3.2.4 Reach D


Figure 4 Typical channel characteristics along Reach D

Reach D is the most sinuous section of the creek, with erosion occurring along the low outer banks of the bends. Tree roots have formed a small bed elevation control midway along the reach. The majority of bank erosion and bed scour occurs downstream of this control point. Some sandstone boulders were observed in the downstream section of the reach.

The downstream end of the reach is piped beneath Research Park Drive, with the realigned creek forming a very sharp bend. Sediment and flood debris have been deposited upstream of the overflow pipes. The opposite (left) bank is showing signs of recent erosion towards the foundations of the adjacent building.

Flood debris was also observed around tree trunks up to a metre above the current water level. Reach D is relatively well connected to its floodplain. Therefore, relatively frequent overbank flows are likely. The western area of Station Site North, on the east side of Research Park Drive, is at approximately the same elevation as the creek, and possibly represents the original creek alignment. Station Site North is, therefore, at increased risk of flooding.

3.2.5 Reach E


Figure 5 Typical channel characteristics along Reach E

Reach E appears to have been artificially constructed, with sandstone bedrock forming the broad, flat channel bed and sandstone block walls forming the banks. In one location, gouges in the rock indicate that ripping was required to create the channel. Boulders have been placed across the channel at intervals, possibly in an attempt to reduce flow velocities through an otherwise low-friction reach. Sediment has become trapped upstream of these boulder dams.

The blocks lining the banks and within the creek have been placed over geotextile fabric. The geotextile has been exposed in places. The riparian corridor along Reach E has little understorey vegetation, and fine sediment has been washed over and between the boulders lining the banks.

Stormwater overflow channels enter the creek in two places, indicating frequent inundation of west Station Site North.

3.2.6 Reach F

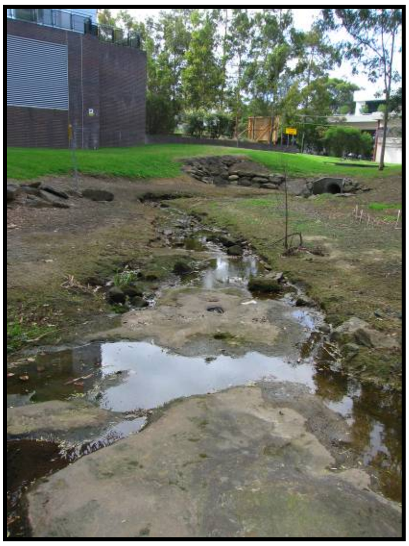

Figure 6 Typical channel characteristics along Reach F

Reach F is a sediment storage reach, with large bars covering the channel bed. The bars appear to have formed above artificial boulder dams mid-way down the reach and just above the Talavera Road pipe. Sedimentation has caused near-blockage of a pipe inflow just upstream of the Talavera Road pipe. The low-flow channel has incised approximately 0.2 – 0.3m into these bars. Flattened vegetation on the bars indicates relatively recent inundation. Sandstone bedrock is shallow along this reach, and outcrops within the downstream section.

The floodplain within Reach F has been artificially constricted by office developments, and is now a relatively narrow corridor between steep embankments. Towards the downstream end of the reach, it appears that the channel has been moved towards the left bank to increase development space. The right bank has been replaced by a high (approx 2.5m) sandstone block wall. Lateral erosion and bed degradation has occurred at the base of this wall, especially where the channel has been severely horizontally and vertically constricted by bedrock (see Drawing 5).

The pipe beneath Talavera Road represents a significant and abrupt decrease in channel capacity. Only a short section of small-diameter pipe has been installed, with a larger pipe just downstream. A grate allowing overflow into the larger pipe is only slightly below road level and flooding of the road occurs.

3.3 Sediment Dynamics

Sediment dynamics describe the way material is moved from source areas to storage areas through a river catchment and its channel. This transfer is an important control on the shape of the river channel and its flow.

