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NL130193

11th April 2014

The General Manager

Attention: Michelle Bisson

Lake Macquarie City Council

126-138 Main Road

Speers Point NSW 2284 | Box 1906 HRMC NSW 2310

Dear Michelle,

Re: Development of 40 and 48 Burton Road, Mount Hutton – Additional Stormwater and Flooding Information (DA/1892/2013)

Further to Council's correspondence and request for further information relating to Stormwater and Flooding we enclose the following documents to aid you in Council's assessment of the proposal:

- Updated Stormwater Management Drawings including Sediment and Erosion Control Drawings
- Updated Stormwater Management and Servicing Strategy Design Report
- Updated Two Dimensional Flood Modelling Investigation

We trust the information above will be helpful in assessing and approving the the design of the development.

Yours sincerely

Ben Clark
Principal
BE (Civil) CPEng NPER RPEQ

STORMWATER MANAGEMENT & SERVICING STRATEGY DESIGN REPORT

for

Eleebana Shores Development

at

Burton Road, Mount Hutton

Job No: NL130193
Revision: E
Date: 11/4/2014

	BY	DATE
Prepared	EA	11/4/2014
Checked	BC	11/4/2014
Admin	LD	11/4/2014

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Executive Summary

Northrop Consulting Engineers were engaged by Eleebana Shores Retirement Living Pty Ltd to undertake concept civil design and documentation to support the Development Application for the proposed seniors living retirement village at Burton Road, Mount Hutton. This report details the concept stormwater management strategy (including quantity and quality), concept soil and water management strategy, and should be read in conjunction with Drawings NL130193- C01DA to C10DA.

The proposed concept stormwater and soil and water strategies comply with Councils 2013 Development Control Plan, associated guidelines and handbooks. Stormwater will be managed within reuse tanks attached to each unit and apartment block, runoff from the road network and from around the units will be conveyed in the street network to six detention tanks that are independent of each other to allow for staging of the development. All runoff from the development will be treated in bio-filtration swales prior to discharge across the northern boundary. Low flows will be collected by surface inlet pits located within the northern swale. Stormwater will be piped to the culvert north of the subject site that passes under Burton Road. Larger flow events will discharge in the same manner as in the pre-developed state, as sheet flow across the northern boundary. Gross pollutant screens and bio-pod pit inserts will also be implemented to meet Councils quality requirements.

The proposed Servicing Strategy for the site is also presented within this report. Preliminary discussions with Hunter Water Corporation suggest the site can be serviced for both water and sewer via the extension of the existing mains to the site. A Preliminary Servicing Advice application is pending.

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Table of Contents

Introduction

Northrop Consulting Engineers were engaged by Eleebana Shores Retirement Living Pty Ltd to undertake concept civil design and documentation to support the Development Application for the proposed seniors living retirement village at Burton Road, Mount Hutton. This report accompanies, and should be read in conjunction with, drawings NL130193 C01DA – C10DA.

The purpose of this report is to summarise the design process and to outline the concept stormwater management philosophy suitable for a Development Application submission. The concept stormwater management philosophy was developed in accordance with Lake Macquarie City Councils Development Control Plan 2013, the Handbook of Drainage Design Criteria and the Stormwater Quality Improvement Device Guidelines. The following documents have been provided in addition to this report to outline the proposed concept stormwater management philosophy:

- Concept Stormwater Management Plan - on drawings NL130193-C04DA to C08DA;
- Concept Soil and Water Management Plan - on drawings NL130193-C01DA, C02DA, C03DA, C09DA, C10DA.

The subject site is identified in the South Creek Flood Study as flood effected in major storm events. On review of the study it is evident water sheets across the subject site and neighbouring properties in major storm events. Northrop have undertaken a flood analysis to determine how to mitigate the effect filling the subject site would have on the surrounding areas. The concept stormwater management philosophy was prepared with due consideration given to the flood analysis. However, the flood assessment is addressed under a separate flooding report.

Existing Site Description

The subject site is approximately 4.96 hectares with a proposed developable footprint of 4.09 hectares. The site is currently rural residential housing. It is bounded to the east by a natural creek, to the west by Burton Road with Residential properties to the north and ducks crossing commercial development to the south.

The site is largely flat in topography with levels ranging from 19.9m AHD in the South-east to 9.9m AHD in the North-west with fall generally in a north-west direction. A number of upstream earthen dams within the Ducks Crossing commercial development overflow through the subject site. The creek to the east of the property has been identified in the South Creek Flood Study, by Cardno Lawson Treloar, as overflowing in major storm events sheeting water across the subject site.

Vegetation around the site is generally grassed with some sparsely scattered larger trees throughout the property. There are two existing dwellings on the subject site along with various livestock fences, dirt access tracks and rural style sheds.

Proposed Development

The current proposal consists of a residential seniors living retirement village with associated community facilities and open space. A small creek exists 40m east of the proposed development. The units are serviced by an internal road network which is accessed from Burton Road. The layout for the development can be seen within drawings NL130193 C01DA – C10DA.

Stormwater Collection and Off Site Discharge

Roof runoff from individual units and the multi-storey apartments will be collected in re-use tanks with overflows piped to the various proposed onsite detention tanks located under the internal roads. Runoff from paved areas will be directed to the road network where it will also be conveyed to the various onsite detention tanks.. Pit inserts will be utilised in all stormwater inlet pits to remove sediment and hydrocarbons. All runoff from the site will be discharged to onsite bio-filtration swales

(via the various onsite detention tanks) prior to discharge along to a proposed pit and pipe network within Councils road reserve. The proposed pit and pipe network within Councils road reserve will convey road water and minor flows from the proposed development north to the culvert crossing under Burton Road. Major flow evens will discharge across the northern boundary as sheet flow as would occur in the sites existing condition. The northern swale will ensure flows are distributed evenly.

The internal road drainage network will consist of a concrete 'v' shaped road with grated stormwater pits located along the road centre line. The road will form the primary overland flow path for stormwater generated within the development.

Stormwater Re-Use

Each unit will be allocated a 3kL reuse tank to conform to BASIX and assist in meeting Council stormwater quality targets. The multi-story apartment buildings and the Community Centre will be allocated 14KL and 14KL reuse volumes respectively..

Reuse tank volumes were calculated using the mitigation depth methodology presented Councils 2004 DCP. A field survey of the site indicates the site is underlain with a moderate to stiff clay. As such runoff potential is considered high. A mitigation depth of 7mm was adopted.

The mitigation storage was calculated as per the following equation:

MS = MIC x MD / 100.

Where:

MS = mitigation storage (Kilolitres)

MIC = Managed impermeable catchment (m^2)

MD = mitigation depth (mm)

To ensure available capacity for mitigation storage and to improve security of supply during dry periods the mitigation storage is increased by 100%.

The average roof areas of single and dual occupancy units is $165m^2$. As such the calculation is as follows:

MS = 2 x 7mm x $165m^2$ / 100 = 2.54kL

Therefore a 3kL tank is proposed for each unit.

Similarly the capacity for the multi-story apartments was calculated as follows:

MS = 2 x 7mm x $936m^2$/100 = 13.10kL

Therefore a 14KL tank is proposed for each multi-story apartment.

Similarly the capacity for the multi-story apartments was calculated as follows:

MS = 2 x 7mm x $988m^2$/100 = 13.83kL

Therefore a 14KL tank is proposed for the Community Centre.

Stormwater Quality

Stormwater quality management will adopt a treatment train approach in order to meet pollutant targets outlined in LMCC SQID guidelines. These targets are reproduced in Table 1.

