# 1. Pauatahanui Stream Modelling Report Introduction

## 1.1 Background

During recent severe rainfall (4 – 6 Jan 2005) properties near Flightys Road and Murphys Road were flooded and the residents subsequently complained to Porirua City Council (PCC).

The residents believe that the frequency of significant flood events in the area has increased. Whether this is attributable to growth of local vegetation in the stream, changed catchment land use, the presence of more bridges/culverts (and unpermitted debris fences), or just more extreme rainfalls in recent years is uncertain.

In order to identify any increase in flood risk, PCC have engaged Connell Wagner to undertake the construction of a computer model of the stream, delineation of flood extent and the development of mitigation options based on currently available catchment information and techniques.

## 1.2 Scope of works

The scope of work consists of the development of a hydrological and hydraulic model of the Pauatahanui Stream. The modelled stream section starts upstream of the SH58 bridge located upstream of the golfcourse (near the entrance) down to the Pauatahanui Inlet. The scope of work for this has been set out under Item 3 of Connell Wagner letter dated 19 January 2005.

## 1.3 Key issues

The following key issues have been addressed in this report:

- Flooding of the sawmill property and the property upstream of Flightys Road bridge
- Flooding of the golf course
- Overtopping of SH58 bridges
- Affect of new bridge at the bottom of the catchment on flow capacity and subsequent risk of flooding
- Impact of wild vegetation growth on the performance of the stream and flood risk

Recent developments in this area that may have affected the capacity and risk of flooding are:

- SH58 realignment works in 1994, comprising realignment of the SH58 section between Flightys Road and the sawmill west of Belmont Road along with a new bridge.
- SH58 Realignment near the Pauatahanui Inlet at the intersection with Paekakareki Hill Road in 2002, creating additional structures in the stream and additional secondary flow path by-passing the old bridge.
- Deposition of gravels in the upper catchment of the stream that slowly move down, causing reduction of flow area.
- Construction and raising of stopbanks around the sawmill, which reduces cross-sectional flow area and storage.
- Uncontrolled growth of vegetation along the stream, reducing stream flow area and increasing stream bank resistance.

### 1.4 Report set up

This report follows an initial walkover carried out in Jan 2005, that identified the areas of concern and subsequently the recommendation to undertake detailed catchment analysis and modelling of the Pauatahanui Stream. The observations during our walkover have been reported separately in Connell Wagner letter to PCC dated 8 July 2005. A copy of this letter has been attached to this report (Refer Appendix G).

This report describes:

- The methodologies of our modelling work
- The topographical survey results
- The hydrological and hydraulic assumptions
- Results of the calibration and validation process
- Initial results of the model
- Possible improvement works
- Conclusions and recommendations regarding our analysis and the model built

## 2. *Pauatahanui Stream Modelling Report Conclusions*

### 2.1 Summary and conclusions

1. A hydrological and hydraulic model of the Pauatahanui Stream has been developed over a length of 5.5 km of the stream. The model starts approximately 200 m upstream of the SH58 bridge near the entrance to the Pauatahanui Golf Course.
2. The hydrological and hydraulic model has been calibrated using:
- rainfall data from various rain gauges in the region
- flow monitoring data from the NIWA flow monitor near the Sawmill at SH58
- observed flood levels near Flightys Road Bridge and the Sawmill
3. Flood levels and extent have been assessed and presented on Drawings FM01 – FM06. The floodmaps represent the flood risks within the surveyed length of the stream. For areas where flooding was expected to be outside the surveyed sections, the extent has been assessed based on field observations, aerial photo's and contour data. The accuracy of information outside of the cross-section boundaries will remain limited until comprehensive topographical data is obtained.

### 2.2 Possible physical improvement works

The following physical improvements to minimise flooding could be undertaken:

1. Removal and or pruning of vegetation along the stream banks especially in the middle reach of the stream from Flightys Road bridge down to Belmont Road bridge. This would reduce roughness substantially and consequently increase flow capacity.
2. Removal of gravels from the streambed. This applies mainly to the upper reaches of the stream where deposition of gravels is noticeable. This would substantially increase the flow capacity especially at the two SH58 bridges near the golf course (Bridge 7 & 9, refer Drawing FM06)
3. Providing detention to increase storage. Available area for potential detention has to be investigated and options could be analysed.
4. Significant upgrade of stream channel profile or structures.

The first two items could be considered as maintenance of the existing stream system whilst the second two would be considered as stream upgrade works. Undertaking the above works would be expected to reduce upstream flood levels, but the potential worsening of downstream flood risks needs to be assessed. Assessment of the impact of the above physical improvements is recommended under Section 2.3.

### 2.3 Improvements to the hydraulic model

The following improvements to the hydraulic model are recommended:

1. Analyse the effect of physical improvement recommendations provided under Section 2.2.
2. The rating curve of the NIWA flow monitoring station at the sawmill, which was last calibrated in 1994, is not accurately represented by the model, despite attempts to increase roughness of the modelled stream. Further investigation is required to clarify the reason behind this variance.

## 2.4 Other issues

Issues associated with this study that would require further attention and/or discussion are identified in this section.

