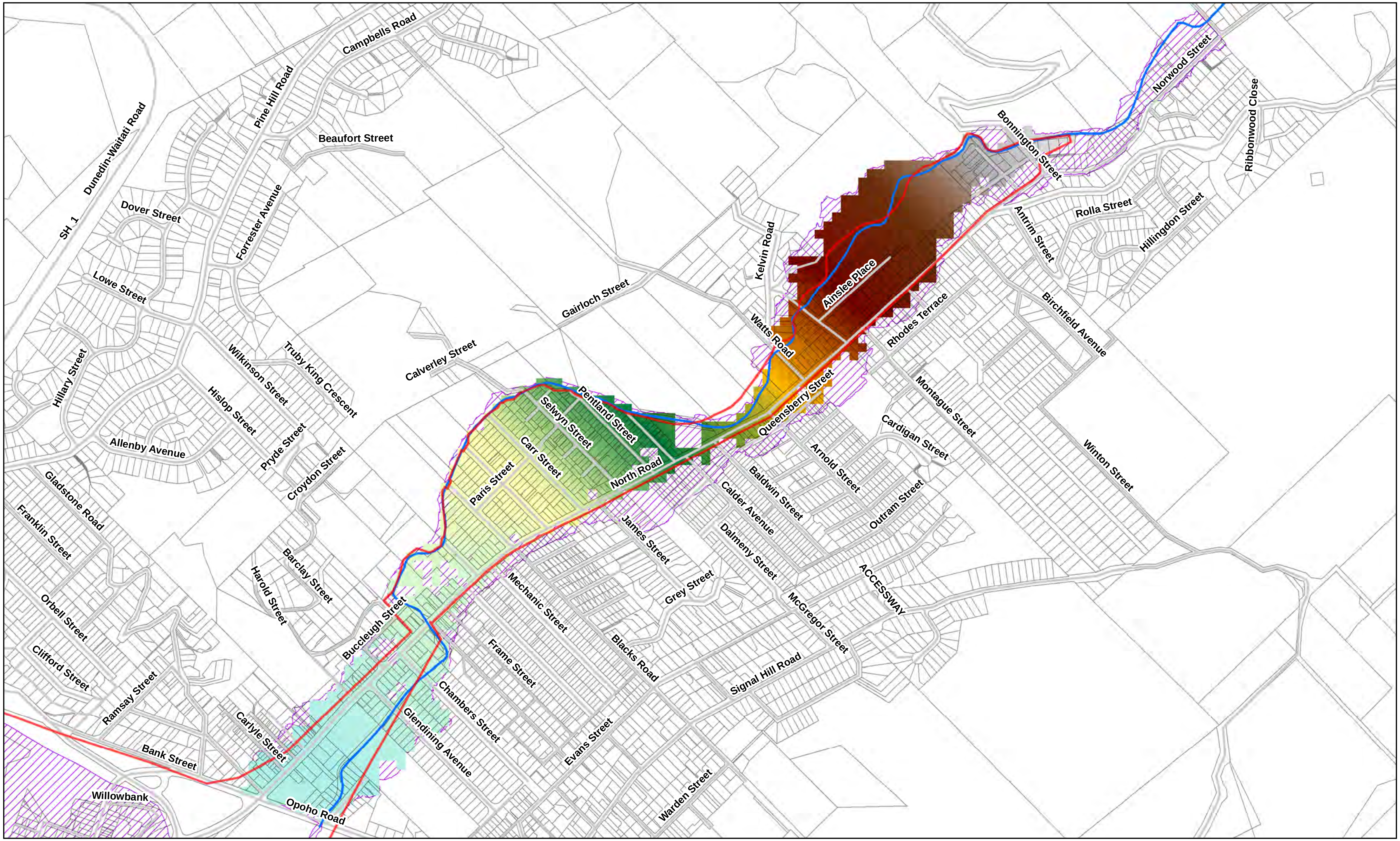
Synthetic Flood Depth with 500 mm Freeboard
NE Valley

Figure C-2

G:\51\32454\GIS\Maps\Mxds\5132454_Z002_RevB_LindsayIterations_GP_FigC-2_depthFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; DepthsPlus_500mmFreeboard20141023 (Oct, 2014), Geomorphological extent (). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:crolin



Paper Size A3 (At Scale: 1:8,000)

0 37.5 75 150 225 300
Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max historic Flood extent
Rivers
Roads
Geomorpho-logical extent*

Flood Level without Freeboard

55.92 m
23.00 m

* The geomorphology of this area suggests that it is at risk of flooding, although the flood risk cannot currently be quantified. 500 mm clearance between finished floor levels and the ground would be advisable

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	B
Date	16 Dec 2014

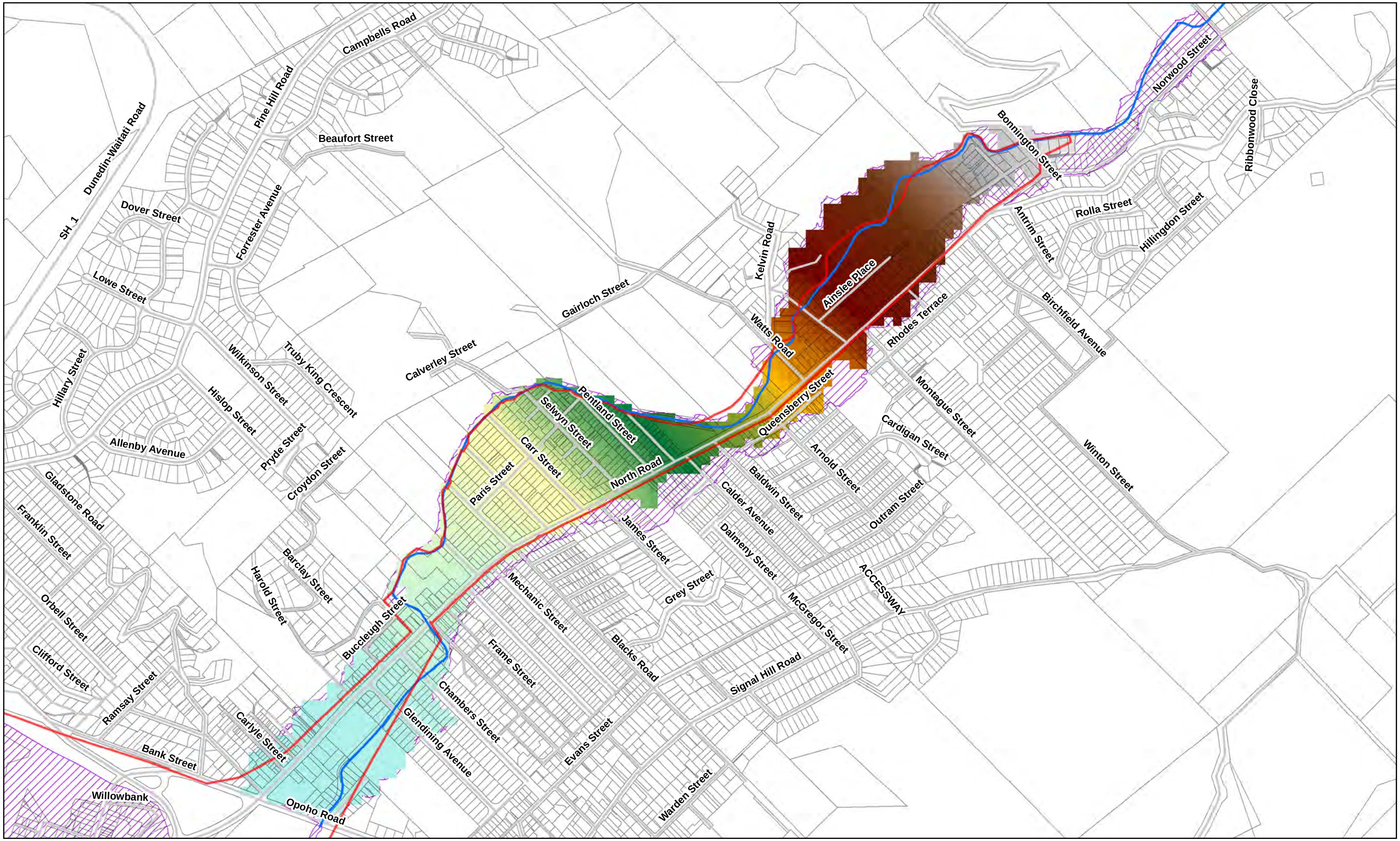
Synthetic Flood Level without Freeboard
NE Valley

Figure C-3

G:\51\32454\GIS\Maps\Mxds\5132454_Z003_RevB_LindsayIterations_GP_FigC-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; Cliped_FloodSurfacewithout(Oct, 2014);Geomorphological extent (). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:crolin



Paper Size A3 (At Scale: 1:8,000)

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

Max historic Flood extent

Rivers

Roads

Geomorpho-logical extent*

Flood Level with 500mm Freeboard

56.42 m

23.50 m

* The geomorphology of this area suggests that it is at risk of flooding, although the flood risk cannot currently be quantified. 500 mm clearance between finished floor levels and the ground would be advisable

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	B
Date	16 Dec 2014

Synthetic Flood Level with 500mm Freeboard
NE Valley

Figure C-4

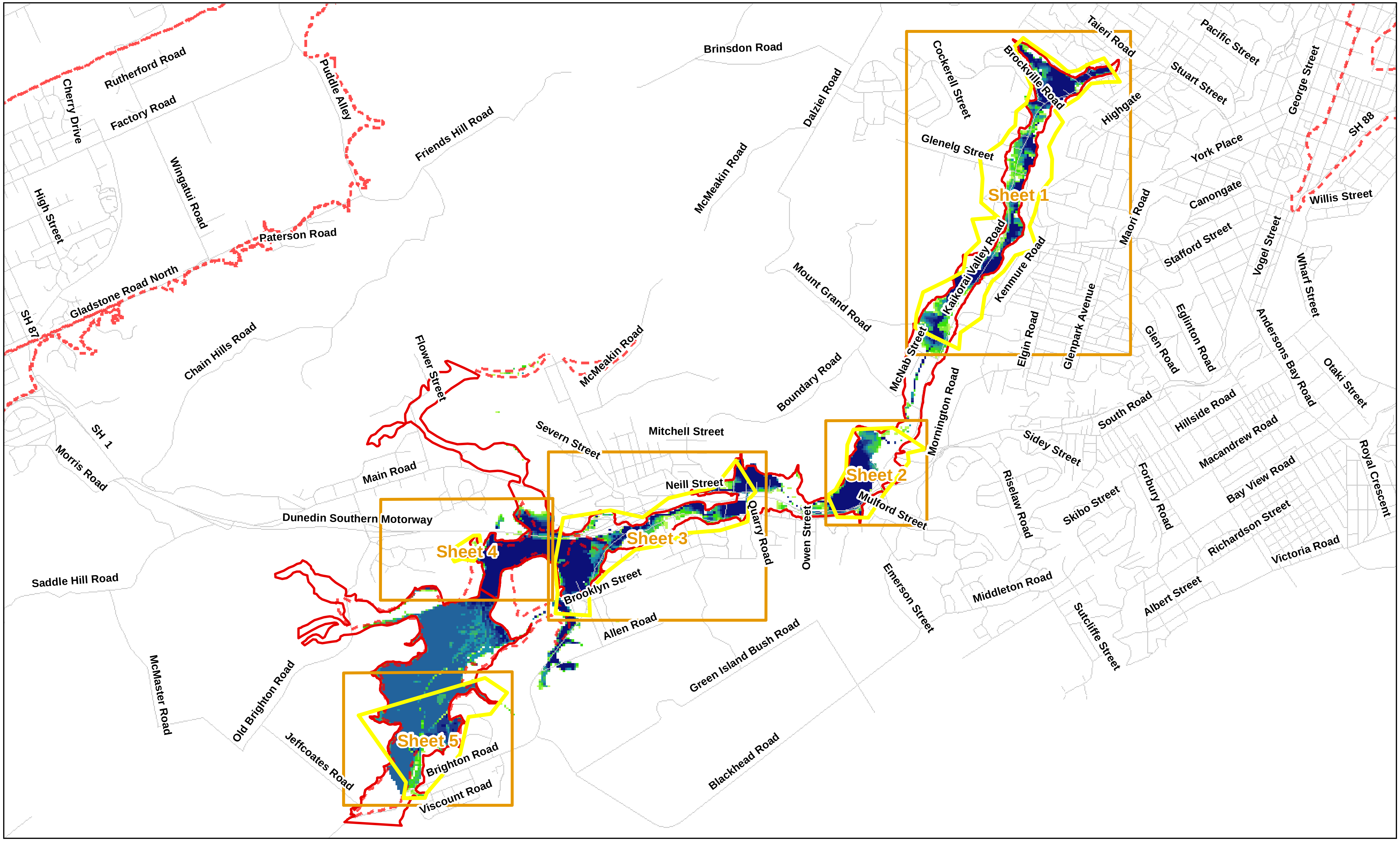
G:\51\32454\GIS\Maps\Mxds\5132454_Z004_RevB_LindsayIterations_GP_FigC-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD: Cliped_Flood_surface_plus500mmFreeBoard (Oct, 2014);Geomorphological extent ( ). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:crolin

Appendix D - (Maps of Estimated Flood Levels – Kaikorai Stream)

- Figure D1: Kaikorai Stream – Synthetic Flood Depth without Freeboard
  - Sheet 0: Overview
  - Sheet 1: Upper Valley
  - Sheet 2: Centre Valley
  - Sheet 3: Lower Valley
  - Sheet 4: Upper Estuary
  - Sheet 5: Lower Estuary
- Figure D2: Kaikorai Stream – Synthetic Flood Depth with 500 mm Freeboard
  - Sheet 0: Overview
  - Sheet 1: Upper Valley
  - Sheet 2: Centre Valley
  - Sheet 3: Lower Valley
  - Sheet 4: Upper Estuary
  - Sheet 5: Lower Estuary
- Figure D3: Kaikorai Stream – Synthetic Flood Level without Freeboard
  - Sheet 0: Overview
  - Sheet 1: Upper Valley
  - Sheet 2: Centre Valley
  - Sheet 3: Lower Valley
  - Sheet 4: Upper Estuary
  - Sheet 5: Lower Estuary
- Figure D4: Kaikorai Stream – Synthetic Flood Level with 500 mm Freeboard
  - Sheet 0: Overview
  - Sheet 1: Upper Valley
  - Sheet 2: Centre Valley
  - Sheet 3: Lower Valley
  - Sheet 4: Upper Estuary
  - Sheet 5: Lower Estuary



Paper Size A3 (At Scale: 1: 32000)

0 0.25 0.5 1 1.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

D-1 Overview

Synthetic Flood Depth without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_KaikoraiIterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird

Paper Size A3 (At Scale: 1: 12500)

0 0.25 0.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Ōtepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