Pollutant	Target
Total Suspended Solids	80% reduction in average annual load[1]
Total Nitrogen	50% reduction in average annual load[1]
Total phosphorous	50% reduction in average annual load[1]
Gross Pollutants	80% reduction in average annual load[1]
Hydrocarbons	50% reduction in average annual load[1]

*[1] data reproduced in table conservatively considers the maximum of the specified range as presented in 'Table 2.1: Stormwater Treatment Framework for Developer Initiated SQUID's' of Councils SQID Guideline.

Table 1 - Pollutant removal targets

SQID will be incorporated throughout the development and the runoff process, with both end of line and at source measures implemented. At source devices include the following:

- Reuse tanks;
- Bio-pods;
- Grassed buffers
- Vegetated swales; and
- Vegetated bio-filtration swales.

End of line treatment devices include:

- Vegetated swales;
- Detention tanks with integrated trash screen; and
- Earthen vegetated swale along the northern boundary.

The above noted devices will polish stormwater runoff and can be categorised as either Primary, Secondary or Tertiary treatment devices. **Table 2** demonstrates the roll each SQID will have in the treatment train, its category and treatment effectiveness.

Device	Category	Reduction Rating			
		Gross Pollutants	Sediment	Nutrients	Hydrocarbons
OSD Systems	Primary	High	Moderate		
Grass Strip	Secondary		High		
Bio-filtration Swale	Secondary		High	Low-Moderate	Low-Moderate
Reuse tanks	Primary		High	Moderate	
Hydrocarbon pit inserts	Tertiary				High

Table 2 - Summary of SQID selected for proposed development

Furthermore MUSIC modeling indicates the proposed treatment train will provide effective pollutant removal. Version 6.0.3 of MUSIC was used with MUSIC link activated. Table 3 provides a summary of the treatment train effectiveness. We note the development will likely have a favorable benefit on water quality in the catchment. As the bio-filtration swales convey runoff from upstream catchments through the site, additional nutrient removal will effectively occur, particularly in dry periods.

	Sources	Residual Load	% Reduction
TSS (kg/yr)	2330	337	85.5
TP (kg/yr)	5.96	3.11	47.8
TN (kg/yr)	54.9	32.8	40.7
GP (kg/yr)	682	0	100

Table 3 – MUSIC results summary

To facilitate in the selection, design and assessment of the proposed SQID system the Developer Initiated SQID Design Checklist has been utilised and is attached in the figure below, **Figure 1**, for Councils review.

Table 3.1: Developer Initiated SQID Design Checklist

Step	Activity	Completed
1	Determine proposed development area and type and identify required stormwater treatment levels **(Section 2)** The levels of stormwater treatment for the different pollutants are (please circle): Gross Pollutants: Very High / (High) / Moderate / Low Coarse Sediment: Very High / (High) / Moderate / Low Medium Sediment: Very High / (High) / Moderate / Low Fine Sediment: Very High / (High) / Moderate / Low Nutrients: Very High / High / (Moderate) / Low Heavy Metals: Very High / High / (Moderate) / Low Oils and Grease: Very High / High / (Moderate) / Low	☑
2.	Meet with Council development assessment team to discuss project including any variations to the treatment framework, hand over of device, water quality monitoring required etc.	☑
3.	Prepare short list of devices or series of devices able to meet treatment levels defined in the Stormwater Treatment Framework **(Section 4 Table 4.1)**	☑
4.	Determine optimal device(s) based on site constraints and prepare concept design. Liaise with Council were required during concept design **(Section 4 & 5)**	☑
5.	Prepare detailed design of preferred device addressing all issues outlined in the design guidelines **(Section 5)**	☑
6.	Prepare Maintenance Plan **(Section 3)**	To be provided at CC
7.	Submit design plans and Maintenance Plan to Council for approval.	
	Company: Northrop Designer: Eran Avery Completion Date: 02/12/13	

Figure 1 - Developer Initiated SQID Checklist to demonstrate devices are designed in accordance with the SQID Guidelines

Stormwater Detention

Onsite Detention (OSD) tanks will be employed to capture, detain and discharge stormwater from the site at a rate less than or equal to the existing undeveloped rate for the 5, 10, 20, 50 and 100 year ARI storm events. The OSD systems will be constructed under the internal road network and be constructed of reinforced concrete or core filled block work. Orifice plates will provide staged discharge control of stormwater from the tanks, to manage peak discharge for all events as discussed above. Trash screens will be fixed within the detention systems to capture gross pollutants.

To size the OSD tanks and their associated discharge control, both the pre and post development flow regimes for the site were assessed. This assessment was undertaken using the 1-dimensional hydraulic/hydrologic modelling software DRAINS. The following parameters were used within the DRAINS model; soil type 3, paved area depression storage 1mm, supplementary area depression storage 1mm and grassed area depression storage 5mm.

The pre-developed catchments were considered 100% pervious to replicate Greenfield conditions. The developed catchments were considered 60% impervious.

In order to accommodate potential staging of the development, the site was divided into 6 discrete catchments. Catchment variables and time to concentration are provided in **Table 4**, IFD data used is presented in **Table 5**, the catchments peak discharge summary is presented in **Table 6** and the OSD tank required volumes are summarised in **Table 7**. Figure 2 presents the adopted catchment arrangements.

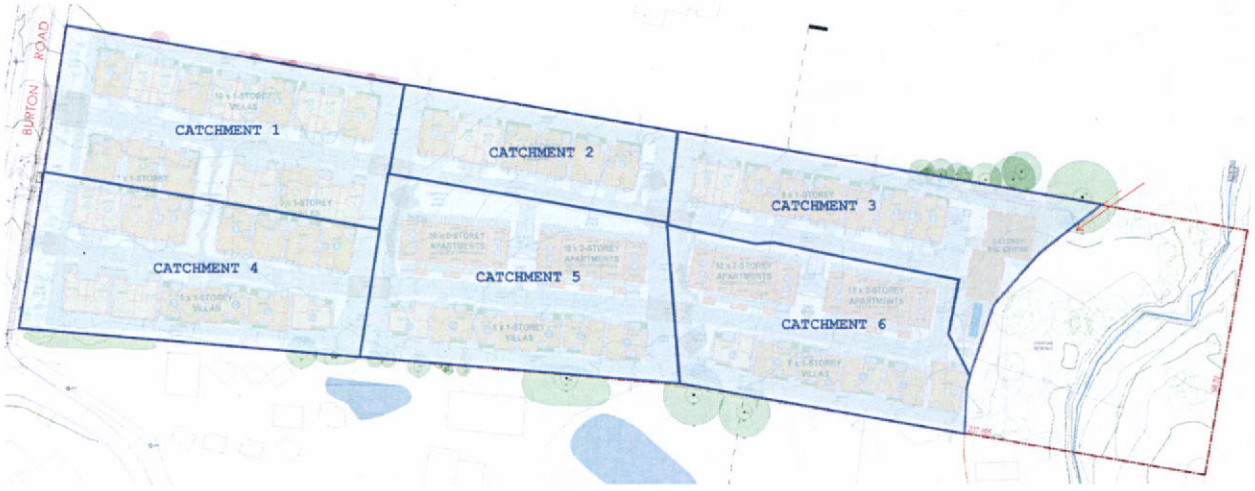

Figure 2 – Catchment map

Catchment	Area (ha)	% Impervious	tc
1	0.79	60	6.6
2	0.40	60	6.6
3	0.63	60	6.6
4	0.77	60	6.6
5	0.81	60	6.6
6	0.69	60	6.6
Total	4.09ha		

Table 4 - Catchment Variables and Time to Concentration

IFD DATA	
$^{2}I_{1}$	34.4mm/hr
$^{2}I_{12}$	7.26mm/hr
$^{2}I_{72}$	2.39mm/hr
$^{7}I_{1}$	66.17mm/hr
$^{7}I_{12}$	14.77mm/hr
$^{7}I_{72}$	5.11mm/hr
G	0.02
F_2	4.31
F_{50}	15.96
Latitude: 32°59'27"	Longitude: 151°39'35"

