Curriculum Vitae: Robert James Hall

Qualifications:

MIPENZ (Civil) CPEng IntPE (NZ) No. 19621
ME (Natural Resources) Lincoln University, N.Z.
BE (Civil). University of Canterbury, N.Z.
NZCE (Civil)
Surface Water Hydrology Course (University N.S.W., Kensington, Aust.)

Professional Associations:

Member of the Institution of Professional Engineers of New Zealand.
Member of New Zealand Society of Large Dams.
Member of Structural Engineers Society of New Zealand.
Member of the New Zealand Geomechanics Society.
Member of N.Z. Society of Coastal Sciences and Engineering.
Member of N.Z. Hydrological Society

Experience:

Twenty six years experience with Catchment Authorities and Regional Government in New Zealand including the investigation, design, promotion and management of river and catchment control schemes and the development of flood plain management strategies. This latter work included development and promotion with the affected communities of the Glenavy Camp and Blandswood Hazard Management Plans, the Orari - Waihi - Temuka, Levels Plains, Pleasant Point, Temuka Township and Ashburton Township Flood Plain Management Plans and preliminary work on the Ashburton Rural Flood Plain Management Plan.

Completed an assessment of flood hazards to Fairlie Township and developed mitigation strategies. Carried out hydraulic modelling of the Arowhenua Floodplain situated to the west of Temuka between the Temuka and Opihi Rivers. Experience in the design, construction and management of detention dams for urban and rural flood protection and the design of irrigation storage dams. Twenty five years experience in the development and operation of flood warning systems and procedures.

At various times provided site inspection services during construction for project designers (Ormond Stock and Associates, Holmes Consulting, Arrow International, viz Fonterra Clandeboye, Timaru Piazza, Retirement Villages, Countdown Supermarket, Timaru Hospital upgrades, Timaru DC office rebuild, and for construction companies Eberts, Fletcher EQC, G.J.Gardiner, Versatile, Jennian Homes, Total Span. Peer review of Waimate Stadium, dairy sheds,

dairy barns. Expert evidence to the Environment Court in 2016 relating to the effects of dam break surges on structural integrity of residential buildings lying within the dam break surge corridor. Transmission Line Section NZED 1970's: Design checks on lattice steel transmission line towers and substation structures, design checks on steel monotube structures and steel box section substation line termination structures and load and deflection proof testing of same (Halfway Bush South Dunedin 220 KV double circuit line, Redcliffs substation, Taradale).

Carry out building risk classifications on buildings (domestic and industrial) following the September 2010 Greendale earthquake in Christchurch and suburbs, and following the 2011 earthquakes. Provide earthquake damage repair Strategies for Fletchers EQR for Mid and South Canterbury. Earthquake damage reports for Insurers and private individuals arising as a consequence of the Canterbury earthquakes. Undertake IEP's for clients. Structural design of residential and commercial properties, including farm bridge designs, provide bridge designs to Timaru District Council for pedestrian and cycle use. Design hydraulic structures for irrigation infrastructure. Provide peer review services to Waimate District Council and Timaru District Council on request for compliance with NZ Building Act. Provide dangerous building assessments for Waitaki District Council. Provide subfloor framing designs for residential buildings subject to occasional flood flows. Foundation designs and design checks and reviews on request to Builders and Building Contractors in South Canterbury and Otago.

Designed pump drainage works for Queenstown Lakes District Council, prepared an assessment of flood hazard and the design of a flood warning system and associated procedures for Fletcher, Dillingham, Ilbau Consortium, Manapouri Power Station new tailrace project.

Completed a review of flood mitigation procedures (establishing floor heights for new dwellings) in Riversdale for the Southland District Council and Environment Southland (2014). Report on scale and nature of flood and sediment related hazards to Franz Josef township and environs from the Waiho River, and Te Anau from the Upukerora River.

Providing investigation and design input to a number of irrigation storage dams (large dams, low PIC, NZ Building Act) in collaboration with GeoSolve and Terra MDC Ltd. in Otago and Canterbury, and routinely peer reviewing dam break and dam design reports for Goldie & Partners in mid and north Canterbury.

Designed siphons for abstraction of water out of manmade water courses i.e. canals [Irishmans Creek Station, Tekapo – Pukaki hydro canal, Morrisons property, RDR, and for irrigation purposes and for auxiliary spillways for detention dams (Hawkes Bay Catchment Board).

Provide engineering advice on river management and erosion protection measures for the Central Plains Irrigation Scheme Rakaia River intake and their Waimakariri River intake the latter by review of Opus International Ltd design proposals, provide river management advice to the NZ Defence Force for the Kahutarawa River at Linton Military Camp through subconsultancy with URS / AECOM, review Opus International designs for river protection works on the Waitaki River for SH 1 at Glenavy.

Relevant Projects

- Flood risk and geotechnical assessments for subdivision proposals at Barrytown , Franz Josef, Levels Plains, Twizel, Bobs Cove, Queenstown, Poison Creek, Queensbury, Mt. Pisa Estate, Cromwell, and Lowburn.
- Flood mitigation options for Woodbank Estate, Hanmer. And various subdivisions on Levels Plains, Pleasant Point, Lowburn, Bobs Cove, Queenstown,
- Engaged by Ministry for the Environment to assist in a Flood Risk Management Review of Marlborough District Councils emergency management functions.
- Stormwater management Gleniti Subdivision, Timaru and rural runoff control options for the north eastern side of Temuka.
- Flood hazard assessment for food store, Winchester South Canterbury.
- In conjunction with GHD assessed and made recommendations on the flood management provisions for the Oceania Gold Fossickers Creek Tailing impoundment structure, Reefton.
- Assisted in the compilation of an Environmental Management Strategy covering waste water and stormwater management and disposal for the New Zealand Dairies Ltd. Studholme dairy factory.
- Waiho River Future Management: report to West Coast Regional Council (2012); co-authored a paper in 2013 issue of Nez Zealand Journal of *Hydrology Recent Behaviour and Sustainable Future Management of the Waiho River Westland New Zealand* (Tim Davies, Blair Campbell, Bob Hall, Chris Gomez) Journal of Hydrology New Zealand Vol 52, No. 1 2013.