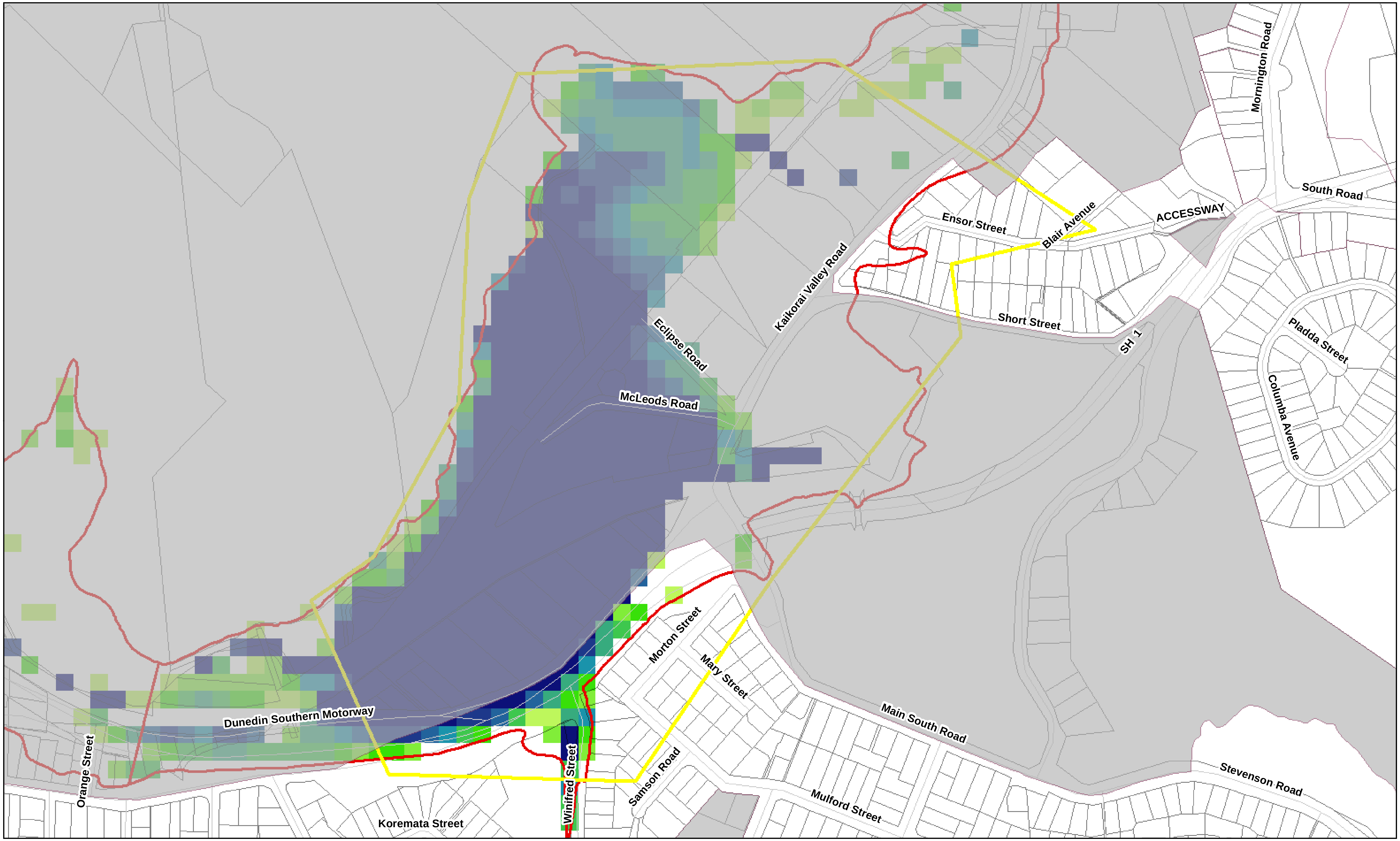
Synthetic Flood Depth without Freeboard

D-1 Sheet 1

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_Kaikoraiiterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

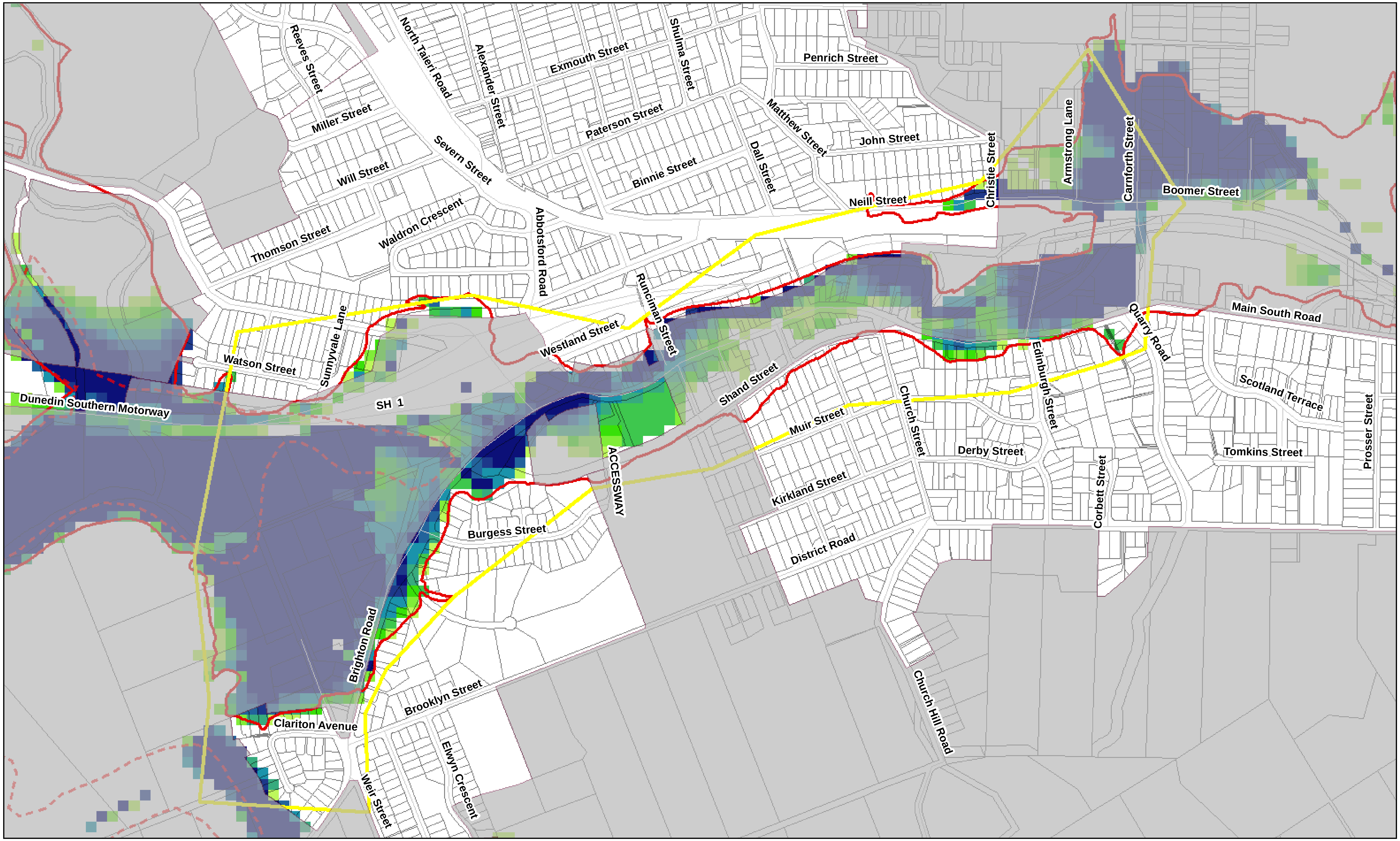
D-1 Sheet 2

Synthetic Flood Depth without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_KaikoraiIterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 6500)

0 0.15 0.3

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

Dunedin City Council
Minimum Floor Levels for Flood
Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

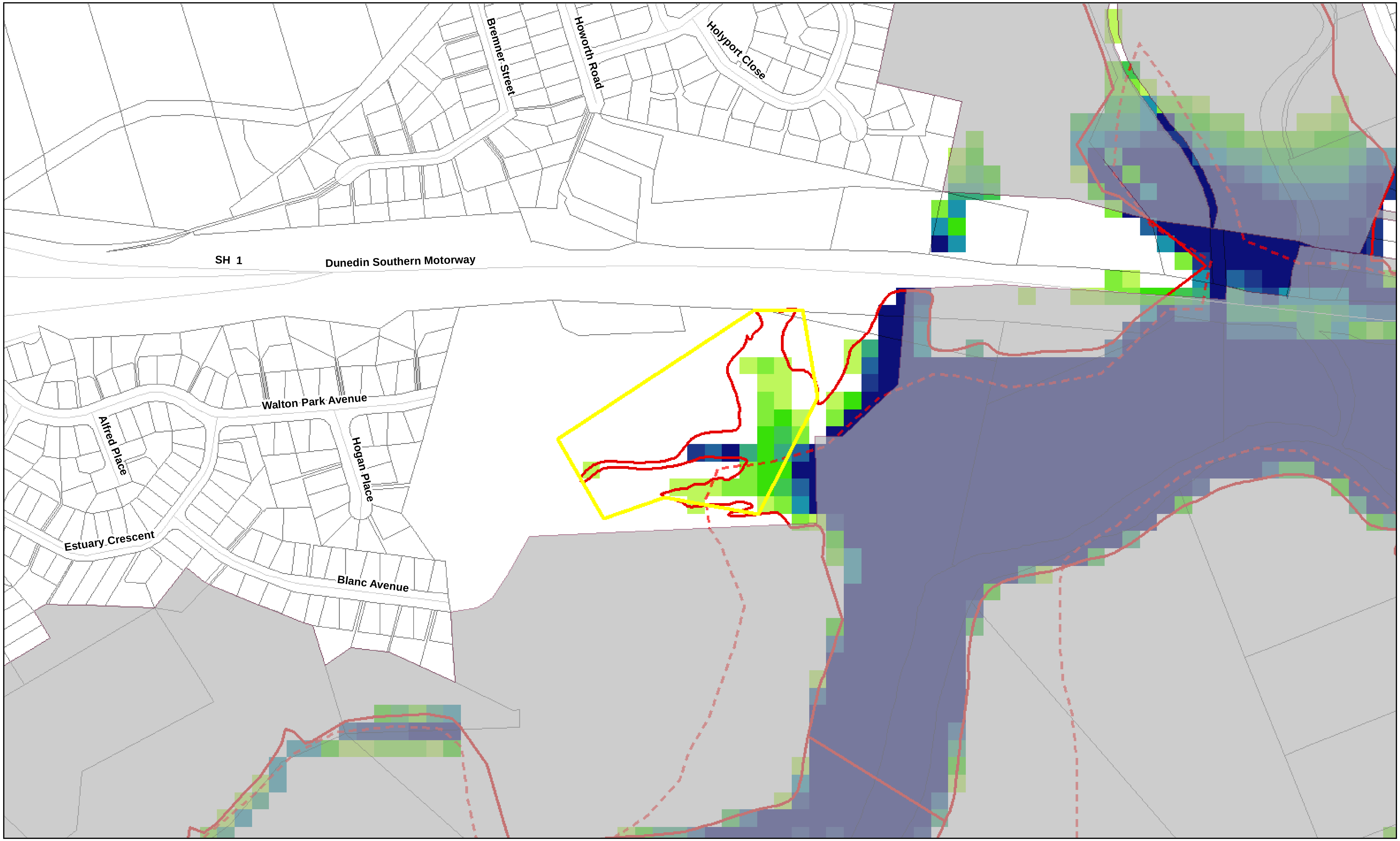
D-1 Sheet 3

Synthetic Flood Depth without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_KaikoraiIterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

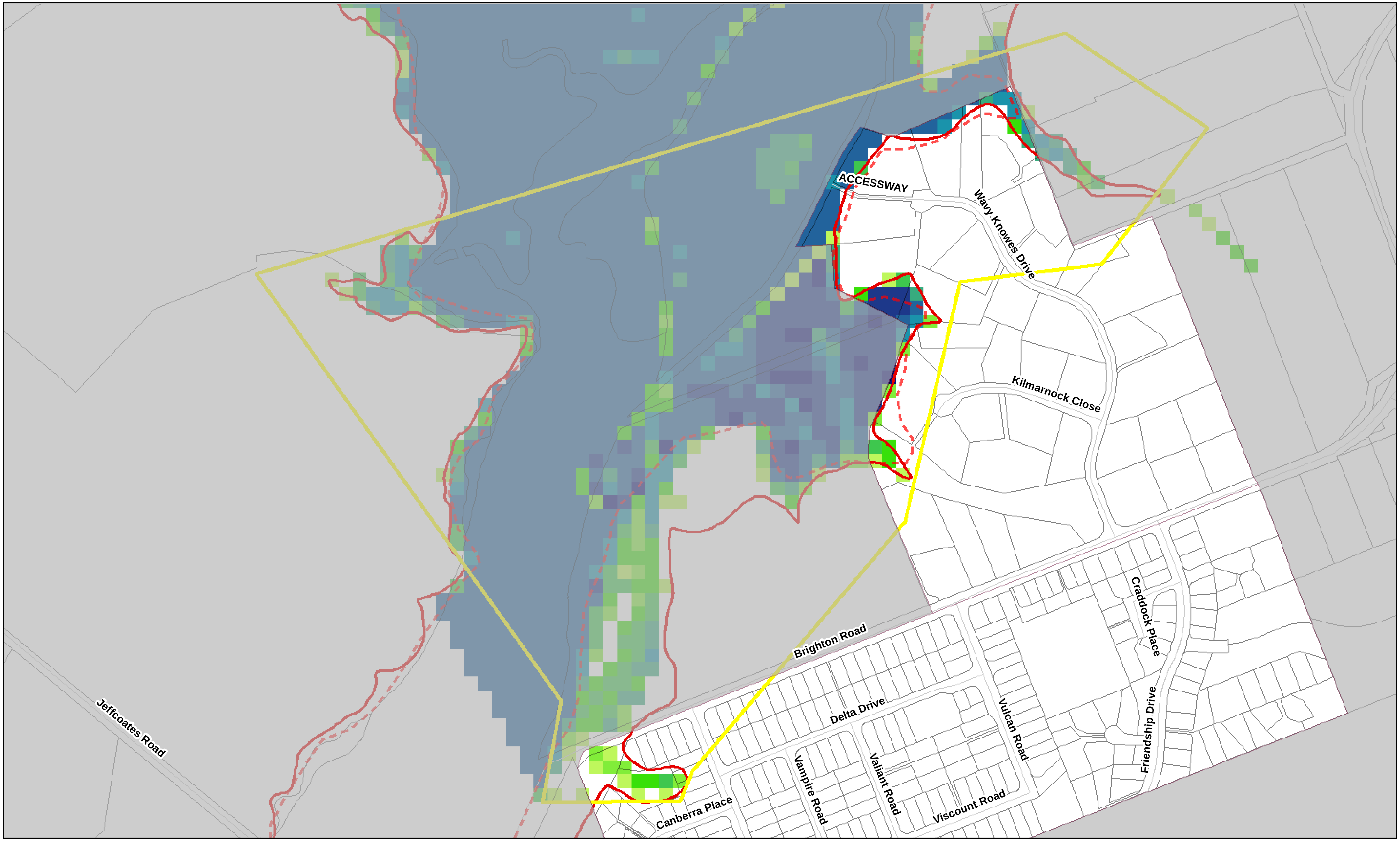
D-1 Sheet 4

Synthetic Flood Depth without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_KaikoraiIterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 5000)