Table 5 - IFD data used (within DRAINS). Data sourced from the Bureau of Meteorology

Peak Discharge Rates (m^3/s)					
Catchment	ARI				
Status	5	10	20	50	100
Catchment 1					
Pre	0.118	0.146	0.194	0.247	0.295
Post	0.118	0.146	0.193	0.237	0.271
Catchment 2					
Pre	0.064	0.084	0.109	0.139	0.166
Post	0.063	0.083	0.109	0.138	0.153
Catchment 3					
Pre	0.106	0.136	0.179	0.228	0.269
Post	0.106	0.136	0.178	0.228	0.266
Catchment 4					
Pre	0.115	0.143	0.189	0.241	0.288
Post	0.115	0.143	0.188	0.236	0.268
Catchment 5					
Pre	0.120	0.148	0.194	0.249	0.297
Post	0.120	0.147	0.193	0.249	0.279
Catchment 6					
Pre	0.104	0.131	0.173	0.221	0.263
Post	0.104	0.131	0.173	0.220	0.245

Table 6 - Catchment Peak Discharge Summary

Tank	Required Volume (m^3)	Associated Catchment
OSD1	152	1
OSD2	65	2
OSD3	97	3
OSD4	150	4
OSD5	154	5
OSD6	133	6

Table 7 – OSD Tank required volumes

Site Discharge Index

A Site Discharge Index, SDI, of <0.1 is achieved as all impervious runoff is retained and discharged into bio-filtration swales. In addition, re-use in each unit and within the multi-story apartment buildings will reduce flow rates and improve water quality in minor frequent rainfall events.

Soil and Water Management

In accordance with Section 2.1.11 of Lake Macquarie City Councils DCP No.1, a Concept Soil and Water Management Plan (drawings NL120348- C01DA, C02DA, C03DA, C09DA, C10DA, dated 11 April 2014) was prepared in accordance with the NSW Department of Housing Publication, "Managing Urban Stormwater – Soils and Construction" (blue book).

To meet the requirements of the 'blue book' and LMCC guidelines, the site was divided into 6 catchments; with consideration given to the existing topography, the proposed development and its staging of construction. A combination of several treatment measures were then incorporated into the concept design to control runoff and dispersing of sediments. These included:

- Cut off swales/diversion drains
- Sediment control fencing
- Rock Check Dams
- Sedimentation basins
- Stabilised site access

Additionally, sedimentation basins were sized in accordance with the 'blue book' for a Type D sediment with calculations and basin sizes for each of the catchments being presented on the Concept Soil and Water Management Plan.

The proposed control measures for each of the catchments were selected in order to provide treatment for all disturbed areas within the site. The proposed site staging plan can be seen in EJE Architecture's drawing 9861-A200-revB, dated April 2014.

Servicing Strategy

The site has had a number of proposals for developments including a similar Aged Care Facility over the past few years. Preliminary servicing advice (Notice of Formal Requirements) has been obtained from Hunter Water Corporation for each of these developments. A revised application has recently be submitted for this proposal to Hunter Water Corporation with formal advice pending as of December 2013.

Preliminary discussions with Hunter Water Corporation have revealed that the advice previously given for the Aged Care development will generally apply to this development. With reference to the attached this advice indicated:

- The nearest water main is located on the corner of Glad Gunson Drive and Burton Street. A lead in water main would be required from this connection point to the proposed development. It is noted that our discussions with Hunter Water Corporation have revealed a development opposite the subject site has recently extended this water main along Burton Road. As such this proposal will likely now need to provide a new road crossing from the extended main in Burton Road;
- The site is not connected to the existing sewer network. Two options for connection to the existing sewer network have been provided. The first and closest is at the intersections of Glad Gunson Drive and Burton Road. This pit has an invert of 13.445m AHD. Based on finished floor levels via flood modeling we do not expect that the site can be drained via gravity to this pit. As such it will be necessary to drain to the DN300 sewer pipe which crosses Burton Road located roughly 150m to the west of the site.

Conclusion

A detailed stormwater management assessment has been undertaken to support a Development Application submission for the proposed seniors living retirement village. The stormwater management system proposed has been shown to demonstrate compliance with the intent of LMCC 2013 DCP, supporting technical manuals and associated guidelines.

We commend our findings to Council for their review.

TWO DIMENSIONAL FLOOD MODELLING INVESTIGATION

for

Eleebana Shores Development

at

Burton Road, Mount Hutton

Job No: NL130193
Revision: B
Date: 11/042014

	BY	DATE
Prepared	EA	11/04/2014
Checked	BC	11/04/2014
Admin	LD	11/04/2014

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Table of Contents

Table of Figures

1 Introduction

1.1 Purpose of this Report

This report has been commissioned by Eleebana Retirement Living Ltd for the purpose of identifying potential constraints to the proposed seniors living on Burton Road, Mount Hutton with respect to local flooding. The report investigates the potential impacts of the proposed development on local flood conditions and specifies the design of a local drainage network that prevents flooding to the proposed development and mitigated impacts on surrounding properties for rainfall events up to the 1% Annual Exceedance Probability (AEP). Additionally this report investigates peak flood levels as caused by the Probable Maximum Flood (PMF).

1.2 Outline of Flooding and Drainage Assessment

The aim of the flooding assessment was to:

- Assess existing flooding by review of the Cardno South Creek Flood Study, supplied by LMCC;
- Replicate the South Creek Flood model to within standard acceptable error limits;
- Design open channel drainage corridor system;
- Determine required Finished Flood Floor Levels (FFL) based on flood levels; and
- Determine impact on offsite local flooding.

To replicate the South Creek Flood Study SOBEK model, the 2-dimentiaonal modelling package XP-storm with TUFLOW hydrodynamic modelling engine was setup utilising parameters and catchment shape files obtained from Lake Macquarie City Council (LMCC). Direct rainfall modelling within the TUFLOW engine was used to determine the hydrologic (rainfall/ runoff) process required for the study.

The South Creek flood study identified a 90 minute duration as critical for the 1% AEP and PMF rainfall events. As such, the critical duration was used to verify Northrop's model was consistent to that used in the South Creek Flood Study. The flood extent and depth were compared to determine the validity of the model.

Following calibration with the SOBEK model, an iterative design approach was adopted. A series of open channel iterations was used to optimize the area of land available for development within the site constraints including the flooding.

The flooding assessment presented in this document details the nature of the proposed development and the analysis undertaken to quantify the extent to which the proposed development will affect existing flooding within the catchment.

1.3 Site Description

The subject site is approximately 4.96 hectares in plan area with a proposed developable footprint of 4.09 hectares. The site is currently used for a rural residential purpose. It is bounded to the east by a creek, to the west by Burton Road, residential properties to the north and the Ducks Crossing commercial development to the south.

The sites topography ranged in levels from 19.9m AHD in the south-east to 9.9m AHD in the north-west. A number of upstream earthen dams within the Ducks Crossing commercial development result in localised overland flow through the subject site. The creek to the east of the property has been identified in the South Creek Flood Study, by Cardno Lawson Treloar as overflowing in major storm events sheeting water across the subject site.

Runoff generated upstream and within the site drains under Burton Road to the north of the subject site through box culverts.

Vegetation around the site is generally grassed with some sparsely scattered larger trees. There are two existing dwellings on the subject site along with various livestock fences, dirt access tracks and rural style sheds.

The proposed development would involve filling in order to ensure all proposed units are above the flood planning level. The preliminary design ground levels and drainage network for the proposed development is presented in drawings NL130193 C01DA – C10DA.