The key features of the sediment dynamics of University Creek are as follows (summarised in Drawing 5):

- The largest source of fine sediment is likely to be from land adjacent to the creek where ground cover vegetation is thin or absent. Examples include construction sites (despite sediment control methods), pavement areas and landscaped areas with little/no understorey vegetation. Currently, Reaches E and F are most prone to sediment inputs of this type.
- Sediment sources from within the creek include:
    - Moderate quantities from bank erosion along Reaches A and D, and bed degradation along Reach C
    - Minor quantities from bank erosion along Reach C, E and F, and bed degradation along Reach B.
- Sediment is transported downstream episodically, during flood events. It is temporarily stored in bars or on the bed of the channel:
    - Major sediment storage within large bars along Reach F upstream of artificial boulder dams;
    - Minor sediment storage on the bed of Reaches B, C, D and E. Deposition has generally occurred within wider sections of the channel, or above dams.

4 FLOOD-RELATED GEOMORPHOLOGICAL ISSUES

Our assessment has indicated several geomorphological processes that may affect the flooding associated with University Creek:

- The creek channel had been artificially realigned, straightened and confined by 1943. Development of the University in 1967 resulted in further artificial alteration. Along Reach D, the creek is at approximately the same elevation as adjacent land (possibly the former creek alignment), which provides a preferential path for floodwaters (see Drawing 5).
- Construction of University and office buildings has occurred within the floodplain. This has both reduced the infiltration potential into already relatively impermeable ground and has removed or constricted the floodplain area, especially along Reach F. Further assessment of the effects of channel constriction along Reach F is provided in an additional report, GEOTLCOV23810AB-AD. The introduction of impermeable surfaces (bitumen, concrete etc.) reduces infiltration, accelerates surface runoff and, therefore, results in rapid rainfall/runoff response times (known as a "flashy" response). The increased flashiness, reduction in available floodplain and historic realignment of the creek are likely to have exacerbated contemporary flooding.
- Sections of the creek which are laterally or vertically constricted (or both) reduce the channel's ability to naturally adjust to variation in driving variables (i.e. flow and sediment inputs). The channel capacity is, therefore, significantly restricted, increasing the likelihood of flooding.

  Vertical restrictions, i.e. bed elevation controls, prevent bed degradation, increasing the likelihood of lateral erosion as the channel attempts to increase capacity during flooding. As sufficient lateral erosion is not possible and flows can rapidly decelerate, upstream flooding occurs. Sediment deposition tends to occur upstream of these points due to flow deceleration, further reducing the channel capacity. Examples include:

  - Resistant bed materials, e.g. bedrock along Reaches C, E and F; residual clay along Reach A; Concrete/pipes at the downstream end of Reaches B, C, D and F (see Figure 7), and within Reach C. Flooding has historically occurred upstream of these constrictions, resulting in uncontrolled surface flows to the west of Station Site South, across Waterloo Road, within the western area of Station Site North; across Research Park Drive; and across Talavera Road;

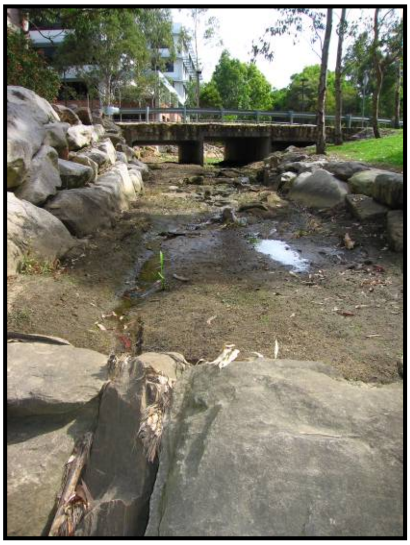

Figure 7 Wide culvert mid-way along Reach F and narrow pipe at downstream end of Reach F, demonstrating a significant reduction in flow capacity

- Tree roots, along Reaches A and D. The prevalence of lateral erosion downstream of the control point along Reach D indicates that the restriction is has limited the instability;
- Dams, such as the detention dam at the downstream end of Reach B; and the boulder dams within Reaches E and F.