- Completed a review of flood mitigation procedures (establishing floor heights for new dwellings) in Riversdale for the Southland District Council and Environment Southland (2014).
- Draft Asset Management Plan for the Lower Waitaki River Control Scheme for Environment Canterbury
- Annual review and reporting on the performance of the Mt. Albert Station, Makarora River bunds
- Design of an avalanche bund on Kitchener Stream, Aoraki Mount Cook for DOC.
- Design check on bridge waterways for DOC in Aoraki Mt Cook National Park
- Provided advice on river morphology to DOC, Aoraki Mt.Cook National Park for the realignment of the Tasman River valley road.
- Peer Review of Central Plains Irrigation Scheme Rakaia River intake as sub-consultant to URS.
- Design irrigation intake river protection measures for Central Plains Water Rakaia and Waimakariri River intakes
- Design and peer review river protection works for NZTA Ahuriri River SH 8, and Waitaki River SH 1.
- Various on-going structural design engagements

Special Interests:

River, floodplain and coastal morphology and processes, hydrology, hydraulic modelling of rivers and floodplains, natural hazard assessments and active involvement with community groups associated with particular flood related hazards, and river and coastal processes, urban and rural stormwater management, investigation, design and construction overview of irrigation storage dams and flood detention dams. Structural design of single and two storied residential and commercial buildings including farm buildings in timber, concrete, reinforced concrete block and steel including appropriate dimensioning for localised effects associated with extreme wind, heavy snow and flood event loadings

R.J. Hall.
MIPENZ (Civil) CPEng Int PE (NZ) No. 19621
R.J.Hall Civil & Environmental Consulting Ltd

Date: 15 May 2017

Employment Record

2011 – Present	Established R.J.Hall & Associates Ltd, Civil and Geotechnical engineering consultancy
2007 - 2011	Merged R.J.Hall Civil & Environmental Consulting Ltd. with GHD and managed GHD's Timaru office and continue to provide civil and environmental engineering consultancy services.
1995 to Oct 2007	Established and ran R.J.Hall Civil & Environmental Engineering Consulting Ltd. in Timaru.
1989 - 1995	Regional Structures and Hazards Planning Manager and Principal Manager (Timaru), Canterbury Regional Council.
1987 - 1989	Chief Engineer to the South Canterbury Catchment Board. Day to day administration of the Board's engineering operations associated with water and soil conservation and flood hazard mitigation activities. Flood warning systems manager.
1987	Senior Rivers and Drainage Engineer for Marlborough Catchment Board. Investigation, design and review of catchment, river and drainage schemes, administration of works programmes and flood warning systems.
1986	Assistant Chief Engineer, Bay of Plenty Catchment Commission. Day to day administration of the Commission's engineering functions including the management of extensive land drainage systems (pumped and gravity) and flood control systems.
1981 - 1986	Chief Engineer, Waitaki Catchment Commission. Management of the Commission's engineering functions associated with soil conservation, river management, hazard mitigation and policy development. Flood warning systems manager.
1975 - 1981	Design Engineer, Hawkes Bay Catchment Board. Structural and hydraulic design of flood mitigation works (stopbanks, detention dams, urban stormwater systems), land drainage systems (pumped and gravity), river morphology studies, hydrological studies, lake and wetland studies, major earthworks investigations, quality control, specification writing and contract supervision.

1974 - 1975	Investigations and Design Engineer, New Zealand Electricity Department. Substation foundation contract supervision, transmission line design and construction supervision, steel box girder terminal structure. Commissioning tests (load - strain - deflection). Special foundation design.
1973 - 1974	University of Canterbury School of Engineering, Civil Engineering Cadet (NZED). Majored in structural design and hydraulics. Vacation employment encompassed the development of seismic resisting support systems for high voltage switching gear, transformer anchorage and retrofitting of such systems.
1971 - 1973	Engineering Officer, New Zealand Electricity Department, Transmission Line Design. Specialised in special foundations for HV transmission line system (river crossings, monotubes), lattice steel tower design checks, deflection and pre-camber computations for steel box monotube towers.
1968 - 1971	Engineering Officer Cadet, New Zealand Electricity Department. Transmission line route selection and surveys.

BEFORE THE HEARINGS PANEL

IN THE MATTER	of Proposed Plan Change 42 Mangaroa & Pinehaven Flood Hazard Extents
BETWEEN	S & S Pattinson
AND	Upper Hutt City Council

STATEMENT OF EVIDENCE OF ROBERT HALL

Introduction

1 My full name is Robert James Hall. I am a Civil and Environmental Engineer, in which capacity I am a Director of R J Hall & Associates Limited. I reside in Timaru.

2 I hold the qualifications of Masters of Engineering (Natural Resources), Bachelor of Engineering (Civil), New Zealand Certificate in Engineering (Civil), Graduate Course in Surface Water Hydrology (University of NSW, Sydney, Australia), Member of the Institution of Professional Engineers of New Zealand, Chartered Professional Engineer (Civil) Int PE (NZ) and a member of the NZ Society of Large Dams, NZ Hydrological Society and NZ Structural Engineers Society and the NZ Geotechnical Society.

3 I have 40 years' experience in the area of water and soil engineering, 12 of which as a Director of R.J.Hall Civil and Environmental Engineering (Timaru). In October 2007 R.J.Hall Civil & Environmental Consulting Ltd was purchased by GHD Ltd. I was employed by that Company as a Civil and Environmental engineer and managed their Timaru office until March 2011, when that office was closed. I then set up my current company, R J Hall and Associates Ltd, of which I am a director. Prior to establishing R J Hall Civil & Environmental Consulting Ltd I was employed by a number of catchment authorities in both the North and South Islands of New Zealand as a civil engineer. I was employed by the Canterbury Regional Council from its inception through to October 1995 when I resigned to establish R.J.Hall Civil & Environmental Consulting Ltd., variously as Principal Design Engineer and Hazards and Structures Engineer and Southern Area Office Manager.

My experience includes hydrological investigations, river processes, flood plain modelling, flood hazards analysis and mapping, and the development of flood plain hazard management policy and flood hazard plans. Although I have experience in hydraulic modelling I do consider myself an hydraulic modeller per se, that is a specialised area in Civil Engineering. Attached to this evidence is a copy of my CV which provides a description of the extent of my involvement throughout my career in flood hazard identification, mapping and policy development.

4 A record of the engineering positions that I have held are as follows:

(a) Design Engineer (Hawkes Bay Catchment Board and Regional Water Board);

(b) Chief Engineer (Waitaki Catchment Commission and Regional Water Board);

(c) Deputy Chief Engineer (Bay of Plenty Catchment Commission and Regional Water Board);

(d) Rivers and Drainage Engineer (Marlborough Catchment Board and Regional Water Board), Deputy Chief Engineer (South Canterbury Catchment Board and Regional Water Board);

(e) Regional Design Engineer and subsequently the Regional Hazards and Structures Planning Manager (Canterbury Regional Council);

(f) Director R.J.Hall Civil & Environmental Consulting Ltd;

(g) Principal Civil Engineer (Timaru), GHD Ltd; and

(h) Director R.J.Hall & Associates Ltd. (Timaru)

5 Although this is a Council hearing, I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

Scope of Evidence

6 I have been asked by S & S Pattinson in respect of their property at 27 Elmslie Road, Pinehaven to:

(a) Review and prepare evidence in relation to the matter of hydraulic neutrality as it pertains to possible future subdivision development in the head of the Pinehaven catchment, and

(b) To review and prepare evidence on the Upper Hutt City Council (UHCC) flood hazard maps

7 I have reviewed the relevant parts of the UHCC Proposed Plan Change 42 Mangaroa and Pinehaven Flood Hazards Extents (PC 42) with respect to the matter set out in 6 (a) & (b) in preparing my evidence

and have visited my Clients property on Elmslie Road, Pinehaven as well as familiarised myself with the Pinehaven Catchment.

