BEFORE THE CHRISTCHURCH CITY COUNCIL

IN THE MATTER	of the Resource Management Act 1991 ('the Act')
AND	
IN THE MATTER	of a private plan change request by Highfield Park Limited to rezone approximately 260 ha of land adjoining Redwood from Rural 3 (Styx-Marshland) to Living G (Highfield)
BETWEEN	**HIGHFIELD PARK LIMITED** Requestor
A N D	**CHRISTCHURCH CITY COUNCIL** Local Authority

EVIDENCE OF ANDREW KEITH BROUGH ON BEHALF OF HIGHFIELD PARK LIMITED

INTRODUCTION

1. My full name is Andrew Keith Brough. I hold the qualification of Bachelor of Engineering (Agricultural) from Canterbury University. I have over 20 years experience as an Environmental Engineer in the fields of stormwater management, wastewater treatment and land application of domestic and industrial wastewater. I am a Senior Environmental Engineer with Pattle Delamore Partners Ltd (PDP).

2. I have extensive experience of stormwater treatment design, stormwater modelling and servicing of developments. The following is a list of a few of the relevant projects relating land development I have been responsible for:

   (a) preparation and presentation of evidence in relation to Plan Change 10 – a private plan change request for re-zoning of land at 140-150 Hussey Road, Christchurch. This project included hydraulic and hydrologic modelling of the re-zoned land plus updating the MOUSE model of the Hampton Grange stormwater pond (a total catchment of approximately 50 hectares) to determine the amount of extra storage required in the Hampton Grange pond, detention storage required on-site to address pipe capacity issues, plus application to Canterbury Regional Council (CRC) for a stormwater consent;

   (b) Peer Review of the Engineering Assessment for Paparoa Views – a proposal to rezone approximately 70.3 ha of Industrial and Rural zoned land to Industrial, Commercial, and Residential zones at Dobson, West Coast;

   (c) Detailed design of the water supply, sewer, and stormwater for a 25 Lot Industrial subdivision at Rolleston, including applications for building consents, consents to Canterbury Regional Council for discharge of stormwater, and construction administration;

   (d) preparation of stormwater management solutions for Plan Change 43 (East Belfast), presentation of evidence at the plan change hearing and preparation of evidence for appeal to the Environment Court;

   (e) carrying out preliminary sizing of stormwater management systems for the Lower Kaputone catchment for the Belfast Area Plan blueprint, using parameters and design criteria supplied by Christchurch City Council (CCC);

3. PDP was first engaged by Highfield Park Limited to provide advice regarding the design of new stormwater, wastewater and water supply services to support a private plan change request by Highfield Park Limited to rezone the land identified as Growth Areas CN5 and CN6 for urban purposes. I have led the services analysis and design inputs into that process.

4. I have read the Environment Court's Code of Conduct and agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this statement of evidence are within my area of expertise.

5. The data, information, facts and assumptions I have considered in forming my opinions are set out in the part of the evidence in which I express my opinions.

6. I have not omitted to consider material facts known to me that might alter or detract from the opinions I have expressed.

SCOPE OF EVIDENCE

7. In my evidence I present information regarding the suitability of the site for residential development with respect to servicing the site for stormwater, wastewater, and water supply. In addition I also provide comments on the Officers Report and submissions as they relate to each aspect of servicing of the development.

EXECUTIVE SUMMARY

8. The site requires the development of new stormwater, wastewater, and water supply services to meet the needs of the development of the site. Approximately 1/3 of the south of the site is subject to historic flooding problems attributable to a stormwater network which is under capacity in the south of the area.

9. For extreme events existing flooding occurs up to a level of about 14.9 m RL (CDB Datum). The existing flooding on site can be alleviated by improving the capacity of the drainage network. The proposed reconfiguration of Horners Drain should provide significant drainage improvements to the general area and aid development of the site.

10. Stormwater treatment for on-site development can be managed by treatment systems that have been promoted by CCC. These would consist of a dry pond and constructed wetland located off line from the main drainage work.

11. CCC have promoted a long term solution for wastewater management which involves installing pump station(s) and rising main(s) to the Northcote Collector located in Main North Road.

12. There is sufficient water resources available from the existing supply to allow development of the site to proceed. Depending on the investigations currently underway by CCC future demand may either be met by new bores installed in the existing developed area or a new bore within the Plan Change Area.

DESCRIPTION OF PROPOSED DEVELOPMENT

13. The overall description of PC67 is provided by other witnesses. The following description relates to matters which impacted on the sizing of the proposed stormwater management facilities, as discussed further below. The proposal contains a Living G (Highfield) Zone along with small areas of Business 1 zoning as shown on the ODP.

14. It is proposed that the Living G zone contains four residential densities. The specifications of the site coverage for residential density areas can be summarised as follows:-

    (a) Density Area A:

        (i) 60% site coverage by dwelling and garage (Critical Standard).
        (ii) Maximum impervious cover (buildings and hardstand) is 85%.

    (b) Density Area B:

        (i) 55% site coverage Development Standard, 60% site coverage Critical Standard by dwelling and garage.
        (ii) Maximum percentage of site covered by paved impervious surfaces is 25%.
        (iii) A total maximum coverage of 85% for Critical Standard.

    (c) Density Areas C:

        (i) 40% site coverage Development Standard, 45% site coverage Critical Standard by dwelling and garage.
        (ii) Maximum percentage of site covered by paved impervious surfaces is 25%.
        (iii) A total maximum coverage of 70% for Critical Standard.

    (d) Density Area D:

        (i) 35% site coverage Development Standard, 40% site coverage Critical Standard by dwelling and garage.
        (ii) Maximum percentage of site covered by paved impervious surface is 25%.
        (iii) A total maximum coverage of 65% for Critical Standard.

15. While the description above defines the maximum permitted site coverage for residential development, in reality not all lots are developed to the maximum site coverage, and impervious surfaces at the rear of properties rarely connect to the stormwater infrastructure. Therefore, the calculations of the stormwater management facilities described later in this report will be based on parameters of impervious cover over the total development area from CCC data for the Draft Styx Integrated Catchment Management Plan (ICMP).

16. For the Business 1 zones I have assumed that there is 90% impervious cover.

17. It is intended that the site meets a CRC requirement for a net residential density of 15 units per hectare. This helps to determine the impervious coverage across the site by limiting the amount of pervious surfaces.

STORMWATER

Existing Drainage

18. **Figure 1** shows the existing drainage network in and around the site. Water flows into the site from a number of drains. The largest are Horners Drain which collects water from Tylers and Winters Road Drains in the south and normally conveys it through the southern part of site and around the northern part of the site following Prestons Road and Hills Road to the Styx River in the north. Kruses Drain and other unnamed drains flow into it that collect urban runoff from northwest Christchurch. The flow from these drains is also normally conveyed by Horners Drain to the Styx River.

19. **Figure 2** shows the natural landslope for the site which is largely to the south. This drains into what is referred to as the Cranford Basin. The surface water levels in the Cranford Basin are controlled by:

    (a) flood pumps which drain Horseshoe Lake;

    (b) the capacity of the existing drainage network; and

    (c) management of control structures that exist in the drainage network.

20. The capacity of the drainage network, in particular, means that water cannot drain away from the southern part of the site at a sufficient rate to prevent water ponding in this area. This is a historic issue. Horners Drain was constructed in the late 1800s in an attempt to relieve the flooding. Horners Drain has been excavated against the natural land slope to drain water into the Styx River. As shown in **Figure 3** it has a very flat bed slope between QEII Drive and Prestons Road with the bed slope steepening from Prestons Road through to the Styx River.

21. Currently Horners Drain has a capacity of approximately 2.5 m^3/s. This capacity is insufficient to relieve the ponding in the southern part of the site or carry the flow from the Kruses Drain catchment. In some circumstances it is possible for flow from Kruses Drain to exceed the capacity of Horners Drain to the north resulting in flow in both northerly and southerly directions along Horners Drain. I observed this occurring on 18 August 2011 after the snow and rain of the preceding 3.5 days.

22. In addition to the water entering the site from the surrounding area there is also runoff that occurs from the land within the site.

23. It is recognised that Horners Drain carries a continuous base flow. This is generated by springs in upstream drains (such as Tysons Drain) which contribute flow to Horners Drain (CCC, May 2005). Horners Drain may also drain groundwater from the site in situations when high groundwater levels occur.

Existing Flooding

24. Christchurch City Council has two models which are used to assess the amount of flooding in the PC67 land and the flows in the drains that discharge from the site. These are the Cranford Basin and Styx River Models. The Cranford Basin model provides predictions of flooding for the storm durations which result in the greatest flooding (the critical duration storm). For the Cranford Basin system the critical storm is one with a duration of 24 hours. **Figure 4** (supplied by Brian Norton (CCC)) shows the current best estimate of the flood level for the 2% AEP event from the Cranford Basin model. This shows peak levels of around 14.8 m to 14.9 m RL over the PC67 land.

25. In extreme events, the flood level is moderated by discharge via Horners Drain in to the Styx River. The Styx River model uses that discharge in assessing the extent of flooding in the Lower Styx Ponding Area. Before the site can be fully developed a full assessment of options to address the flooding in the south of the site will need to be completed.

Shallow Groundwater Levels

26. The depth of the shallow groundwater will impact on the detailed design of the stormwater management systems for the development. The preferred option which I will discuss later utilises dry ponds and constructed wetlands. The invert of the ponds need to be above groundwater most of the time, while it would be useful if a base flow was maintained through the wetlands. The level and range of groundwater will affect the area required for the dry ponds and the base level of the wetlands.

27. To begin this process Highfield Park Ltd has engaged PDP to install 8 monitoring wells in and around the site. So far these have been monitored on 12 occasions, seven of which coincided with monitoring carried out at the Tyrone Street pump station by Christchurch City Council. The water levels in the well at Tyrone Street have been monitored since 1984. **Figure 5** shows the location of the Tyrone Street Well along with the 8 monitoring wells.

28. A preliminary analysis of the two sets of data has been carried out and from a comparison with the long term data at Tyrone Street we have made an initial assessment of likely water levels across the site. **Figures 6 and 7** show the simulated water levels in the 8 monitoring wells along with the measured water levels in the Tyrone Street well. These levels show a seasonal variation with the highest water levels typically being between July and October. The water levels indicate that, based on the preliminary design to date, the groundwater will likely be above the invert of the dry ponds for differing periods (depending on location) so that a low flow drainage channel will be required in these dry ponds. The results also indicate that the wetlands are likely to receive groundwater inflow. Once again the duration will depend on the location of the wetland.