### *2.4.1 Gravel deposition*

Deposition of gravels is obvious at the downstream side of the SH58 bridge near the golfclub (refer Section 5.6). Evidence of this is an old shed near the golfclub entrance that now is nearly completely covered by gravels. It is understood that over a long period of time, gravels have been raising the streambed level and consequently the cross-sectional flow area of bridges and the stream channel have been reduced. This evidence suggests that approximately 1-2 m of gravels have been deposited in this area. According to Steve Murphy (GWRC employee living in the area at Moonshine Road), the majority of the gravel deposition is a result of uncontrolled earthworks further up Moonshine Road. A property owner developing a forestry block used to cut tracks on this site, which ultimately resulted in erosion and gravels being washed into the stream, approximately 4 km upstream of the golfcourse. These earthworks have ceased some time ago and Mr Murphy has noticed that streambed levels in the upper reaches of the stream along Moonshine Road are dropping. In his opinion, it seems that most of the gravels have been eroded downstream leaving a reasonable stable streambed. Further deposition of such extensive volumes of gravels is therefore unlikely.

This matter however, indicates the need for Council to maintain regulatory control over works in the upper catchments.

### *2.4.2 Future urban development*

The model has been calibrated to existing conditions, ie hydrological inputs such as CN & R values reflect any attenuation in upstream catchments. Any attenuation has not been specifically identified and may or may not be retained as the catchment develops. However, it is recommended that future urbanisation or major roading works be required to attenuate flows, such that the works do not worsen downstream flow peaks and hence flood levels.

If this is not done it is recommended that a “future” urbanisation model be developed, which would utilise different hydrological parameters to represent best estimates of future higher impermeability and possible filling of low lying storage areas. The outputs from this would then be used to set minimum building levels for future subdivisions and development.

### *2.4.3 Storage and extent of flooding*

The catchment and its subcatchments have significant low lying areas where flooding and flood storage occurs. However good quality topographical information for the catchment is limited except where cross sections have been surveyed for this project. This effects the way flood plain attenuation is modelled and the area of flood extents shown on the flood maps.

Storage on flood plains, where captured by the cross section survey has been explicitly modelled. The attenuation impacts of storage outside the surveyed cross sections have been estimated by inputs into the hydrological model and the calibration against the present flow monitoring information, which reflects flood plain attenuation presently occurring.

If the model is to be used to asses the effects of possible changes to the flood plains (eg filling of areas for housing or development) then good quality topographical information will be required so that the impacts of ponding changes can be quantified.

The flood hazard maps provided with this report represent the existing levels of catchment development and stream condition (October 2005). They are based on computed water levels rounded to the nearest decimal point. They show floodable areas identified from the cross section information surveyed. There are likely to be other areas with flood risk that are not shown on the flood maps because:

- They are outside the boundaries of the cross section survey
- They are affected by local effects outside the main stream model (eg undersized culverts or side channels)
- They are within the contributing sub-catchments

### *2.4.4 Freeboard considerations:*

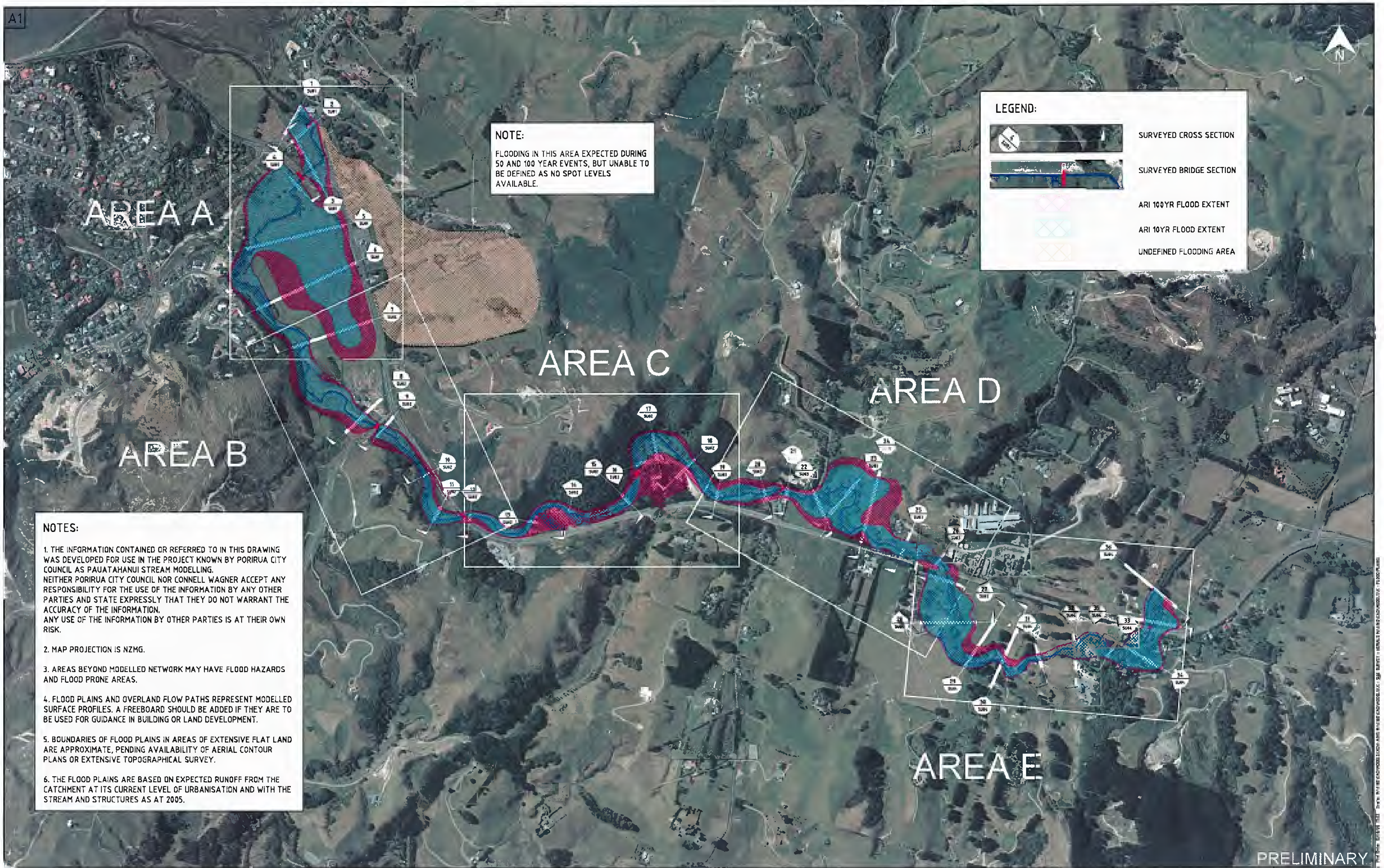
The levels computed from the stream modelling are average water levels at any cross section point. If the information is to be used for construction of planning purposes, a freeboard should be added to the levels. The freeboard covers such things as:

- Field data approximations of:
  - Cross section and stream roughness variability
  - Averaging ground levels and interpolation of cross sectional areas
  - Omission of detailed features of structures
- Analytical approximations such as:
  - Basic modelling approximations
  - Rainfall variability across the catchment
  - Quality of soil permeability assumptions
  - Variability of catchment soil saturation rate and base flow at the start of the simulation.
  - The reality that stream surfaces are not smooth when in flood, but can be very wavy
- Outside influences:
  - Waves can be generated by vehicles moving across flood areas
  - Likelihood of debris effects particularly where (stock) fences or structures cross the stream
  - Areas where stream flows have high velocities generate irregular wavy water surfaces.

The extent of freeboard actually used depends on:

- The nature of the stream eg a broad flat floodplain may justify a lesser freeboard than a fast flowing stream.
- The level of risk (defined as probability multiplied by the damage) caused by flooding. High populated areas may require higher freeboard than rural areas.

Freeboards typically used range from 300 mm (flat slow ponds) to over 1 m (Hutt River). For this stream an average freeboard of 500 to 600 mm would be appropriate, although if major new confining works are to be done, the marginal cost of achieving greater freeboards is often relatively small.




| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | | | |

Connell Wagner

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

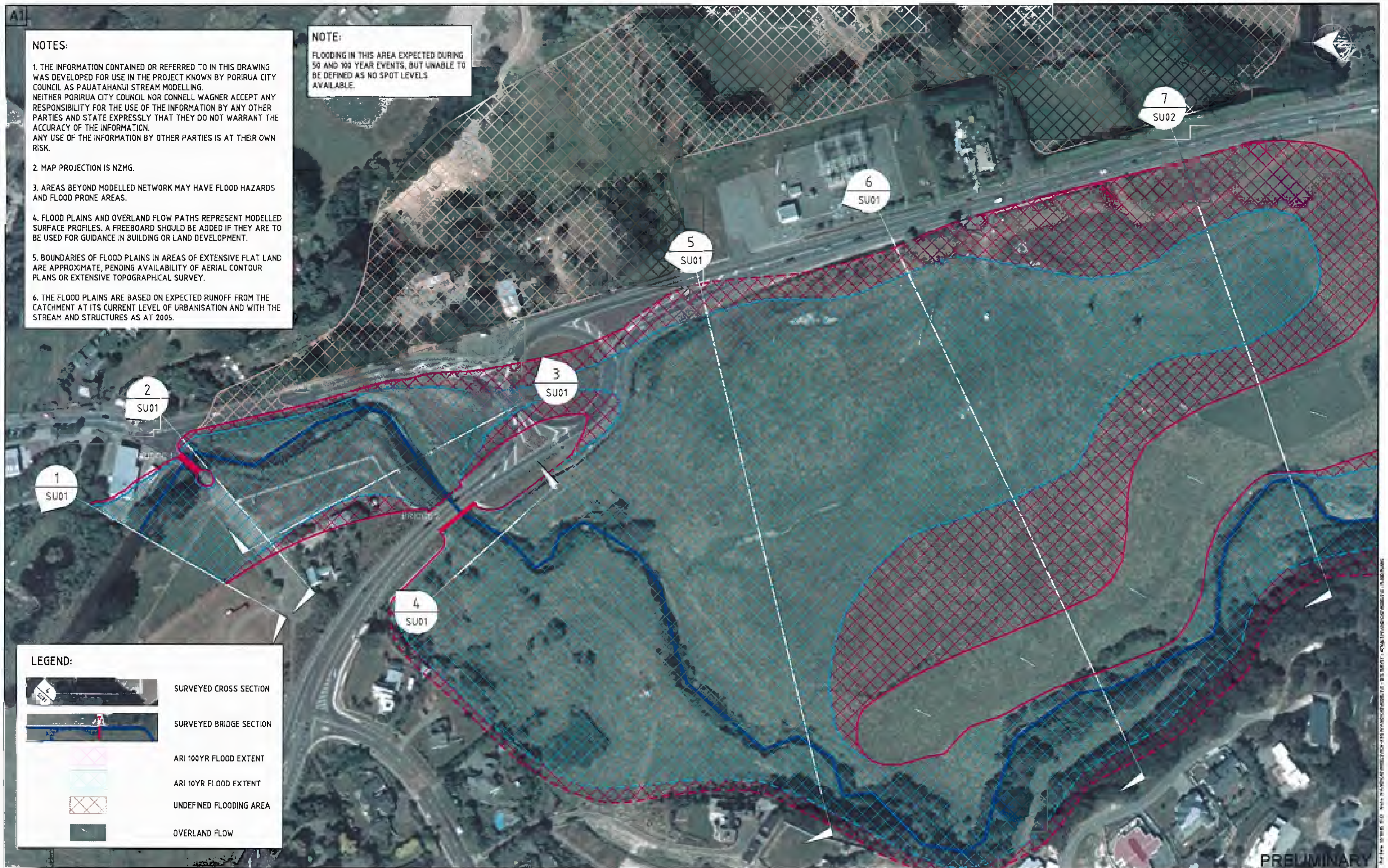
| | | Signed | Date |
|---|---|---|---|
| Drawn | AM | ARM | 12.10.05 |
| Designed | RVL | | 12.10.05 |
| Verified | RJC | | 12.10.05 |
| Approved | CBH | | 12.10.05 |