Hydraulic Neutrality

8 My clients S & S Pattinson have expressed concerns relating to the effects of increased runoff occurring from possible future subdivision in the head of the Pinehaven Catchments unless adequate provisions are made to ensure that hydraulic neutrality is achieved with respect to such development.

9 As the UHCC, AEP 1 in 100 year plus climate change flood hazard maps demonstrate, significant parts of the Pinehaven Stream catchment flanking the stream already have a measure of flood hazard in existence and accordingly there is little if any scope to allow this hazard to become any greater as a consequence a lack of control on the management of runoff from such future development.

10 I note that this matter has been considered in PC42 and in particular Policy 9.4.10 and more comprehensively Sec 1.8.11 of Appendix 8 addresses this important matter with reference to index storms of both a 1 in 10 and 1 in 100 year events.

Further to that, hydraulic modelling was undertaken by Greater Wellington Regional Councils (GWRC) original consultants Sinclair Knight Mertz (SKM), and this formed the basis for the UHCC flood hazard maps. Montgomery Watson Harza (MWH) were engaged by GWRC in 2008 to undertake preliminary hydrological investigations. These investigations identified 15 sub-catchments in the Pinehaven catchment. Using these sub-catchments, GWRC subsequently proceeded to generate AEP 1 / 100 flood hydrographs for each of these 15 sub-catchments as input to an hydraulic model. The hydrographs which were generated were in turn based on design rainfalls which had been increased by 16% to allow for climate change effects. Importantly it should be noted that these hydrographs were based on the catchments hydrologic characteristics (e.g. vegetation cover, extent, location, form and distribution of urban development) prevailing at the time these hydrographs were generated. Accordingly it is to be anticipated that any departure from these catchment characteristics which have the effect either singularly or in combination of increasing the rate of runoff will result in an increase in both the runoff volume and peak discharge of

any sub-catchment affected. In situations where sub-catchment outflows merge going downstream these changes will be reflected also in the water course downstream from such confluences. These original GWRC hydrographs are in effect an expression of the pre-development flows for the catchment, and are those which must be preserved by the hydraulic neutrality provisions of PC 42 referred to above.

A copy of the GWRC AEP 1 / 100 (inc climate change effects) hydrographs were given to S.Pattinson and are not at presently in the public domain as far as I am aware. These hydrographs and the hydrological assessments from which they were derived in conjunction with the 1 in 100 year estimated combined stream and overflow discharge of 4.45 cumec at 27 Elmslie Road, i.e. the S & S Pattinson property as I understand it are the basis on which GWRC generated flood maps in the Pinehaven catchment and inparticular those for the Pattinsons property at 27 Elmslie Road. I understand also that the GWRC AEP 1 in 100 flood which includes provision for climate change effects is the basis on which the UHCC flood maps for that catchment were produced. The 4.45 cumec discharge quoted above wasconfirmed to the Pattinson's by A.Allan on behalf of GWRC and in effect provide the hydrological baseline against which the effectiveness of any future hydraulic neutrality proposals for development in the Pinehaven catchment upstream of the Pattinson's property can be made.

These hydrographs both in their 2008 graphic and tabulated form need to be formally released to the community and they need to be in the same form as those provided to the Pattinson's as described above.

11 On the basis of the foregoing (Par 10), I conclude that provided the UHCC ensures that their Policy 9.4.10 and methodology of Sec 1.8.11 of Appendix 8 of PC42 is adhered to in full in the assessment and consenting of any future subdivision development upstream of the Pattinsons property at 27 Elmslie Road, Pinehaven then it is reasonable to conclude that their concerns associated with the need to preserve hydraulic neutrality to the 2008 baseline in the Pinehaven catchment may provide a basis for the Pattinsons to consider if their concerns have been adequately addressed. Never the less it would with respect be essential that the UHCC include as an appendix to PC42 a map of the Pinehaven catchment which specifies what AEP 1 / 100 discharges (including climate change) have been considered by GWRC at specific

locations in these catchments and confirm that these were the basis on which the GWRC used in their hydraulic models and which forms the basis of both the UHCC and GWRC flood hazard maps. This information will then provide a 2008 baseline reference for Council in the administration of it's functions with respect to hydraulic neutrality. In addition this same information would act as a guide to future developers to form their runoff management strategies and a basis from which the public generally can be satisfied that hydraulic neutrality is being maintained in the catchment commensurate with any development that is being proposed.

Further to that the values of the discharge estimates that are provided on those maps must include climate change and to be consistent with those values that have been employed in the GWRC modelling exercise.

In order tp provide a clear and unambiguous message to the community as to what the actual baseline is in the Pinehaven catchments against which the effectiveness of future developments strategies for maintaining hydraulic neutrality are then in addition to the above the flood maps themselves need to be based on the 1 in 100 AEP plus climate change water level profiles without the inclusion of freeboard. Further to that they need to show in an easily readable way the relative flood hazard classifications as used for example in the NSW Government method or something similar such as that used in the Hamilton City flood hazard maps.

Flood Hazard Map 46 Vicinity of 27 Elmslie Road, Silverstream

12 Flood hazard plans are an essential tool for the management of flood risk. The Pattinsons realise this and support that concept. As we know such plans are in two parts, the plan proper which describes the area over which the plan operates, the reason for it, how it has been developed, how it integrates with other plans and is intended to give effect to Councils policies and how it is to be interpreted, and includes flood hazard maps which provide in graphic form information to assist in the correct interpretations. It is therefore imperative that the form of the maps that accompany the hazard plan convey a clear and accurate message as to what exactly is being represented on these plans. If the

intention is that the maps have been designed to describe only in the broadest terms the nature of the flood hazards that exist within the catchment being represented on any particular map so that persons can readily see where Councils flood hazard policies and rules are to be given effect, then that needs to be made clear on the map, notwithstanding the fact that such information may already exist in the body of the flood hazard plan. Secondly if that is the case and the intention is that if more detailed information relating to the flood hazard is required then the flood hazard map needs to clearly state that and provide direction as to where that more detailed information may be found e.g. in the UHCC case, GWRC. As they stand the UHCC flood maps fail to do this. My interpretation of these maps is that they have include 300mm of freeboard separately for both the areas where AEP 1 /100 plus climate change stream flow is confined at one level and then again at a higher level for that event where berm flow purportedly exists. The true left and true right extremity of this berm flow freeboard plane where the modelling predicts berm flow exists then forms the boundary for the flood hazard extent when it goes to zero on rising ground. In my experience flood hazard is usually described in relative terms such as high, medium or low flood hazard based on a range of values based on the product of average velocity of flow and average flow depth. Nowhere on these maps is that type of classification evident other than a loose reference to " ponding " with a dotted line demarcating the outward limit of " ponding" and described as " flood hazard extent". Accordingly the UHCC flood maps as they presently stand in my opinion do not accurately define areas of hazard in any meaningful form and need to be revised to do so. I will address this matter further with particular reference to the Pattinsons property at 27 Elmslie Road, Pinehaven.