Stormwater Management Options

29. CCC has developed a hydrologic and hydraulic model for the Cranford basin catchment which includes the site. The runoff calculated from this model has been provided to PDP by CCC for specific storm events as shown in Figure 5. In addition CCC has developed a spreadsheet model for sizing stormwater detention facilities for the Styx ICMP. This has been provided to PDP by Ken Couling (CCC). These have been used to size stormwater management systems as described below.

30. The volume and rate of runoff from urban development is dependent on the amount of impervious cover and whether any at source measures have been implemented to reduce the rate of runoff (e.g. roof water tanks). For the purposes of this assessment no at source measures have been included.

31. For the purposes of assessing a stormwater management solution we have adopted the design methodology that CCC are using for the Styx ICMP on the basis that any stormwater management system developed for the site would be adopted and maintained by CCC in the future. I consider that the method of treatment of stormwater runoff from residential areas proposed by the CCC in the Styx ICMP will achieve a water quality suitable for discharge to the Styx River.

Preferred Stormwater Management Option

32. The preferred stormwater management option for the site consists of a first flush treatment system consisting of a dry basin followed by a constructed wetland, along with detention storage. These would be sized to treat the runoff resulting from the first 25 mm of rainfall. Stormwater detention to match pre- and post-development flows would be provided.

33. CCC staff (Ken Couling pers. comm., August 2011) have indicated that they are willing to consider a system which utilises the freeboard within the pond and wetland to provide detention storage for runoff in excess of the treatment volume. This provides partial storm detention storage and is based on the remaining volume of runoff being contained in the Lower Styx Ponding Area (as defined in the City Plan and shown on City Plan Maps 1b, 4b, and 11b) at Brooklands.

34. For the purposes of providing areas to be shown on the outline development plan I have assumed that the stormwater management options include detention storage for the difference between pre- and post-development runoff that occurs during a storm event. The areas shown have been based on an average depth of the first flush basin and detention storage of 1.0 m. The areas occupied by each residential density as shown on the Master Plan have been used to calculate the areas of the stormwater management systems shown on the Master Plan.

35. These treatment and detention facilities will be offline from Horners Drain so they can manage runoff from the development but not the other runoff that discharges into Horners Drain.

Management of Existing Flooding

36. One potential method to address the existing flooding described in paragraphs 24 and 25 is to re-configure Horners Drain to increase its capacity. This increase in capacity can be achieved by:

    (a) re-aligning Horners Drain so the travel path is shorter;

    (b) re-grading the invert to provide a more constant grade (as shown in **Figure 9**, removing the flat grade from QEII Drive to Prestons Road (shown in **Figure 3**);

    (c) change the drainage channel cross-section to carry more water and at a shallow depth.

37. The applicant proposes to do all three and the proposed new alignment for Horners Drain is shown in the Master Plan prepared by Harrison Grierson Consultants Ltd.

38. The proposed realignment of Horners Drain will result in significant benefits to CCC. Horners Drain currently is up to 5 m deep and has a reinforced concrete lining to support the sides. This lining is severely corroded such that the reinforcing rods within the concrete are exposed. It is well overdue for repair. In addition due to the very flat grade along part of its length the capacity of Horners Drain is limited so that it does not relieve existing flooding to the south as well as it might. By carrying out the development including realigning Horners Drain, Highfield Park Limited would address these issues for Christchurch City Council.

39. **Figure 10** shows the current estimate of the flood levels in the Cranford Basin for the 2% AEP event if the capacity of Horners Drain is improved to 3 m^3/s. The improvement in capacity of the drain does not completely address the extent of flooding in the south of the site and some flood storage will be required.

40. Design of the drain will determine its capacity and hence the flood level. Therefore the applicant is proposing to defer the development in the southern area of the site (as shown on the Master Plan) until the further detailed design and modelling has been carried out which will confirm the final area required for flood management.

Existing Stormwater Discharges to Horners Drain

41. In addition to its function to relieve flooding in the south, some areas outside of the Plan Change site in the Cranford Basin model discharge directly to Horners Drain. These include the Kruses Drain catchment and the catchments to the west of the Plan Change site and north of Prestons Road. At a minimum the existing capacity of these drains will need to be maintained.

42. Apart from potentially re-configuring these drains, it is not proposed to carry out any treatment or flood mitigation measures to address flows from these areas. Although I note in para 39 of Appendix 8 of the Officer's Report that Council *"may seek to acquire lands within the development area, or enter into separate cost-share agreements to provide some 'retro-fit' mitigation of offsite catchments".* This is a process which CCC and the applicant can address during the subdivision application phase and does not impact on the overall proposal for stormwater management provided for the PC67 land.

Alternative Stormwater Management Options

Alternative Stormwater Treatment

43. In addition to the preferred stormwater management option described above, there are other possible treatment options. These include:

    (a) vegetated swales;

    (b) infiltration basins;

    (c) extended detention wet ponds;

    (d) proprietary treatment devices;

    (e) combinations of the above.

44. The advantages and disadvantages for each individual treatment system are presented in the "Waterways, Wetlands, and Drainage Guide" (CCC, 2003). Rather

than repeating that information here the following discussion will focus on other treatment systems that are potentially feasible options for this site.

45. Vegetated swales are primarily conveyance systems where some removal of contaminants can be achieved by filtering of water as it passes through the stems of the plants growing in the swale. Swales are generally used in conjunction with other systems. The principal disadvantage with them is that they need a significantly larger amount of land area for conveying stormwater compared with pipes in the ground. In a residential layout with higher building densities and therefore smaller lot sizes and minimal frontages, swales can be an inconvenience at accessways, driveways, and intersections, where a piped section or culvert is required anyway.

46. Swales do have an advantage in that they can convey significant flows at relatively flat slopes. As the site is relatively flat they do have the potential to be used in this area. They may be utilised in areas where higher flows mean that the flow capacity benefits of the swales are desirable.

47. Due to the predicted high groundwater table, infiltration basins are not recommended as there is likely to be insufficient separation between the infiltration basins and the groundwater table which reduces the potential for satisfactory treatment of groundwater. During large storm events these systems may contribute to localised flooding by excessively raising groundwater levels.

48. Extended detention wet ponds can be located in sites where groundwater is intercepted. They generally fit in well with CCC's six values approach except that they probably do not provide the recreational options available compared to a dry detention pond.

49. Proprietary treatment options come in many shapes and forms, and fall into three distinct categories:

    (a) settling;

    (b) hydrodynamic separation;

    (c) filtration.

50. Filtration options generally provide the greatest removal of contaminants and the settling options the least removal rates. These devices are designed based on the flow rate through them rather than retaining a volume of water. Therefore in general they provide treatment with a smaller footprint than the pond or wetland options. While these systems do not achieve all of the six values, the potential treatment performance for the best proprietary systems is greater than for most of the other treatment options described above. As these treatment devices are sized

based on a flow rate, sometimes a dry detention basin, to buffer the flows, in front of the treatment device is required to achieve an economically sized system.

51. The best removal rate of contaminants is achieved using a treatment train approach where treatment systems are installed in series. CCC suggests such an approach for the treatment of stormwater. The treatment system they would prefer to see is swales for conveyance and filtering of stormwater followed by a dry detention basin for treating the first flush, with a wetland for polishing the treated stormwater from the detention basin. CCC consider that this treatment train best meets the six values approach.

Alternative Stormwater Detention

52. At this stage, the areas set aside for stormwater management are based on providing total detention of the difference between the pre-development and post-development runoff for the PC67 land for the critical duration storm event for the Styx River. The final volume required will depend on acceptance by ECan of the proposal by CCC to raise flood storage in the Lower Styx Ponding Area (LSPA). If this can be raised, then only partial detention storage would be required on the site with the remaining volume discharged into the Styx River and detained in the LSPA.

53. The consequence of not requiring all the areas currently set aside for stormwater management is that the remainder of these areas could be used for recreation reserve such as Neighbourhood Parks. The precise details of how much land is required for stormwater management and how much is available for recreation reserves will be confirmed at subdivision stage.

Alternative to Horners Drain Realignment

54. The detailed engineering and geotechnical design for the proposed alignment will be carried out at during the subdivision design. This work may identify the need for changes to the layout to achieve a suitably robust solution. I understand that Highfield Park Ltd propose that the Rules relating to the any alterations to the Horners Drain alignment are changed from being non-complying to discretionary. I consider this is appropriate so that alterations made to the layout during the detailed design are not subject to an unnecessarily difficult planning process.

Staging of Development

55. Highfield Park Ltd has indicated to me that the first stage of the site development will occur in the area north of Prestons Road. The first stage involves a significant amount of cut (estimated at around 600,000 m^3). The realigning of Horners Drain cannot occur until most of this excavation has occurred to bring the land down to its finished level. It is too early in the development programme to determine the sequencing of the work and how many lots will be developed at any one time.

56. While the preliminary earthworks are happening on the site the current alignment of Horners Drain needs to be maintained so that flows can continue from the south without impeding the development. Once the new alignment is created north of Prestons Road then the unused length of Horners Drain can be partly filled in and maintained for local drainage purposes.

57. The work CCC has done as part of the Styx Catchment Stormwater Management Plan (SMP) has identified a solution for stormwater management to the south of the site. This is identified in the SMP as a large stormwater management facility called Horner/Kruses at the southern end of the PC67 land Figure 4 of Appendix 8 of the Officer's Report. Once the detailed design of this system is completed and the final area confirmed then the deferment can be lifted from the southern third of the site.

Consenting Requirements for Discharge of Stormwater to the Styx River

58. The Styx River is a tributary of the Waimakariri River. At the time of preparing the Servicing Report to support the plan change, activities associated with the Waimakariri River and its tributaries were covered by the Waimakariri River Regional Plan. Since then, by order of CERA (dated 23 May 2012), the Christchurch City sub-catchments draining to the Styx River have been moved under the jurisdiction of the Natural Resources Regional Plan (NRRP).