Drawing Title: FLOOD HAZARD MAP

CW Project No. 416D 40 CC

Scale 1:5000 @ A1, 1:10000 @ A3

Drawing No. FM01 Rev. 01




| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | RVL | | |

**Connell Wagner**

Connell Wagner Limited
Lumley House, 3 Hunter Street (PO Box 1591)
Wellington New Zealand
Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

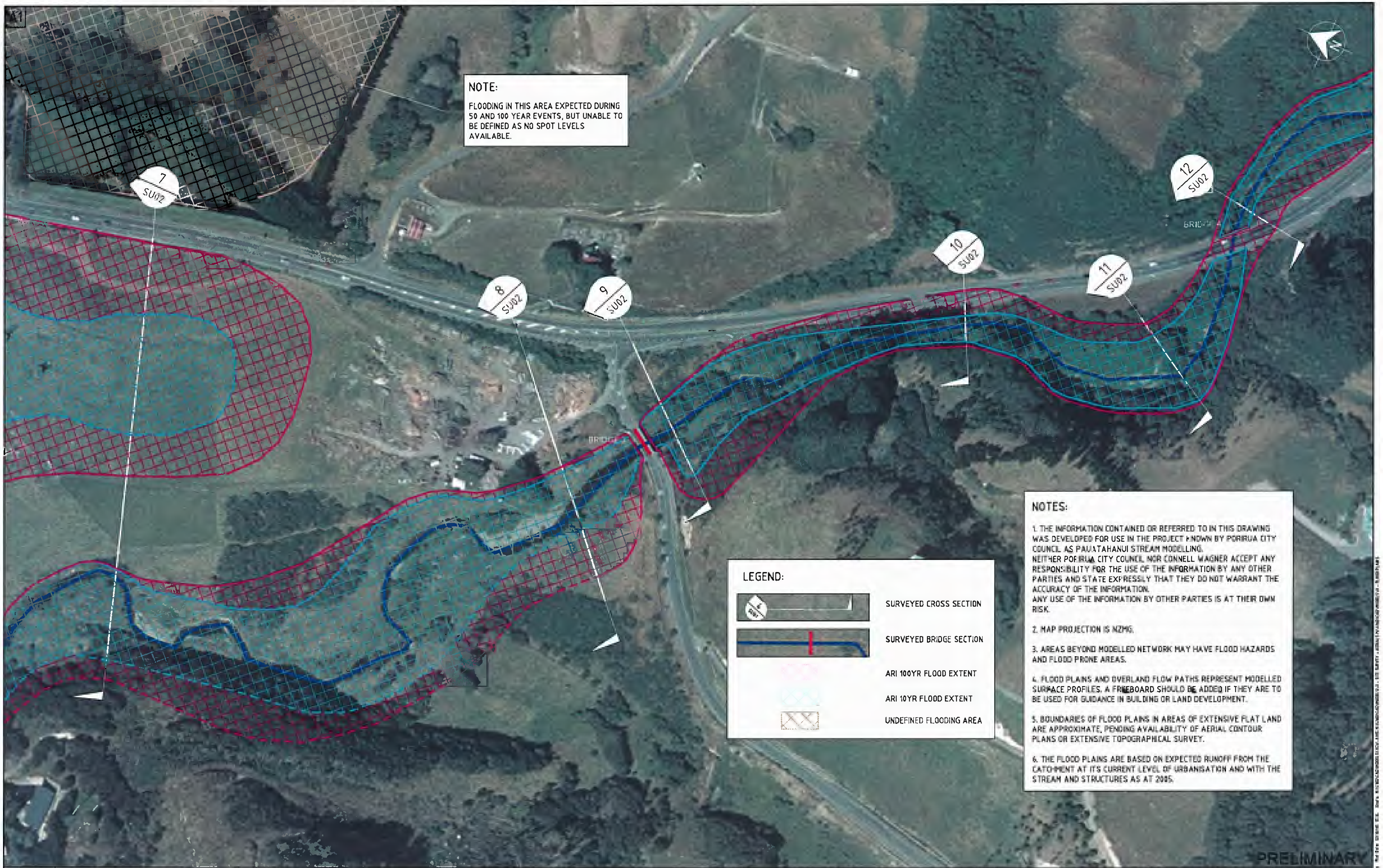
| | Signed | Date |
|---|---|---|
| Drawn AM | | 12.10.05 |
| Designed RVL | | 12.10.05 |
| Verified RJC | | 12.10.05 |
| Approved CBH | | 12.10.05 |