Lateral constrictions, i.e. width restrictions, prevent lateral adjustment of the channel and can cause rapid flow deceleration. This can result in increased bed degradation, bed deposition and upstream flooding. Examples include:

- Resistant bank materials, e.g. bedrock along Reaches E and F; block walls along reaches E and F; and residual clay along Reach A;
- Tree roots, along Reach A;
- Narrow piped sections, especially at the downstream end of Reach F (see Figure 7).

- Sharp meander bends can affect flow efficiency, causing rapid flow deceleration and sediment deposition, much in the same way as lateral constrictions. This occurs particularly at the downstream end of Reach D, where the creek is piped below Research Park Drive.
- High channel banks, through incision, artificial alteration, or due to local topography, can cause dissociation of the channel and its floodplain. This means that, during flood events, flows tend to remain within the incised channel

5 UNIVERSITY CREEK IMPROVEMENT OPTIONS

5.1 Keys to Successful Flood Management

Creeks are interlinked systems. Therefore, changes to the geomorphology of the catchment surface or creek channel at one location may affect neighbouring locations, often downslope or downstream. Streams in "good" geomorphological condition are still subject to channel erosion, sediment deposition and, therefore, channel migration. There are many ways in which geomorphology and its linkages can be considered in order to effect sustainable flood management. The key to successful implementation of control measures is a good understanding of the likely channel processes, dynamics and behaviour, which allows a more realistic forecast of possible channel response to various options.

5.2 Potential Constraints

By its nature, a development will alter the natural – and artificial – environment. The planned design introduces several more road and footpath crossings of the creek, which could both reduce the area available for flood storage and also create further channel constrictions, if not sympathetically designed.

The current design may impose the following constraints:

- New bridges within Reaches B, C and D, potentially reducing channel capacity;
- Proposed construction within contemporary floodplain causing reduction of potential flood storage at the Station Sites;
- Widespread construction may result in increased sediment inputs to the creek, from construction materials and bare ground (after removal of ground cover vegetation), even with implementation of sediment control plans. Deposition of this sediment within the creek, particularly along Reach F, could reduce the channel capacity and block pipes.

5.3 Opportunities for Channel Improvement and Flood Management

We have based our consideration of the potential opportunities for channel improvement and flood management partly on the current building and road layout (since the development design has not been finalised), and the development Master Plan. Examples of opportunities along University Creek include (from upstream to downstream):

- Enlarge the overflow culvert above the detention dam at the downstream end of Reach B, and construct an embankment to the east to reduce downstream flooding, in particular of Station Site South. This dam is currently faced with rock armour, which is visually unappealing and does not appear to serve a purpose at the upstream face. The rock could be replaced with a reinforced geofabric and ground cover vegetation establishment encouraged. The rock on the downstream face appears to be effectively reducing flow velocities
- Widen channel within Reach C, but create a multi-level geometry, to allow more efficient flows of different magnitudes, i.e. a narrow low flow channel, with wider mid- and high-flow channels.
- Replace or refurbish pipe entry points, where degradation and/or lateral erosion has caused damage to the concrete aprons. Ideally these should include flow energy dissipation measures to reduce scour and erosion of the main creek channel.
- Consider the use of sub-surface overflow tanks, particularly within the Station Site developments. This option has been briefly discussed with TTW, who have designed gravel-

filled tanks at similar sites. An assessment of potential contamination should be undertaken prior to implementation.

- Consider realigning all or part of Reach D to the Station Site North side of Research Park Drive. One alternative would be to create a formal overflow channel running from just downstream of Waterloo Road directly to the stormwater overflow within Reach E. A further alternative would be to realign the creek to remove the sharp bend at the road crossing.

- Create a channel along Reach E which is more natural in both appearance and process. At the moment, it is likely that sediment is being washed over and through the banks, and there is little opportunity for in-channel vegetation to become established. A multi-level channel could be constructed with an element of self-adjustability. The rock walls could be replaced with planted gabions or geofabric-protected earth banks. A channel which contains sediment bars, and shallow riffles and deeper pools would allow establishment of in-channel and riparian vegetation; increase both the geomorphological and ecological channel condition through creation of flow variability; and reduce sediment inputs. The flood capacity of such a channel would not be reduced if a well-though-out design is implemented.