59. While preparing the application for the Plan Change I was aware that Christchurch City was preparing the Styx Catchment Stormwater Management Plan (SMP) consent application to ECan. This SMP covers the PC67 site. Therefore a decision was made by the applicant not to apply for a stormwater discharge consent to ECan at that time as it was hoped that CCC would have lodged consent for the SMP and have it accepted by ECan. I understand that once the SMP is accepted as complete by ECan the SMP may be treated as operative in accordance with Rule WQL7 of the NRRP. This would allow CCC to authorize new discharges under the SMP and hence the PC67 site would not need to apply for its own separate consent.

60. I understand from discussions with Brian Norton (Planning Engineer, CCC) that CCC have now lodged the Styx Catchment Stormwater Management Plan consent to ECan, and it is now being considered by ECan for completeness under Section 88 of the RMA. I am confident that this consent will be accepted by ECan in the period between now and when the stormwater discharge consent will be required for the PC67 land. Should this not happen my clients will need to separately apply for a stormwater consent for the PC67 land. Either way I consider a consent for discharge of stormwater can be obtained. Provisional acceptance by CCC of the stormwater management proposed is indicated in paras 22 to 30 of Brian Norton's Stormwater report (Appendix 8 of the Officers Report).

Summary of Stormwater Management for the Site

61. Flooding can occur over the southern part of the site during heavy sustained rainfall. This flooding, in part, is attributed to insufficient capacity in Horners Drain. The development of this site provides an opportunity for the lack of capacity in Horners Drain to be resolved. Subject to agreement from CCC, ECan, Highfield Park Limited propose to realign and reconfigure Horners Drain. As described earlier in my evidence these changes to Horners Drain can provide an increased capacity which will reduce the potential for flooding on site and resolve the problem CCC have with maintaining the current drain.

62. Treatment and detention systems have been sized consistent with the design promoted by CCC for the Styx ICMP. Many other alternative systems are available to manage the stormwater.

63. I consider that stormwater management solutions exist which will allow the site to be used for residential development.

Comment on Officers Report

64. In terms of stormwater management the Officer relies on the technical input presented in Brian Norton's report (Appendix 8) of the Officer's report.

65. I have already discussed aspects of the Brian Norton's report. At the outset we consulted with CCC staff as to the type of stormwater management they would require and we have presented a system that we consider reflects the City's own vision for stormwater management facilities in this area. I consider that Brian Norton's report reflects that, and I agree with his para 48 as to the mitigation measures to be implemented as part of the stormwater design for the site.

66. In para 33 of Brian's evidence he discusses the availability of land within the Horners Drain corridor for open space and local purpose utility reserve. I agree with him that the width of the water surface during a 2% AEP event will set the area of the local purpose utility reserve. It was intended that this open space corridor was sufficiently sized so that there was open space that would be available for Neighbourhood Parks. I believe that this area was not included into the initial calculations of the reserve areas required but would be assessed at the subdivision consent stage after further detailed stormwater engineering design had been completed.

67. The Officer's report takes on board the advice from Brian Norton and the review of the submissions to make a few recommendations for proposed amendments to the Rules package. The table below summarise those recommendations:

Proposed Amendment	Paragraph Reference in Officer Report	Amendment Reference in Appendix 13
Amend policy – wording of stormwater management provision	190	4
Amend info requirements – include info on sediment discharge at time of subdivision	193	19
Amend rules – wording of deferral provisions for southern land	198-200	15, 17
New rule – Floor levels must be above 0.5% AEP return period flood event	203	13
Amend policy (and assessment matter) - refer to Styx Stormwater Management Plan	222	2, 21

68. I fully accept the amendment 2, 19 and 21 in Appendix 13 as proposed. For the amendments 4 and 17 I accept the general nature of the proposed amendments but suggest that the rules use the terms surface water management and stormwater management rather than include the additional words relating to detention, treatment and disposal. In my opinion a surface water/stormwater management system is one that provides both treatment and detention. If I was only providing for treatment or detention I would use those terms to describe the system.

69. With respect to the fourth amendment listed, this level for the minimum floor level is inconsistent with how CCC planning engineers have specified recommended floor levels across Christchurch. In the flood management areas the floor level is based on the 0.5% AEP flood event plus freeboard, while for other areas it is based on the 2% AEP flood event plus 400 mm freeboard.

70. The principal risk of flooding in the PC67 area results from flooding in the Cranford Basin. Any increase in flood volume will only result in a small incremental increase in water level across the flood area. It is unlikely that the 0.5% AEP event will result in more than 400 mm increase in water levels hence the current method used by CCC planning engineers is appropriate. The CCC planning engineers are generally conservative in their approach and I fear that they would wish to apply a freeboard to the modelled 0.5% AEP event to account for modelling uncertainty.

71. The application of a freeboard would raise the building floor levels an unreasonable distance above the finished section levels, which are likely to be at the 2% AEP level, meaning that it may be impracticable to build a house. In addition the house may not meet recession plane requirements and other building consent rules. Therefore I propose the following revised wording Amendment 13 of Appendix 13:

12.4.13 Minimum design standard for floor levels

The minimum design standard for building floor levels shall be *400 mm* above a~~n~~ *the level in the Cranford Basin resulting from a 24 hour duration* ~~0.5~~ *2*% AEP return period flood event .

WASTEWATER

Existing Wastewater

72. Currently, the Plan Change Area is predominantly rural and is not serviced by Christchurch City Council (CCC) wastewater sewers and instead utilises individual septic systems. A Council wastewater reticulation network services the developed areas of Redwood to the west and Belfast to the north west (both residential and industrial) of the Plan Change Area. There is little or no network availability to the south (the pipe in Hills Rd being too small to be considered) and nothing to the east.

73. **Figure 11** shows that the closest existing public trunk connection is the 375 mm gravity sewer running north-south along Grimseys Rd on the western boundary of the Plan Change Area. This sewer gravitates into Pump Station 53 (PS53), on Grimseys Rd at its southern end. In addition, Pump Station 74 (PS74) is located upstream of the 375 mm trunk main on Preston's Rd. Discussions with CCC officers indicate that there is no capacity available within either of these pump stations, to allow connection of significant new development from the Plan Change Area.

74. PS74 and PS53 both connect into the Northern Relief trunk sewer system by way of a large sewer pipeline known as the Northcote Collector sewer. This 675 mm diameter sewer is located on Main North Rd, to the west of the Plan Change Area. This sewer gravitates into the Northern Relief trunk sewer, which conveys wastewater to Bromley wastewater treatment plant.

75. Discussions with CCC officers in November 2011 indicated that the Northern Relief trunk sewer was already at capacity before the earthquake and that post-earthquake, with an increase in Inflow & Infiltration to the damaged sewer network, CCC were struggling to meet the consent conditions imposed by ECan for the operation of sewer overflows during wet weather conditions. At that time, CCC were working to quantify the extent of the problem, by way of a new wastewater hydraulic model, which was being constructed and calibrated. Once complete, this model was to be used to investigate mitigation works or upgrades which would relieve the overflows to the satisfaction of Environment Canterbury.

76. More recent discussions with CCC officers have confirmed that the wastewater hydraulic model is now calibrated, and has been used to look at the impacts of upgrading works to the trunk wastewater system. CCC confirmed that the results of these investigations indicate that the completion of major upgrading works, which

were under construction prior to the earthquakes, will significantly reduce the numbers of overflows from the wastewater system into the environment during storm events.

77. Further modelling investigations by CCC, have resulted in the fast-tracking of a previously identified upgrade project, known as the Wairakei Diversion, and the identification of another upgrade project, known as the Colombo St Diversion. It is anticipated by CCC that completion of both of these projects, expected in the next 12 to 24 months, will further reduce overflows into the Avon River, from the Northern Relief trunk sewer, to below consented levels. The published CCC Long Term Plan (LTP) also contains a further $33 million for upgrading of the Northern Relief trunk sewer system, to create additional capacity of growth. Theses upgrade are scheduled for completion prior to 2018 and will ensure that, as growth continues in the North West of the city, CCC will continue to meet its wastewater overflow obligations.

78. Further to this, CCC officers indicate that they have also signed an Overflow Consent Compliance Strategy Agreement with Environment Canterbury. Part of this agreement sets aside those conditions, of the existing overflow consent, which relate to permitted frequency of overflow. Discussions with CCC indicate that the procurement of this agreement, along with the upgrade works outlined above, effectively remove any barriers to the rezoning of the Plan Change Area, which are associated with wastewater capacity.

Proposed Wastewater

79. It is anticipated that the PC67 area will develop in a generally north to south direction, with the initial stages of development taking place north of Preston's Rd. As per CCC instructions, it is proposed that wastewater from the initial stages of the development will be pumped to the Northcote Collector via a new pressure main to be constructed along Preston's Rd.

80. As outlined in the Water and Wastewater Assessment Report, appended to the PC67 Officers Report, there are a number of options available with respect to internal servicing of the PC67 Area for wastewater. Further discussion will be required with CCC at subdivision stage to agree the most appropriate method of providing wastewater reticulation to service the development. These discussions will also consider geotechnical advice on the liquefaction and lateral spread potential of the site, and any mitigation measures that are implemented.

81. Further progressive development of the land to the south of Preston's Rd, may eventually require a second pumped connection to the Northcote collector sewer, downstream of the initial connection. Again this will is a detailed design issue which will be resolved through the subdivision process.

Comment on Officer's Report

82. I have read the Officer's Report and the Water and Wastewater Assessment Report appended to the PC67 Officers Report. The details and conclusions presented in the report are in line with the discussions I have had with Council Officers over the course of the Plan Change process. I agree with the conclusion of the Officers Report that there is no wastewater related impediment to the rezoning of the Plan Change Area as requested in PC67.

83. The Officer proposes amendments 9, 14, and 16 (Appendix 13) to remove the Special Rules relating to development not proceeding until capacity in the sewer network becomes available and including a reference to the General Rules. those changes are acceptable to me as capacity issues have now been addressed.

WATER SUPPLY

Existing Water Supply

84. The Plan Change Area is not currently serviced by the CCC water supply network. Instead, water supply for the area has been sourced from aquifers via individual private wells.

85. The local topography is generally flat pasture, with a gentle falls in the north east and south west. Beyond the typical water demand from proposed urban land uses and fire fighting demand, there are no significant pressure constraints caused by the contours of the Plan Change land.

86. The nearest CCC source for the supply of water is Redwood pump station, and associated wells, located at 54 Preston's Road. From this station, a 300 mm diameter watermain runs along Preston's Road and terminates at a 150 mm main extending along Grimseys Road. From this intersection point a 150 mm diameter main runs towards the PC67 Plan Change Area, along the northern side of Preston Road, terminating outside 167 Preston Road, which is the most eastern dwelling along Preston's Road.