Drawing Title: AREA A FLOOD HAZARD MAP

CW Project No. 416D 40 CC

Scale 1:1000 @ A1
1:2000 @ A3

Drawing No. FM02 Rev. 01




NOTE:
FLOODING IN THIS AREA EXPECTED DURING 50 AND 100 YEAR EVENTS, BUT UNABLE TO BE DEFINED AS NO SPOT LEVELS AVAILABLE.

LEGEND:

- SURVEYED CROSS SECTION
- SURVEYED BRIDGE SECTION
- ARI 100YR FLOOD EXTENT
- ARI 10YR FLOOD EXTENT
- UNDEFINED FLOODING AREA

NOTES:

1. THE INFORMATION CONTAINED OR REFERRED TO IN THIS DRAWING WAS DEVELOPED FOR USE IN THE PROJECT KNOWN BY PORIRUA CITY COUNCIL AS PAUATAHANUI STREAM MODELLING.
NEITHER PORIRUA CITY COUNCIL NOR CONNELL WAGNER ACCEPT ANY RESPONSIBILITY FOR THE USE OF THE INFORMATION BY ANY OTHER PARTIES AND STATE EXPRESSLY THAT THEY DO NOT WARRANT THE ACCURACY OF THE INFORMATION.
ANY USE OF THE INFORMATION BY OTHER PARTIES IS AT THEIR OWN RISK.

2. MAP PROJECTION IS NZMG.

3. AREAS BEYOND MODELLED NETWORK MAY HAVE FLOOD HAZARDS AND FLOOD PRONE AREAS.

4. FLOOD PLAINS AND OVERLAND FLOW PATHS REPRESENT MODELLED SURFACE PROFILES. A FREEBOARD SHOULD BE ADDED IF THEY ARE TO BE USED FOR GUIDANCE IN BUILDING OR LAND DEVELOPMENT.

5. BOUNDARIES OF FLOOD PLAINS IN AREAS OF EXTENSIVE FLAT LAND ARE APPROXIMATE, PENDING AVAILABILITY OF AERIAL CONTOUR PLANS OR EXTENSIVE TOPOGRAPHICAL SURVEY.

6. THE FLOOD PLAINS ARE BASED ON EXPECTED RUNOFF FROM THE CATCHMENT AT ITS CURRENT LEVEL OF URBANISATION AND WITH THE STREAM AND STRUCTURES AS AT 2005.

| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | RVL | | |

Connell Wagner

Connell Wagner Limited
Lumley House, 3 Hunter Street (PO Box 1091)
Wellington New Zealand
Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

