Appendix M

Engineering Design Consultants Limited Stormwater Mitigation Report

Pioneer City West – Palmerston North

Stormwater Mitigation Report

For: Pioneer City West Limited
Project: 9871
Date: 24th May 2013

Engineering Design Consultants Ltd

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Revision No.	Date	Engineer	Description
1	25/2/13	IH	Final Draft for comment
2	24/5/13	IH	Plan Change application

Report prepared by:

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1. Background

This report is provided in connection with the Plan Change application for development of the Pioneer City West site (PCW). We outline the issues associated with stormwater runoff and provide recommendations for mitigation to minimise any adverse effects associated with the increased impervious coverage resulting from future development.

2. Flood Risk Information

The site area has been subject to various reports in connection with flood risk which are summarized below.

2.1 Reports for Pioneer City West

Pioneer City West limited engaged John Philpott & Associates (JPA) in 2009 to provide a report on flood risk at the site. The hydrological model was prepared by River Edge Consulting (REC) as sub-consultant to JPA.

The PNCC engaged Barnett & Macmurray Ltd (BM) to peer review the reports by JPA and REC. The hydraulic model results were also discussed with Horizons Regional Council before issue of the final report (8 June 2009), which confirmed that flooding from the Mangaone Stream and Manawatu River in a 1 in 500 year storm does not encroach onto the subject site. The nearest area of inundation occurs along Pioneer Highway adjacent to the south end of the site, as indicated in Figure 2.1.

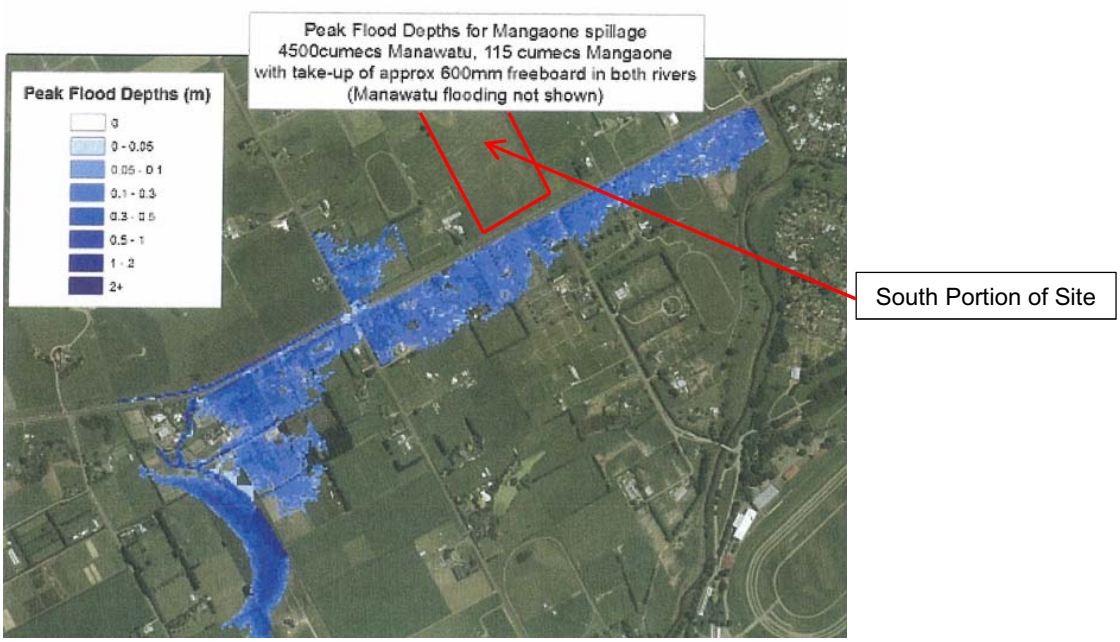


Figure 2.1 – *Flood Plain Estimate for 1/500 Year Storm (courtesy JPA)*

2.2 Reports for PNCC

The PNCC investigated flood risk and stormwater management for the subject site and surrounding land as part of their assessment on development of the City West Urban Growth Area.

REC prepared a report for the PNCC in October 2010. Their assessment confirmed a flood risk in the 1 in 500 year storm which was very similar to that determined during their previous assessment for Pioneer City West in 2009 (see Figure 2.2).