0 0.125 0.25

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Depth (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01- 1.25m
- 1.26m - 1.50m
- 1.51m - 1.75m
- 1.76 - 2.00m
- 2.01 - 9.07m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Ōtepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

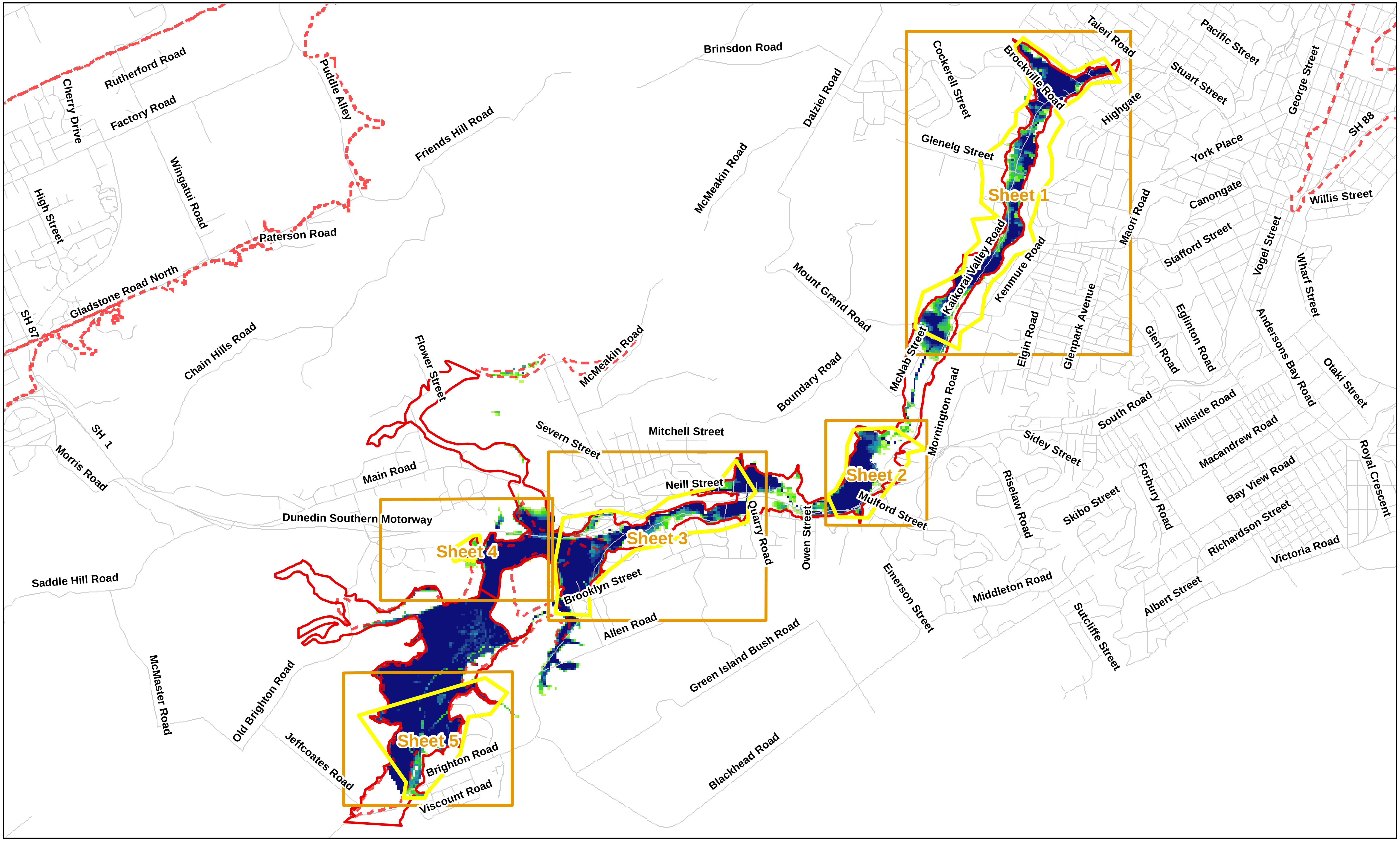
D-1 Sheet 5

Synthetic Flood Depth without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z017_RevA_KaikoraiIterations_GP_FigD-1_depth.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depthOnly (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 32000)

0 0.25 0.5 1 1.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

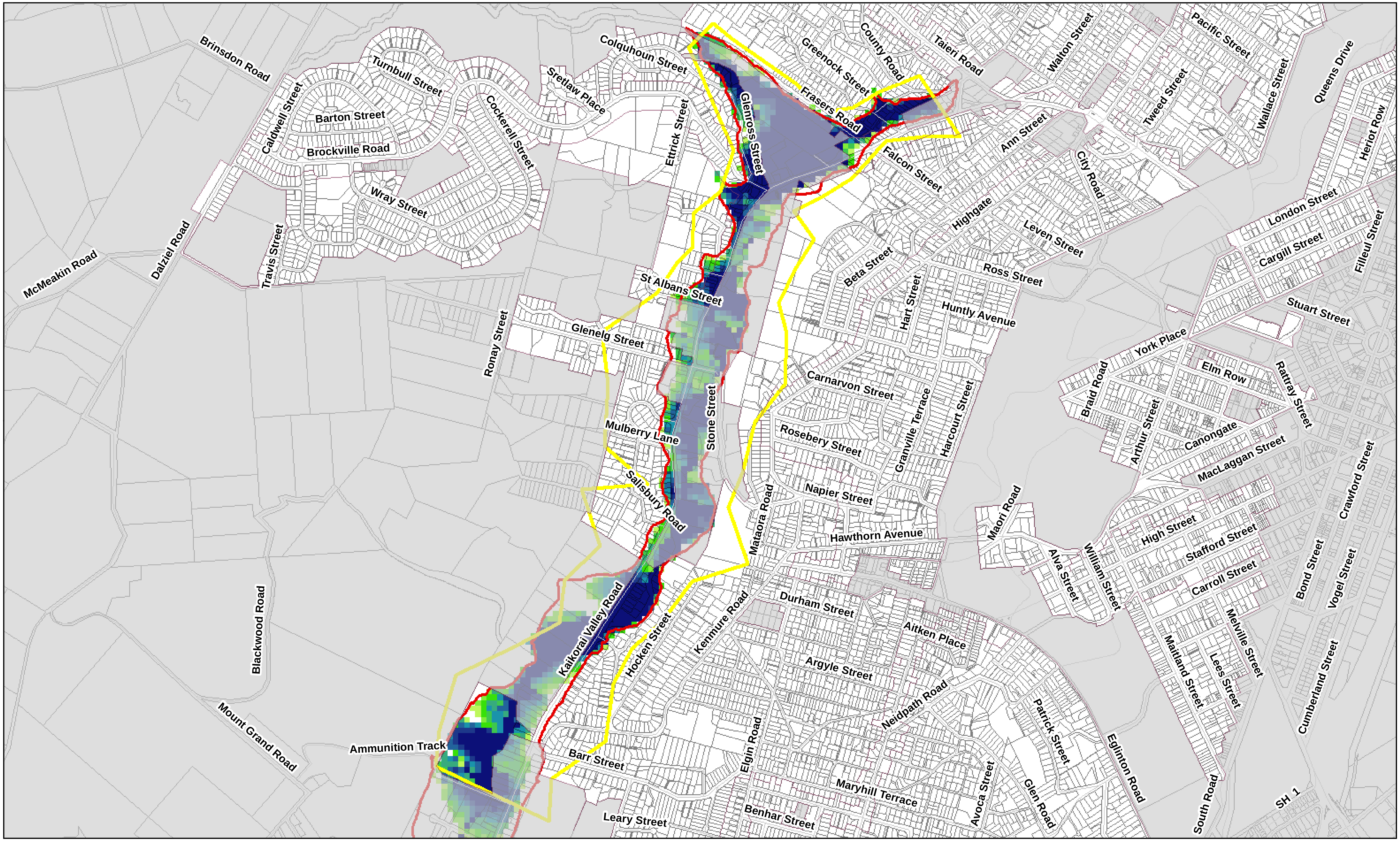
D-2 Overview

Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_KaikoraiIterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 12500)

0 0.25 0.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

GHD

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Ōtepoti

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

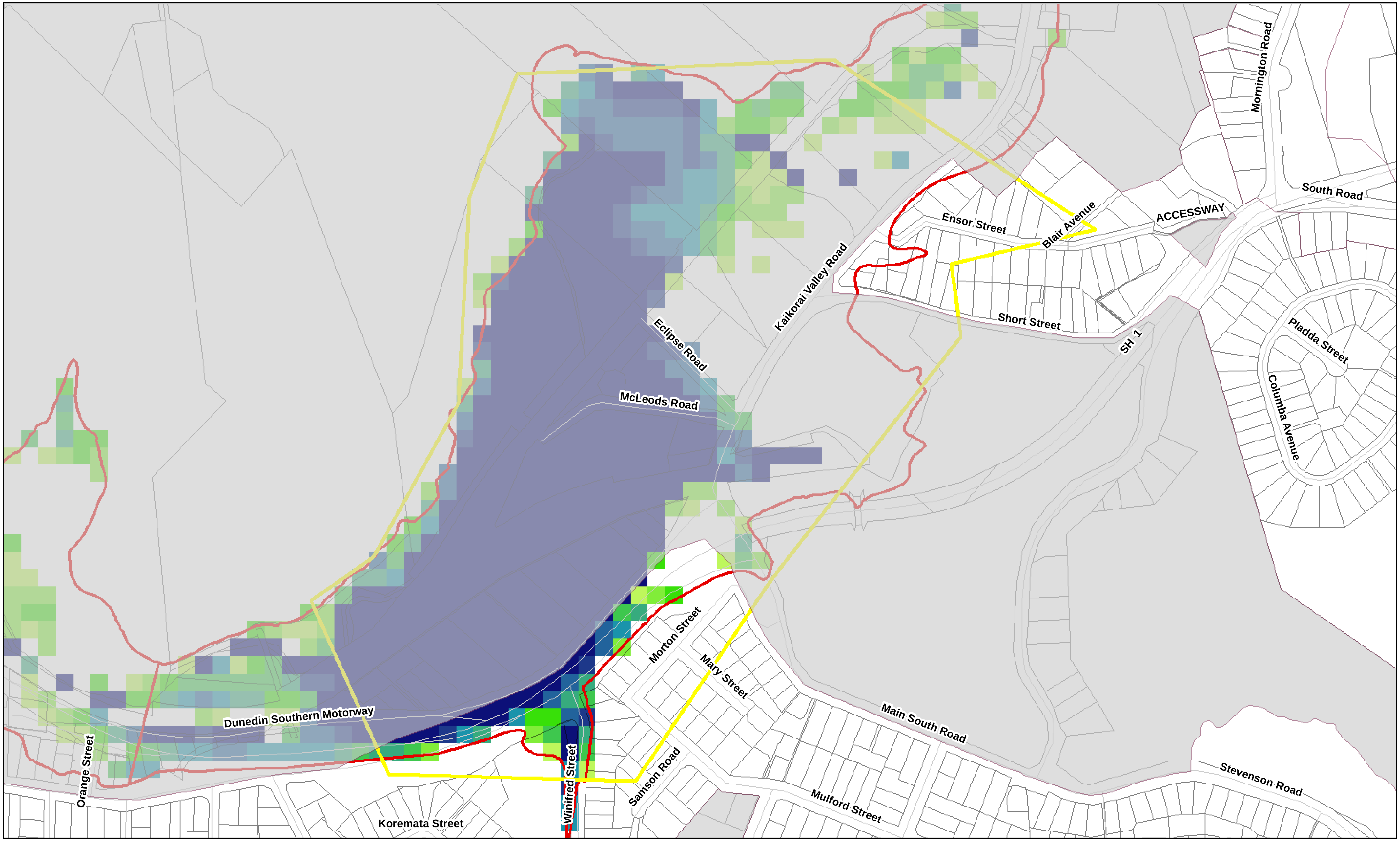
Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai
D-2 Sheet 1
Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_Kaikoraiiterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

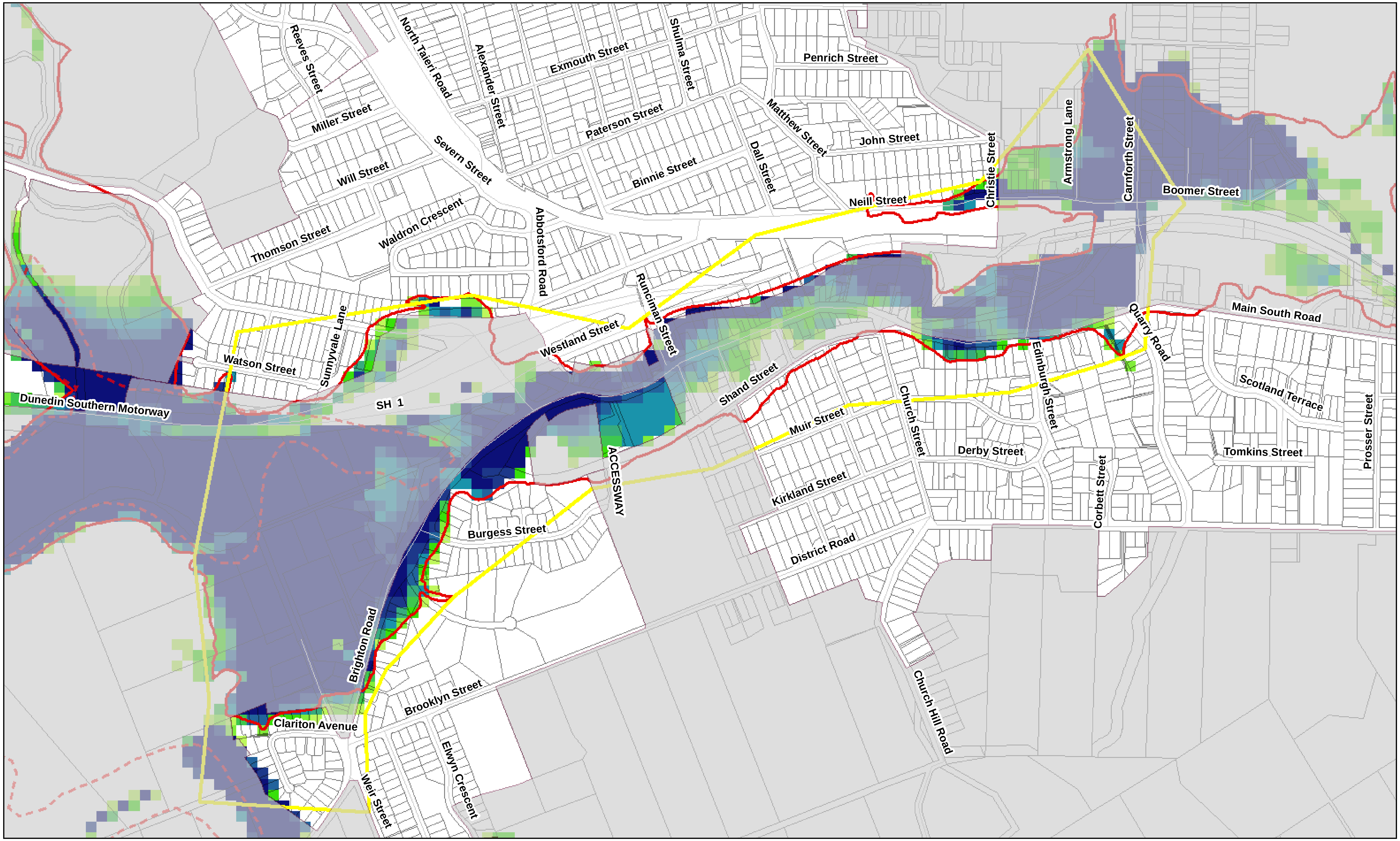
D-2 Sheet 2

Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_KaikoraiIterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 6500)