2 Model Setup

A XP-storm 2D flood model of the site and surrounding catchment was setup to evaluate flood behaviour of the proposed development. A pre (existing case) and post development model topography has been developed for the study. A 4m x 4m grid was selected for the study to match that of the SOBEK model prepared by Cardno Lawson Treloar for the South Creek Flood Study. In the region around the proposed development a 1m x 1m model grid size was used to allow representation of channels, in 2-dimentions, in the developed scenario.

2.1 Model Topography

The pre, or existing case, model used a digital elevation model (DEM) of the existing topography based on LiDAR data collected in 2007. The LiDAR data used within this study is consistent with that used in the SOBEK model.

The post-developed model used a combination of elevation shape and fill elements, within XP-Storm, draped over the DTM to represent the proposed development fill and cut zones.

2.2 Catchment Parameters

Lake Macquarie City Council provided shape files used in the South Creek Flood Study that represented different land use areas. These shape files were imported into the XP-storm model and the same roughness and loss parameters applied as in the SOBEK model.

2.3 Model Hydrology

To ensure consistency with the South Creek Flood Study, direct rainfall was used to define the model hydrology. Direct rainfall modelling generates runoff directly on the grid negating the need to pre-define sub-catchments.

For design events, rainfall depths were obtained from the South Creek Flood Study to ensure consistency. Standard temporal patterns for use in design flood estimation from AR&R (1987) were used. PMP temporal patterns were obtained from the Commonwealth Bureau of Meteorology's' paper 'The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method'.

As shown in the South Creek Flood study the 90 minute duration was found to be critical for the catchment. An initial and continuing loss model is incorporated into the model utilising loss parameters from the South Creek Flood Study.

2.4 Catchment Features

Catchment features, such as detention basins, trunk drainage infrastructure and earthen berms used in the SOBEK model were implemented in this study. LMCC provided geospatially referenced drainage infrastructure files to input into the model. While details, such as invert level, grade, Manning's roughness and diameter, were obtained from the South Creek Flood Study to ensure consistency. As with the SOBEK model, where 1D elements were employed in the model, appropriate 1D/2D linkages were utilised to ensure flow continuity.

3 Existing Scenario and Calibration

To ensure consistency with the South Creek Flood study the model was setup to replicate the results obtained by the Cardno Lawson Treloar SOBEK flood model. Comparison between the models was performed using the existing results set provided by Council.

The comparison shows a strong correlation between the SOBEK and TUFLOW models with generally less than 50mm difference in flood depth through the site. A graphical representation of this comparison is shown in Figure 1in the Appendix.

Slight variations in depth have occurred due to the way that the different programs implement the grid and underlying flow equations. These variations are not significant and since the parameters used were the same as those adopted in the Cardno study, a sensitivity analysis has not been undertaken. Furthermore, since the TUFLOW model will be used for primarily comparison purposes we consider these variations to be acceptable.

4 Proposed Development Impact

The Proposed development has been designed to convey all rainfall events up the Probable Maximum Flood, PMF, through and around the site without causing water damage to habitable floor levels. As per Councils requirements, finished floor levels have been selected as the maximum of the 1% AEP plus 500mm freeboard or the PMF peak flood level. Generally speaking the 1% AEP with freeboard was found to be critical for the eastern two thirds of the proposed development. Finished floor levels in the western third were set based on the PMF.

Runoff generated internally within the site will be directed away from habitable areas to stormwater collection infrastructure for treatment and detention prior to discharge. Internal stormwater design has been documented in report NL130193 E01 "Stormwater Management & Servicing Strategy Design Report".

External to the subject site, the proposed development has been designed to mitigate any impact filling of the flow path will have on upstream and downstream flood levels. It was found through the investigation two cross channels and a ring drain would provide the required conveyance to pass the 1% AEP.

Regional flooding extent for the 1% AEP event is shown to remain unaffected by the proposed development. Locally, flood levels increase within the property boundary in the proposed open channel network as intended.

Minor variation in depth in neighbouring properties was observed. On average, depth has increased or decreased by less than 30mm in the critical 1% AEP 90 minute event. Within the existing low lying area, adjacent the most western proposed cross channel, water levels increased above the 30mm range. As this zone is an existing drainage flow path and is located along a property boundary we consider the effects of this increase to be negligible. Figure 4, '1% AEP Elevation Comparison', in the appendix shows the zone of influence and depth range around the subject site.

5 Discussion

It should be noted that this assessment has been undertaken at a broad concept level and a number of minor drainage issues may need to be resolved during the details design phase, CC stage. These design items include;

- Design of bridge/ Culvert structures;
- Detailed specifications of re-enforced earth/ retaining walls along channel banks;

Bridge and culvert crossings will be designed to minimise risk of blockage and ensure channel conveyance is unaffected. Retaining wall and re-enforced earth banks will be designed to ensure required conveyance is achievable as per the results of this study.

6 Conclusions

A 2-dimentional direct rainfall on grid, XP-Storm, model was developed, Verified against the South Creek Flood Study and used to investigate local flooding impacts of the proposed Eleebana Shores Living Retirement Village in Burton Road, Mount Hutton. The model was shown to replicate the results of the SOBEK South Creek Flood Study model for the existing catchment with strong correlation of flood extent and depth.

The proposed develop scenario was modelled and involved simulating fill areas to achieve finished floor levels above the maximum of the 1% AEP plus freeboard or the PMF peak flood level . Two cross drainage open channels and a ring drain are proposed to convey floodwaters through the site so as not to negatively impact on upstream properties. The channels in combination with an earthen level spreader will evenly distribute flood waters across the northern boundary so as not to disadvantage downstream land owners.

The development was found to generally have less than a 30mm impact in flood depths on surrounding properties.

We commend our findings to Council for their review.