- Relocate the creek to the west of the willow tree at the constriction within Reach F. At the moment, the right bank is being undercut as a result of both bed degradation and lateral erosion. This is likely to be occurring in response to artificial channel realignment and constriction of the channel width (see report GEOTLCOV23810AB-AD for detailed assessment of this issue). Relocation and widening of the creek would allow the constriction to be removed and flow conveyance improved.

- Enlarge the pipe at the downstream end of Reach F. This currently represents a significant reduction in channel capacity. It may be possible to remove the smaller pipe altogether, allowing flows to directly enter the larger pipe just downstream. This will still cause an abrupt reduction in capacity but, since the land beyond this point is out of the jurisdiction of the University, options for further improvement are limited.

5.4 Recommendations and Future Opportunities

- At all new bridges and creek crossings, use a culvert or pipe which does not cause a reduction in channel capacity.

- When designing stormflow/sewage inflow pipes, allow for future channel change (degradation, sedimentation, lateral erosion).

- Reduce the reliance on hard rock/concrete engineering. There are many “soft” and bio-engineering products and techniques which are just as effective as traditional methods and which often have less impact on the channel.

- Allow in-channel and riparian vegetation to become established. Suitable plants should not reduce the channel capacity, as they become flattened during high-velocity flows. This vegetation will, however, improve the appearance, geomorphological and ecological condition, and stability of the channel and near-channel materials. The existing Turpentine Ironbark forest areas could be allowed to develop understorey vegetation and expand.

6 REFERENCES

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http://www.ryde.nsw.gov.au/WEB/SITE/RESOURCES/DOCUMENTS/PDF/Committees/FPRMS&P_No1_presentation.pdf

Other

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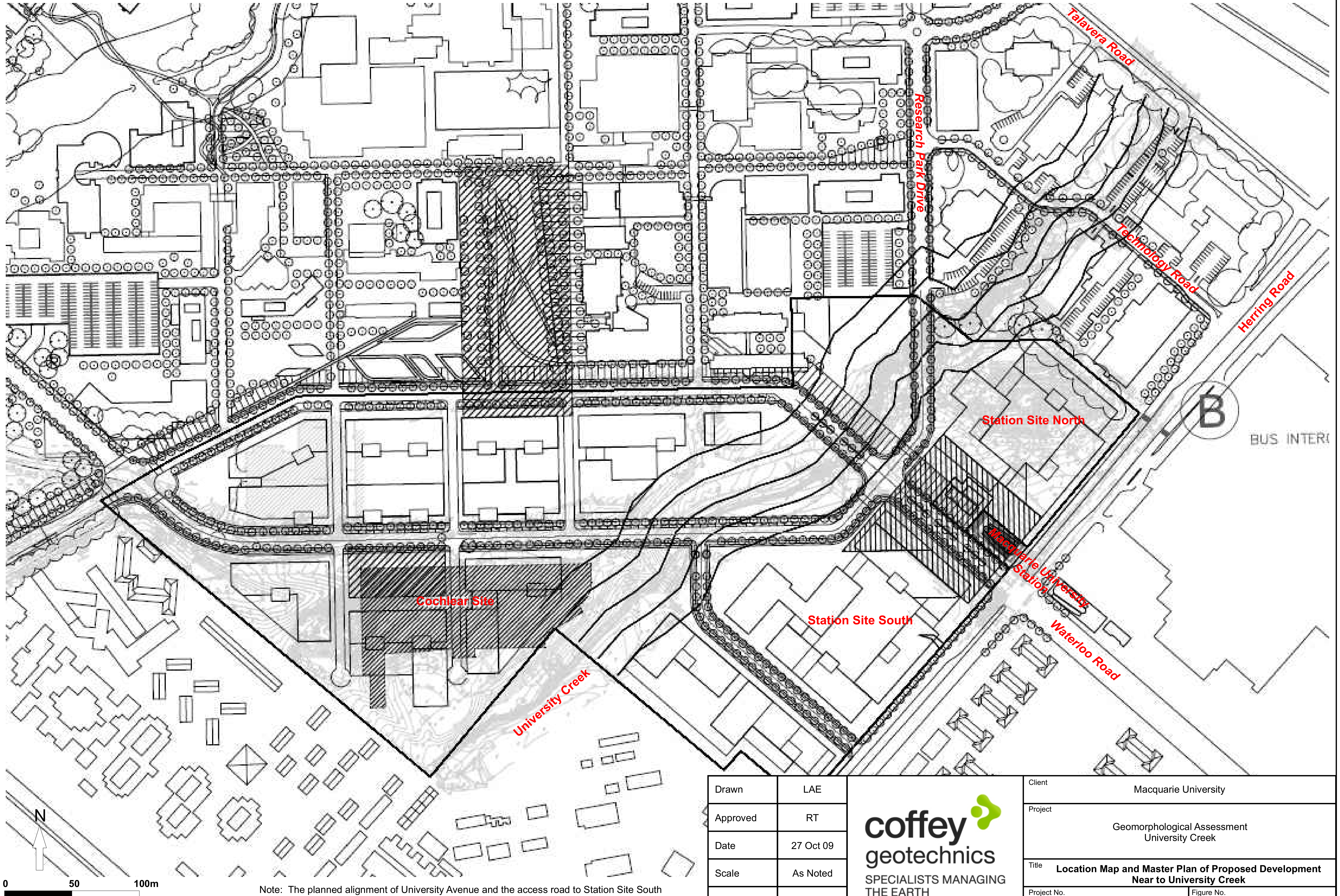
Aerial Imagery