87. The Redwood pump station, and associated infrastructure, is part of the North West water supply zone. This is a large zone which comprises most of North West Christchurch and the existing zone is bounded by a number of proposed growth areas, including PC67. Discussions with CCC indicate that there are a number of projects contained within the Long Term Plan, to upgrade the headwork's capacity of the North West zone, through the provision of new wells and pump stations. There is also an on-going investigation by CCC looking at rezoning the Christchurch water supply network to increase efficiency and improve resilience. CCC advises that water supply is not an impediment to the rezoning of the PC67 Plan Change Area.

Proposed Water Supply

88. It is proposed to connect the initial stages of the development to the existing water main infrastructure in Preston's Rd. This will initially be a single-end fed, however there will be an opportunity to create dual feed into the northern part of the development through a link to the existing water main on Willowview Drive. This will require a new main to be laid through the NZTA designation for the Northern Arterial Motorway, however this is not unusual and there will be a number of services that will cross the motorway along its length. Again, this is a design detail which will be resolved with CCC at subdivision stage.

89. As development progresses, it is probable that a new pumping station may be required within the PC67 area. This need will be dependent on the results of CCC growth modelling of the water supply network and also the outcomes of its on-going water supply rezoning investigation project. If a pump station is required in the future, it will be funded and constructed by CCC through the LTP process. Water supply pump station upgrades are treated as part of a general zone upgrade, rather than a specific upgrade for a Plan Change, and are hence typically funded by CCC. The applicant will continue to work with CCC through the subdivision process to accommodate the location of such a pump station, if CCC decides that one is required.

Comment on Officer's report

90. The Officer's report is consistent with my understanding of the situation and confirms that there is no issue with water supply.

COMMENT ON SUBMISSIONS

91. The following submissions raise issues with regard to servicing of the site:

NO.	SUBMITTER	ISSUES RAISED
S31	B & J Watson	Impact on existing septic tank, well
S33	B Berryman	Provide services to his property
S47	D Ballagh	Stormwater / flooding
S49	The Lonestar Trust	Allow alternative servicing
S50	TA Mundy	
S56	W & K Hamilton	Stormwater, effect on bores
S62	C Andrew & R Pickering	Geotech, soils, flooding
S90	D Ward	Stormwater, effect on bores
S52	Canterbury Regional Council	Changes to wording of stormwater and deferral provisions, Floor Levels
S59	Ellington Residents	Rezoning of stormwater land

	Association	
S64	Styx Living Trust	Sewage overflows and stormwater treatment
S89	Canterbury District Health Board	Sewage overflows, stormwater flooding and mosquitoes
F77-102	Te Ngai Tuahuriri Runanga	

92. I will deal with each of these in turn.

93. Submission 31 provides conditional support providing PC67 does not impact on the operation of the existing septic tank and well. There is nothing proposed in the servicing that will impact on the well and septic tank. It is noted that Condition 5 of Rule WQL9 of the NRRP requires that if a sewage pipeline network becomes available then the property shall connect to the sewer (presumably at the property owners cost) within 6 months of that sewer becoming available. This may be triggered depending on the provisions set out in the Rule.

94. Submission 33 requests that services are provided to that property. The property is located outside the Plan Change area and the servicing does not need to address that property. Nether-the-less as with S31 the NRRP Rule WQL9 may require the connection to an available sewer.

95. Submission 47 requests that the existing Queen Elizabeth Drive and Philpotts Road ponding basins are considered in conjunction with the plan change and comment that they have concerns about the current management and maintenance of these basins. The Plan Change does not need to address stormwater management outside the plan change site except to ensure that flooding is not exacerbated. The aim of the proposals in PC67 are to not make flooding worse and to possibly reduce the flood levels in the Cranford Basin. However the operation and maintenance of existing stormwater management facilities outside the PC67 land is considered to be an issue to take up with CCC and cannot be considered at this time.

96. The identical submissions 49 and 50 raise issues with the deferred zoning for stormwater and the servicing for sewage and water supply. With the lodging to ECan by CCC of its application for the Styx Catchment Stormwater Management Plan, the issues of stormwater management in this deferred zone are largely addressed. This will be finalised during more detailed design. At this stage it is appropriate to leave the deferred zoning in place. It should be noted that development is intended to proceed from the north. By the time development is required in this area the issues of stormwater management will be resolved and the deferred zoning will be removed. The issues of servicing for sewage and water supply are in the process of being addressed so that when development proceeds in the southern area sewer capacity will be available as will water supply.

97. **Submission 56** opposes the proposal due to the effect of the development will have on runoff and the flood storage that occurs in the area. I consider that the proposed stormwater management addresses both of these issues.

98. **Submission 62** raises concerns about existing flooding and changes to flooding levels as a result of the development. The investigations recognise the existing flooding and the Plan Change presents stormwater management to address additional stormwater and to try and mitigate the existing flooding by including a realigned Horners Drain to increase its capacity.

99. **Submission 90** raises issues about protection of onsite bores, creating more flooding and increase in groundwater levels. As has been described previously it is considered that wells would not be affected and stormwater flooding has will be mitigated. It is not anticipated that the development will raise groundwater levels. Due to increased imperviousness it is possible that the shallow unconfined groundwater beneath the site may drop due to less infiltration, however the underlying confined groundwater will not be affected.

100. **Submission 52** from the Canterbury Regional Council raises several matters relating to stormwater management. Firstly they incorrectly state that PC67 is being dealt with by the Styx Catchment Management Plan. We acknowledge that it would be useful and practical to be integrated within that process but are willing to apply for a separate consent if required. Secondly the submissions recommend changes to the Rules around development of the deferred land. This was accepted by the Officer in the proposed changes and I have discussed this in paras 81 and 82 above where I accept those changes but suggest minor changes to the wording. The final matter relates to the setting floor levels to the 0.5% flood level which I accept, but as described in para 83 I have suggested revised wording to add certainty to this requirement.

101. **Submission 59** from the Ellington Residents Association wants land proposed for stormwater management in the deferred area not to be included in the Living G zone. This is more a planning issue rather than a technical issue and I support the rationale in the officer report for rejecting this submission (para 201-202).

102. **Submission 64** from the Styx Living Trust raise matters relating to sewage overflows and stormwater treatment. The proposal will not involve any wet weather overflows to the Styx River. The discussion was around the potential for increases in the operation of the overflows to the Avon River. As stated in Para 88 above CCC officers indicate that they have signed an Overflow Consent Compliance Strategy Agreement with Environment Canterbury to address increase sin overflows in the Avon catchment. The Styx Living Trust generally support the proposed stormwater management and have suggested changes to the wording of the Plan. Those

changes are discussed in the Officer's report and I agree with the Officer's decisions on whether to accept or reject the matters raised in the submission.

103. Submission 89 from the Canterbury District Health Board raises issues with respect to sewage overflows and flooding/stormwater management that creates environments where mosquitoes and midges may breed. I have discussed sewage overflows in my previous paragraph. With respect to mosquitoes and midges, since 1996 when I began working on stormwater management the minimisation of the mosquito breeding habitat has always been a consideration. This has been achieved by minimising the detention time in dry basins, avoiding wet basins except where a good inflow is available and minimising the shallow zones around wetland margins where mosquitoes could breed.

104. The further submissions by Te Ngai Tuahuriri Runanga (F77-102) support all the submissions above. Hence I consider these further submissions have been addressed in my previous paragraphs.

CONCLUSIONS

105. I have investigated the servicing of the site for stormwater, sewage and water. Options exist for each service to support residential development of the site.

106. Capacity exists within the existing wastewater network to accommodate initial development to the north of Prestons Road and will become available to allow the development to continue south of Prestons Road.

107. Existing capacity exists in the water supply network for the area north of Prestons Road and new wells either in the north west of Christchurch or on the site will provide the additional water required.

108. Stormwater management facilities and flood mitigation have been allowed for in the ODP so that development can proceed without exacerbating existing flooding. Once more detailed design is completed the deferred zoning from the southern part of the site. This will be addressed well before the development of this area will proceed. In due course the realignment of Horners Drain may assist in reducing the existing flooding.

109. There are no matters in submissions that have not been addressed in the ODP or by way of changes recommended in the Officer's report. Apart from some minor wording changes I support those changes recommended where they relate to servicing.

110. Therefore, with respect to servicing the site I consider all matters have been addressed and conclude that the PC67 could proceed.