13 Attached Figures 1 & 2. being UHCC flood hazard map 46. Fig 1. was included in Appendix 4 of PC42 when released for public consultation. Fig 2. is the same map as Fig 1. but on which some modifications were made which affected the location of the outer limits of the " ponding areas" shown on the original Fig 1. map. As I understand it, Fig 2. was released after the consultation period closed as an appendix to the Sec 42A report for PC42 in response to a submission or submissions received through the public consultation period. I offer no opinion of the propriety or otherwise of this procedure but I note that there is nothing on

either of these maps to distinguish Fig 2 from Fig 1. other than the actual changes which were made. In my experience it is customary when preparing plans and modification are required to those plans in that process that some form of explanation and identification system is employed so that the changes which have occurred between the issues are clearly identifiable. No such system has been employed here in effect we have two plan 46's both with the same date but released at different times and with differing flood hazard zones shown on them.

14 The legend on Plan 46 (Fig1., & Fig2.) describe six characteristics of the plan, the extension of the "erosion hazard area", " flood hazard extent " the " ponding area", " overflow path", river / stream corridor" and " Pinehaven Catchment overlay". The underlying map shows the various parcels of land in the catchment the street names that apply and the addresses of each land parcel.

15 When I consider the Pattinsons property at 27 Elsmlie Road, I see that most of the land on the true left of Pinehaven Stream between that stream and Elmslie Road is described as a " ponding area" in a light blue shading whilst the stream proper is defined by a darker blue shading. An overflow path is shown in yellow on Elmslie Road as an overflow path and lies beyond the south western limit of the flood hazard extent. In essence I interpret this to imply that all or most of the runoff from that part of the Pinehaven catchment rising above Elmslie road in the AEP 1 / 100 year flood is captured by that road and runs down hill more or less separately and sub-parallel to the Pinehaven Stream.

16 There is nothing on the plan that tells me why " ponding " as such is a flood hazard, and how that area may differ from the flood hazards that might be present in the " River / Stream corridor", nor where to find that information be it in the UHCC Mangaroa / Pinehaven flood management plans or from the GWRC. It would appear that maps such as Map 46 are intended as a first step in such a process but nowhere on either Map 46 being Fig 1. or Fig 2.,is that made clear.

17 Fig's 3A & 3B. attached are Pinehaven Stream flood maps provided to a neighboring property on Elmslie Road by the GWRC at the owner of 23 – 25 Elmslie Road request in May 2017 . Fig 3A show the elevation of the flood hazard surface above ground line in metres on a grid system whilst Fig 3B gives the reduced level of that surface as opposed to the actual depth. A note on the map identifies these flood hazards as having

been derived for an AEP 1 / 100 year situation which includes provision for climate change and freeboard. Whilst not stated on the plans I am aware that in this part of the catchment freeboard has been set at 300mm.

18 It is evident that these flood hazard maps extent beyond the boundary of 23 – 25 Elmslie Road and include parts of 27, 29 and 31 Elmslie Road.

19 The legends on Fig 3A & 3B differentiate flood hazards on the basis of depth with in particular light blue being 0.05m (i.e. presumably for depths up to 50mm), a slightly darker blue as less than 0.5m (500mm). The legend also identifies this map as representing the 100 year climate change event with freeboard and notes that the underlying 0.5m contours shown on the map are derived from a 2009 Lidar survey. These maps indicate that the Pinehaven Stream through the Pattinsons property is contained within its banks although it is difficult to determine that easily from the pixilated map format. I have carried out my own hydraulic analysis for a flow of 4.45 cumec in this reach and when my result is compared with flow depth information provided to the Pattinsons by both GWRC and M.Laws output from the GWRC hydraulic modelling it is evident that in all cases the stream flow at this level of discharge including 300 freeboard is contained with the primary channel. Fig 4 attached compares my result with the flood map produced by the GWRC for the AEP 1 / 100 flood flow with 300mm freeboard applied. There is a marked contrast in these two flood maps. This difference arises from the way the GWRC map is compiled, a 300mm freeboard is applied in both cases but their model predicts some limited shallow overland flow as well as the stream flow. When this is displayed in the manner they have used, it creates a very misleading impression of what is actually happening at the site. I will elaborate on that in Par 20 onwards. In direct contrast my map shows the actual extent of the likely flooding based on the current landform and its present use. As I will explain shortly, at present I do not think that the overland flow predicted by the GWRC hydraulic modelling will actually occur on the Pattinson property in the manner that the model predicts and accordingly the justification for mapping in the manner that they have is in my view wrong and is as a consequence creating a misleading impression of what is likely to occur in an event of this kind.

20 The information contained on Fig 3A. provides us with an impression of what GWRC hydraulic modelling predicts for flood depth in the AEP 1 / 100 year climate change event but it tells us nothing about the nature of the flood waters depicted on the maps other than its depth including freeboard which I understand to be 300mm although that is not stated anywhere on the map.

21 When I look specifically at 27 Elmslie Road on Fig 3A. the greater part of the land on the true left bank lying between Pinehaven Stream and the south western boundary of the property adjacent to Elmslie Road I see that the water depth plus 300 freeboard is with the exception of some small areas shown primarily 0.3m in depth. If there is flood water of some kind present in the areas identified with 0.3m of depth and given the intervals being used are steps of 0.1m one might conclude that the actual water depth if present at all would be in the range of 0 to 49mm assuming that the actual modelled depth excluding the 300 mm freeboard, has been either rounded up or down, in this case down. This map does not tell me what form the water has, e.g. is it "ponding" as the UHDC flood map 46 (Fig 1, Fig 2) indicate or is it moving water and if so where has that come from and what route is it following and how fast it is moving. In my experience "at a site flood hazard" is customarily determined and described on the basis of the scale of the product of the flow depth and the flow velocity. So whilst these maps are described as flood hazard maps in reality they are flood water depths maps. Having said that it is expected that the velocities associated with these depth profiles would be available from GWRC on request as it is information that is generated in the hydraulic modelling process.

22 I understand from my discussions with Mr. Stephen Pattinson that variously A.Allan (GWRC) and separately M.Laws (SKM) have indicated that the flood flows across the Pattinsons property are respectively 4.24 cumec of channel flow and 0.21 cumec of overland flow, or 1.00 cumec of overland flow and 3.4 cumec of in channel flow. The latter figures are introduced on page 35 of the Becca 13 July 2015 report " Pinehaven Stream – Flood Mapping Audit ".

23. It is fairly obvious from looking at the actual modelled water depths that can be derived from the depths shown on Fig 3A by subtracting 300mm of freeboard, that there could not possibly be 1.00 cumec of overflow on

the land on the true left bank at 27 Elmslie Road extending up towards the road in a south westerly direction. Accordingly I conclude that A.Allan's description of the flow conditions are in fact wrong and cannot be relied upon.

24 When you examine the topography of 27 Elmslie Road and the upstream property on the ground on site it is also immediately apparent that the presence of timber paled fences, raised ground and houses etc. on the true left bank at and upstream of 27 Elmslie Road would make it near impossible for flood waters in an AEP 1 / 100 year event to pass down the true left berm and cross 27 Elmslie Road as these overland flood discharges being suggested would.