1943 aerial image – Land and Property Management Authority (LPMA) – http://imagery.maps.nsw.gov.au

1970 image – Department of Lands

Drawings



Note: The planned alignment of University Avenue and the access road to Station Site South now differ from those shown

Drawn	LAE
Approved	RT
Date	27 Oct 09
Scale	As Noted
Original Size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Client: Macquarie University

Project: Geomorphological Assessment University Creek

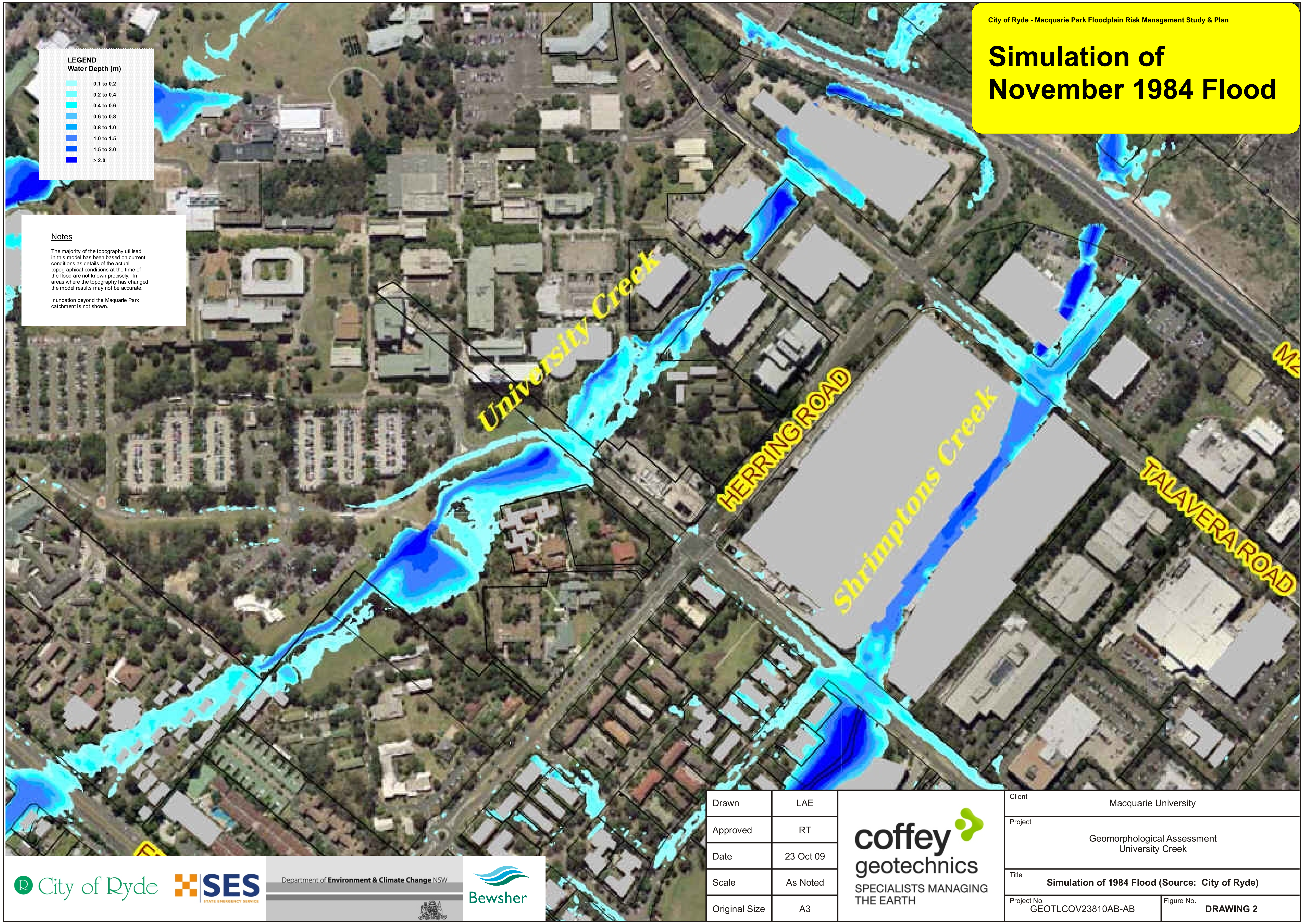
Title: **Location Map and Master Plan of Proposed Development Near to University Creek**

Project No.: GEOTLCOV23810AB-AB

Figure No.: **DRAWING 1**

City of Ryde - Macquarie Park Floodplain Risk Management Study & Plan

Simulation of November 1984 Flood



Notes

The majority of the topography utilised in this model has been based on current conditions as details of the actual topographical conditions at the time of the flood are not known precisely. In areas where the topography has changed, the model results may not be accurate.

Inundation beyond the Maquarie Park catchment is not shown.

City of Ryde | SES State Emergency Service | Department of Environment & Climate Change NSW | Bewsher