REFERENCES

CCC. 2003. *Waterways, Wetlands and Drainage Guide.*

CCC. 2005. *CREAS Horners/Tysons Stream, Natural Asset Condition Report*. Christchurch City Council.

Andrew Brough
9 November 2012

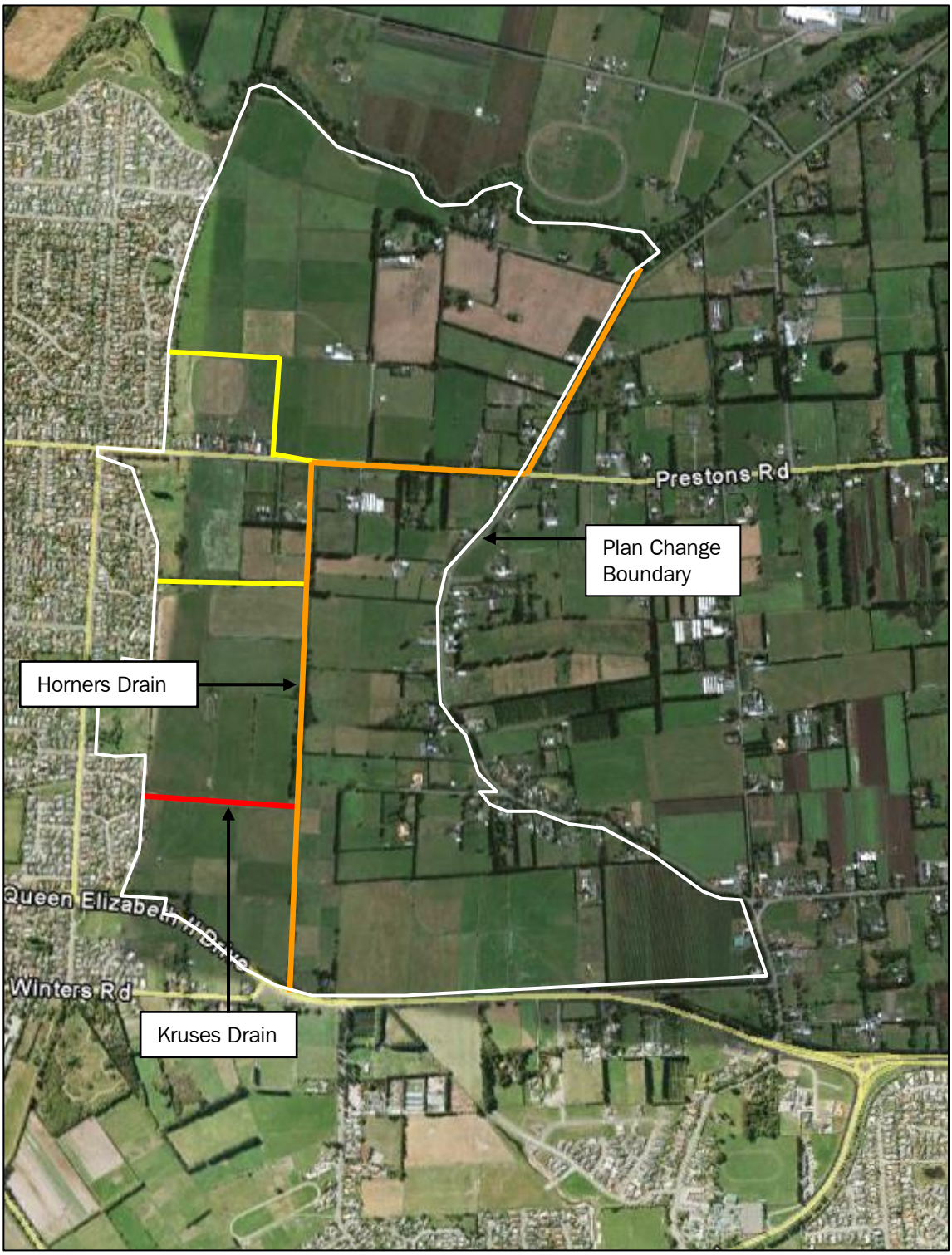

Figure 1: Location of Main Surface Drains

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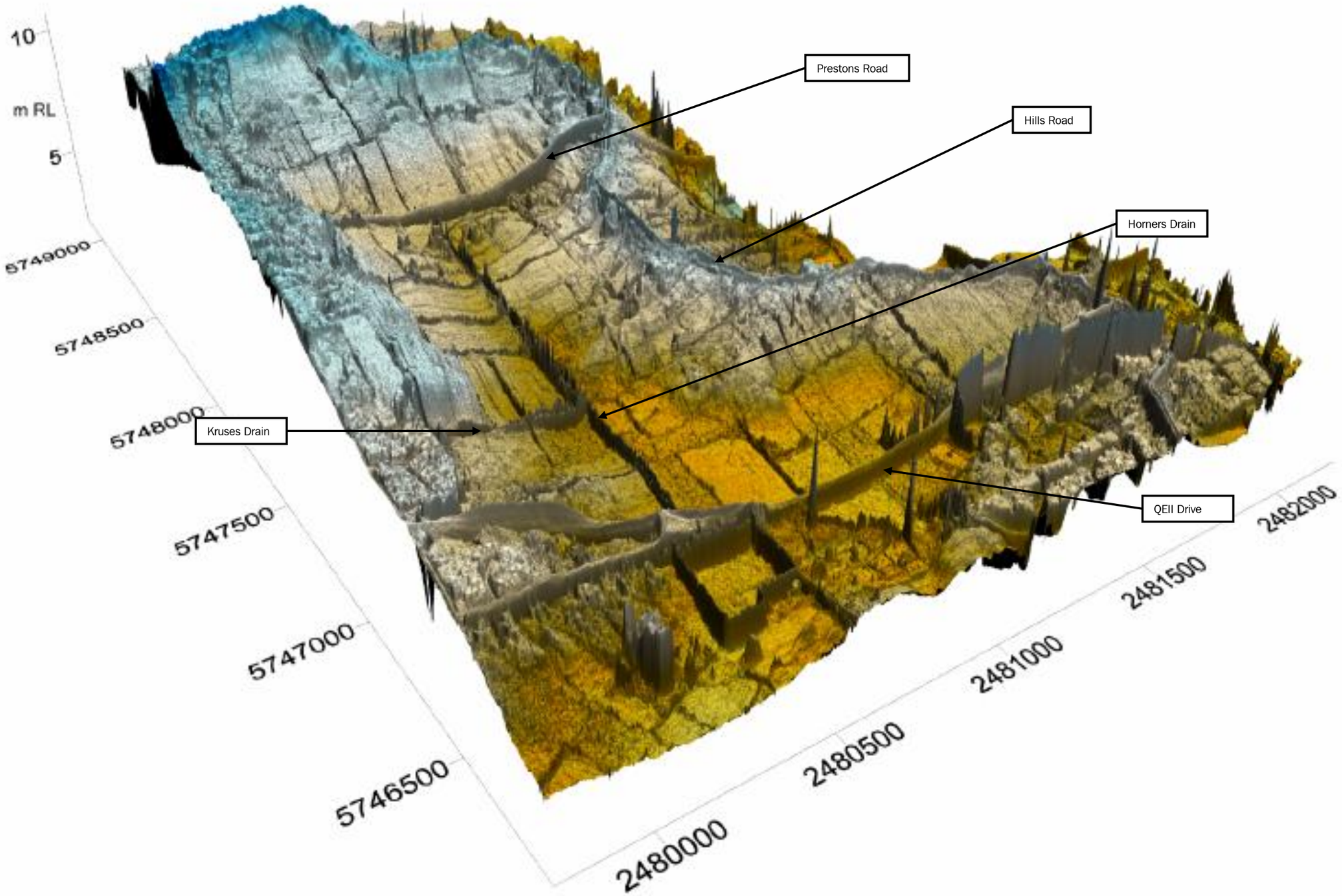

Figure 2: 3D Plot of 1 m LIDAR Data across Highfield Park

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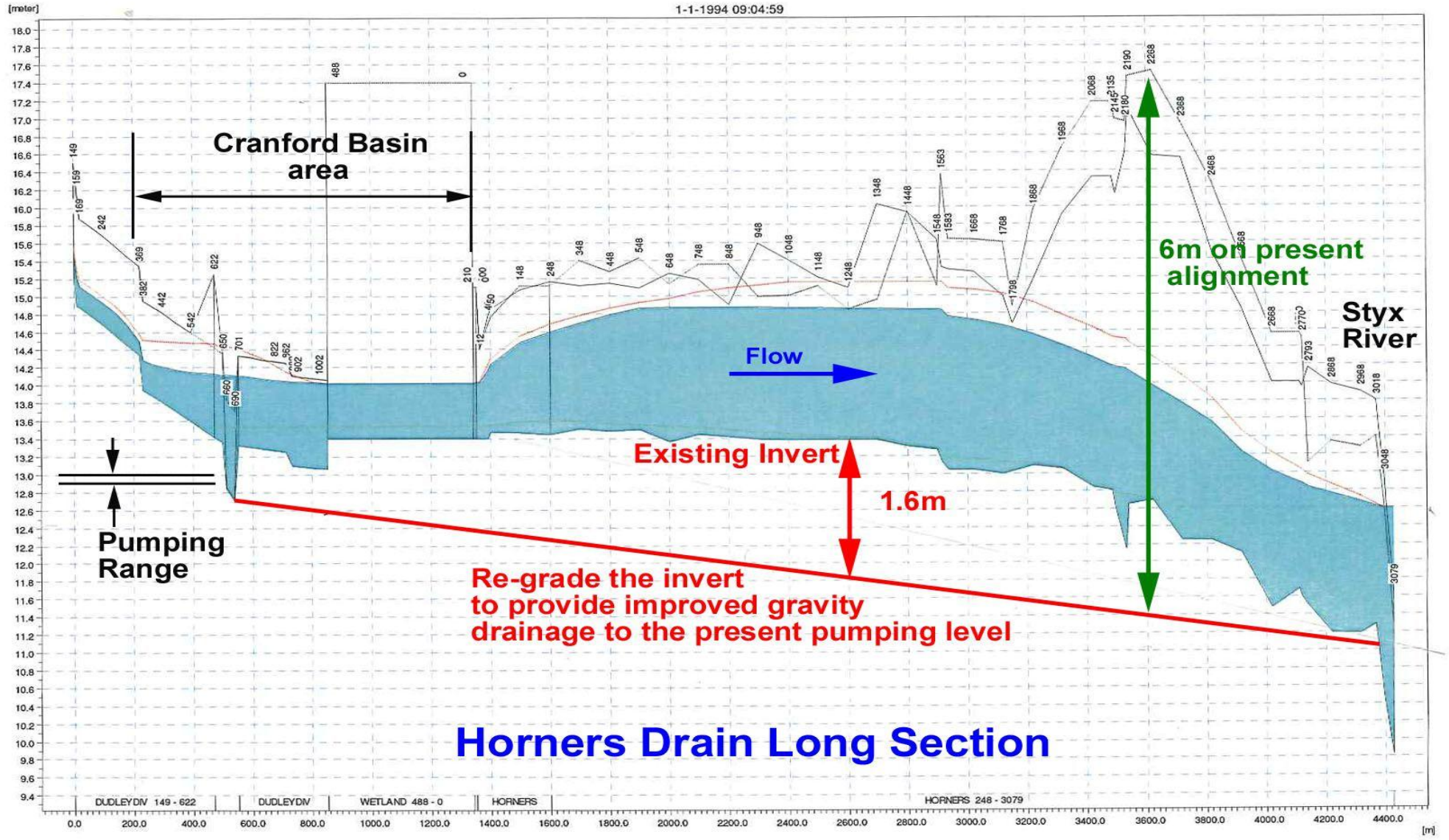

Figure 3: Long Section of Horners Drain (Source CCC)