7 Appendix

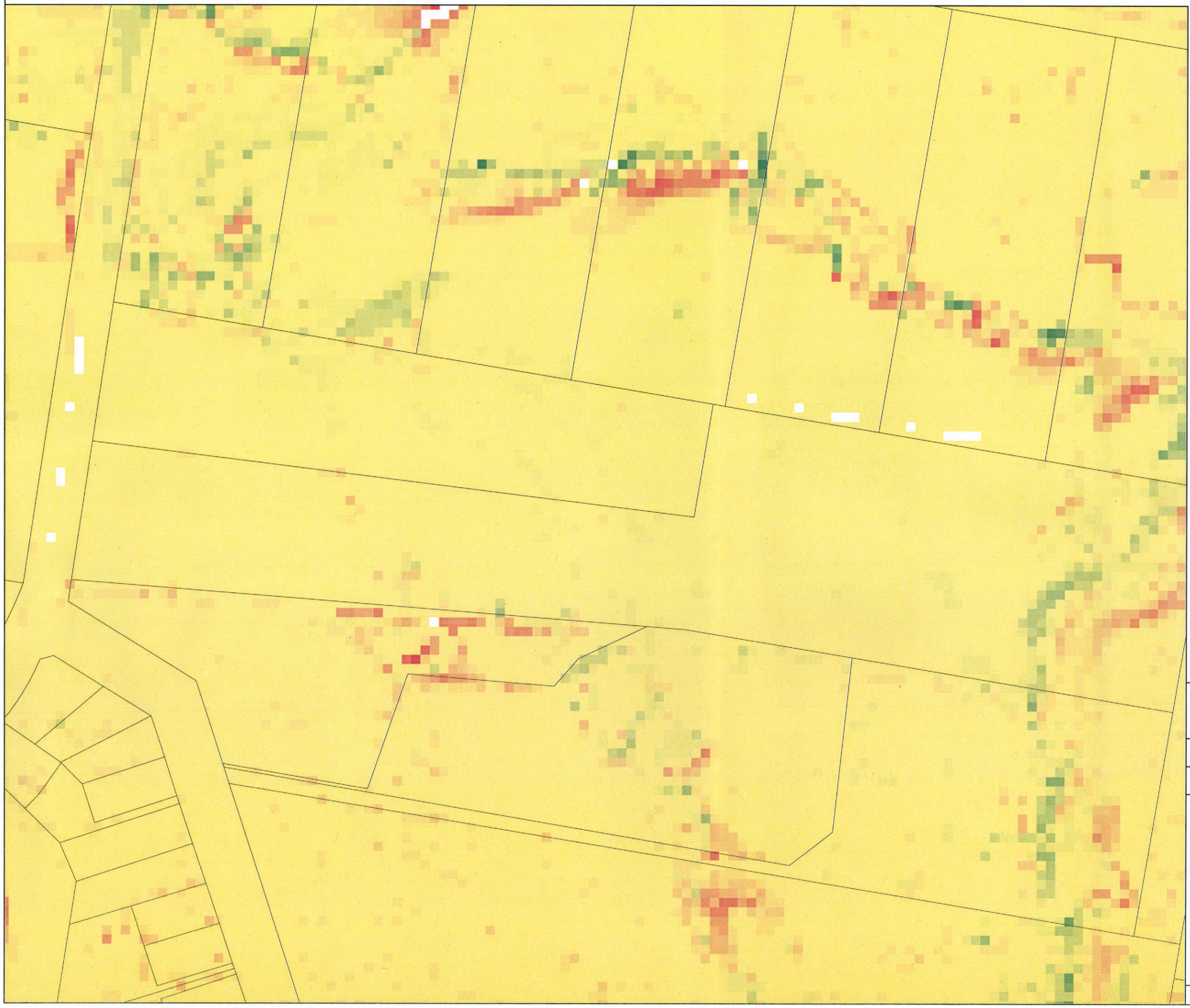

Figure 1
Comparison of Cardno SOBEK and Northrop TUFLOW results

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

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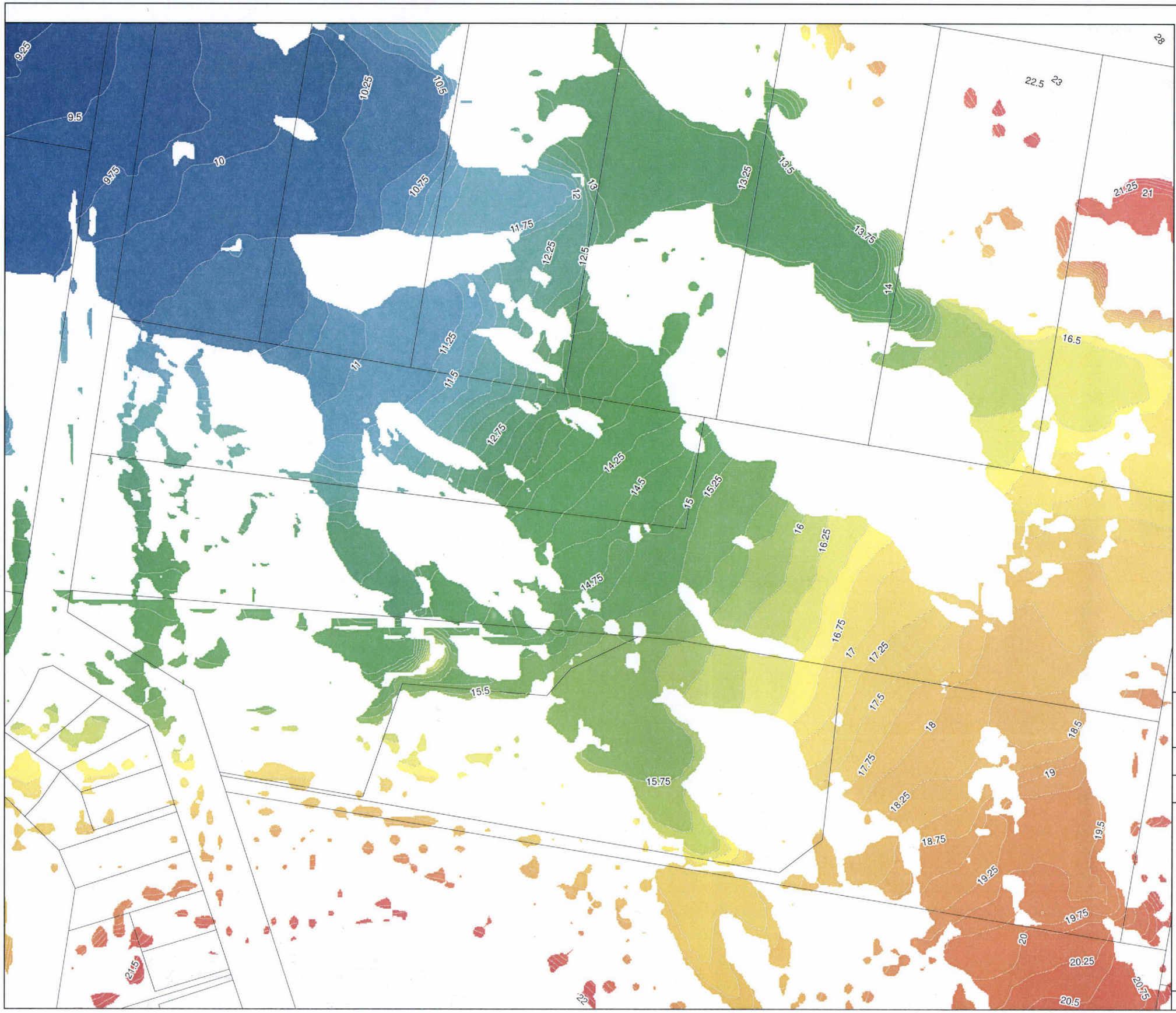

Legend

9.17 - 9.25	15.51 - 15.75
9.26 - 9.50	15.76 - 16.00
9.51 - 9.75	16.01 - 16.25
9.76 - 10.00	16.26 - 16.50
10.01 - 10.25	16.51 - 16.75
10.26 - 10.50	16.76 - 17.00
10.51 - 10.75	17.01 - 17.25
10.76 - 11.00	17.26 - 17.50
11.01 - 11.25	17.51 - 17.75
11.26 - 11.50	17.76 - 18.00
11.51 - 11.75	18.01 - 18.25
11.76 - 12.00	18.26 - 18.50
12.01 - 12.25	18.51 - 18.75
12.26 - 12.50	18.76 - 19.00
12.51 - 12.75	19.01 - 19.25
12.76 - 13.00	19.26 - 19.50
13.01 - 13.25	19.51 - 19.75
13.26 - 13.50	19.76 - 20.00
13.51 - 13.75	20.01 - 20.25
13.76 - 14.00	20.26 - 20.50
14.01 - 14.25	20.51 - 20.75
14.26 - 14.50	20.76 - 21.00
14.51 - 14.75	21.01 - 21.25
14.76 - 15.00	21.26 - 21.50
15.01 - 15.25	21.51 - 21.75
15.26 - 15.50	