25. Given the above we are left with the conclusion if there are flood waters on 27 Elmslie Road in an AEP 1 / 100 year event as GWRC and SKM claimed, then they have either come off the road itself or are simply shallow overland flow generated by the 100 year rainstorm over the catchment and is then draining towards and eventually into PInehaven Stream.

26. Both Fig 1.and Fig 2 and Fig 3A and Fig 3B clearly don't indicate that the land lying to the north east of Elmslie Road and 27 Elmslie Road have flood waters either ponding of flowing over it which would exclude Elmslie Road as a possible source of any water in the order of 49mm or less on the area shown on Fig 3A with a depth including 300mm freeboard of 0.3m. Given that situation the water that is anticipated on that land in an AEP 1 / 100 year event which includes climate change must be shallow overland flow of the type described in Par 25. above.

27. I estimate using HIRDS V3 and the Rational Method that the depth of this type of overland flow would be typically in the order of 10 to 13 litres per second (0.010 – 0.013 cumec) with a flow depth in the order of 11 to 13 mm where it flows down the driveway adjacent to the house and with velocities in the order of 0.2m/s. This result is in the same order of water depths determined in Par 26 above albeit a lot smaller. By no stretch of the imagination could we describe these conditions as hazardous, traditionally we accept them as a nuisance and the NZ Building Code accommodates such conditions by specifying a minimum floor level e.g. NZS3604 Sec 7.5.2.1 (b) (i) & (ii), slab on ground construction, unprotected by permanent paving 150mm elevation (masonry veneer wall), 225mm elevation (other exterior claddings).

28. Given the above it is difficult to see how a 300mm freeboard is necessary at all on 27 Elmslie Road in the areas on the true left bank berm area on Fig 3A where that standard has been adopted and it should be removed from both the GWRC and UHCC flood hazard map for this property from those areas.

29. Freeboard is customarily applied to situations such as those that we are considering here where flood waters for example are either flowing or at rest (ponding). Where they are flowing and subsequently brought to rest, the water level rises locally by an amount described as the velocity head and whose value is the square of the approach velocity divided by twice the value of gravitational acceleration [e.g. a 2 m / sec velocity will yield a velocity head of (2 x 2 / 2 x 9.81 = 0.2m)]. In addition to that freeboard also allows for uncertainty in the values estimated for the flows being considered. By way of example for water flowing in a channel we might apply a freeboard equal to 1/6 th of the depth. Applying that approach to the Pinehaven Stream at 27 Elmslie Road we would arrive at 1.5m / 6 = 0.25m which we round up to 0.30m. For the shallow overland flow areas we don't require anything like 300mm, perhaps 50mm would be more than sufficient on flat ground and perhaps 100mm where surface undulations can locally trap and subsequently elevate water levels. In any event in these shallow overland flow situations the requirements of e.g. NZS3604 are more than sufficient.

30. Based on the assessment above I am of the opinion that for the berm area we are considering here on the true left bank of 27 Elmslie Road some clarity around the nature of the flood waters on that land in an AEP 1 / 100 year event (inc. climate change) is warranted to provide a better understanding at to what the land described on the UHCC flood hazard maps as " ponding " means because ponding per se is not accurate description of what is likely to be occurring on that land and accordingly creates a misleading impression.

32 In reality the areas zoned as " ponding " on the UHCC flood hazard maps is purportedly land which they consider on the advice of the GWRC that may be affected in some way by flood waters sourced from the Pinehaven Stream in an AEP 1 / 100 rainstorm event for which adjustments for future climate change effects have been included. In effect the UHCC flood hazard maps do not provide any real understanding of the nature of the flood hazard as such if it is present at

all. In order to understand what the UHCC flood hazard maps supposedly show in any detail, an approach must be made to the GWRC and have them source that detail from the GWRC flood maps which as has been described above are in themselves difficult to interpret. As has been explained above the GWRC apply 300mm of freeboard above both the surface water flowing in the stream and separately and at a different level on any surface water that the GWRC flood model predicts flowing on the berm regardless of the depth of that berm flow nor whether or not it might actually be there at all in an AEP 1 / 100 year event. Freeboard applied in this way creates a very confusing and misleading impression of the nature of the flooding present if at all and fails to clarify the scale of the hazard in any meaningful way. In reality it has the effect of concealing the actual flood conditions that may be present at a site and fails to quantify the true nature of the flood hazards that may be present.

Summary

33. In summary

(a) whilst there may be sufficient information presently held by GWRC which the community could use to determine a baseline against which to gauge whether or not hydraulic neutrality is being preserved in the face of further residential development say in the headwaters of the Pinehaven Stream. This information though is not presently freely available in the public domain. That situation needs to be remedied by publishing AEP 1 / 100 year peak flow estimates at discrete points down the catchment and these need to be included as an integral part of PC 42 as an appendix. That information must be representative of the pre-development condition of the Pinehaven catchments as determined by and represented in the hydrological assessments made by GWRC in 2008 and presented in a form that can be readily understood by lay people.

(b) Flood hazard maps (e.g. Urban Hazard Map 46) contained in PC 42 needs to be made informative with the addition of text to give a clearer understanding of their purpose and where more detailed information pertaining to the flood hazards associated with the flood hazard extent on the hazard maps may be found. In order to achieve that the flood hazard maps need to show the AEP 1 in 100

plus climate change flood profile free of freeboard and with relative flood hazard classifications clearly identifiable on those maps.

(c) The term " ponding " used on the UHCC flood hazard maps are a poor choice of terminology and should be replaced with wording which more accurately describes what the nature of the flood hazards are that are identified for such areas. Having said that the maps should ensure that they limit the areas mapped as having flood hazards present, to those areas where actual flooding and related flooding effects are likely to be present and not confuse the issue by including freeboard (s) as GWRC has done and which ultimately has been adopted by UHCC to determine what their maps describe as " flood hazard extent".