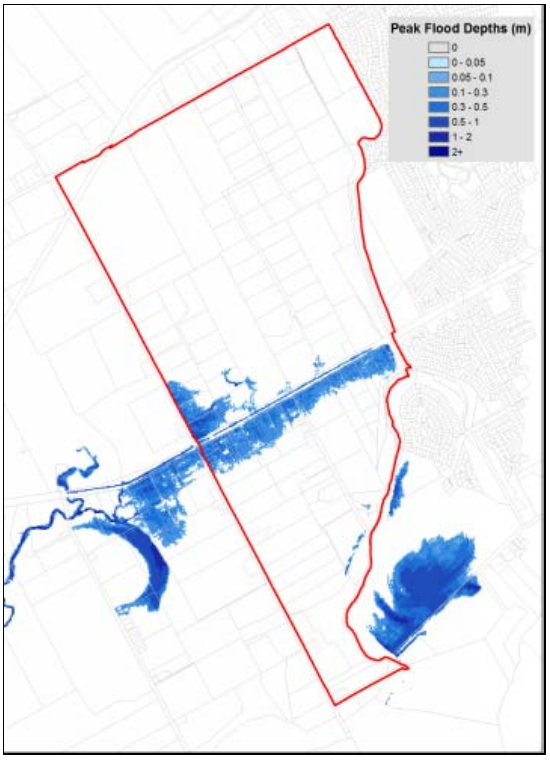


Figure 2.2 – *Flood Plain Estimate for 1/500 Year Storm (REC 2010)*

The subject site is shown essentially clear of flooding from the Mangaone Stream and Manawatu River in the 1 in 500 year storm. The REC report confirmed that flooding across the subject site could only occur if the stopbanks along the Mangaone Stream were to fail during the 1 in 500 year storm. In this scenario, a shallow flow of water (50-100mm) was predicted across the site, with some deeper ponding localized in the north-west corner. This is considered a small risk, and we note that Policy 10-2 (e) of the Proposed One Plan indicates the Mangaone stopbank system is actually suitable for providing 1 in 500 year flood protection without the need for further mitigation. In any case, the wide shallow nature of flow predicted in such an unlikely event, should be suitable for diversion along the future roading network to designated ponding areas and out to the lower lying land below the site. These provisions would provide suitable hazard avoidance to meet the requirements of Policy 10-2 (d).

The PNCC commissioned Mr Brian Kouvelis to prepare a draft Stormwater Master Plan for the City West Urban Growth Area (issued April 2012). This report accepted that development of the area could be protected from flood risk, and concentrated on providing recommendations for the mitigation of any adverse effects associated with the development envisaged. Our report investigates the use of these mitigation measures for development of the Pioneer City West site to minimize adverse downstream effects.

2.3 Horizons One Plan

Figure I:3A: Taonui Basin Spillways, Floodways and Floodable Areas, from the Horizons One Plan (See Figure 2.3) confirms that the subject site is outside of any Floodway (solid green area below) or Floodable Area (dotted green area) associated with the Taonui Basin, which forms part of the Lower Manawatu Flood Protection Scheme.

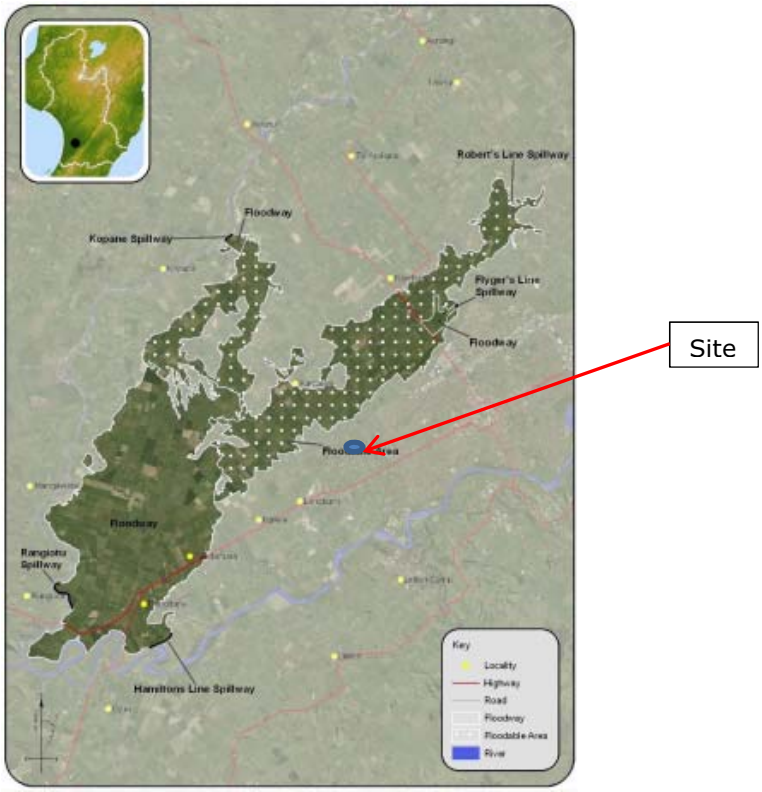


Figure 2.3 – *Taonui Basin Spillways, Floodways and Floodable Areas (Horizons One Plan)*

Policy 10-2 (a) seeks to avoid development within the Floodways and Floodable Areas which are based on the 1 in 200 year storm. We therefore confirm that the subject site is outside these areas.

3. Council Stormwater Master Planning

The Palmerston North City Council engaged consulting engineer Mr Brian Kouvelis to undertake a preliminary investigation into stormwater planning issues for the potential development of the City West Proposed Urban Growth Area (which included the subject site and surrounding land).