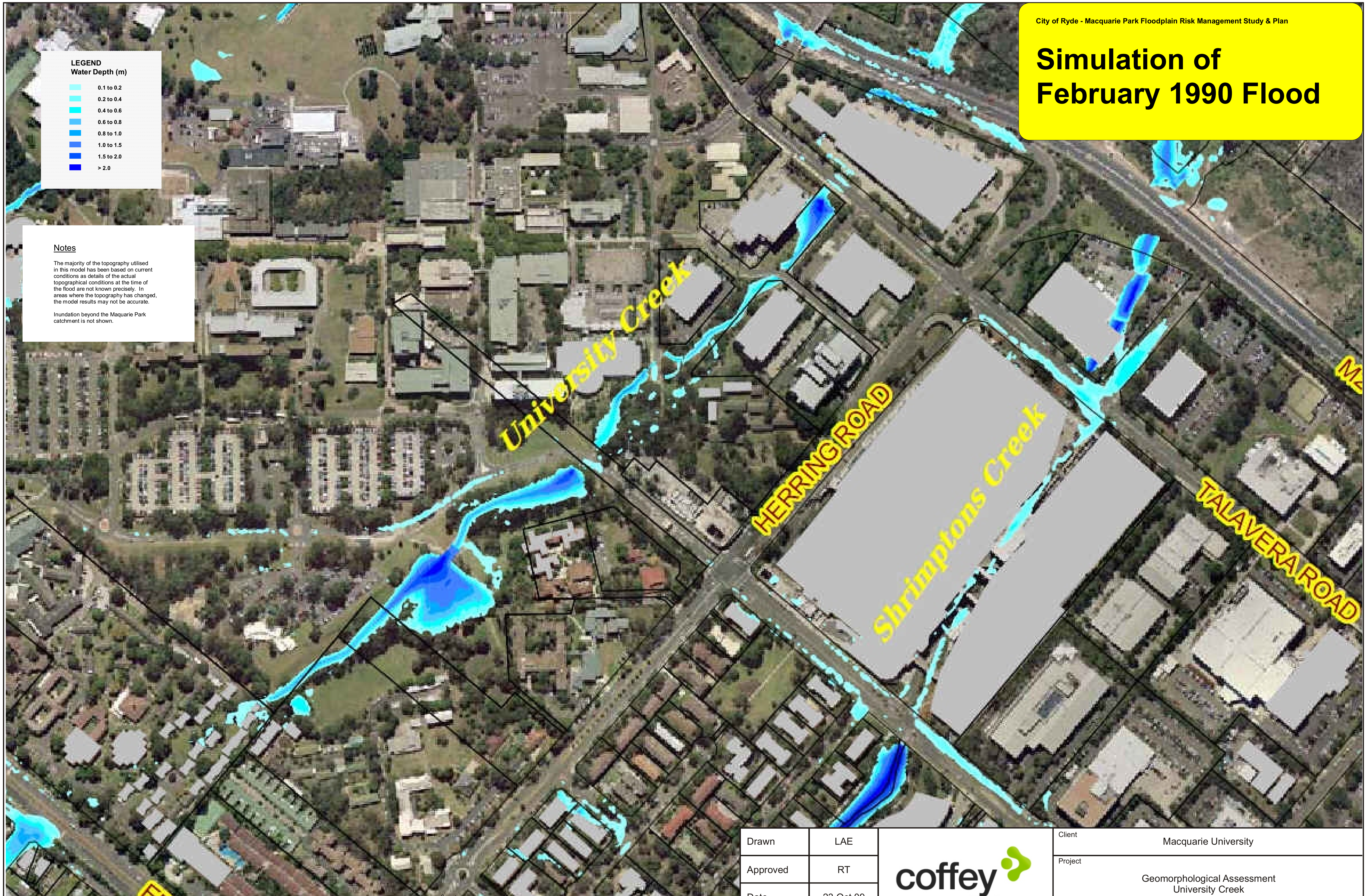
Drawn	LAE
Approved	RT
Date	23 Oct 09
Scale	As Noted
Original Size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Client	Macquarie University
Project	Geomorphological Assessment University Creek
Title	Simulation of 1984 Flood (Source: City of Ryde)
Project No. GEOTLCOV23810AB-AB	Figure No. DRAWING 2

City of Ryde - Macquarie Park Floodplain Risk Management Study & Plan

Simulation of February 1990 Flood



LEGEND
Water Depth (m)

- 0.1 to 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- > 2.0

Notes

The majority of the topography utilised in this model has been based on current conditions as details of the actual topographical conditions at the time of the flood are not known precisely. In areas where the topography has changed, the model results may not be accurate.