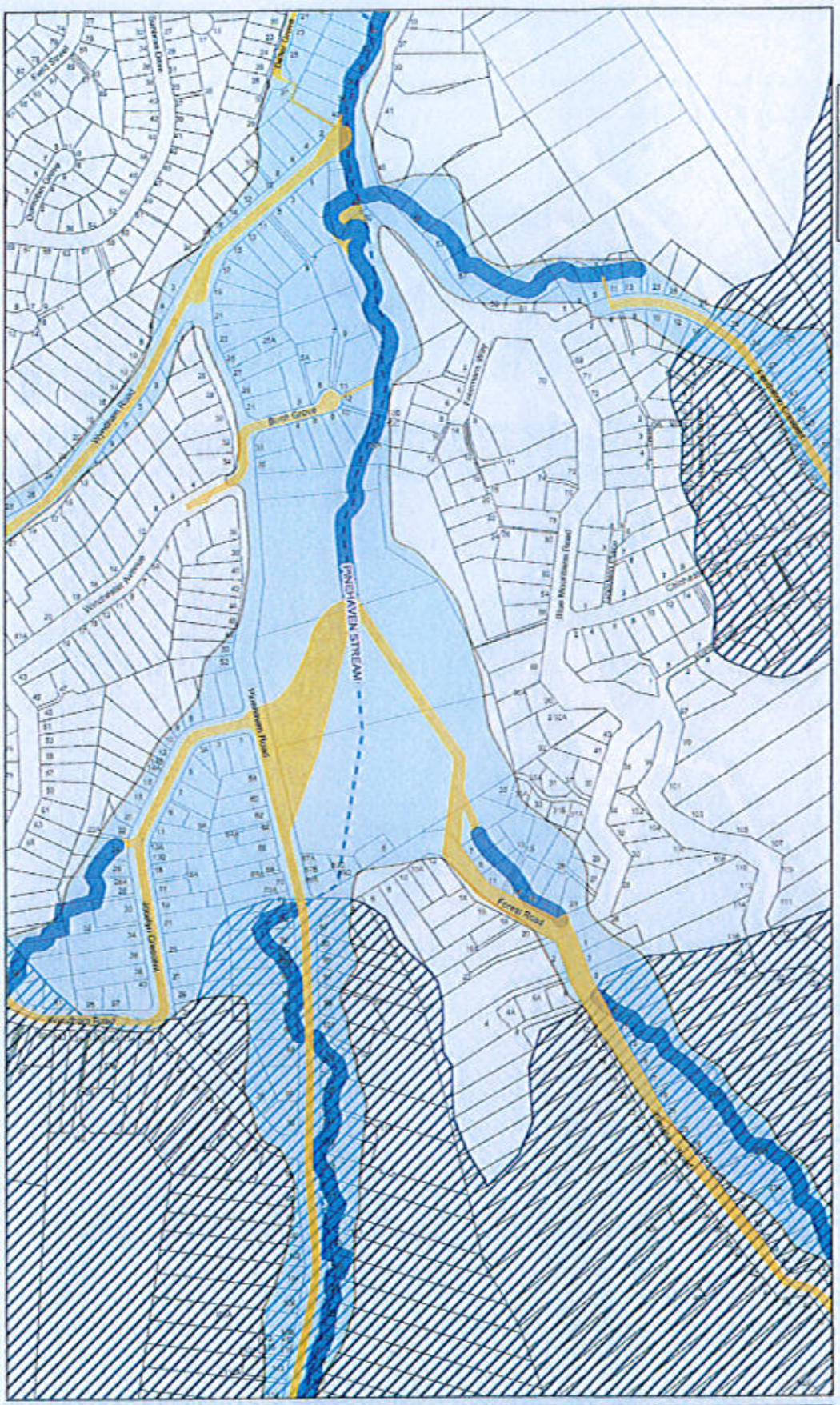
(d) My assessment of the situation on the Pattinsons property and the deficiencies evident in both the UHCC and GWRC flood hazard maps are likely to be present elsewhere in the catchment and not limited simply to the Pattinson property and accordingly this indicates to me that a critical review of what is presenty being made available with respect to the nature and extent of the flood hazards in the Pinehaven and Mangaroa catchments needs to be undertaken to ensure that what is eventually produced serves the purpose of presenting flood hazard information across the catchment in an informative and accurate way that can readily be understood by the community.

.....