This technical study concluded that it would be appropriate to provide stormwater detention ponds to limit adverse effects on land immediately downstream from the potential urban growth area, and the Taonui Basin where flood storage provisions need to be protected. Several areas of land below the City West Proposed Urban Growth Area were identified as being feasible for future detention ponds, subject to further survey and design work. This report for Council also recognised the benefits associated with incorporation of low impact urban design principles into future development (eg swales, raingardens, and rainwater tanks etc), but concluded these would not be sufficient unless used in conjunction with detention ponds.

We consider the stormwater planning concepts identified for Council in connection with potential development of the wider catchment area suitable for incorporation into development of the Pioneer City West site. This development should therefore include some low impact urban design provisions combined with detention ponds to establish an effective 'treatment-train' approach for stormwater mitigation.

4. Stormwater Mitigation Objectives

The following key objectives have been identified for stormwater mitigation:

- Make provision for stormwater runoff originating from upstream land (ie land to the east of the site) to pass through and/or around the site without any adverse effect on the neighbouring land, or development itself. This can be accommodated with stormwater reticulation and designated overland flow paths (mainly road corridors) designed to collect and convey stormwater in a controlled manner. Any future reticulation or flow path collecting runoff from surrounding land does not need to be routed through proposed mitigation provisions at the subject site. Reliance on complete soakage systems has generally be considered unsuitable.

- Provide some low impact urban design measures to minimize the volume of runoff, provide water quality treatment, and increase the time of concentration. This site is considered suitable for long gentle swales along the roading alignment and rainwater harvesting tanks to provide a source of non-potable water in dwellings, commercial buildings, and general landscape areas. The use of rain-gardens could also be possible below future commercial carpark areas, dependent upon the final design layout and ground profiles.

- Collect runoff from the subject site using new reticulation designed in accordance with the engineering design standards of the Palmerston North City Council. The reticulation shall discharge into ponds that will control the future rate of runoff to the pre-development level. This flow rate control should be provided for all storms up to the 100 year event. These provisions will protect downstream land from the adverse effects associated with the potential increased rate of discharge resulting from increased impervious coverage.

- Configure the future stormwater ponds, flow paths, and the primary reticulation to allow for efficient collection, treatment and discharge of stormwater using the natural contour to mimic existing discharge as far as practical. The pond outlets, spillways and various flow paths should be designed to spread the attenuated flow out into a non-concentrated type, for interception by existing road drainage provisions (upgraded as necessary) around the lower perimeter of the site.

- The land on which building development takes place should be generally elevated above the roading network to provide for good land drainage and natural protection from overland flow of stormwater.

5. Proposed Stormwater Mitigation

Existing site features are indicated on Drawing 9871/C01, and the proposed concepts for future stormwater mitigation are indicated on Drawing 9871/D01. The concepts will involve treating the site in three separate sub-catchments with three separate stormwater ponds, and diverting stormwater runoff from land east of the site past these mitigation features. Each of the sub-catchments is outlined below.

- North Sub-Catchment

This incorporates around 38 Ha of land across the northern part of the site. Reticulation and overland flow paths are required to divert stormwater runoff south-west into a new stormwater pond (designated as the North Pond). The North Pond should have a pipe to control release of stormwater in the 1-10 year storms into the Rongotea Road channel. A weir should be used to control release from the pond in the 100 year storm to a wide spillway which spreads the flow out along the lower south west boundary of the site parallel to Rongotea Road.

A small portion of this sub-catchment in the northern corner of the site, should continue to discharge out to Longburn Road after some attenuation provided using pipe storage and/or swales with additional surface ponding to retain the existing pattern of runoff.

- Central Sub-Catchment

This incorporates around 25 Ha of land in the central part of the site, and a portion of the pan 'handle' which flows to the north-west. A new pond designated the Central Pond can be provided for this area with a pipe and spillway to the Rongotea Rd channel, similar to the North pond.

- South Sub-Catchment

This incorporates around 10 Ha of land which flows to the south side of the site, where a smaller pond (South Pond) can be constructed to release stormwater into the Pioneer Highway drainage channel provisions via a pipe and weir similar to the North and Central ponds.

6. Stormwater Analysis

6.1 Existing Runoff

We have used Hec-Hms to assess stormwater runoff from the site and conduct preliminary sizing for the detention ponds. Analysis is based around a normalized 24 hour storm with a short duration high intensity event 'nested' into this period. The hydrograph is scaled for the 10 and 100 year events using HIRDS data and allowance for a 2 degree rise in temperature (ie global warming effects).

As the development layout and composition may vary, we have based our analysis on a generalized site coverage (ie 50%) and time of concentration. Further analysis can be conducted at the stage when detailed design is required for the developments infrastructure. This current analysis is focused on determining the approximate layout and size of future ponding provisions as part of the Resource Consent process only.