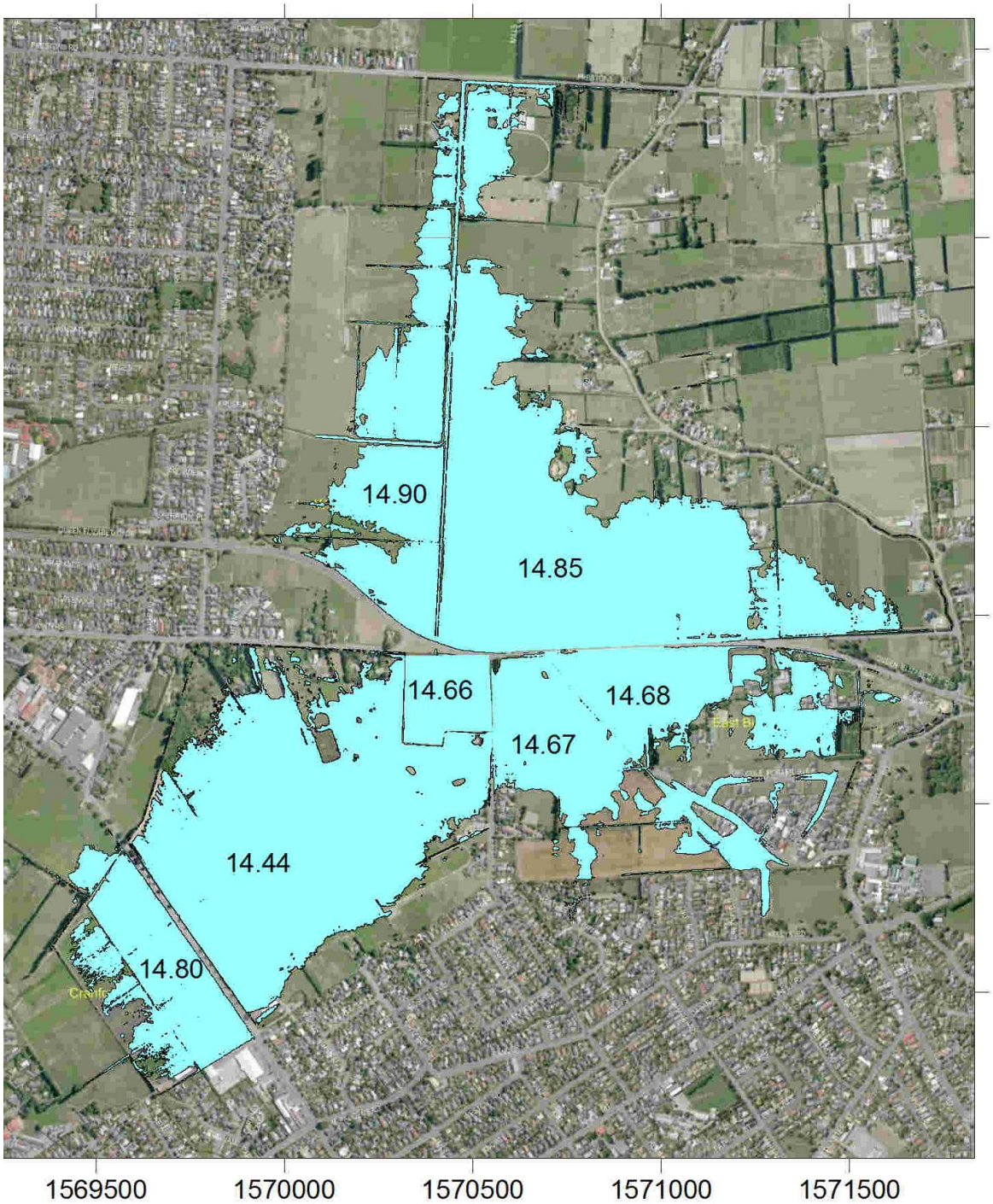

Figure 4: Existing Flood Levels in Cranford Basin for 2% AEP 24 hr Event (Source CCC)