0 0.175 0.35

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

Dunedin City Council
Minimum Floor Levels for Flood
Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

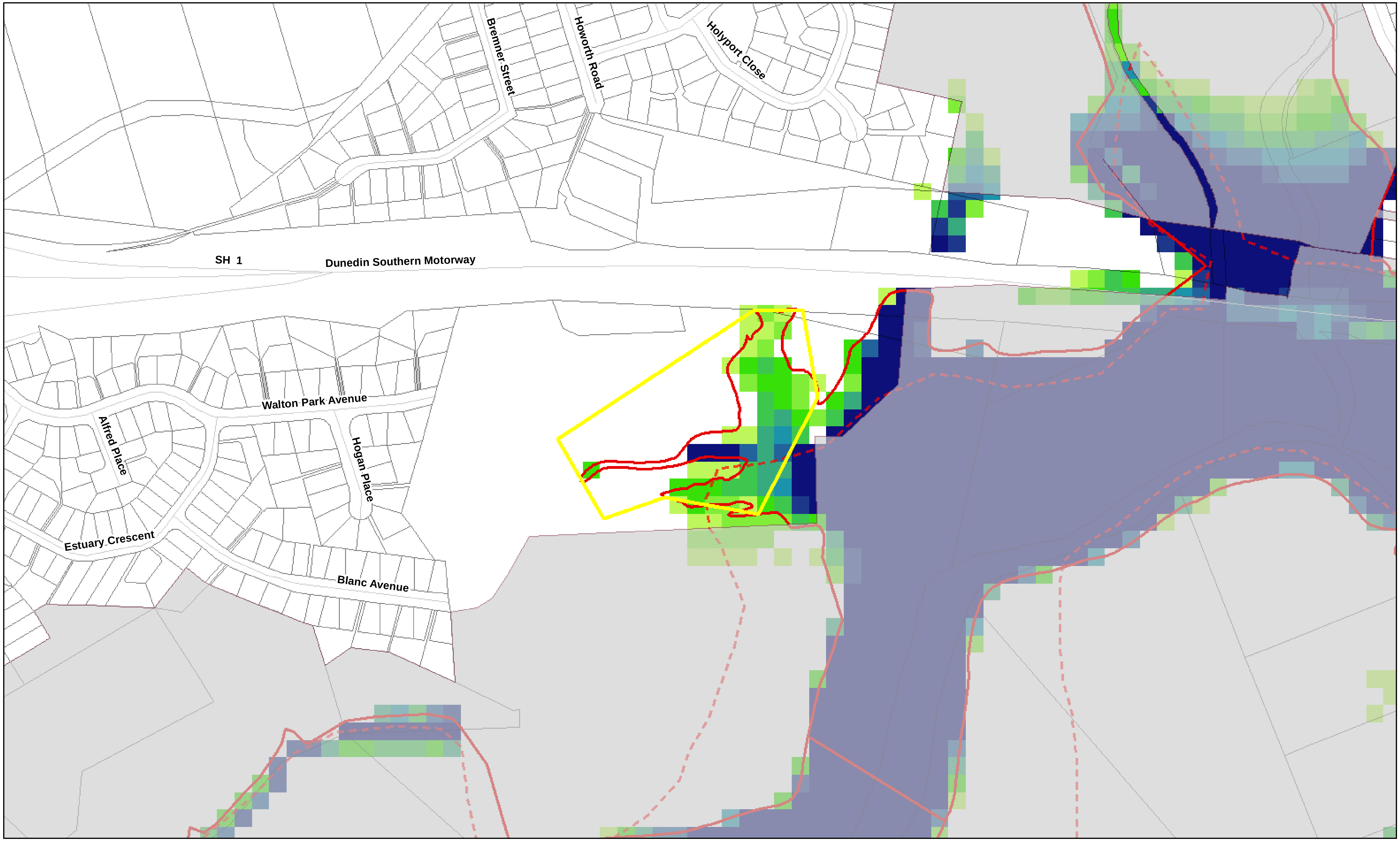
D-2 Sheet 3

Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_KaikoraiIterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

Dunedin City Council
Minimum Floor Levels for Flood
Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

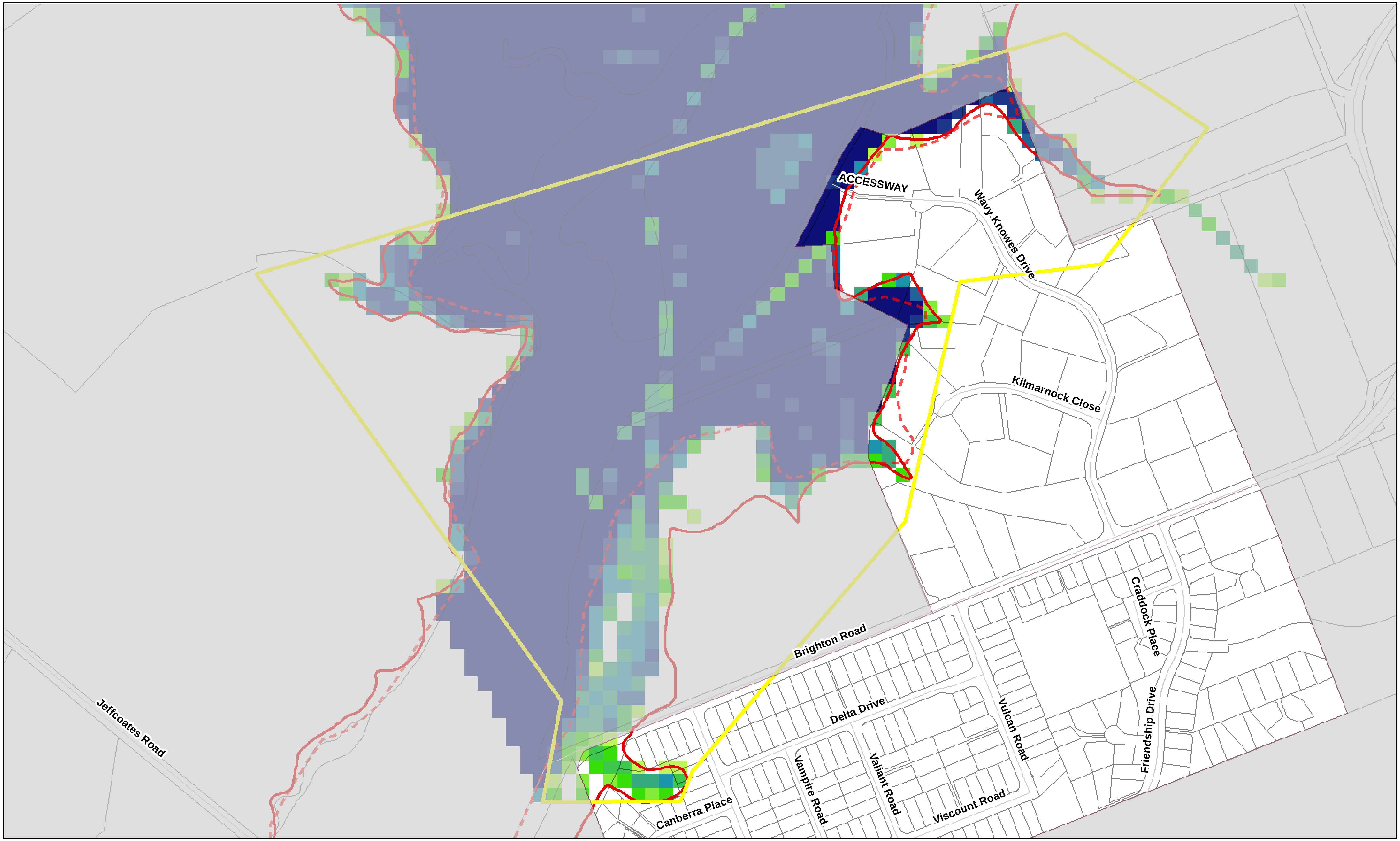
D-2 Sheet 4

Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_KaikoraiIterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 5000)

0 0.125 0.25

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Area of Investigation
- Geomorphological Extent
- Max Historic Flood Extent

Flood Depth (with 500mm Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51m - 1.75m
- 1.76m - 2.00m
- 2.01m - 9.57m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

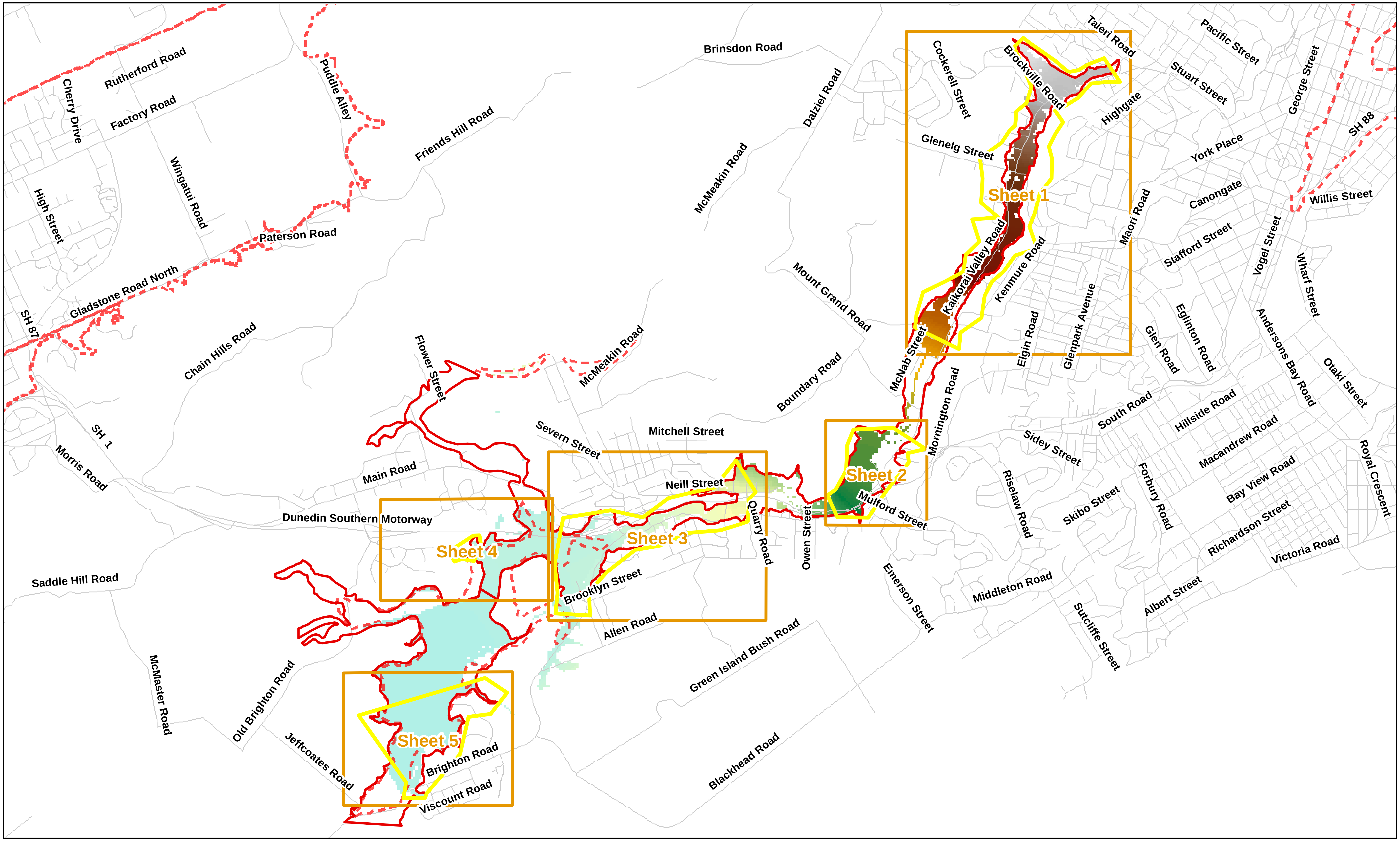
Job Number 51-32454
Revision A
Date 25 Nov 2014

Kaikorai
D-2 Sheet 5
Synthetic Flood Depth with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z018_RevA_KaikoraiIterations_GP_FigD-2_depth_FB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_depth_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 32000)

0 0.25 0.5 1 1.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai
D-3 Overview
Synthetic Flood Level without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird

Paper Size A3 (At Scale: 1: 12500)