6.2 Existing Runoff

Runoff from the existing site has been determined using the following parameters:

Impervious coverage	0%
CN (pervious)	74
Ia (pervious)	5 mm
Tc (pervious)	30-40 minutes
24 hr rainfall depth (10 yr)	90 mm (NIWA with 2 degree climate change factor)
24 hr rainfall depth (100yr)	145 mm (")

The Hec-Hms model for the existing site is indicated below:

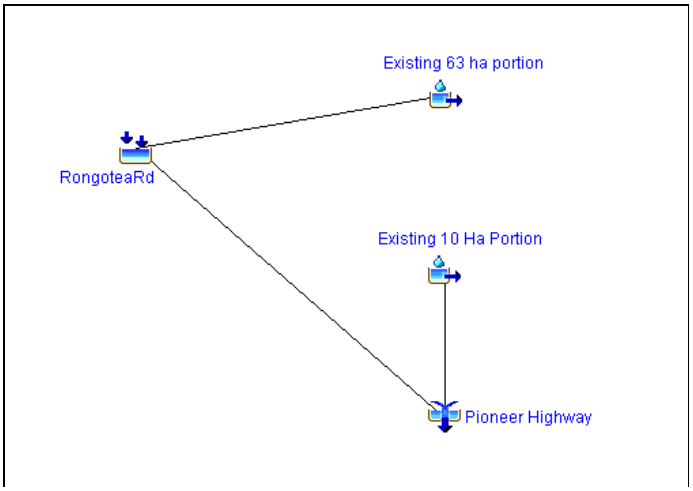


Figure 6.1 - *Existing Hec-Hms Model*

Results for the existing site are indicated below:

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Existing 63 ha portion	0.63	1.7981	01Jan2000, 10:35	36.60
Existing 10 Ha Portion	0.10	0.2854	01Jan2000, 10:35	36.60
Pioneer Highway	0.10	0.2854	01Jan2000, 10:35	36.60
RongoteaRd	0.73	2.0836	01Jan2000, 10:35	36.60

Table 1 - Existing 10 Year Storm

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Existing 63 ha portion	0.63	3.8932	01Jan2000, 10:35	75.89
Existing 10 Ha Portion	0.10	0.6180	01Jan2000, 10:35	75.89
Pioneer Highway	0.10	0.6180	01Jan2000, 10:35	75.89
RongoteaRd	0.73	4.5112	01Jan2000, 10:35	75.89

Table 2 - Existing 100 Year Storm

We note the estimated peak discharge from the un-developed 63 ha portion of the property (combined north and central sub-catchments) and the un-developed south portion of the property (south sub-catchment) is 3.89 m^3/s and 0.62 m^3/s respectively in the 100 year storm. This corresponds reasonable well with the 3.5m^3/s and 0.6m^3/s estimated by Pirie Consultants in Paragraphs 50 and 53 of their report dated August 2009 for Pioneer City West to outline infrastructure provisions.

It is therefore inferred the hydrograph and parameters used in the above analysis produce results consistent with the simplified Rational Method used to date for estimation of the stormwater runoff in accordance with the Palmerston North City Council requirements.

6.3 Developed Site – No Mitigation

We have assessed stormwater runoff for a fully developed site assuming no mitigation and using the following parameters:

Impervious coverage	50% (assumed overall coverage)
CN (pervious)	74
Ia (pervious)	5mm
Tc (pervious)	30-40 minutes
CN (impervious)	98
Ia (impervious)	0mm
Tc (impervious)	20 minutes
24 hr rainfall depth (10 yr)	90 mm (NIWA with 2 degree climate change factor)
24 hr rainfall depth (100yr)	145 mm (")

The Hec-Hms model for the developed site (no mitigation) is indicated below:

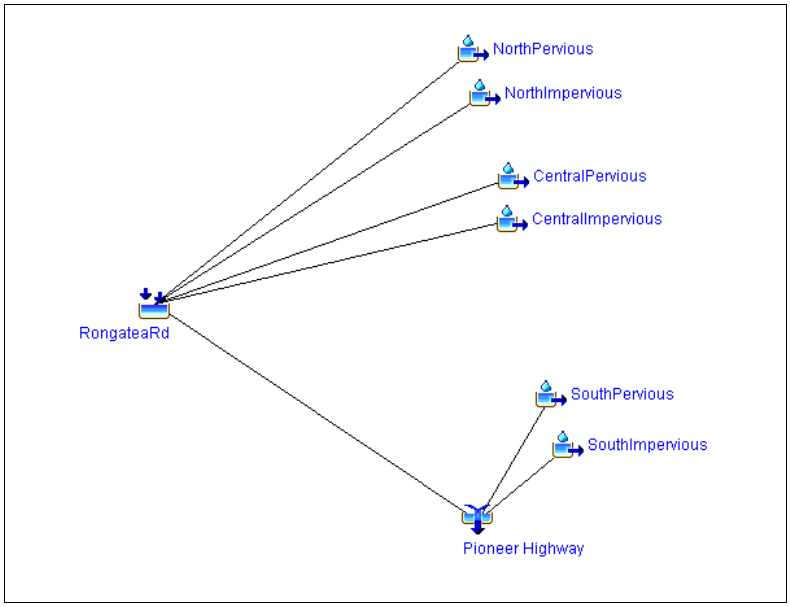


Figure 6.2 - *Future Site with No Mitigation*

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
NorthImpervious	0.190	1.9755	01Jan2000, 10:12	89.58
NorthPervious	0.190	0.6154	01Jan2000, 10:35	40.74
CentralPervious	0.125	0.4049	01Jan2000, 10:35	40.74
CentralImpervious	0.125	1.2997	01Jan2000, 10:12	89.58
SouthPervious	0.050	0.1619	01Jan2000, 10:35	40.74
SouthImpervious	0.050	0.5199	01Jan2000, 10:12	89.58
Pioneer Highway	0.100	0.6244	01Jan2000, 10:14	65.16
RongateaRd	0.730	4.5580	01Jan2000, 10:14	65.16

Table 3 – Future 10 Year Storm No Mitigation

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
NorthImpervious	0.190	3.1389	01Jan2000, 10:12	142.32
NorthPervious	0.190	1.2964	01Jan2000, 10:34	82.48
CentralPervious	0.125	0.8529	01Jan2000, 10:34	82.48
CentralImpervious	0.125	2.0651	01Jan2000, 10:12	142.32
SouthPervious	0.050	0.3412	01Jan2000, 10:34	82.48
SouthImpervious	0.050	0.8260	01Jan2000, 10:12	142.32
Pioneer Highway	0.100	1.0559	01Jan2000, 10:14	112.40
RongateaRd	0.730	7.7083	01Jan2000, 10:14	112.40

Table 4 – Future 100 Year Storm No Mitigation

The analysis indicates the existing peak discharge from the site will be increased from around 4.5m^3/s to 7.7m^3/s in the 100 year storm if no mitigation is provided. Mitigation is considered appropriate to lower the future rate of runoff to the pre-development level as outlined below.

6.4 Developed Site – With Pond Mitigation

Analysis has been undertaken for the fully developed site using the parameters indicated in Section 6.3 of this report, and incorporation of stormwater ponds. This Hec-Hms model is indicated below:

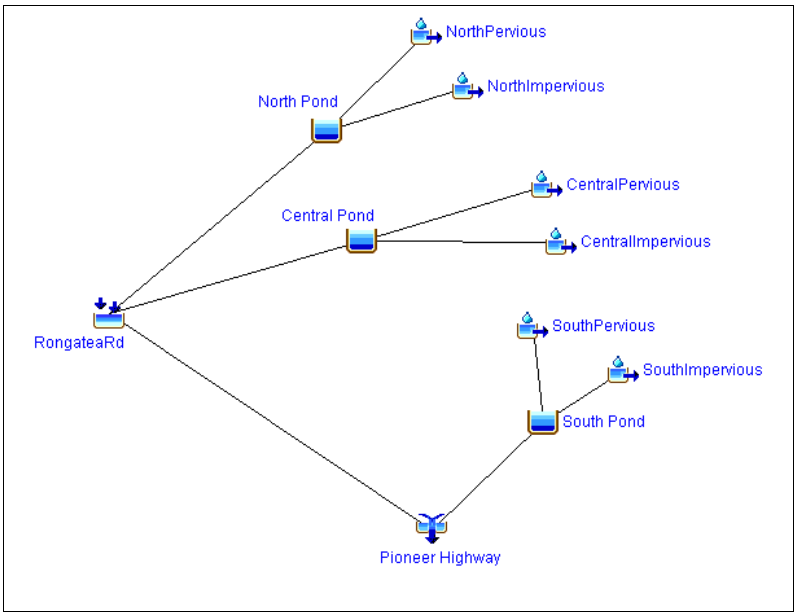


Figure 6.3 - *Future with Mitigation*

The following pond configuration (Table 5) has been determined for effective control of the peak rate of discharge to the pre-development level:

ASPECT	NORTH POND	CENTRAL POND	SOUTH POND
Volume	10,300m^3 of peak storage for 100 year storm.	5,500m3 of peak storage for the 100 year storm	1,500m3 of peak storage for the 100 year storm
Approx. Size	100m x 60m	90m x 40m	40m x 20m
Wetland	Nominal for water quality	Nominal for water quality	Nominal for water quality
Primary Control (1-10 storms)	525mm diameter orifice	450mm diameter orifice	300mm diameter orifice
Overflow Control (10-100 storms)	1.75m wide weir at base increasing to 3.5m at top.	1.4m wide weir at base increasing to 2.5m at top	1.15m wide weir at base increasing to 1.75m.
Storage Depth (above wetland)	1.30m in 10 year storm 1.73m in 100 year storm	1.14m in 10 year storm 1.72m in 100 year storm	1.38 in 10 year storm 1.85m in 100 year storm

Table 5 – Pond Configuration

The ponds have been designed as simple rectangular shapes with vertical sides at present. More appropriate landscape forms should be used, and their plan dimensions generally increased as necessary to allow for batters and to reduce the storage depth if a lower embankment height is considered more practical.