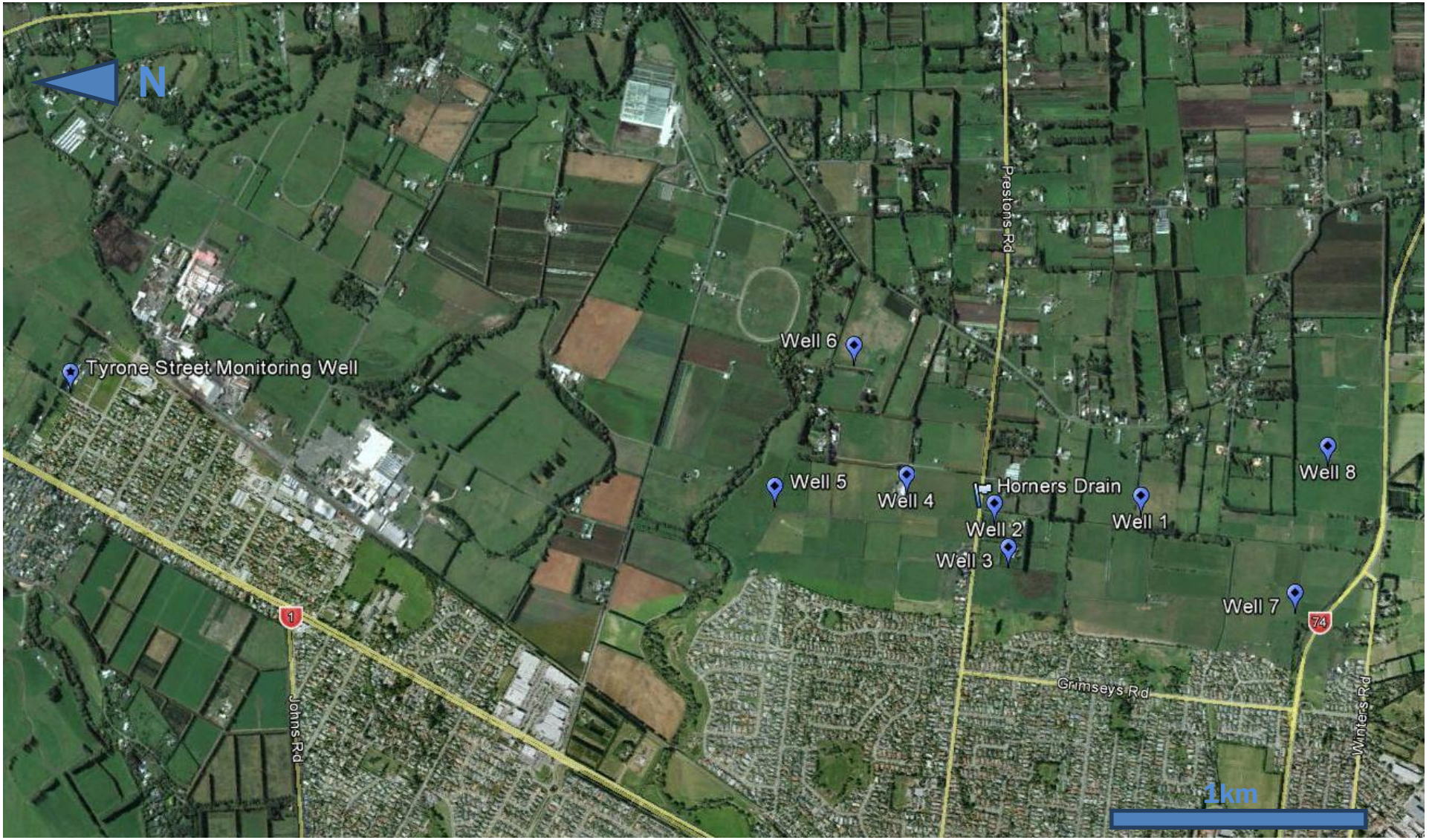

Figure 5: Location of Shallow Groundwater Monitoring Wells

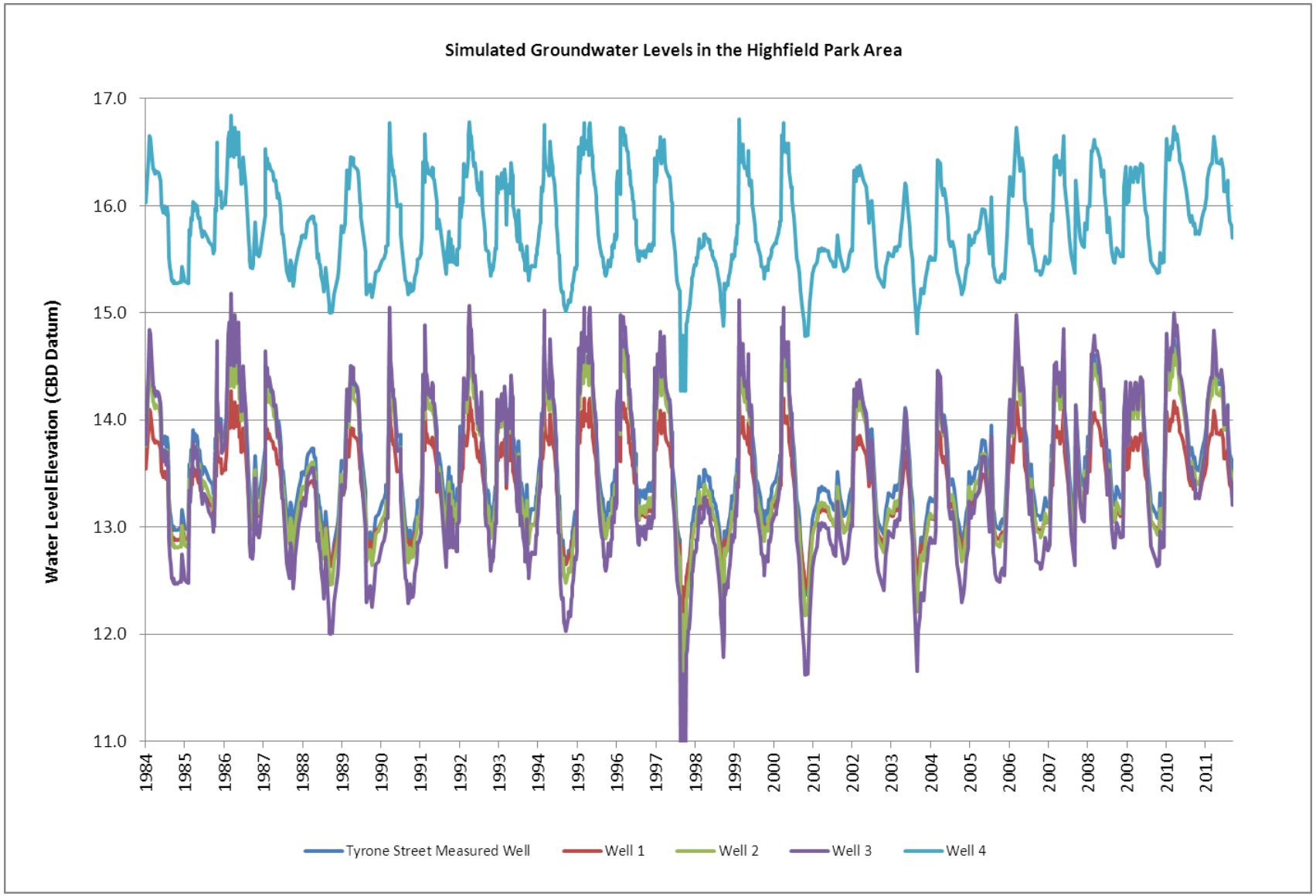

Figure 6: Simulated Groundwater Levels – Wells 1 - 4

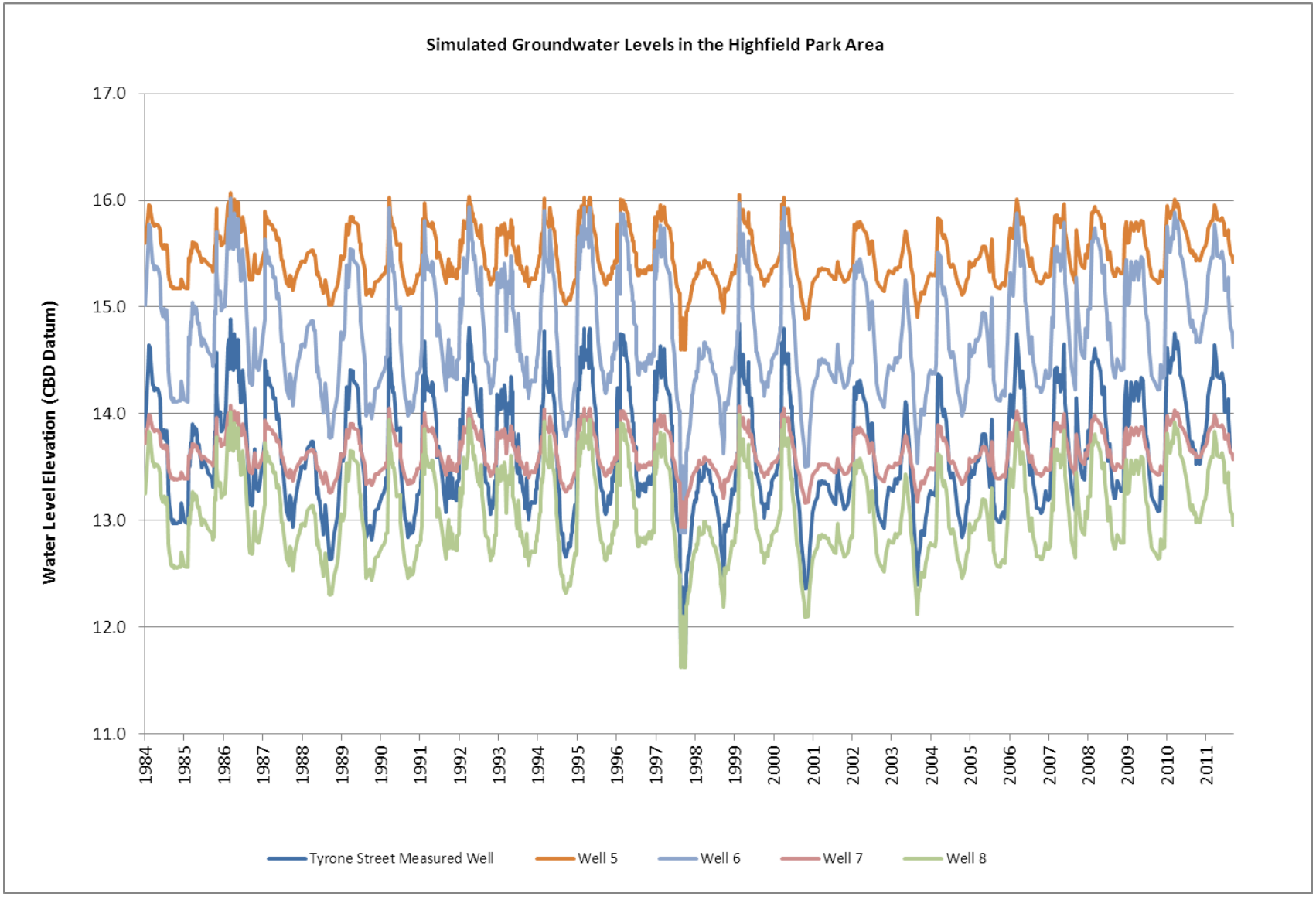

Figure 7: Simulated Groundwater Levels – Wells 5 - 8

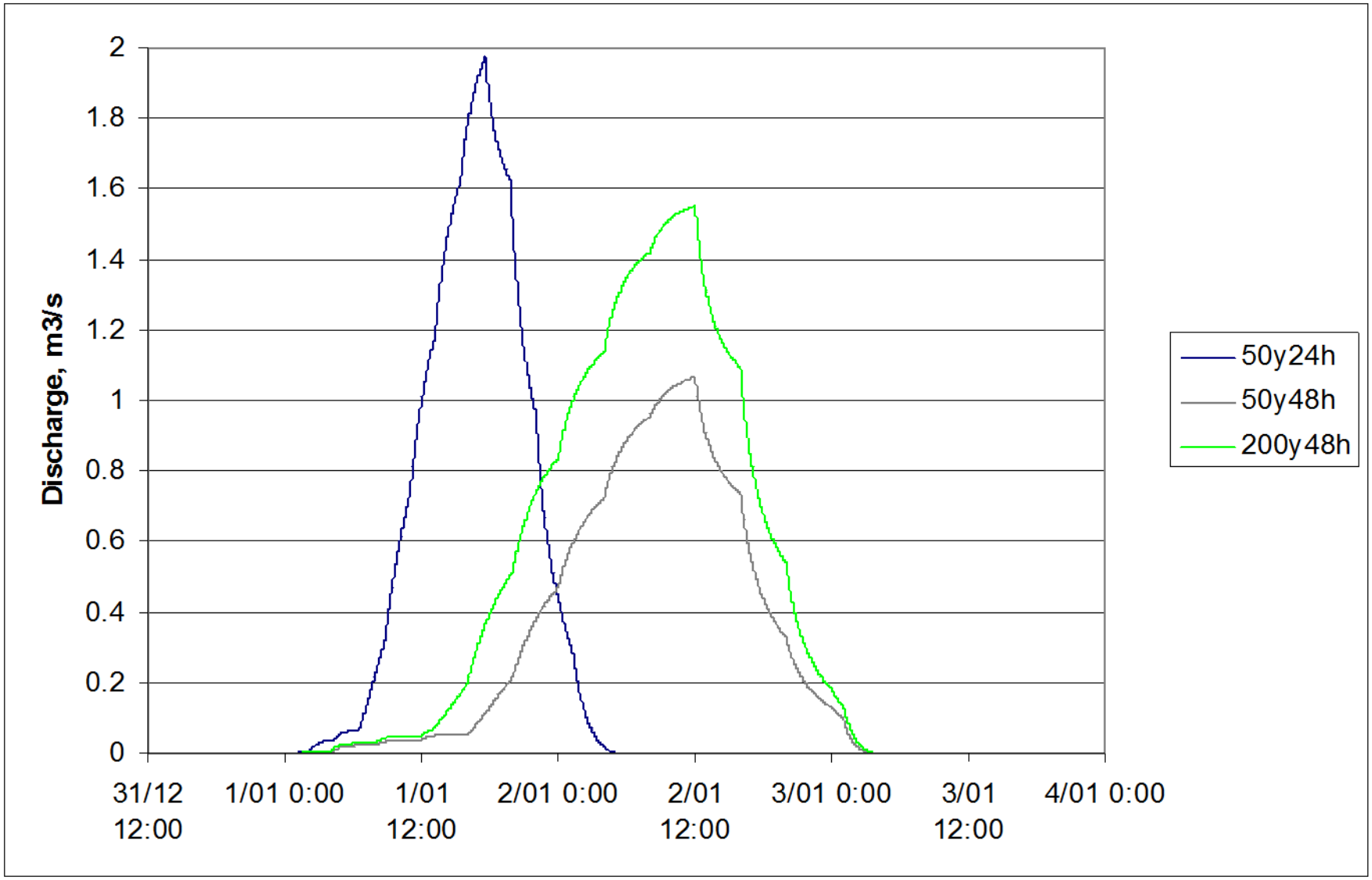

Figure 8: Estimated Predevelopment Runoff Rates for Highfield Park (Source V.Henderson, CCC)