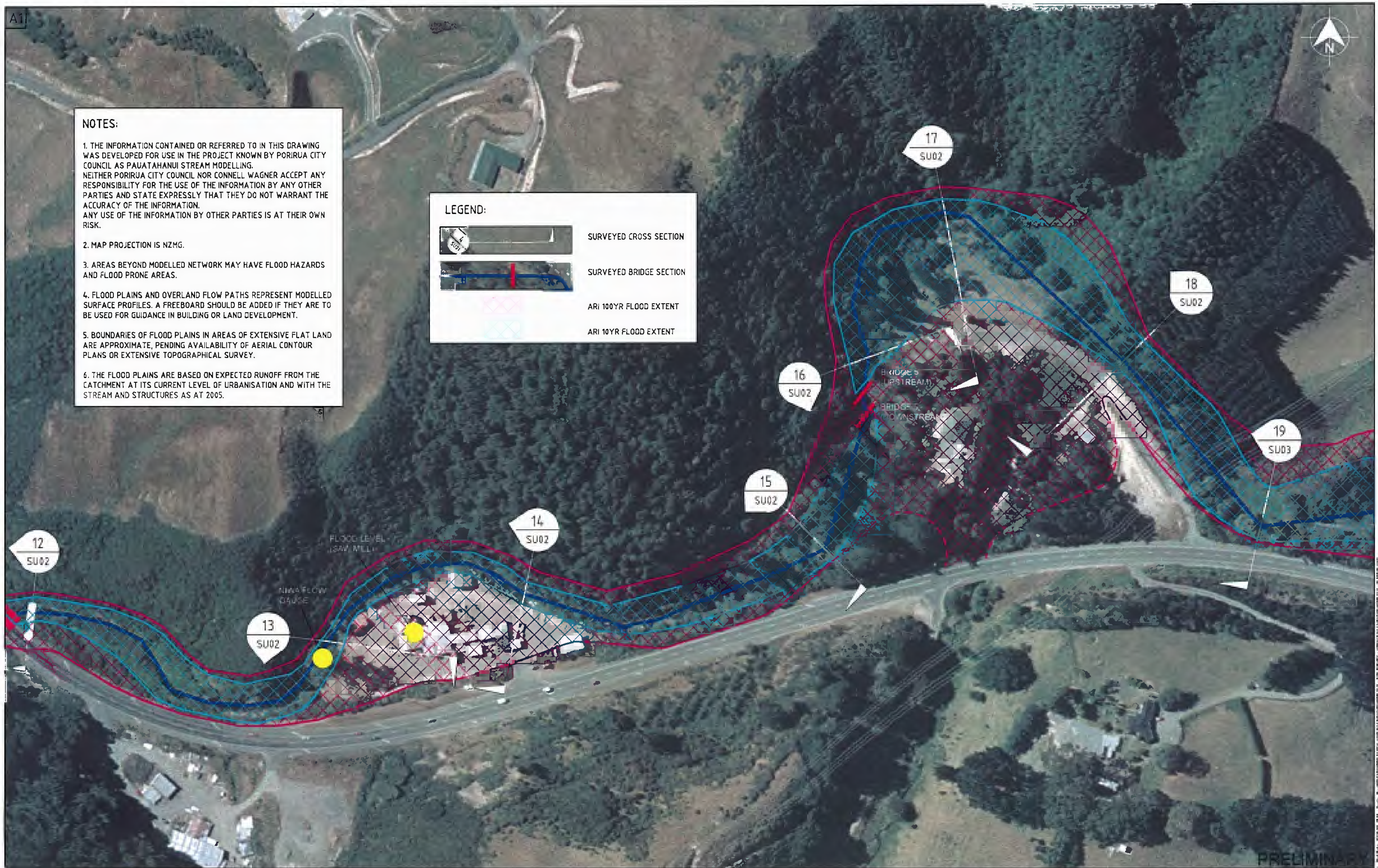
| Drawn | Signed | Date |
|---|---|---|
| AM | | 12.10.05 |
| Designed RVL | Signed | Date 12.10.05 |
| Verified MCG | Signed | Date 12.10.05 |
| Approved CBH | Signed | Date 12.10.05 |

Drawing Title: AREA B FLOOD HAZARD MAP

CW Project No. 416D 40 CC

Scale 1:1000 @ A1
1:2000 @ A3

Drawing No. FM03 Rev. 01




NOTES:

1. THE INFORMATION CONTAINED OR REFERRED TO IN THIS DRAWING WAS DEVELOPED FOR USE IN THE PROJECT KNOWN BY PORIRUA CITY COUNCIL AS PAUATAHANUI STREAM MODELLING.
NEITHER PORIRUA CITY COUNCIL NOR CONNELL WAGNER ACCEPT ANY RESPONSIBILITY FOR THE USE OF THE INFORMATION BY ANY OTHER PARTIES AND STATE EXPRESSLY THAT THEY DO NOT WARRANT THE ACCURACY OF THE INFORMATION.
ANY USE OF THE INFORMATION BY OTHER PARTIES IS AT THEIR OWN RISK.

2. MAP PROJECTION IS NZMG.

3. AREAS BEYOND MODELLED NETWORK MAY HAVE FLOOD HAZARDS AND FLOOD PRONE AREAS.

4. FLOOD PLAINS AND OVERLAND FLOW PATHS REPRESENT MODELLED SURFACE PROFILES. A FREEBOARD SHOULD BE ADDED IF THEY ARE TO BE USED FOR GUIDANCE IN BUILDING OR LAND DEVELOPMENT.

5. BOUNDARIES OF FLOOD PLAINS IN AREAS OF EXTENSIVE FLAT LAND ARE APPROXIMATE, PENDING AVAILABILITY OF AERIAL CONTOUR PLANS OR EXTENSIVE TOPOGRAPHICAL SURVEY.

6. THE FLOOD PLAINS ARE BASED ON EXPECTED RUNOFF FROM THE CATCHMENT AT ITS CURRENT LEVEL OF URBANISATION AND WITH THE STREAM AND STRUCTURES AS AT 2005.

LEGEND:

- SURVEYED CROSS SECTION
- SURVEYED BRIDGE SECTION
- ARI 100YR FLOOD EXTENT
- ARI 10YR FLOOD EXTENT

| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | RVL | | |

Connell Wagner

Connell Wagner Limited
Lumley House, 3 Hunter Street (PO Box 1891)
Wellington New Zealand
Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