0 0.25 0.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

GHD

DUNEDIN CITY COUNCIL

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 25 Nov 2014

Kaikorai

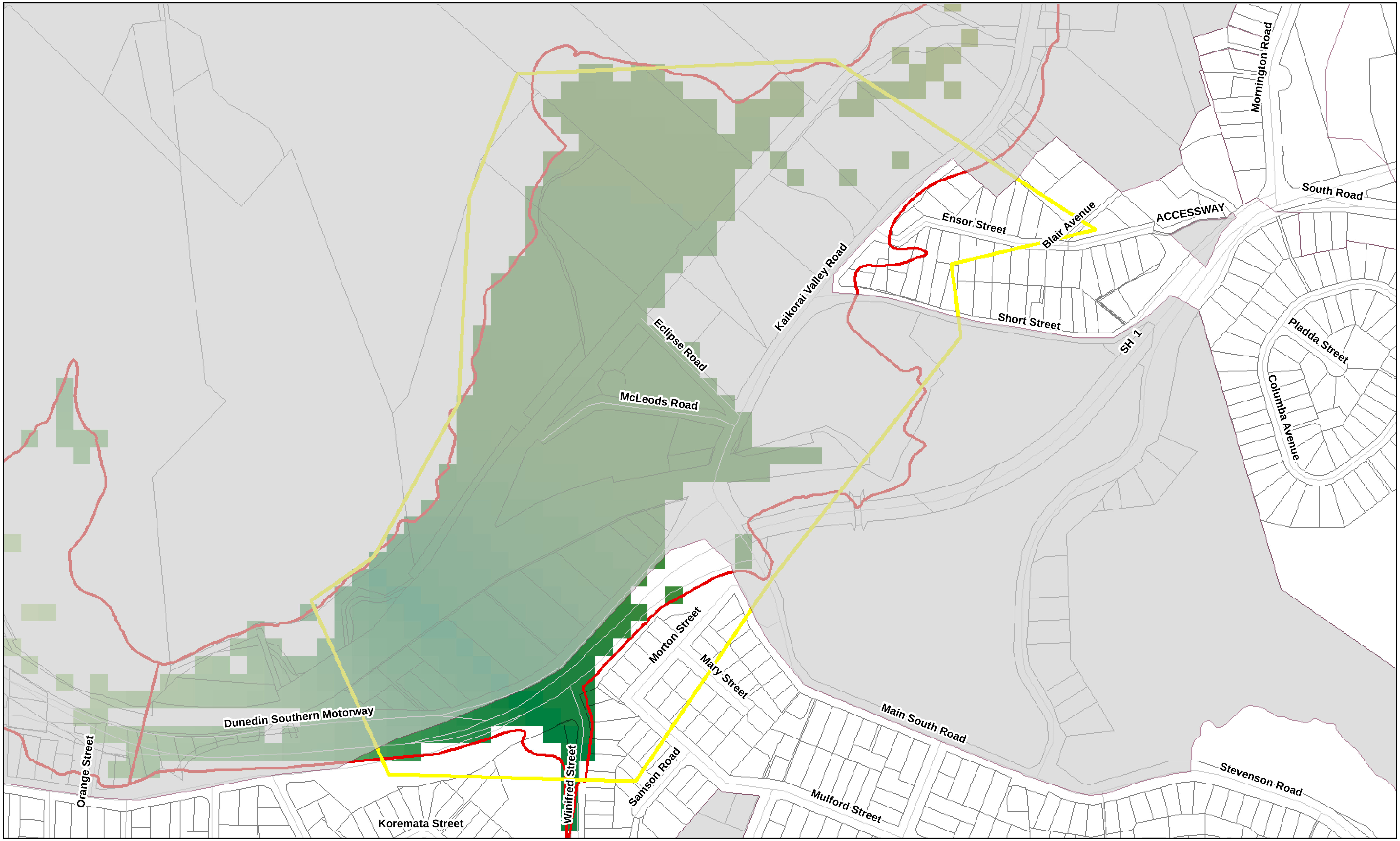
D-3 Sheet 1

Synthetic Flood Level without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 25 Nov 2014

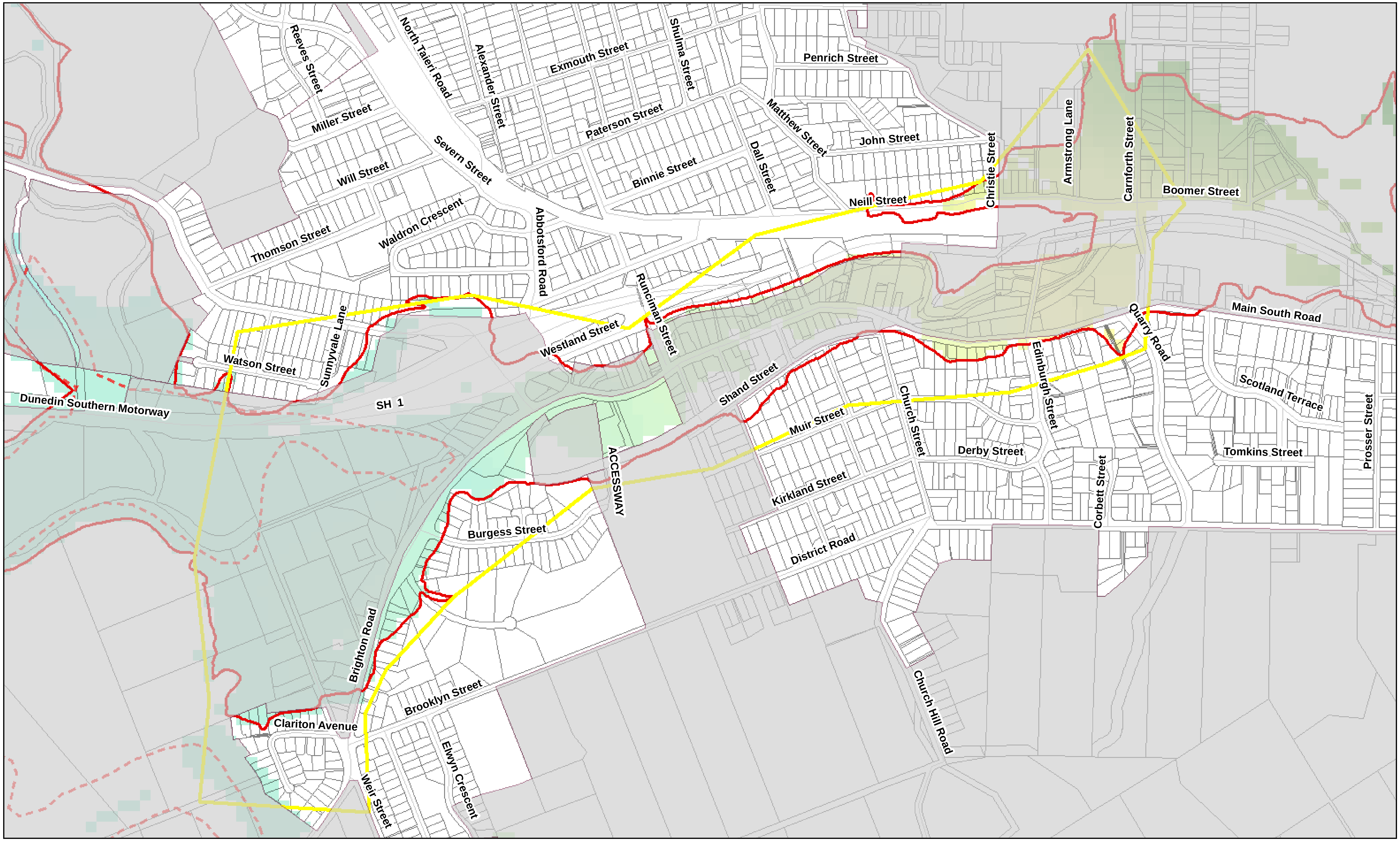
Kaikorai
Synthetic Flood Level without Freeboard

D-3 Sheet 2

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 6500)

0 0.175 0.35

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

GHD

DUNEDIN CITY COUNCIL

Dunedin City Council
Minimum Floor Levels for Flood
Vulnerable Areas

Kaikorai
Synthetic Flood Level without Freeboard

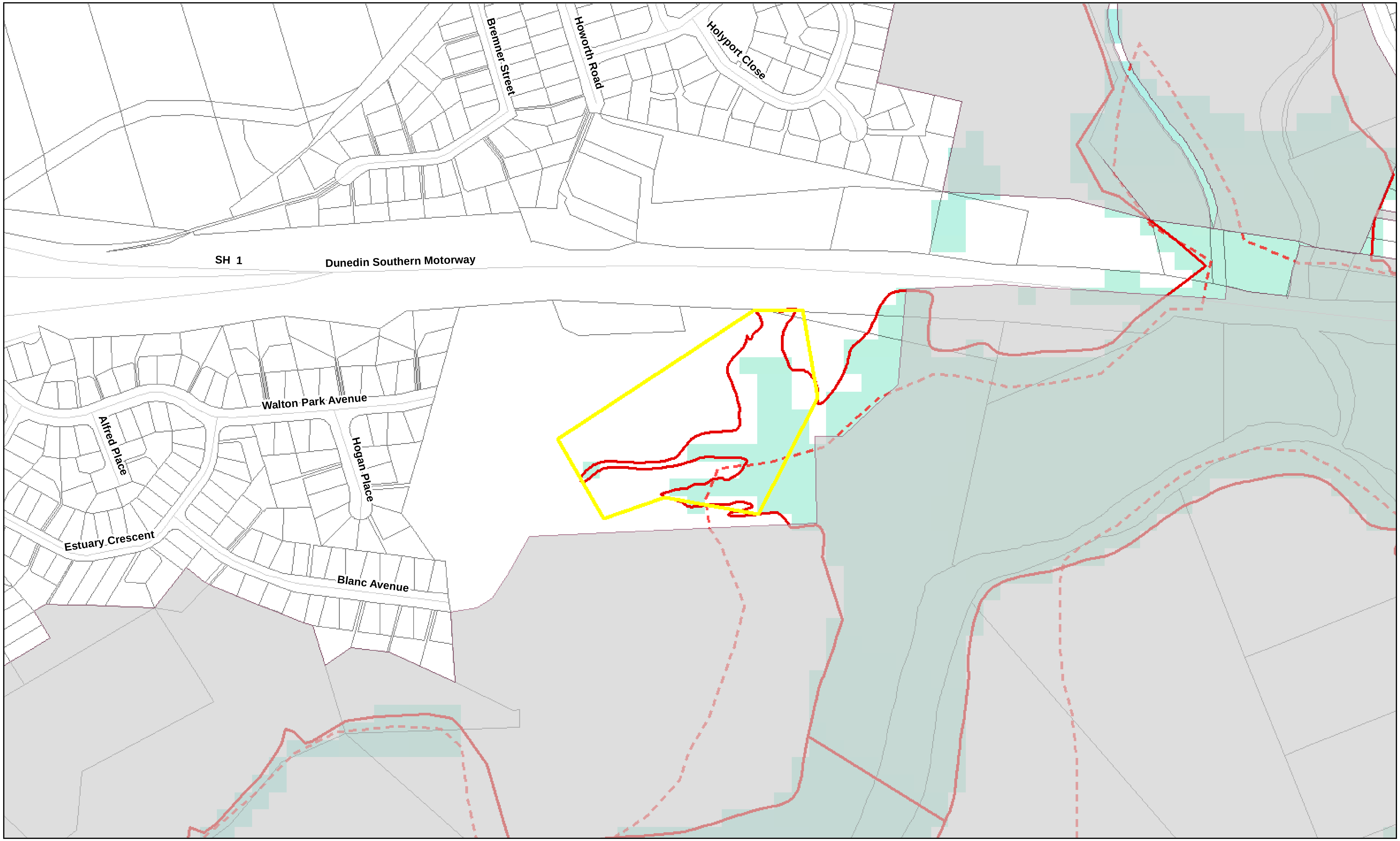
Job Number	51-32454
Revision	A
Date	25 Nov 2014

D-3 Sheet 3

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 25 Nov 2014

Kaikorai

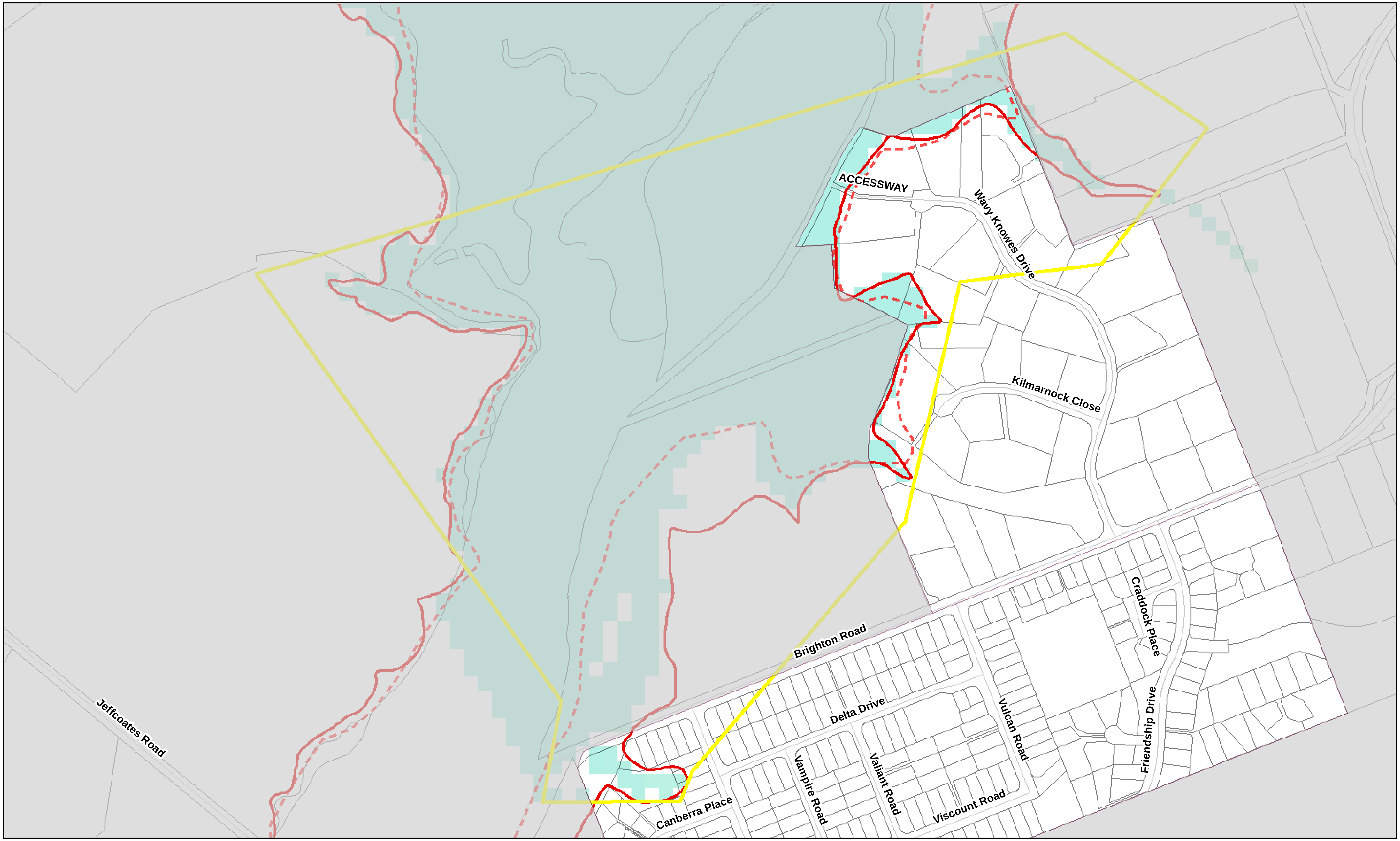
D-3 Sheet 4

Synthetic Flood Level without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 5000)

0 0.125 0.25

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Rivers
- Roads
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (without Freeboard)