The future rate of runoff in the 10 and 100 year storms is indicated in Tables 6 and 7.

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
NorthImpervious	0.190	1.9755	01Jan2000, 10:12	89.58
NorthPervious	0.190	0.6154	01Jan2000, 10:35	40.74
North Pond	0.380	0.6222	01Jan2000, 11:31	63.99
CentralPervious	0.125	0.4049	01Jan2000, 10:35	40.74
CentralImpervious	0.125	1.2997	01Jan2000, 10:12	89.58
Central Pond	0.250	0.4667	01Jan2000, 11:19	64.33
SouthImpervious	0.050	0.5199	01Jan2000, 10:12	89.58
SouthPervious	0.050	0.1619	01Jan2000, 10:35	40.74
South Pond	0.100	0.3279	01Jan2000, 10:47	64.74
Pioneer Highway	0.100	0.3279	01Jan2000, 10:47	64.74
RongateaRd	0.730	1.3803	01Jan2000, 10:55	64.21

Table 6 – Future 10 Year Storm with Mitigation

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
NorthImpervious	0.190	3.1389	01Jan2000, 10:12	142.32
NorthPervious	0.190	1.2964	01Jan2000, 10:34	82.48
North Pond	0.380	2.1249	01Jan2000, 10:50	107.90
CentralPervious	0.125	0.8529	01Jan2000, 10:34	82.48
CentralImpervious	0.125	2.0651	01Jan2000, 10:12	142.32
Central Pond	0.250	1.6194	01Jan2000, 10:43	110.22
SouthImpervious	0.050	0.8260	01Jan2000, 10:12	142.32
SouthPervious	0.050	0.3412	01Jan2000, 10:34	82.48
South Pond	0.100	0.8510	01Jan2000, 10:29	111.68
Pioneer Highway	0.100	0.8510	01Jan2000, 10:29	111.68
RongateaRd	0.730	4.4040	01Jan2000, 10:46	109.21

Table 7 – Future 100 Year Storm with Mitigation

6.5 Analysis Summary

Stormwater ponds subject to further specific design can be used to effectively control the future peak rate of runoff to the pre-development level for the 10-100 year storms as summarised in Table 8.

Storm	Existing	Future No Mitigation	Future Mitigated
10 year	2.08 m^3/s	4.55 m^3/s	1.38 m^3/s
100 year	4.51 m^3/s	7.71 m^3/s	4.40 m^3/s

Table 8 – Existing and Future Peak Flow Comparison

Additional low impact provisions (rainwater harvesting tanks, swales, raingardens) should also be used to provide some mitigation for the volume of runoff. These provisions have been conservatively ignored from the preceding hydraulic analysis. The ponds should also incorporate a permanent pool of water (ie wetland) to provide water quality treatment provisions that enhance treatment provided with swales along roading corridors.

7. Conclusions

- Existing site features are indicated on Drawing 9871/C01.

- Existing reports prepared for Pioneer City West (Refer Section 2.1) confirm the site is not at risk of flooding from the Mangaone Stream or Manawatu River in the 1 in 500 year storm. Reports for Council (Refer Section 2.2) also confirm the site is not subject to flooding from these sources, unless there is an unlikely stopbank failure on the Mangaone Stream. Policy 10-2 (e) of the One Plan indicates this stopbank system is considered adequate for flood protection in the 1 in 500 year storm and stipulates no further mitigation is generally considered necessary. Development at the subject site can in any case incorporate overland flow paths and earthworks to safely convey stormwater flows from such an extreme event in accordance with Policy 10-2 (d).

- The site is outside of the Floodway and Floodable Areas of the Taonui Basin as required for development under Policy 10-2(a) of the Proposed One Plan.

- Future development can lead to an increase in the volume and rate of stormwater runoff. The PNCC have indicated it will be appropriate for development to incorporate mitigation provisions that minimize the increase to the volume of runoff, minimise changes to the rate of stormwater runoff and provide water quality treatment.

- The Council engaged Mr Brian Kouvelis to identify appropriate stormwater mitigation provisions for the City West Proposed Urban Growth Area. The preliminary reporting to Council identified some benefits associated with low impact design, and confirmed that stormwater ponds would be necessary to establish appropriate mitigation for the open channels below the development area and the Taonui flood protection basin.

- The stormwater mitigation options considered by Council for the City West Proposed Urban Growth Area have been adopted for the Pioneer City West site.