Robert Hall

Director R.J.Hall & Associates Ltd

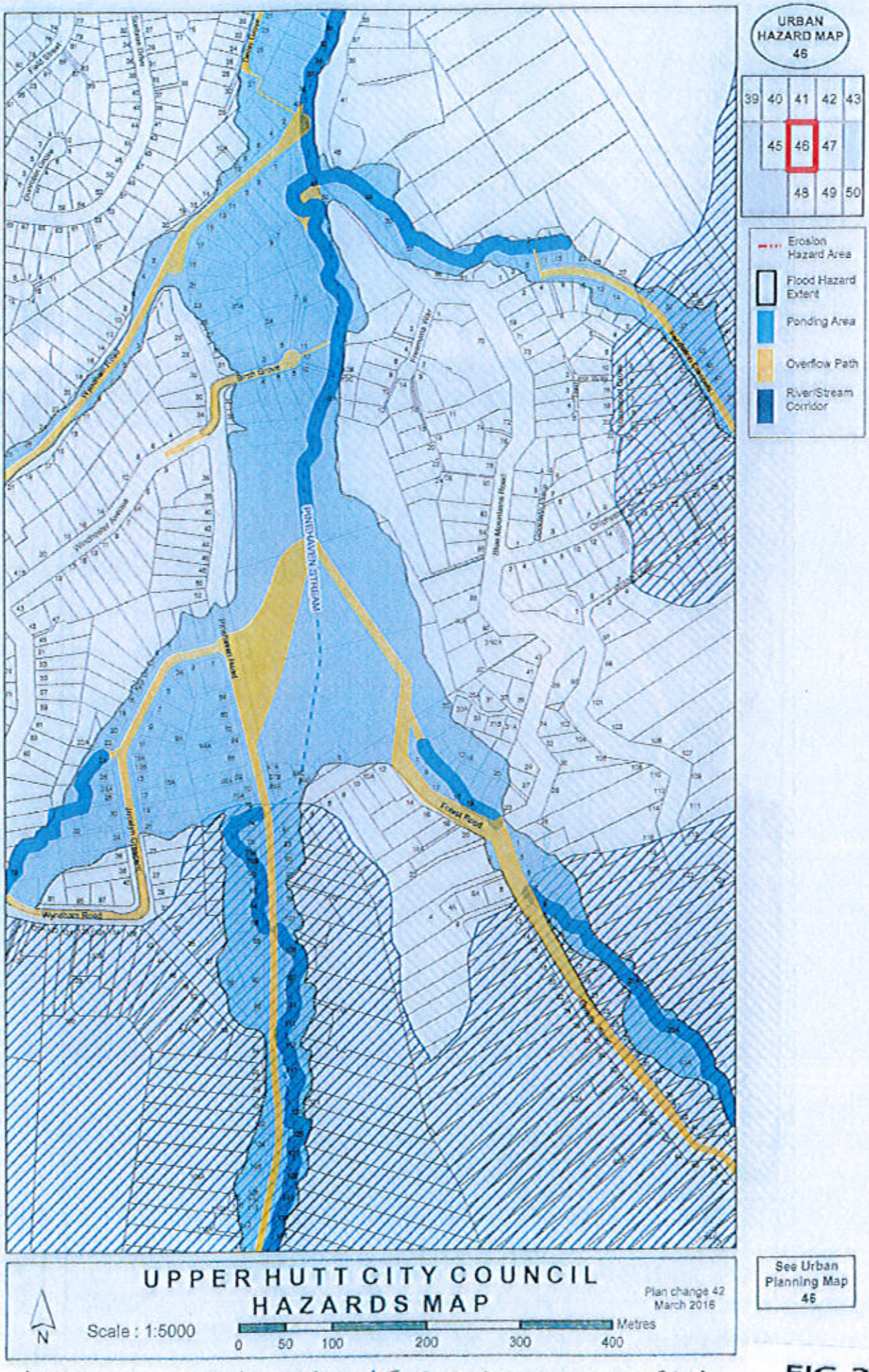
26 September 2017



APPENDIX 4, OF PC42 AS NOTIFIED

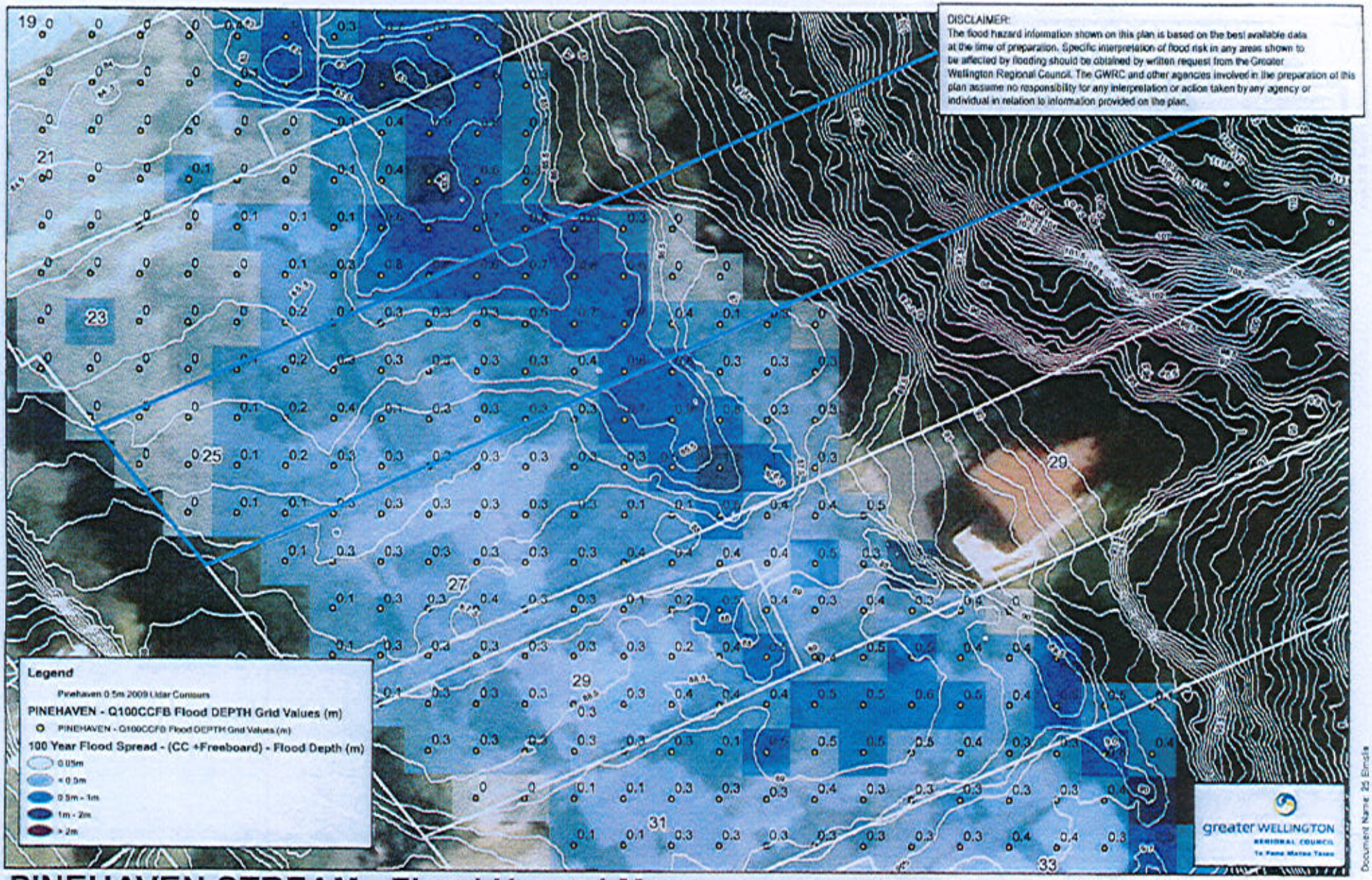
FIG 1

PART OF SEC42A REPORT



AMENDED MAP 46 ISSED AFTER SUBMISSIONS ON PC42

FIG 2



PINEHAVEN STREAM - Flood Hazard Map

25 Elmslie Road - Water depth

User Name: westlakes
Plotted 3:27:32 p.m., 22/05/2017

Regional Orthophotography Copyright : GWRC / NZAM 2013
Topographic and Cadastral data is copyright LINZ