Figure 2
1% AEP Existing Water Surface Elevation

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

NORTHROP
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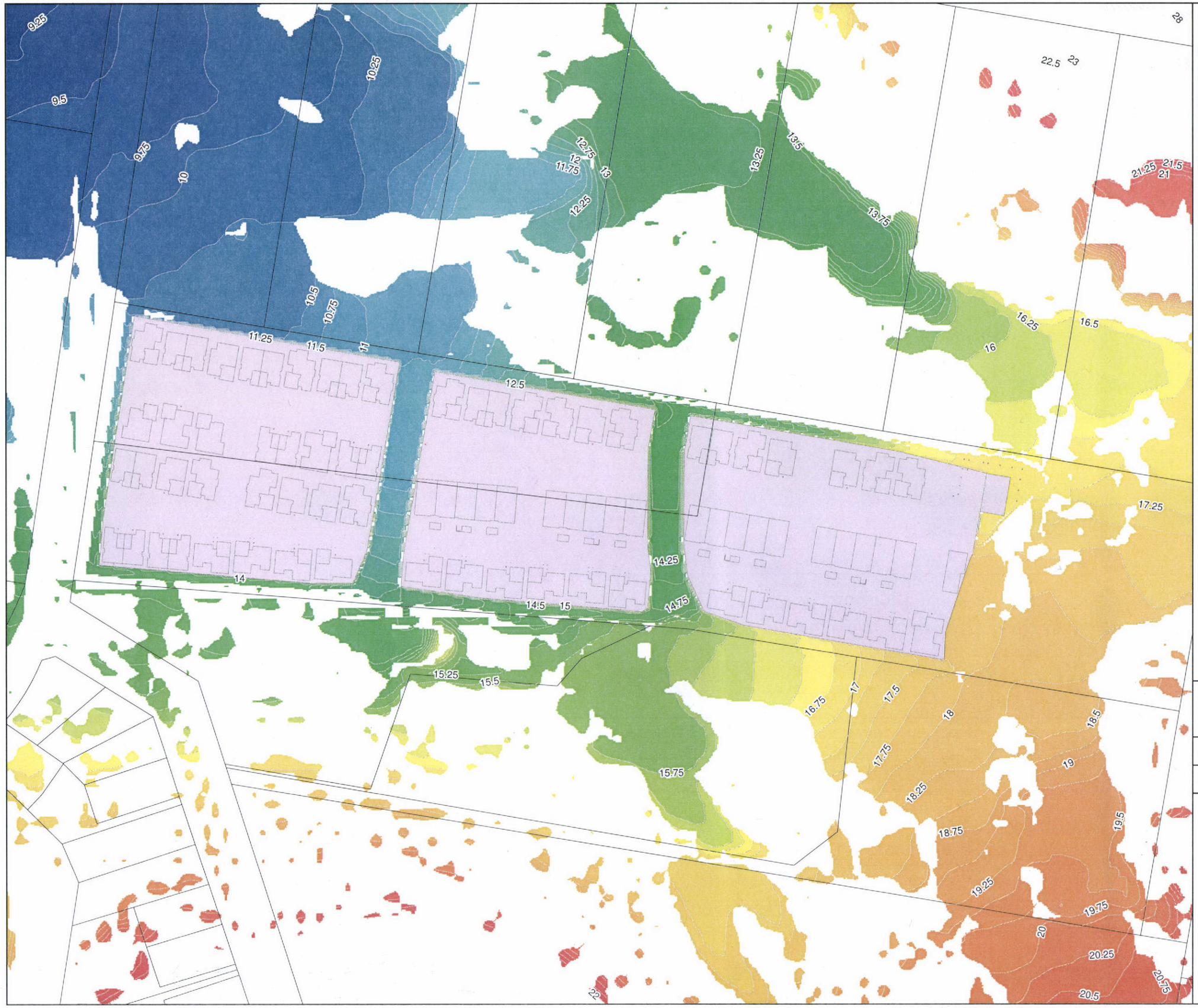

Legend

9.17 - 9.25	15.51 - 15.75
9.26 - 9.50	15.76 - 16.00
9.51 - 9.75	16.01 - 16.25
9.76 - 10.00	16.26 - 16.50
10.01 - 10.25	16.51 - 16.75
10.26 - 10.50	16.76 - 17.00
10.51 - 10.75	17.01 - 17.25
10.76 - 11.00	17.26 - 17.50
11.01 - 11.25	17.51 - 17.75
11.26 - 11.50	17.76 - 18.00
11.51 - 11.75	18.01 - 18.25
11.76 - 12.00	18.26 - 18.50
12.01 - 12.25	18.51 - 18.75
12.26 - 12.50	18.76 - 19.00
12.51 - 12.75	19.01 - 19.25
12.76 - 13.00	19.26 - 19.50
13.01 - 13.25	19.51 - 19.75
13.26 - 13.50	19.76 - 20.00
13.51 - 13.75	20.01 - 20.25
13.76 - 14.00	20.26 - 20.50
14.01 - 14.25	20.51 - 20.75
14.26 - 14.50	20.76 - 21.00
14.51 - 14.75	21.01 - 21.25
14.76 - 15.00	21.26 - 21.50
15.01 - 15.25	21.51 - 21.75
15.26 - 15.50	

Figure 3
1% AEP Post Water Surface Elevation

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

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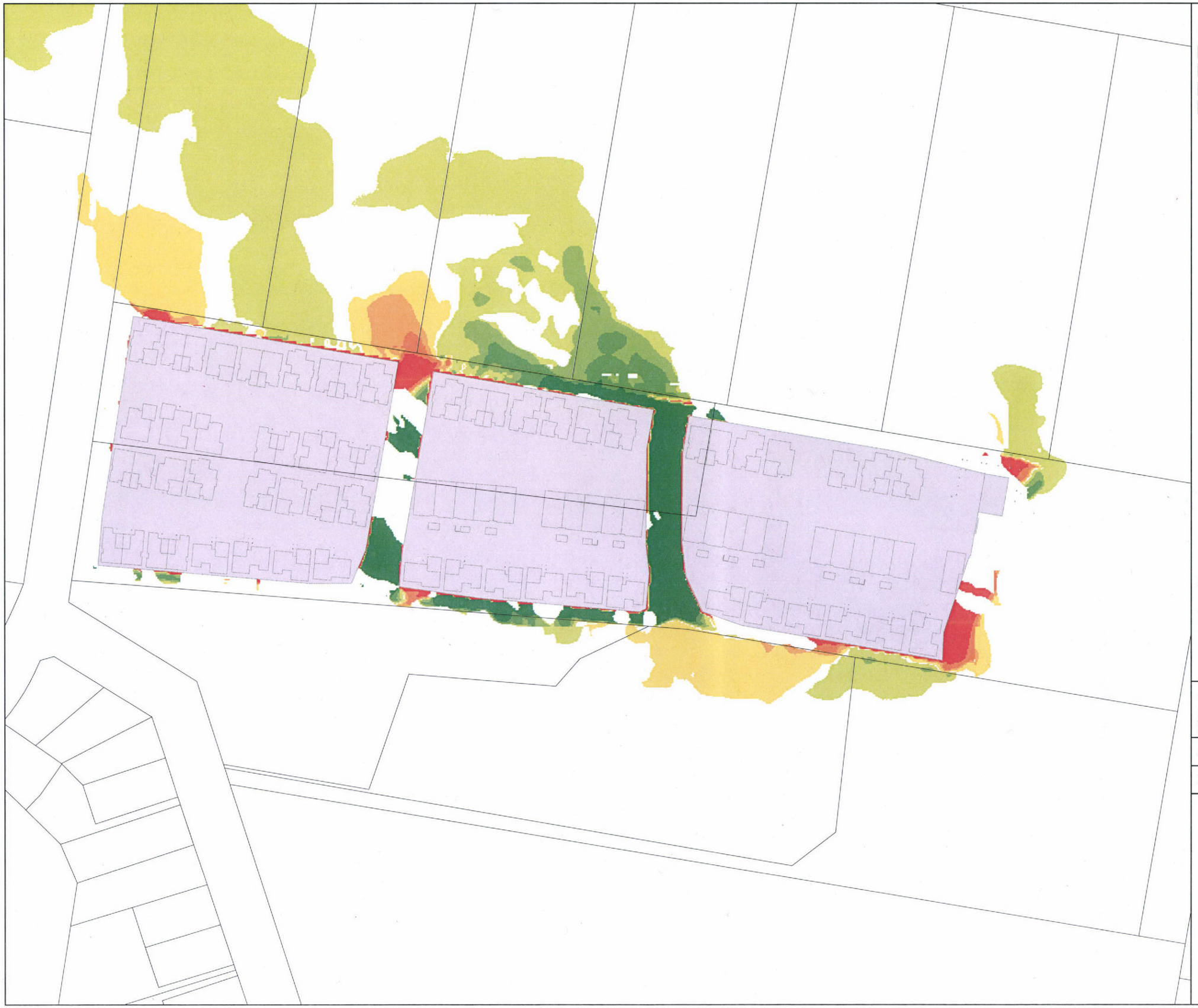