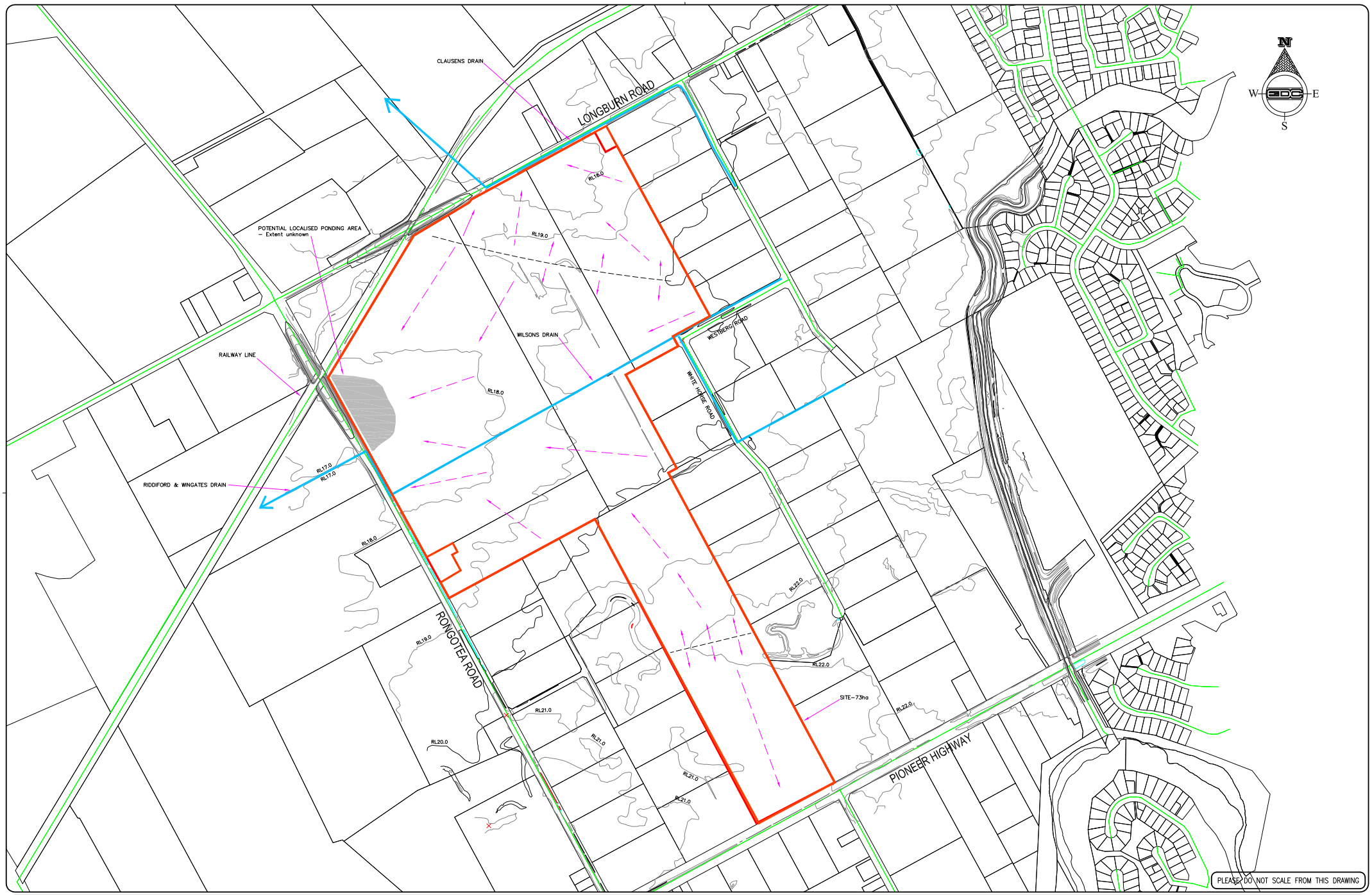
- The proposed roading alignment is considered suitable for establishment of overland flow paths across the site. The building areas should generally be elevated slightly above the future roading network to provide flood protection.

- Low impact design can be used to limit any changes in the volume of stormwater runoff and minimise any changes to the timing of runoff. This should include the use of grass swales, rainwater harvesting tanks and rain-gardens below future commercial car-parking areas. These low impact design provisions do not however provide a high level of control for the peak rate of discharge, which must be provided using future stormwater ponds.

- Three stormwater ponds are recommended for the development as generally shown on Drawing 9871/D01. Some filling may be necessary in the north-western corner of the site to ensure as much of the northern sub-catchment as possible can be directed into the North pond. This fill will also remove the existing risk of localized inundation to building areas across the lower lying land in the north-west corner of the site closest to the railway line.

- Stormwater analysis confirms that ponds as generally indicated on Drawing 9871/D01 will be feasible for providing effective mitigation. The future rate of stormwater discharge can be restricted to the pre-development level for the 10-100 year storms. Detailed design can address the final size, shape, and configuration of their outlets to control all critical storm events and durations in consultation with the PNCC and Horizons.