140.55 m

1.52 m

GHD

DUNEDIN CITY COUNCIL

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 25 Nov 2014

Kaikorai

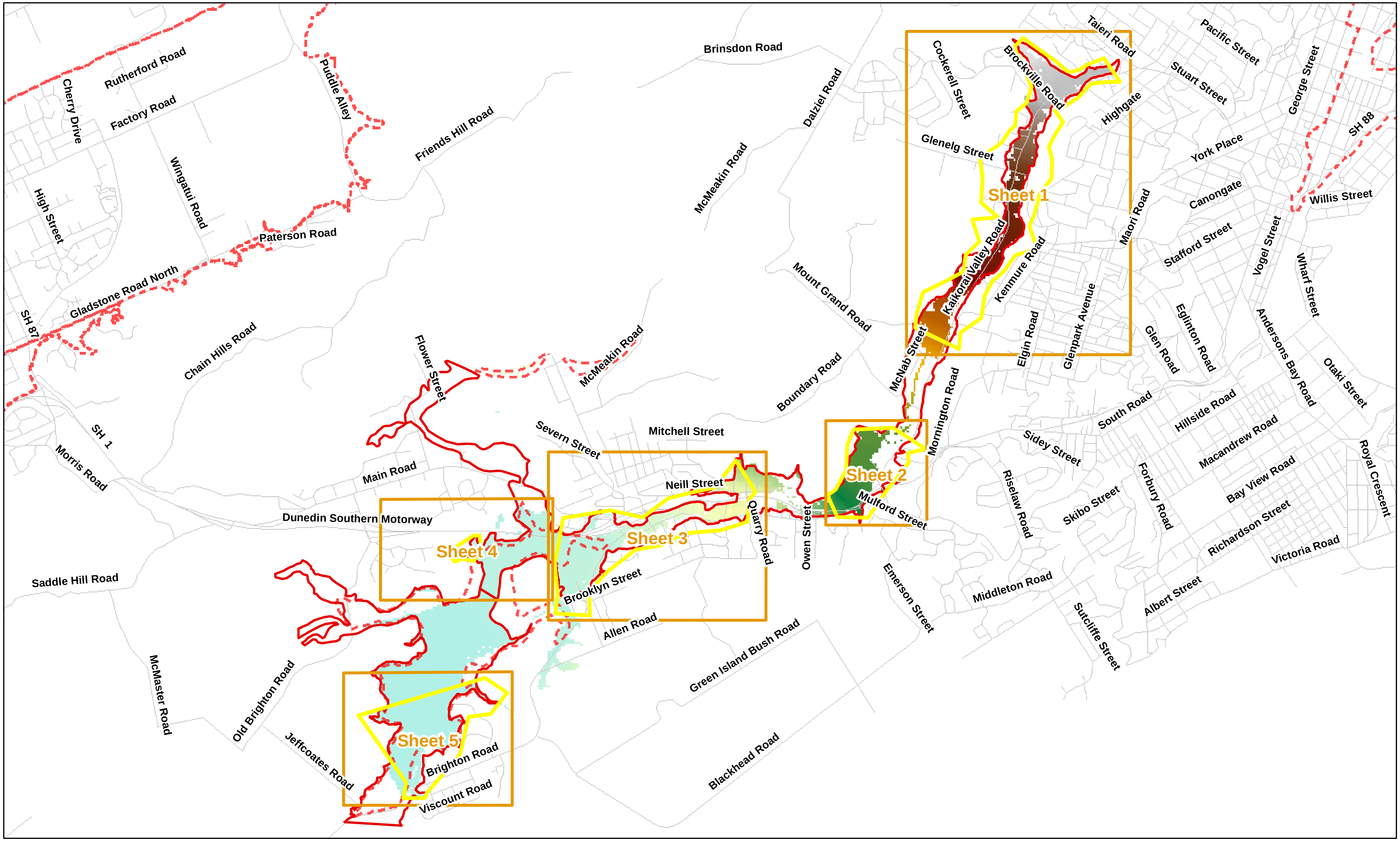
D-3 Sheet 5

Synthetic Flood Level without Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z019_RevA_KaikoraiIterations_GP_FigD-3_level.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 32000)

0 0.25 0.5 1 1.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Index Sheets
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

GHD

DUNEDIN CITY COUNCIL

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai
Synthetic Flood Level with 500mm Freeboard

D-4 Overview

G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_KaikoraiIterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird

Paper Size A3 (At Scale: 1: 12500)

0 0.25 0.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

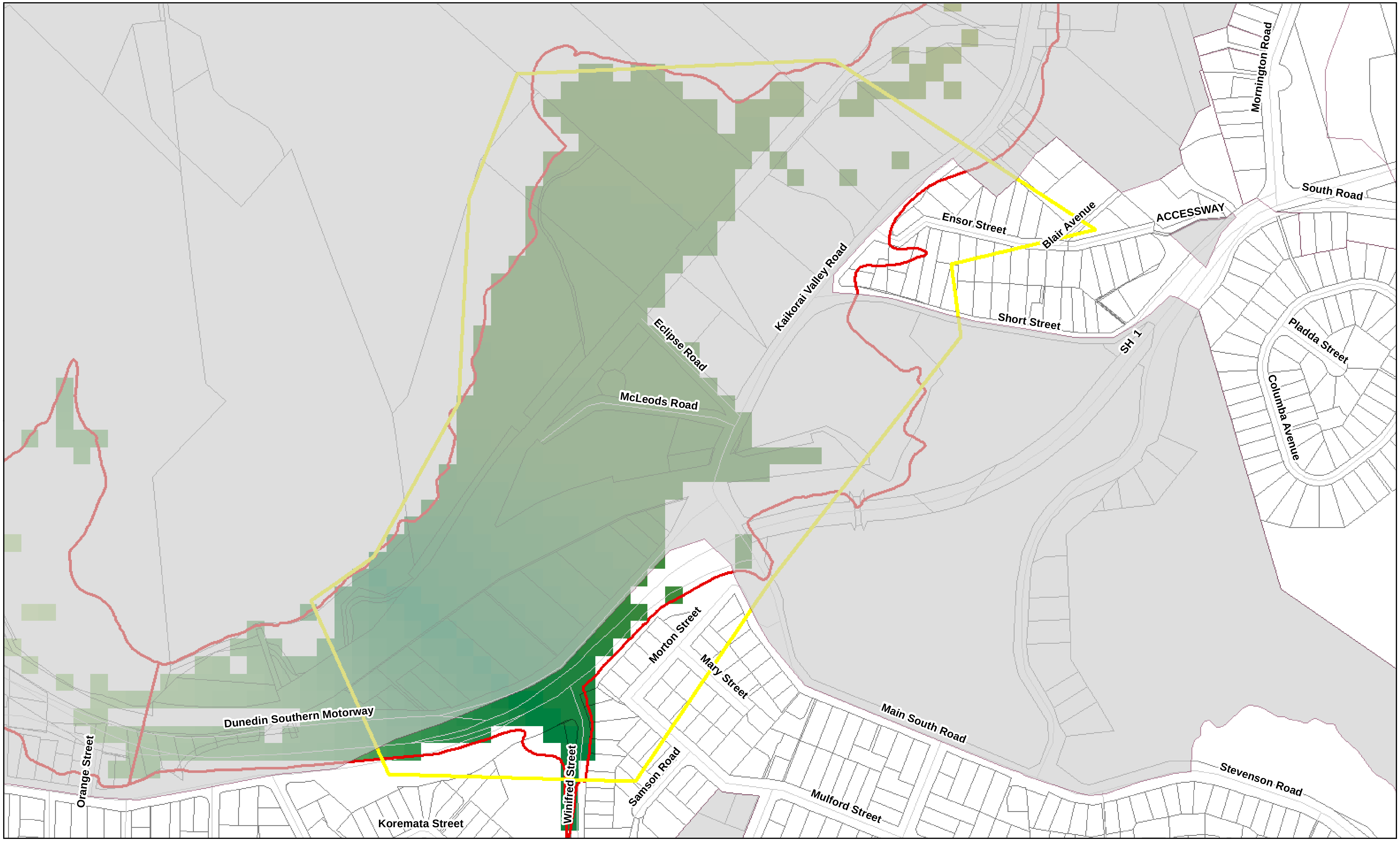
Kaikorai
Synthetic Flood Level with 500mm Freeboard

D-4 Sheet 1

G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_KaikoraiIterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

Dunedin City Council
Minimum Floor Levels for Flood
Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

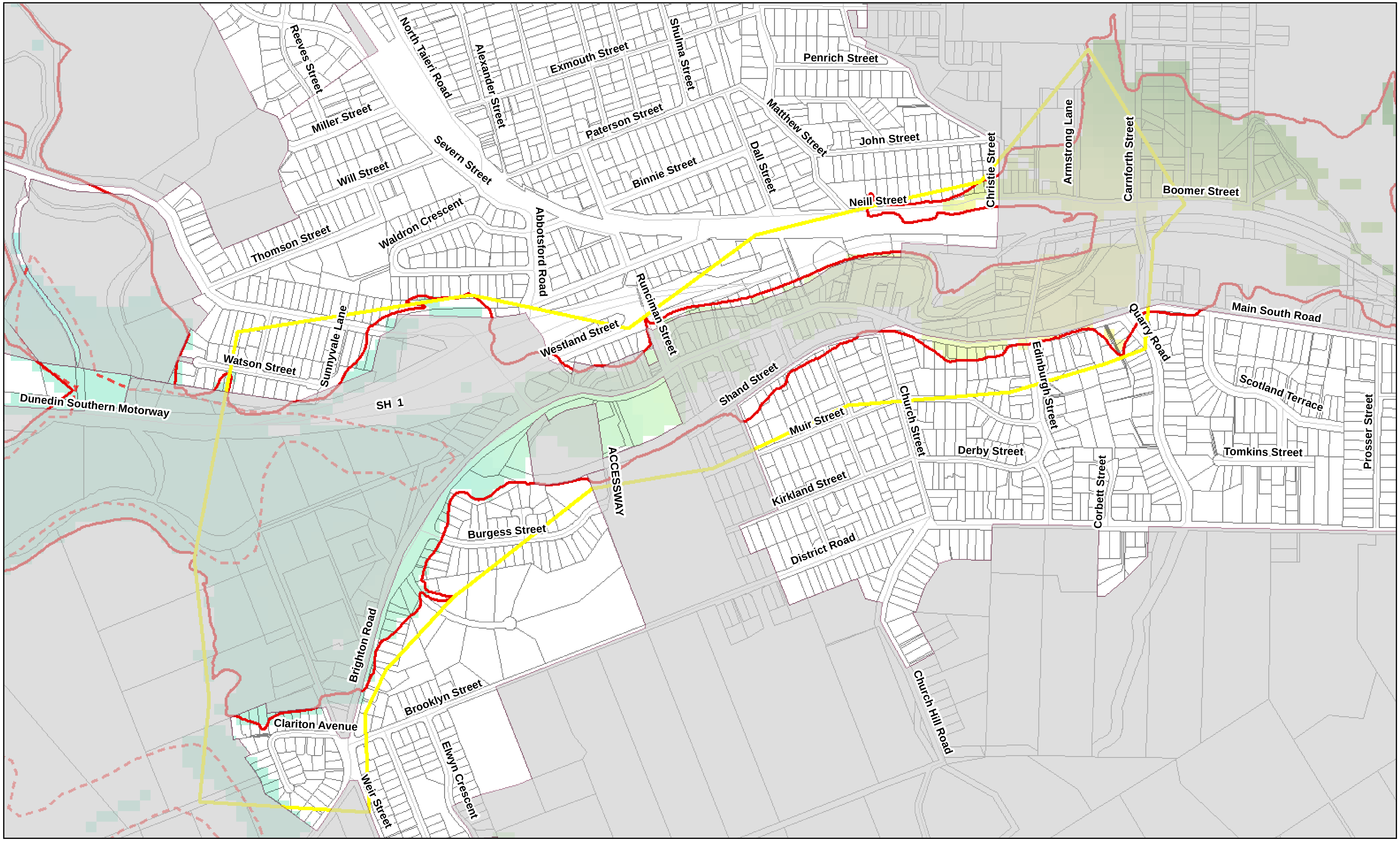
D-4 Sheet 2

Synthetic Flood Level with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_KaikoraiIterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 6500)

0 0.15 0.3

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai

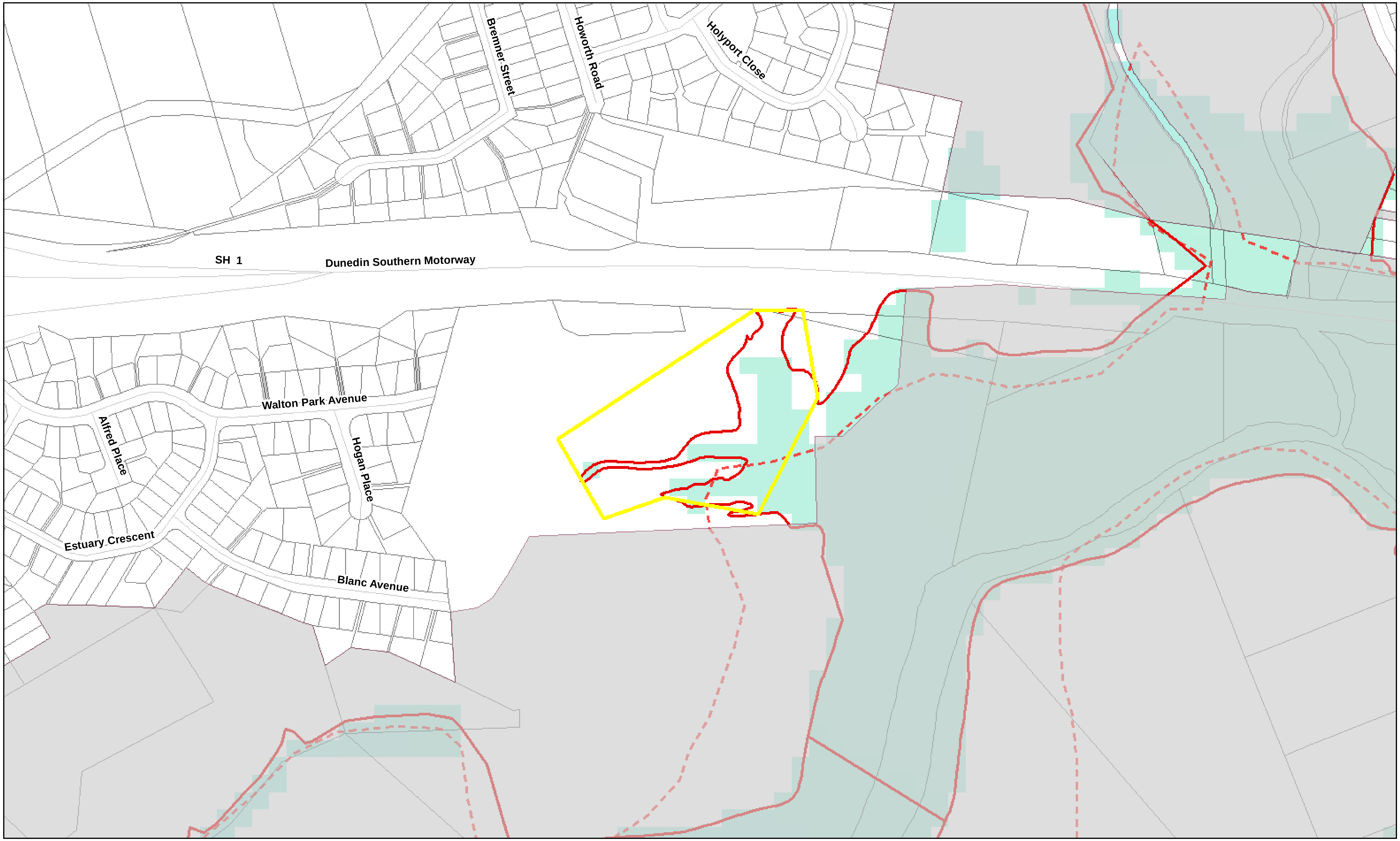
D-4 Sheet 3

Synthetic Flood Level with 500mm Freeboard

G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_KaikoraiIterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.co.nz **W** www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 4000)