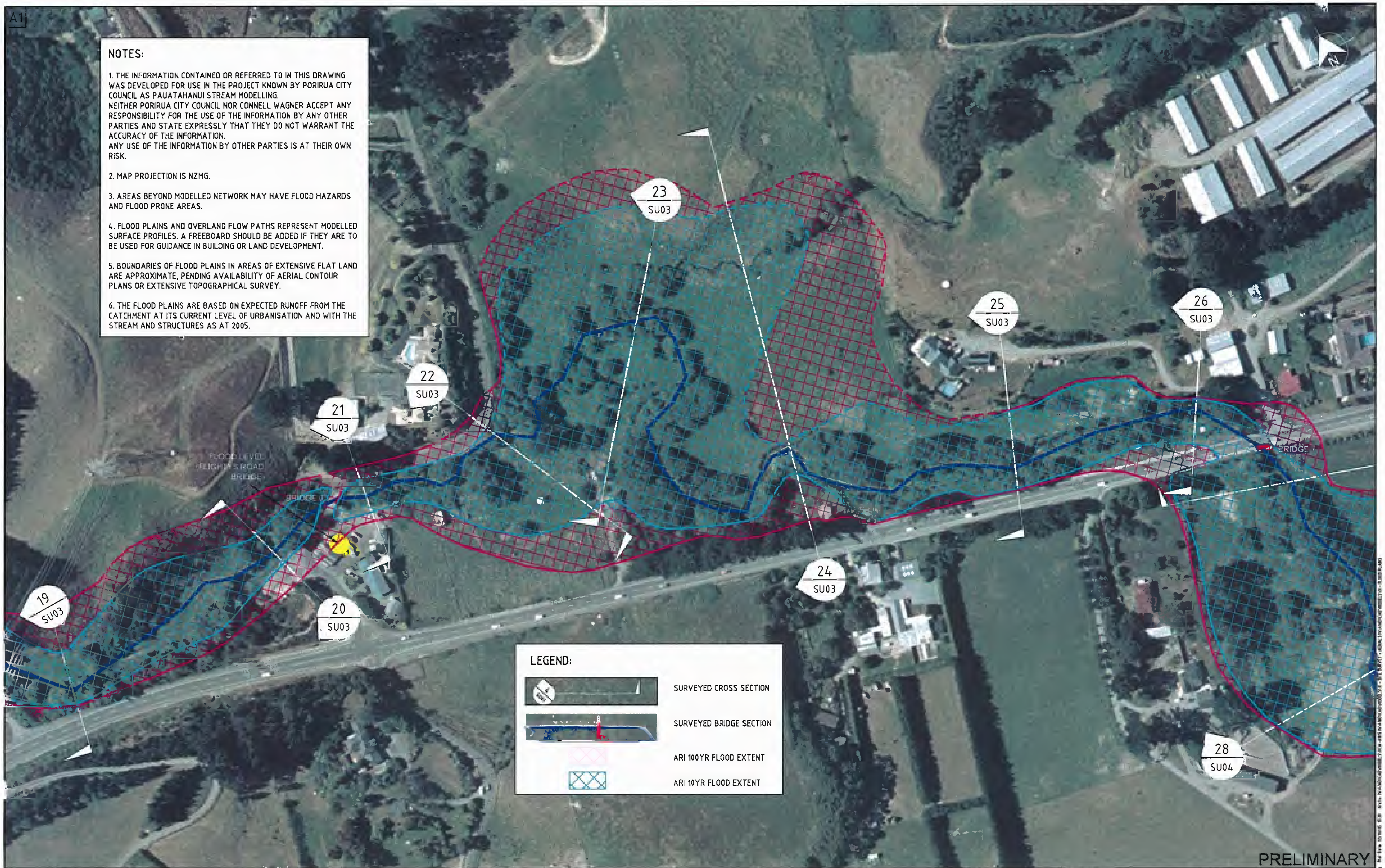
| | Signed | Date |
|---|---|---|
| AM | | 12.10.05 |
| Designed RVL | | 12.10.05 |
| Verified RJC | | 12.10.05 |
| Approved CBH | | 12.10.05 |

Drawing Title: AREA C FLOOD HAZARD MAP

CW Project No. 416D 40 CC

Scale 1:1000 @ A1 1:2000 @ A3

Drawing No. FM04 Rev. 01




| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | RVL | | |

**Connell Wagner**

Connell Wagner Limited
Lumley House, 3 Hunter Street (PO Box 1591)
Wellington New Zealand
Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