- Further site survey and engineering design work will be necessary for all stormwater mitigation provisions recommended in this report. These should generally be designed in accordance with the engineering design standards manual of the PNCC.



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DATE		REVISION	BY	CHK

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PROJECT: **PIONEER CITY WEST PALMERSTON NORTH**

DRAWING TITLE: EXISTING SITE PLAN

DESIGNED	IH
DRAWN	JM
REVIEWED	-
DATE	-

A1 SCALE	1:4000
A3 SCALE	1:4000
PAPER SPACE SIZE	1:1 @ A1

PRELIMINARY ONLY
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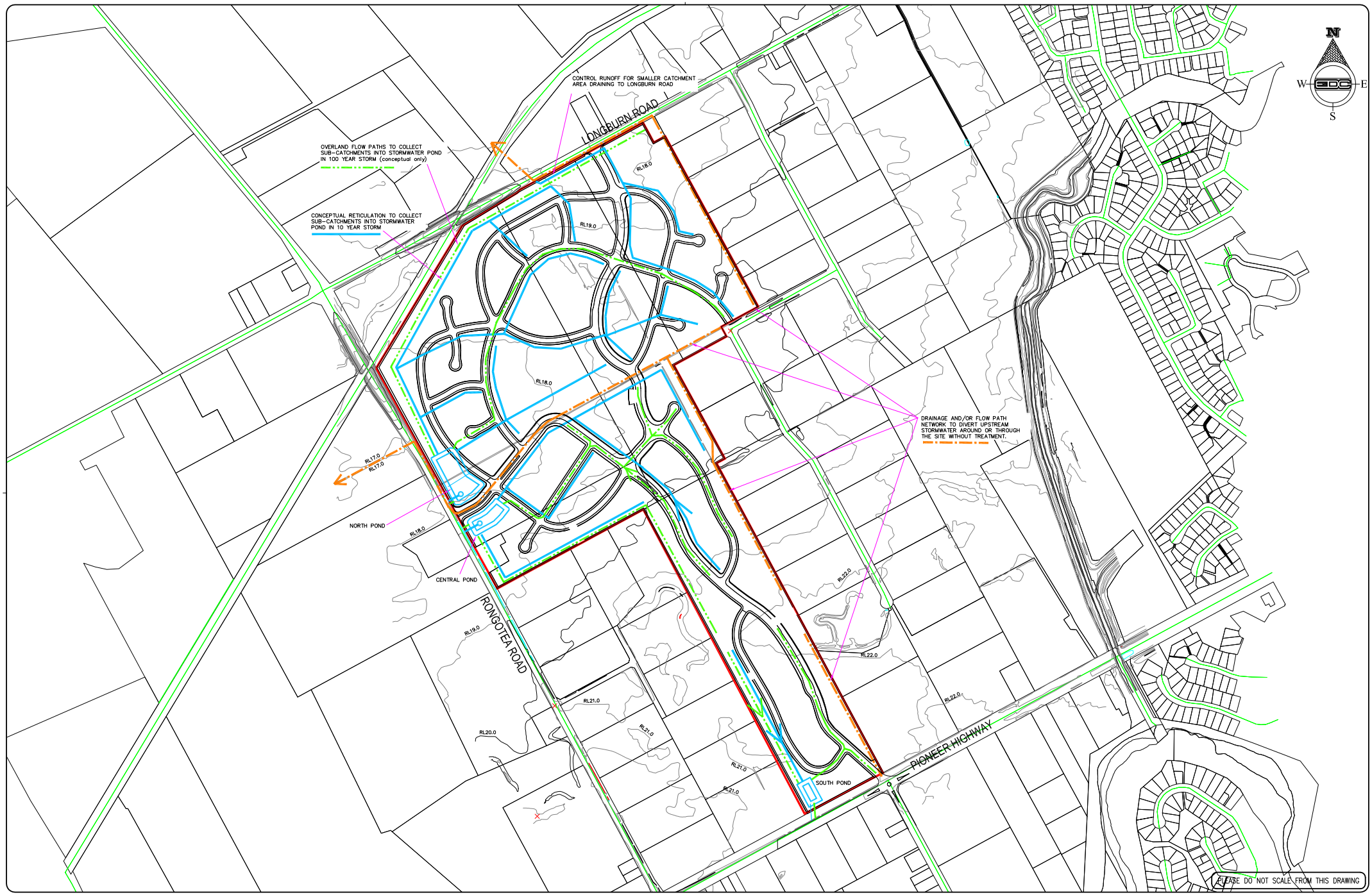
PROJECT 9871 | DRAWING C01 | REVISION A



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PROJECT: **PIONEER CITY WEST PALMERSTON NORTH**

DRAWING TITLE: DRAINAGE CONCEPTS

DESIGNED	IH
DRAWN	JM
REVIEWED	–
DATE	–

A1 SCALE	1:4000
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PAPER SPACE SIZE 1:1 @ A1

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PROJECT 9871 | DRAWING D01 | REVISION A