Figure 4

1% AEP Elevation Comparison

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

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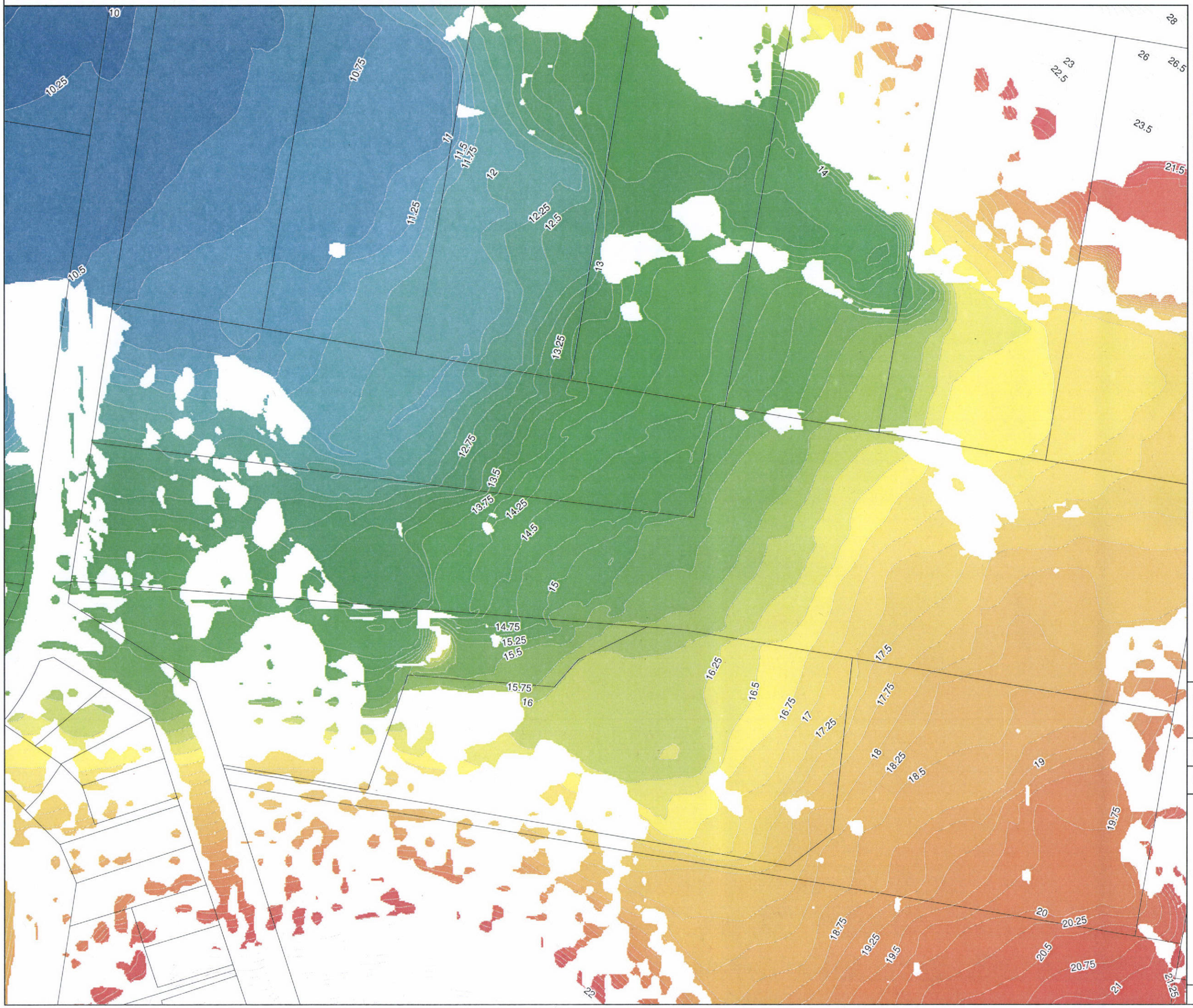

Legend

9.17 - 9.25	15.51 - 15.75
9.26 - 9.50	15.76 - 16.00
9.51 - 9.75	16.01 - 16.25
9.76 - 10.00	16.26 - 16.50
10.01 - 10.25	16.51 - 16.75
10.26 - 10.50	16.76 - 17.00
10.51 - 10.75	17.01 - 17.25
10.76 - 11.00	17.26 - 17.50
11.01 - 11.25	17.51 - 17.75
11.26 - 11.50	17.76 - 18.00
11.51 - 11.75	18.01 - 18.25
11.76 - 12.00	18.26 - 18.50
12.01 - 12.25	18.51 - 18.75
12.26 - 12.50	18.76 - 19.00
12.51 - 12.75	19.01 - 19.25
12.76 - 13.00	19.26 - 19.50
13.01 - 13.25	19.51 - 19.75
13.26 - 13.50	19.76 - 20.00
13.51 - 13.75	20.01 - 20.25
13.76 - 14.00	20.26 - 20.50
14.01 - 14.25	20.51 - 20.75
14.26 - 14.50	20.76 - 21.00
14.51 - 14.75	21.01 - 21.25
14.76 - 15.00	21.26 - 21.50
15.01 - 15.25	21.51 - 21.75
15.26 - 15.50	