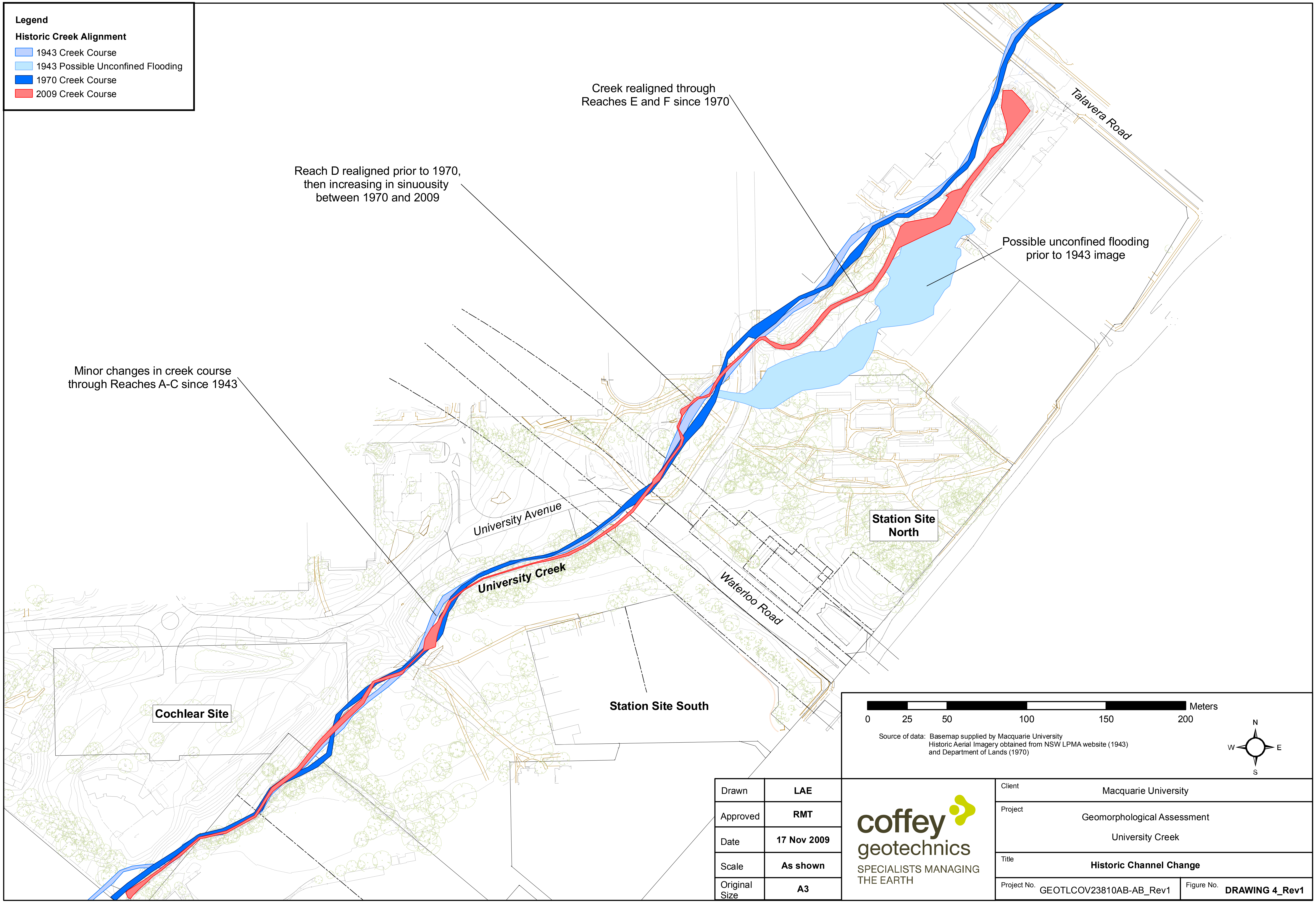
Inundation beyond the Maquarie Park catchment is not shown.

City of Ryde | SES State Emergency Service | Department of Environment & Climate Change NSW | Bewsher

Drawn	LAE
Approved	RT
Date	23 Oct 09
Scale	As Noted
Original Size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Client	Macquarie University
Project	Geomorphological Assessment University Creek
Title	Simulation of 1990 Flood (Source: City of Ryde)
Project No. GEOTLCOV23810AB-AB	Figure No. DRAWING 3



Source of data: Basemap supplied by Macquarie University
Historic Aerial Imagery obtained from NSW LPMA website (1943)
and Department of Lands (1970)

Drawn	LAE
Approved	RMT
Date	17 Nov 2009
Scale	As shown
Original Size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Client	Macquarie University
Project	Geomorphological Assessment University Creek
Title	Historic Channel Change
Project No.	GEOTLCOV23810AB-AB_Rev1
Figure No.	DRAWING 4_Rev1