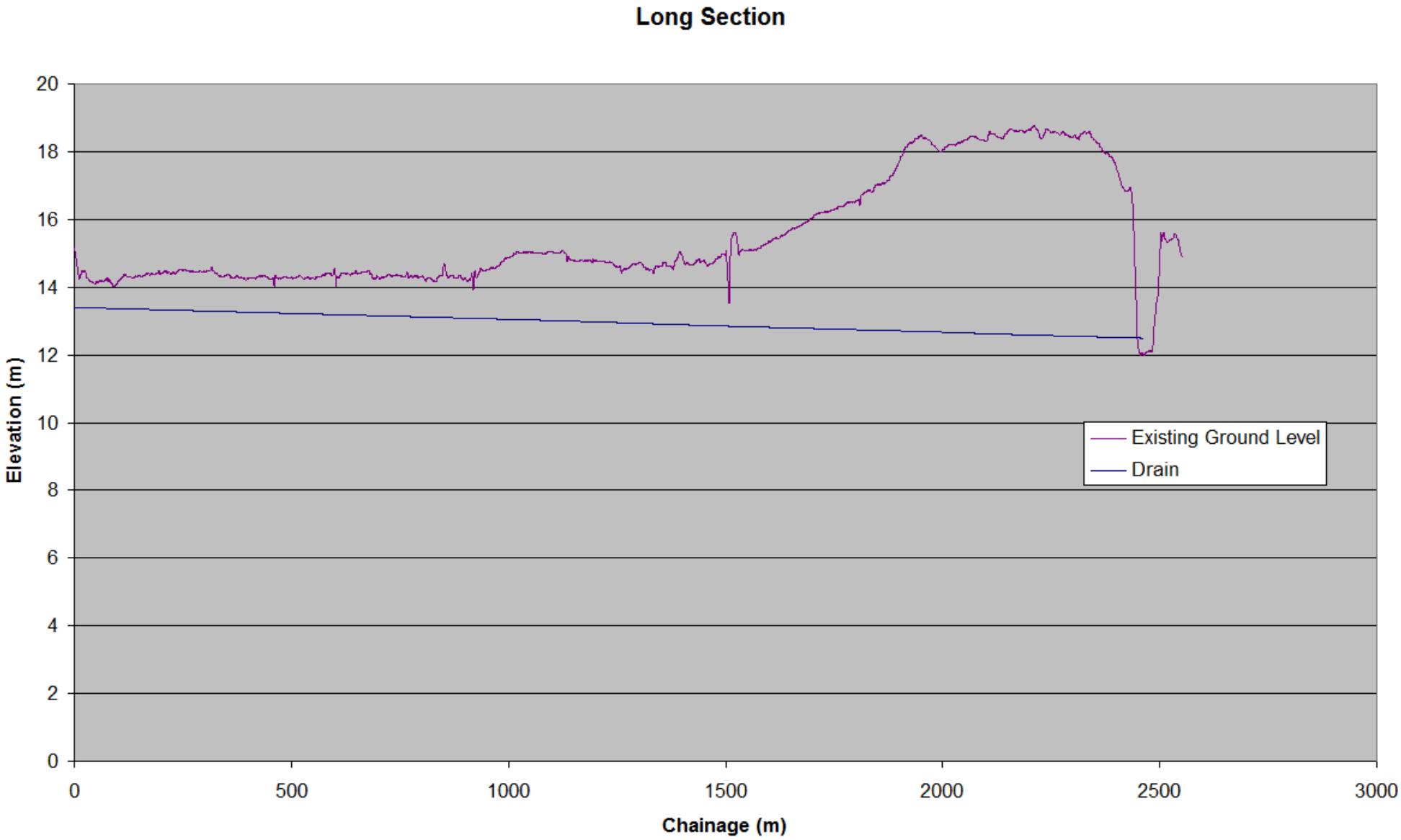

Figure 9: Revised Horners Drain Long Section from QEII Drive to the Styx River Along Alignment Shown in Master Plan

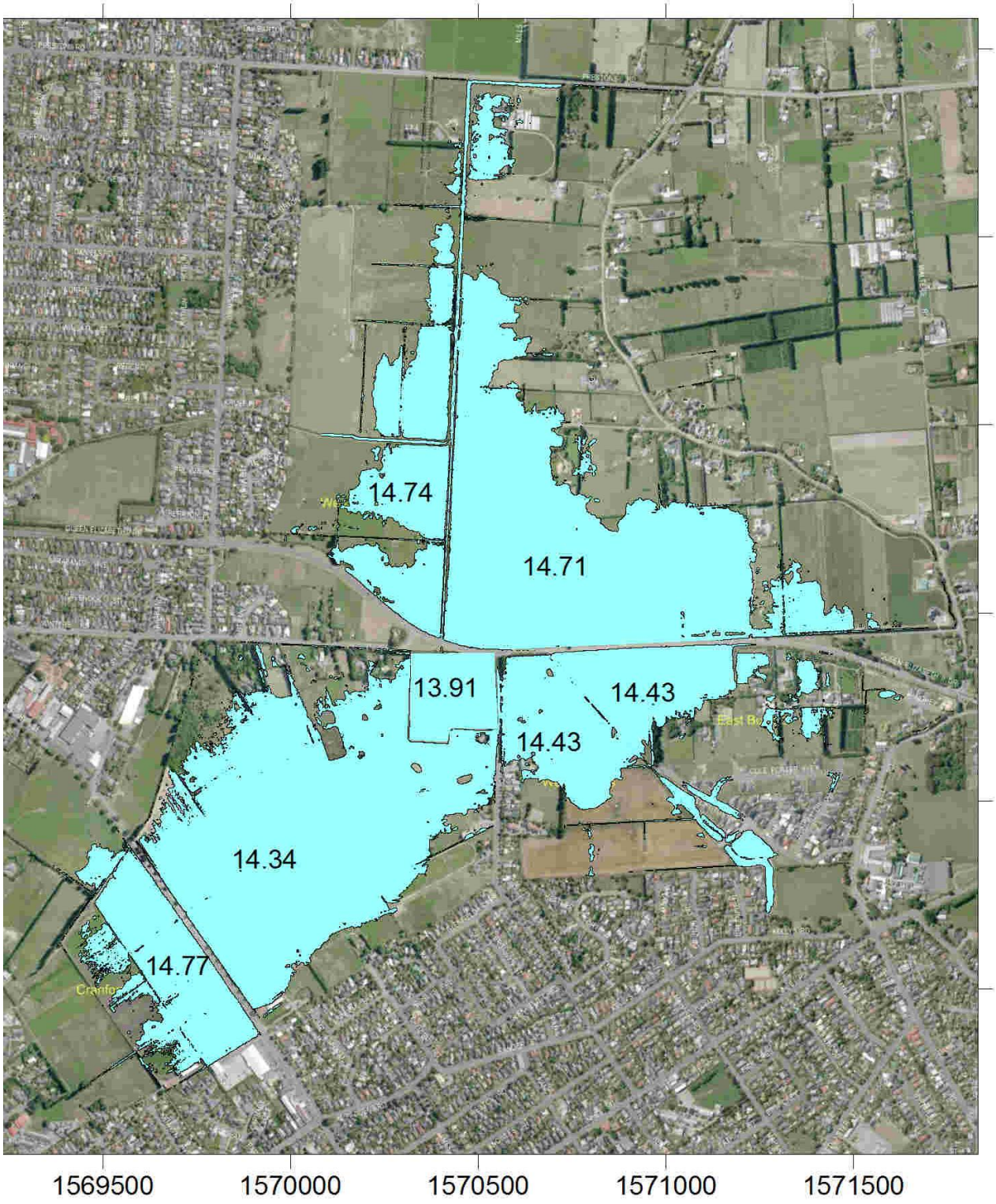

Figure 10: Cranford Basin Flood Levels with Horners Drain Upgrade for the 2% AEP 24 hr Event (Source CCC)

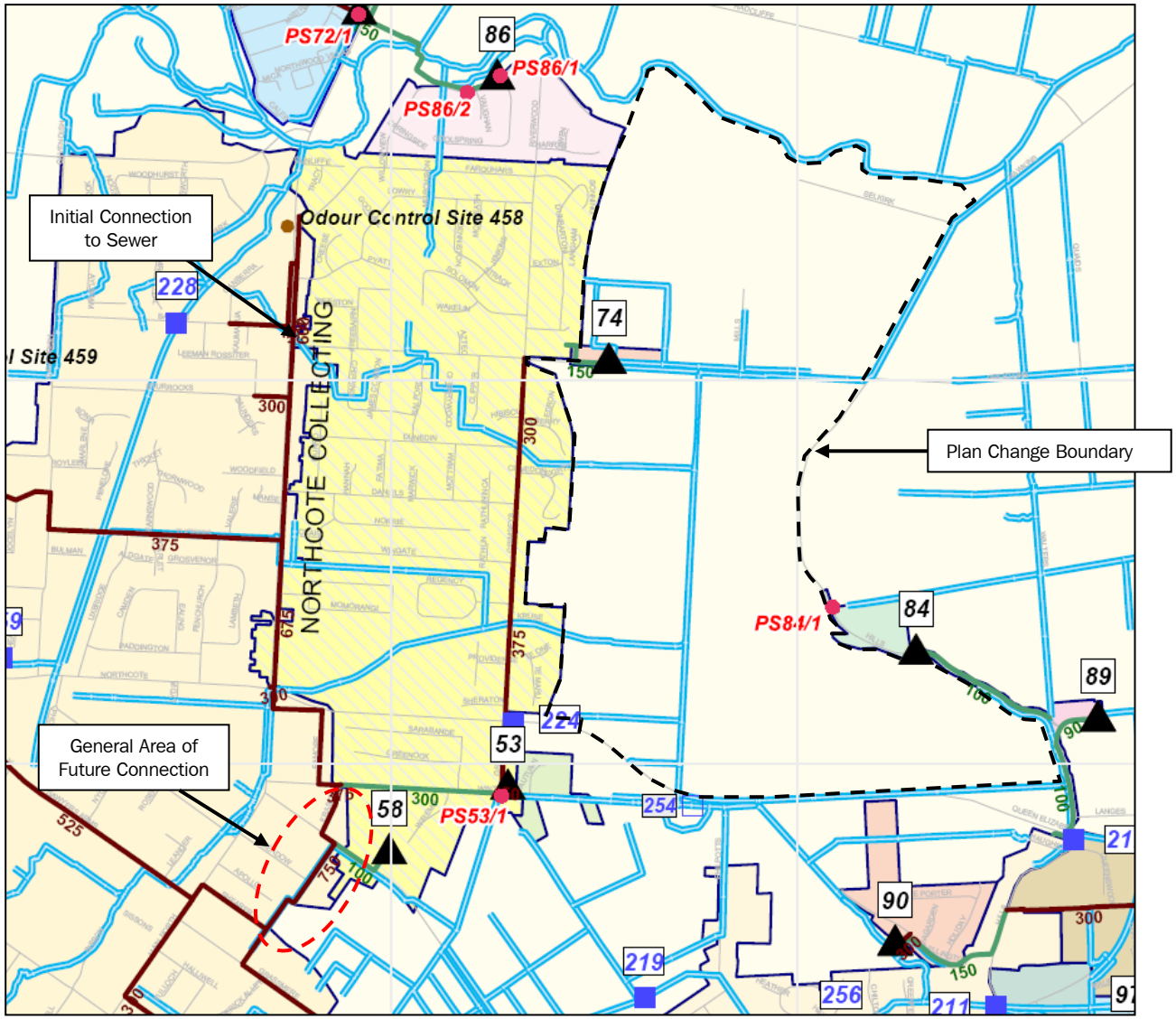

Figure 11: Location of Wastewater Mains and Pump Stations in the Vicinity of the Plan Change 67 Site