Figure 5
PMF Existing Water Surface Elevation

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

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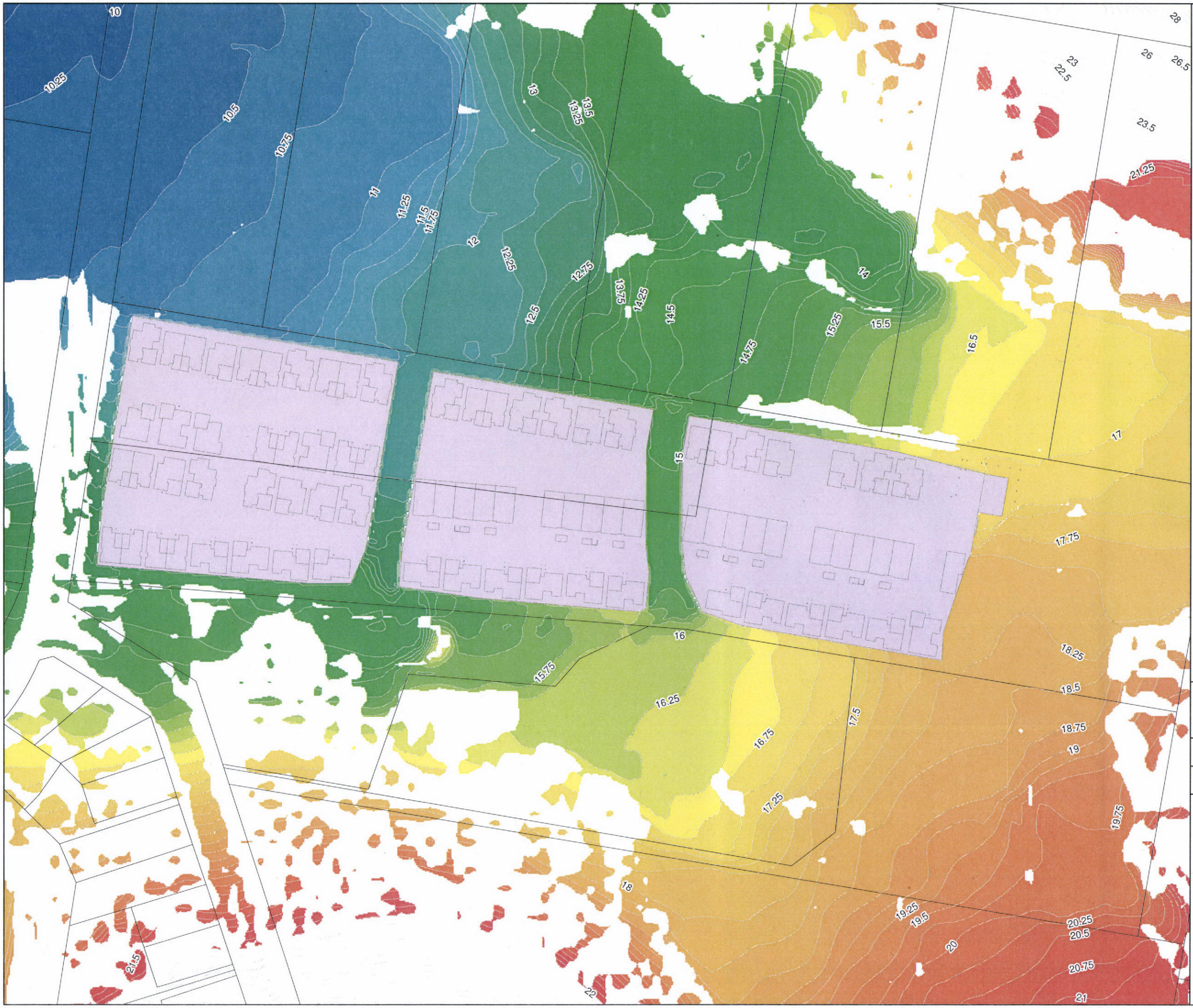

Legend

9.17 - 9.25	15.51 - 15.75
9.26 - 9.50	15.76 - 16.00
9.51 - 9.75	16.01 - 16.25
9.76 - 10.00	16.26 - 16.50
10.01 - 10.25	16.51 - 16.75
10.26 - 10.50	16.76 - 17.00
10.51 - 10.75	17.01 - 17.25
10.76 - 11.00	17.26 - 17.50
11.01 - 11.25	17.51 - 17.75
11.26 - 11.50	17.76 - 18.00
11.51 - 11.75	18.01 - 18.25
11.76 - 12.00	18.26 - 18.50
12.01 - 12.25	18.51 - 18.75
12.26 - 12.50	18.76 - 19.00
12.51 - 12.75	19.01 - 19.25
12.76 - 13.00	19.26 - 19.50
13.01 - 13.25	19.51 - 19.75
13.26 - 13.50	19.76 - 20.00
13.51 - 13.75	20.01 - 20.25
13.76 - 14.00	20.26 - 20.50
14.01 - 14.25	20.51 - 20.75
14.26 - 14.50	20.76 - 21.00
14.51 - 14.75	21.01 - 21.25
14.76 - 15.00	21.26 - 21.50
15.01 - 15.25	21.51 - 21.75
15.26 - 15.50	

Figure 6
PMF Post Water Surface Elevation

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

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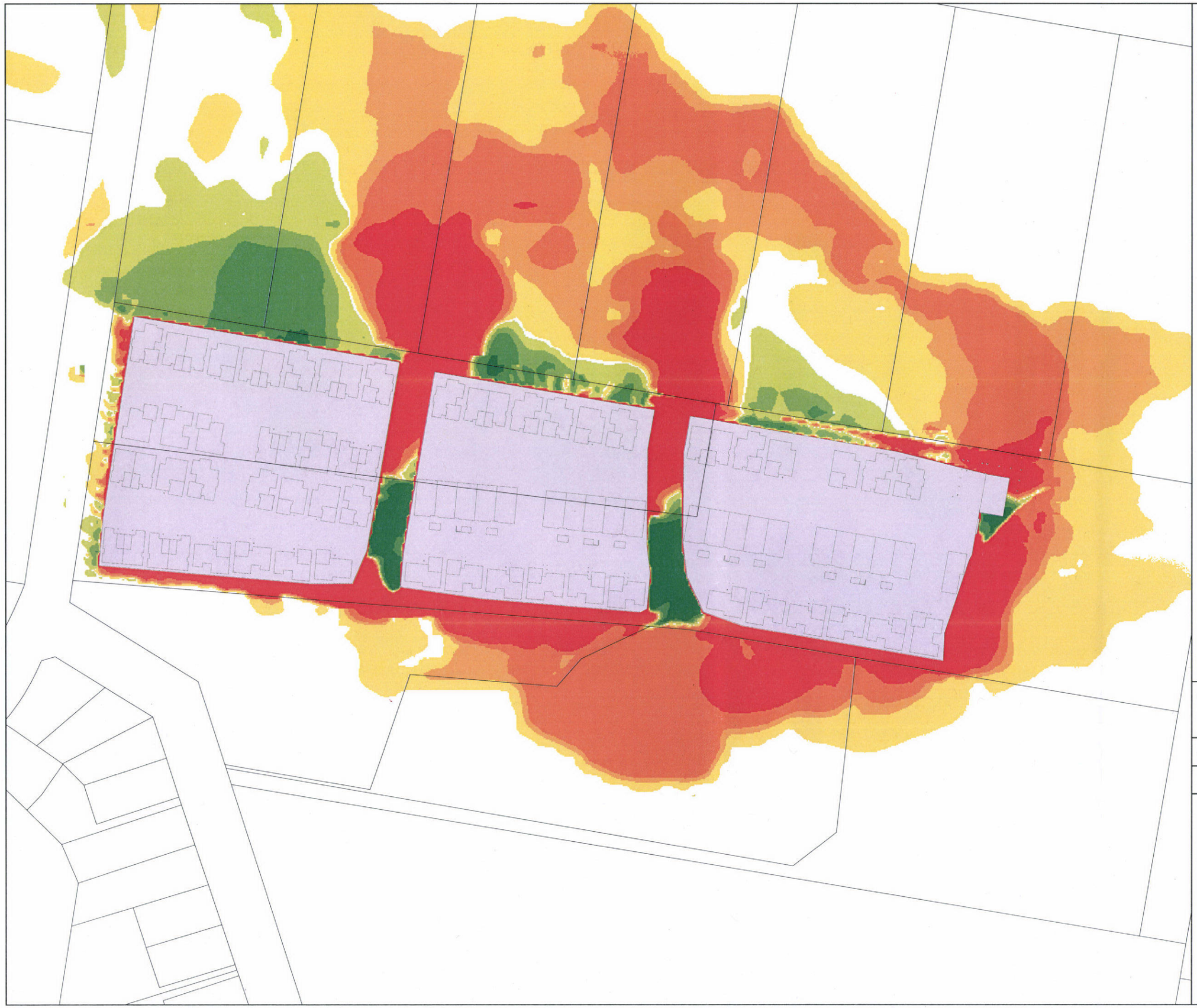

Figure 7

PMF Elevation Comparison

Job Name
Eleebana Shores
Burton Road, Mount Hutton

Job Number NL130193 **Rev** A

Date 10 April 2014

N

Meters
0 12.5 25 50

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