0 0.1 0.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number 51-32454
Revision A
Date 25 Nov 2014

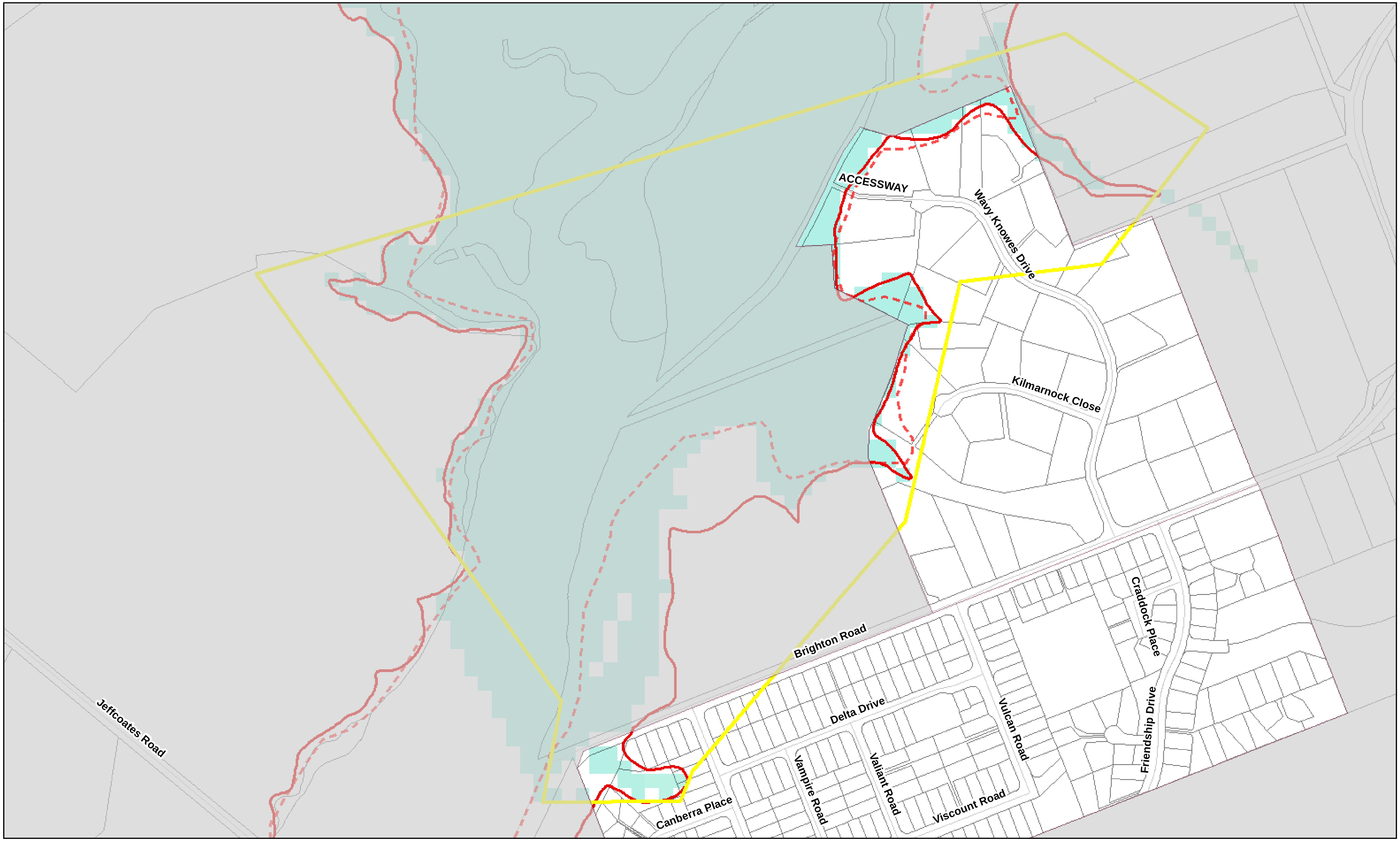
Kaikorai
Synthetic Flood Level with 500mm Freeboard

D-4 Sheet 4

G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_KaikoraiIterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird



Paper Size A3 (At Scale: 1: 5000)

0 0.125 0.25

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Non-Residential
- Residential
- Roads
- Rivers
- Geomorphological Extent
- Max Historic Flood Extent
- Area of Investigation

Flood Level (with 500mm Freeboard)

141.05 m

2.02 m

Dunedin City Council
Minimum Floor Levels for Flood Vulnerable Areas

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Kaikorai
Synthetic Flood Level with 500mm Freeboard

D-4 Sheet 5

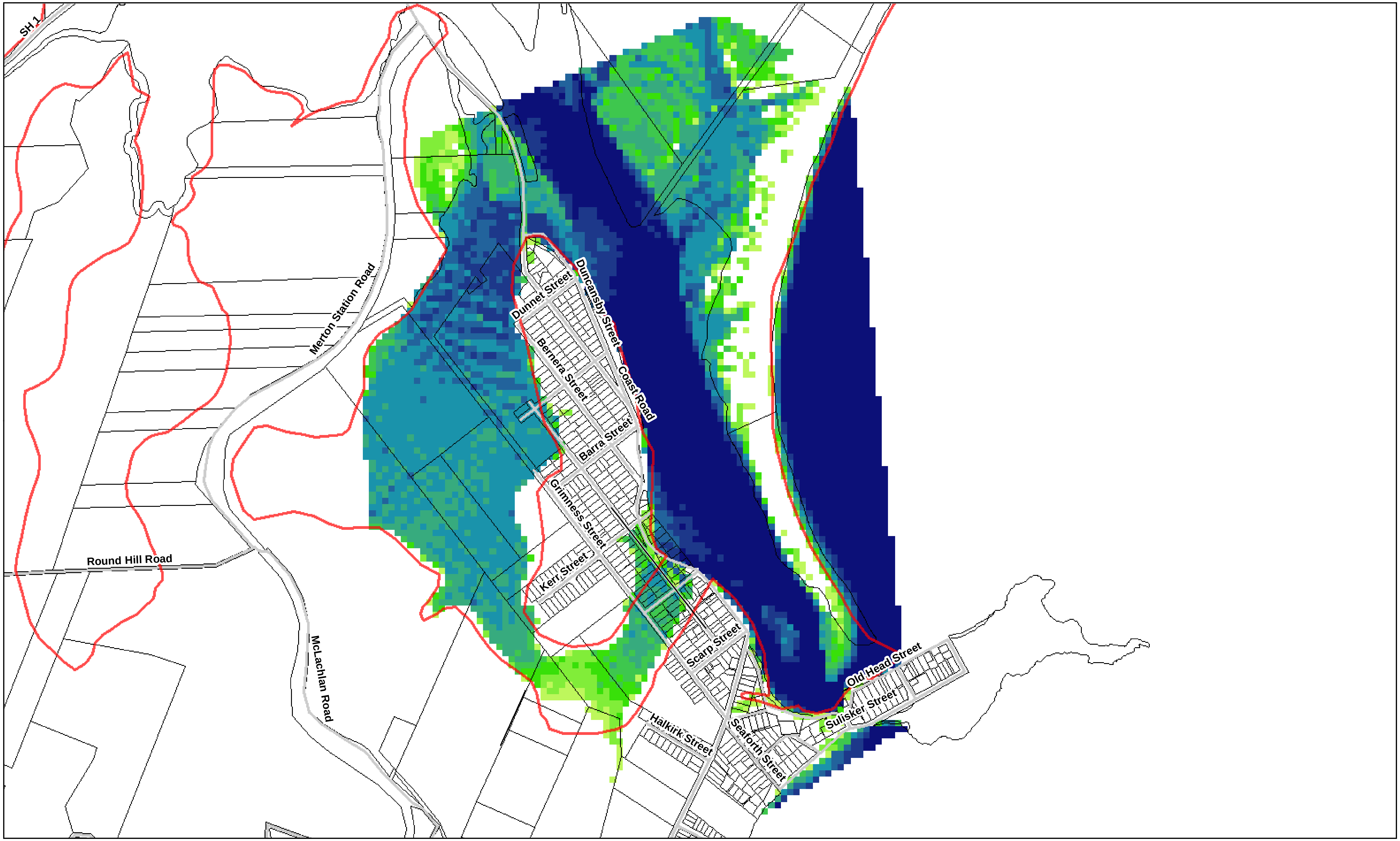
G:\51\32454\GIS\Maps\Mxds\5132454_Z020_RevA_Kaikorailterations_GP_FigD-4_levelFB.mxd

GHD House, 226 Antigua Street, Christchurch 8011, PO Box 13468, Christchurch 8141 New Zealand T 64 3 378 0900 F 64 3 377 8575 E chcmail@ghd.co.nz W www.ghd.com

Data source: GHD; FloodDepth_v5_WaterSurface_withFB (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014) Created by:jbird

Appendix E - (Maps of Proposed Floor Levels – Karitane)

- Figure E1: Karitane – Synthetic Flood Depth without Freeboard
- Figure E2: Karitane – Synthetic Flood Depth with 500 mm Freeboard
- Figure E3: Karitane – Synthetic Flood Level without Freeboard
- Figure E4: Karitane – Synthetic Flood Level with 500 mm Freeboard



Paper Size A3 (At Scale: 1:11,000)

0 100 200 400

Meters

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max historic Flood extent
- Rivers
- Roads

Flood Depths (without Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51 - 1.75m
- 1.76 - 2.00m
- 2.01 - 2.76m

Dunedin City Council
Minmum Floor Levels Project

Job Number	51-32454
Revision	A
Date	25 Nov 2014

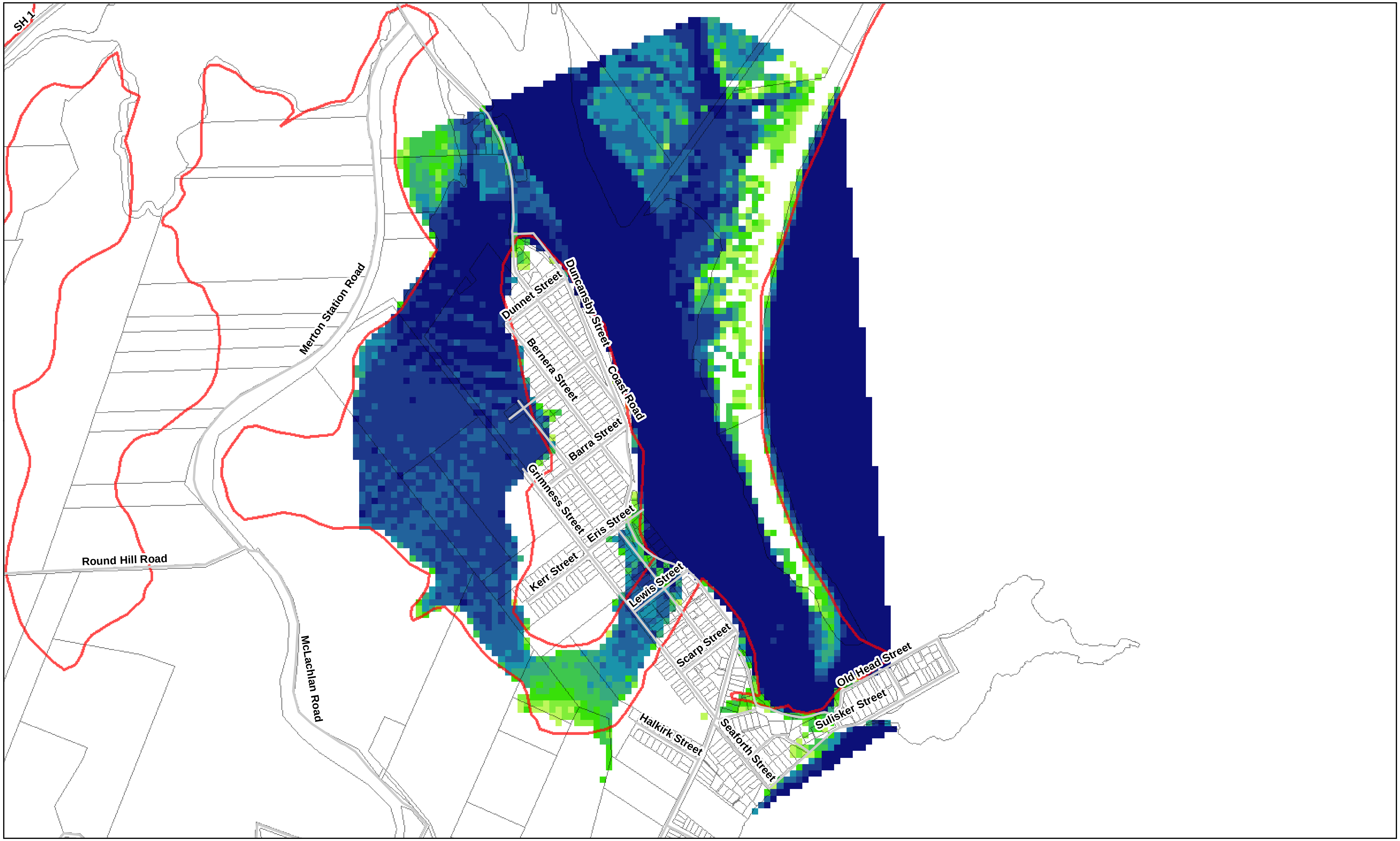
Karitane - Synthetic Flood Depth without Freeboard

Figure E-1

226 Antigua Street Christchurch 8011 T 64 3 3780900 F 64 3 3778575 E chchmail@ghd.com W www.ghd.com

G:\51\32454\GIS\Maps\Mxds\5132454_Z005_RevA_KaritaneIterations_GP_FigE-1_depth.mxd

GHD; FlooddepthsKaritaniePostiveDepths_cliped_final (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:jbird Created by:jbird



Paper Size A3 (At Scale: 1:11,000)

0 100 200 400
Meters

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max historic Flood extent
- Rivers
- Roads

Flood Depths (with Freeboard)

- < 0 m
- 0.01 - 0.25m
- 0.26 - 0.50m
- 0.51 - 0.75m
- 0.76 - 1.00m
- 1.01 - 1.25m
- 1.26 - 1.50m
- 1.51 - 1.75m
- 1.76 - 2.00m
- 2.01 - 3.30m