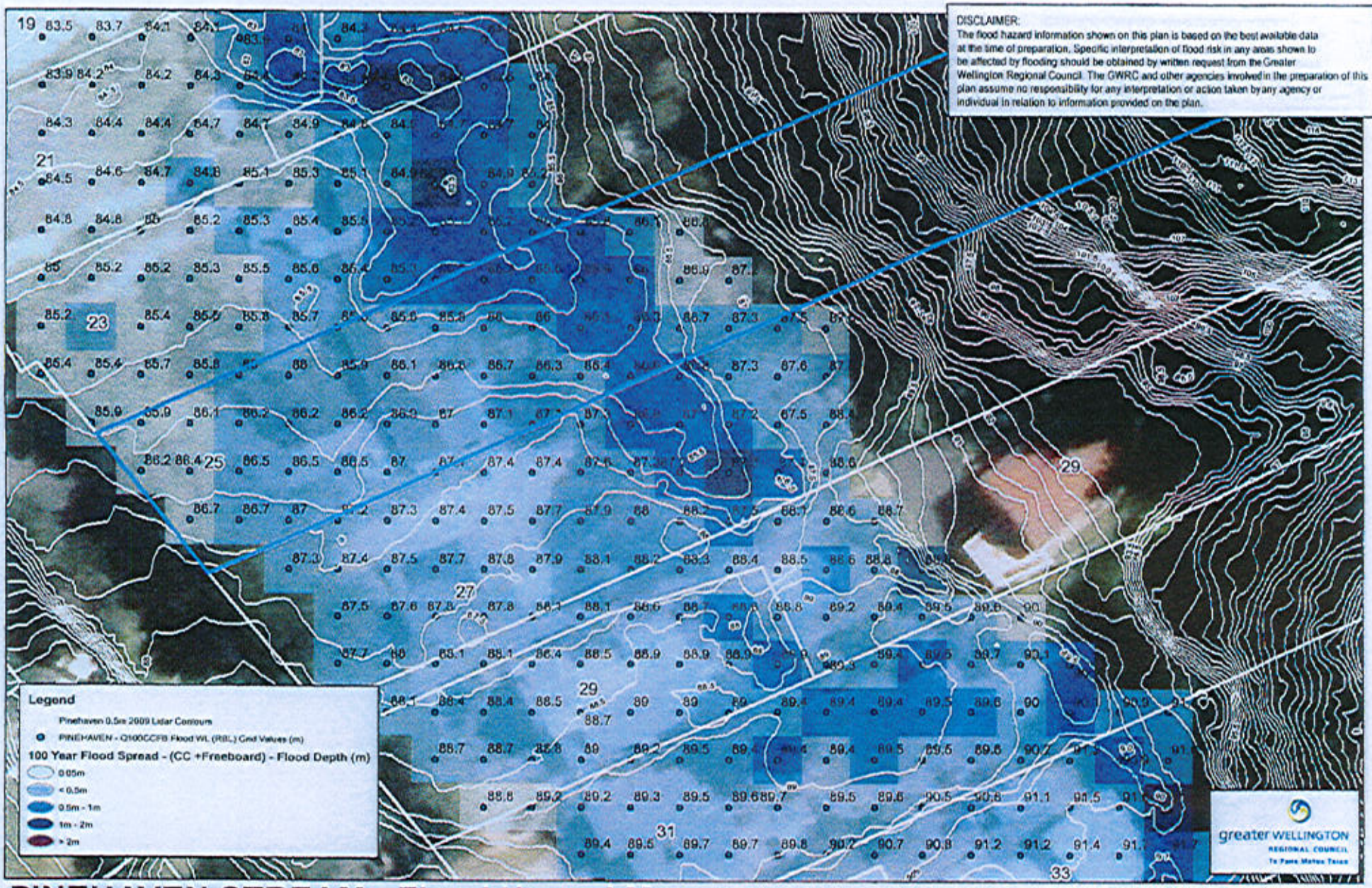
0 2.5 5 10 15 20 25 Metres

A4 Scale : 1:500

N

FIG 3A

Document Name 25 Elmslie



PINEHAVEN STREAM - Flood Hazard Map

25 Elmslie Road - Water level

User Name: westlakes
Plotted 3:21:36 p.m., 22/05/2017

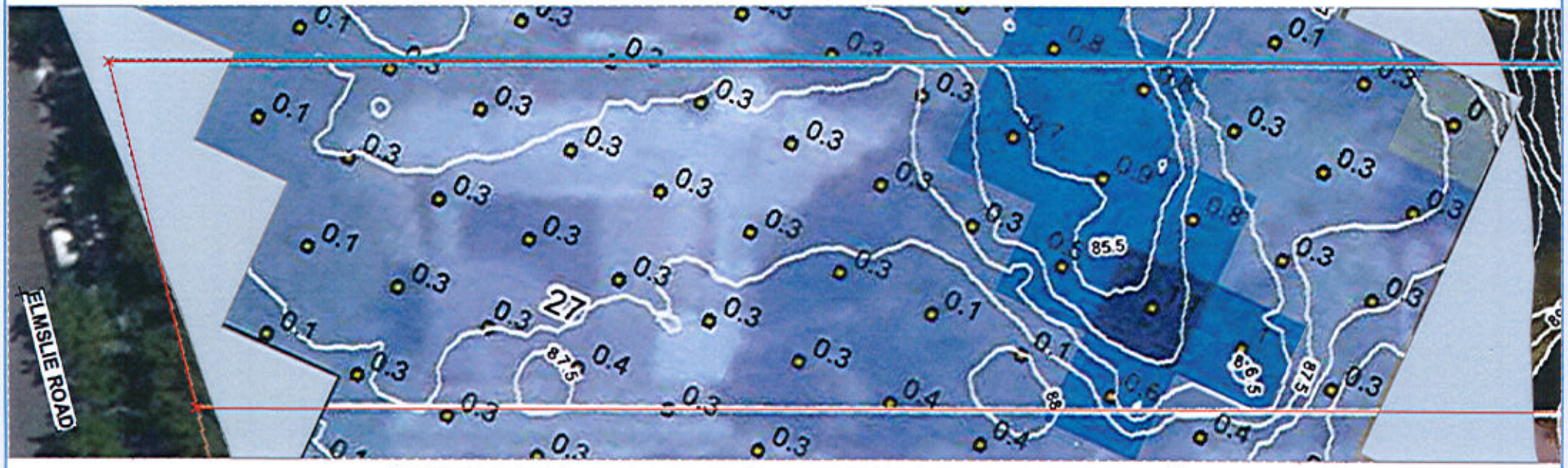
0 2.5 5 10 15 20 25 Metres

A4 Scale : 1:500

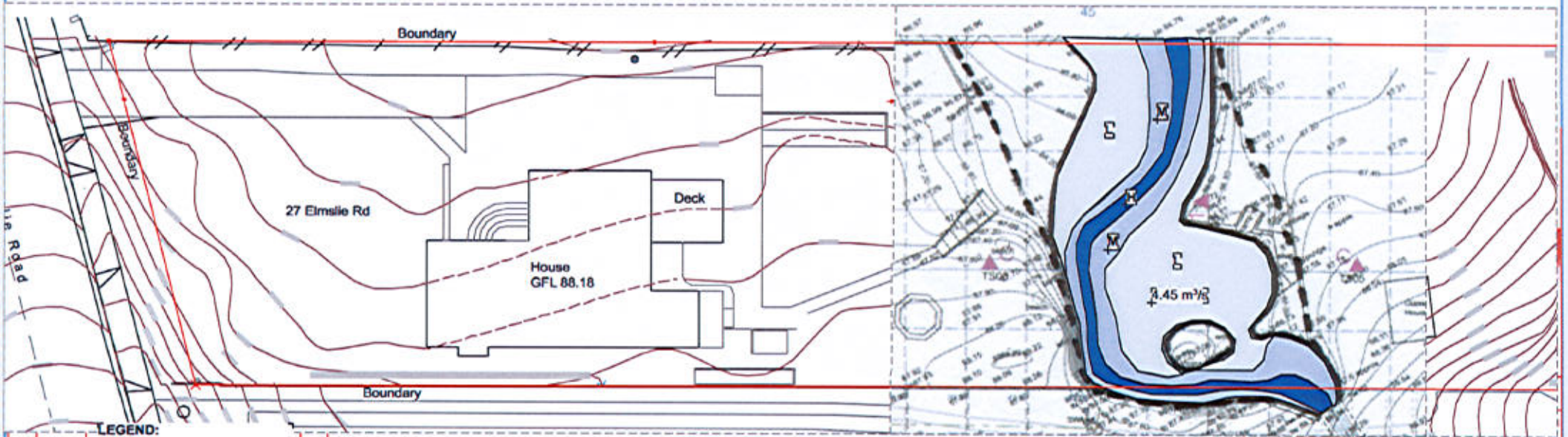
N

Document Name: 25 Elmslie

FIG 36



#27 GWRC - Q100 CC 100-year Flood Map for 27 Elmslie Road, Pinehaven (September 2017) 1:200 @ A3 size



R J Hall - Q100 CC 100-year Flood Map for 27 Elmslie Road, Pinehaven (September 2017) 1:200 @ A3 size

R J Hall - **Fig. 4**