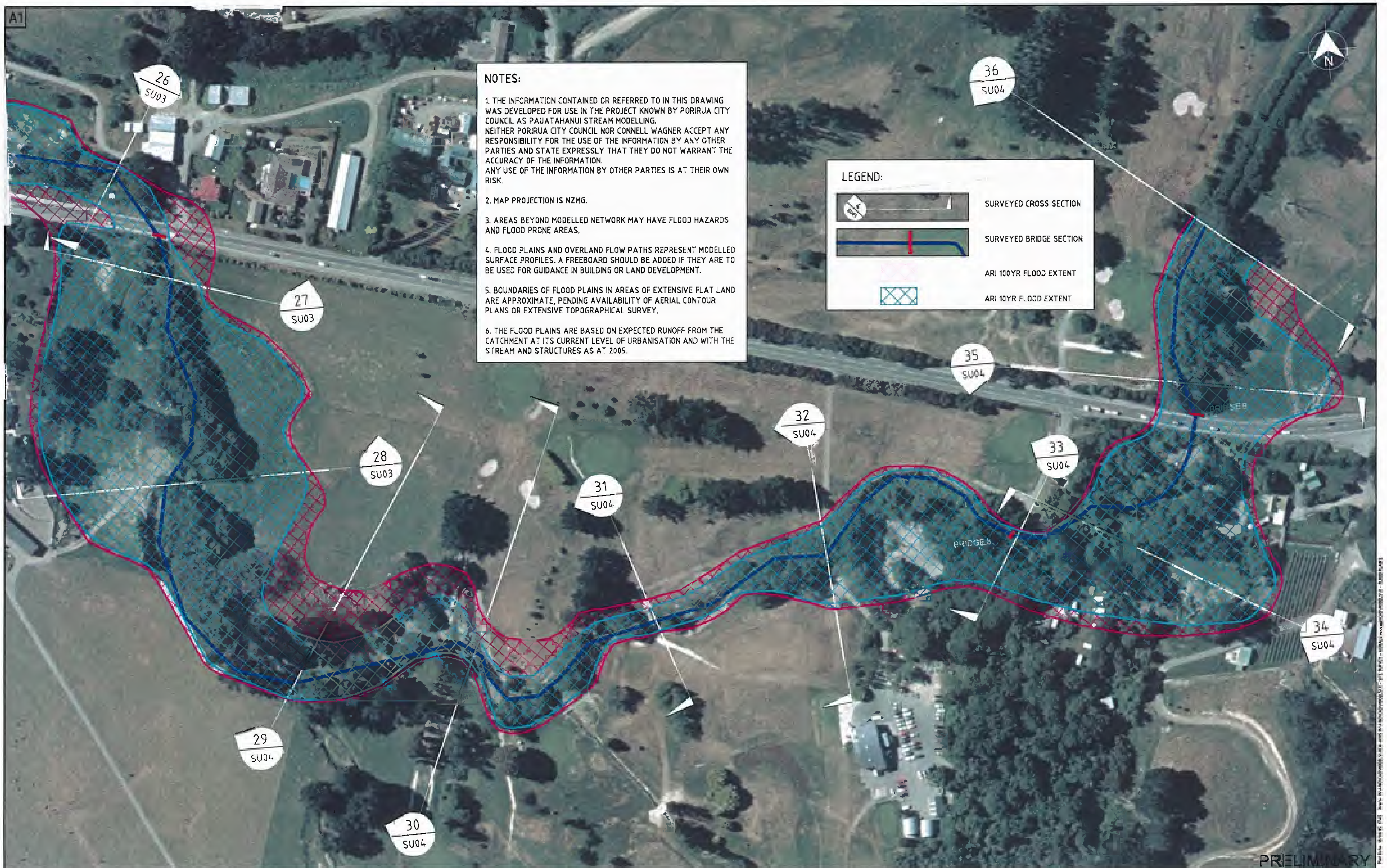
| | | Signed | Date |
|---|---|---|---|
| Drawn | AM | | 12.10.05 |
| Designed | RVL | | 12.10.05 |
| Verified | RJC | | 12.10.05 |
| Approved | CBH | | 12.10.05 |

Drawing Title: AREA D FLOOD HAZARD MAP

CW Project No. 416D 40 CC

Scale 1:1000 @ A1
1:2000 @ A3

Drawing No. FM05 Rev. 01




NOTES:

1. THE INFORMATION CONTAINED OR REFERRED TO IN THIS DRAWING WAS DEVELOPED FOR USE IN THE PROJECT KNOWN BY PORIRUA CITY COUNCIL AS PAUATAHANUI STREAM MODELLING. NEITHER PORIRUA CITY COUNCIL NOR CONNELL WAGNER ACCEPT ANY RESPONSIBILITY FOR THE USE OF THE INFORMATION BY ANY OTHER PARTIES AND STATE EXPRESSLY THAT THEY DO NOT WARRANT THE ACCURACY OF THE INFORMATION. ANY USE OF THE INFORMATION BY OTHER PARTIES IS AT THEIR OWN RISK.

2. MAP PROJECTION IS NZMG.

3. AREAS BEYOND MODELLED NETWORK MAY HAVE FLOOD HAZARDS AND FLOOD PRONE AREAS.

4. FLOOD PLAINS AND OVERLAND FLOW PATHS REPRESENT MODELLED SURFACE PROFILES. A FREEBOARD SHOULD BE ADDED IF THEY ARE TO BE USED FOR GUIDANCE IN BUILDING OR LAND DEVELOPMENT.

5. BOUNDARIES OF FLOOD PLAINS IN AREAS OF EXTENSIVE FLAT LAND ARE APPROXIMATE, PENDING AVAILABILITY OF AERIAL CONTOUR PLANS OR EXTENSIVE TOPOGRAPHICAL SURVEY.

6. THE FLOOD PLAINS ARE BASED ON EXPECTED RUNOFF FROM THE CATCHMENT AT ITS CURRENT LEVEL OF URBANISATION AND WITH THE STREAM AND STRUCTURES AS AT 2005.

| Rev. | Date | Revision Details | By | Ver. | App. |
|---|---|---|---|---|---|
| 01 | 12.10.05 | ISSUE FOR INFORMATION | RVL | | |

Connell Wagner

Connell Wagner Limited
Lumley House, 3 Hunter Street (PO Box 1591)
Wellington New Zealand

Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com

Client: Porirua City Council

Project: PAUATAHANUI STREAM MODELLING

| | | | |
|---|---|---|---|
| Drawn | AM | Signed | Date 12.10.05 |
| Designed | RVL | Signed | Date 12.10.05 |
| Verified | RJC | Signed | Date 12.10.05 |
| Approved | CBH | Signed | Date 12.10.05 |

Drawing Title: AREA E FLOOD HAZARD MAPS

CW Project No. 416D 40 CC

Scale 1:1000 @ A1
1:2000 @ A3

Drawing No. FM06
Rev. 01