Dunedin City Council
Minmum Floor Levels Project

Job Number	51-32454
Revision	A
Date	25 Nov 2014

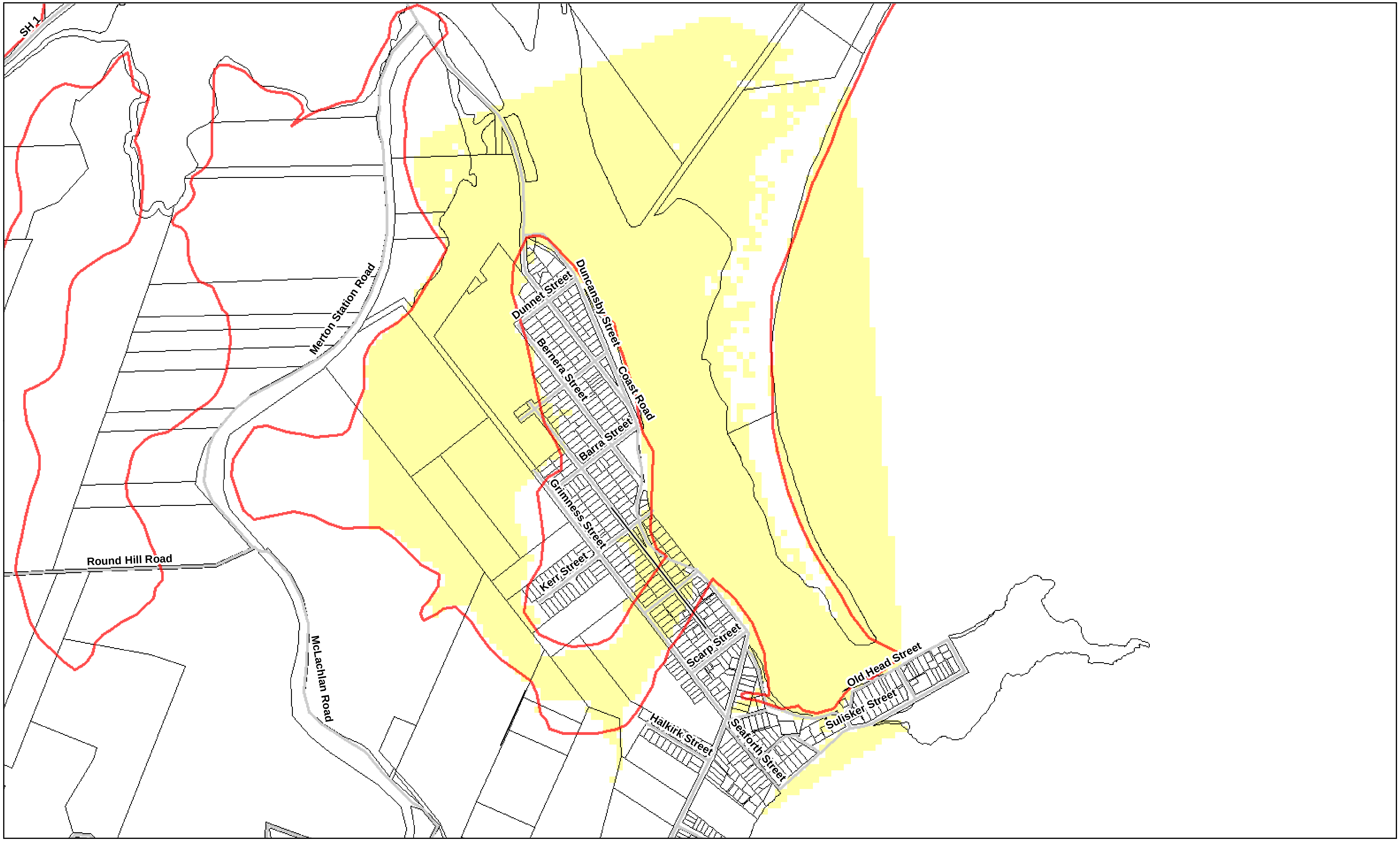
Karitane - Synthetic Flood Depth with 500mm Freeboard

Figure E-2

G:\51\32454\GIS\Maps\Mxds\5132454_Z006_RevA_KaritaneIterations_GP_FigE-2_depth_FB.mxd

226 Antigua Street Christchurch 8011 T 64 3 3780900 F 64 3 3778575 E chchmail@ghd.com W www.ghd.com

Data source: GHD; FlooddepthsKaritaniePostiveDepths_withFB_cliped (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:jbird Created by:jbird



Paper Size A3 (At Scale: 1:11,000)

0 100 200 400

Meters

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features

- Max historic Flood extent
- Rivers
- Roads

Water Surface Level

- 2.00 m

Dunedin City Council
Minmum Floor Levels Project

Job Number	51-32454
Revision	A
Date	25 Nov 2014

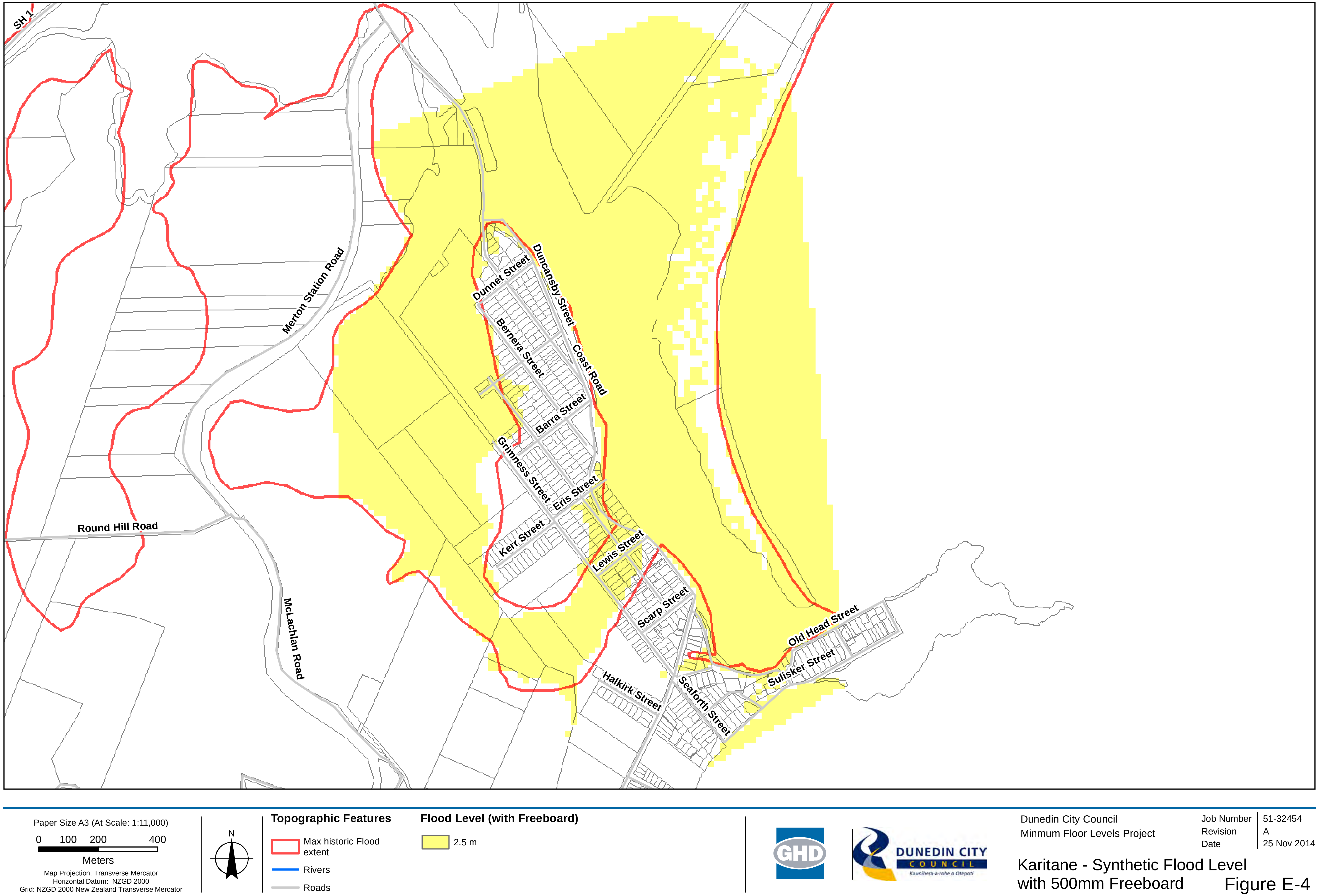
Karitane - Synthetic Flood Surface without Freeboard

Figure E-3

G:\51\32454\GIS\Maps\Mxds\5132454_Z007_RevA_KaritaneIterations_GP_FigE-3_level.mxd

226 Antigua Street Christchurch 8011 T 64 3 3780900 F 64 3 3778575 E chchmail@ghd.com W www.ghd.com

GHD; FlooddepthsKaritaniePostiveDepths_cliped_final (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:jbird Created by:jbird



Dunedin City Council
Minmum Floor Levels Project

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Karitane - Synthetic Flood Level with 500mm Freeboard

Figure E-4

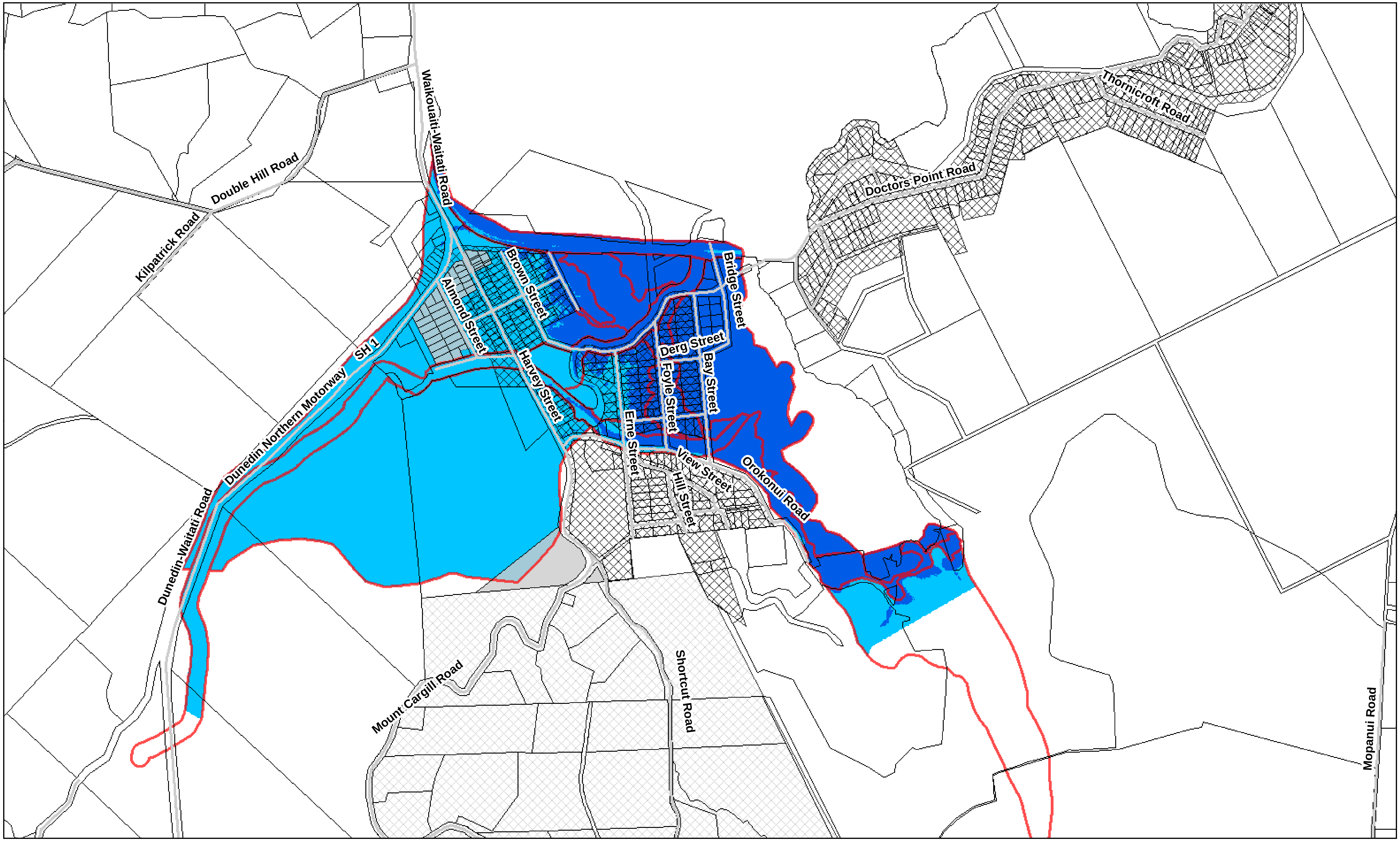
G:\51\32454\GIS\Maps\Mxds\5132454_Z008_RevA_KaritaneIterations_GP_FigE-4_level_FB.mxd

226 Antigua Street Christchurch 8011 T 64 3 3780900 F 64 3 3778575 E chchmail@ghd.com W www.ghd.com

Data source: GHD; FlooddepthsKaritaniePostiveDepths_withFB_cliped (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:jbird Created by:jbird

Appendix F - (Map of Proposed Floor Levels – Waitati)

- Figure F1 – Waitati – Synthetic Floor Level with Freeboard



Paper Size A3 (At Scale: 1:11,000)

0 100 200 400

Meters

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Topographic Features
- Max Coastal Hazard Extent
- Rivers
- Roads

Zoning
- Other Zoned Areas
- Residential
- Rural Residential

Floor Levels (with Freeboard)
- Zone of 3.8 m Floor Level
- Zone of Floor height 500 mm above ground

Dunedin City Council
Minmum Floor Levels Project

Job Number	51-32454
Revision	A
Date	25 Nov 2014

Waitati - Synthetic Floor Level with Freeboard

Figure F-1

G:\51\32454\GIS\Maps\Mxds\5132454_Z021_RevA_Waitati_JJB_FigF-1_depth.mxd

226 Antigua Street Christchurch 8011 T 64 3 3780900 F 64 3 3778575 E chchmail@ghd.com W www.ghd.com

GHD; FlooddepthsKaritaniePostiveDepths_cliped_final (Oct, 2014). LINZ; nz_primary_parcels_titles (Jul, 2007), nz_road_centre_line_elect (Jul, 2007). DCC; DunedinDistrictFloodHazardArea (2014), Dunedin_River_centerline_20140912 (Sept 2014). Created by:jbird Created by:jbird

GHD

GHD Building
226 Antigua Street, Christchurch 8011
T: 64 3 378 0900 F: 64 3 377 8575 E: chcmail@ghd.com

G:\51\32454\Technical\Reporting\MinimumFloorLevelsReport_Rev1.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Marburg M van der Peet	T Preston		M van der Peet		23 Dec 14
1	M van der Peet	T Preston		M van der Peet		20 Mar 15

www.ghd.com