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Mr Robin Bourne  
Mid Murray Council  
49 Adelaide Road  
MANNUM SA 5238

## **STABILITY RISK MANAGEMENT, REVIEW OF MONITORING DATA MANNUM CARAVAN PARK**

Dear Robin

### **Introduction**

Golder Associates Pty Ltd has undertaken a review of survey monitoring data from the Mannum Caravan Park.

Lyndon Sanders, Principal Geotechnical Engineer, first visited the Park with Jai O'Toole of the Department for Water on 17 June 2010 with our report on that visit being provided to the Department for Water via document 107662007-010-L-Rev0 dated 6 July 2010. In that report we recommended monitoring of the north-eastern boundaries of the Park. We understand that Alexander Symonds Pty Ltd (Alexander Symonds) has been conducting survey monitoring of these portions of the site since September 2011 and that those areas have been closed to the public.

The aim of the monitoring is to detect movement of the ground that might indicate instability potentially affecting the Caravan Park grounds along the boundary between the Caravan Park and the adjoining Hermann Gass Bird Sanctuary and Murray River.

Our review was requested to assess whether instability is indicated by the survey measurements available to date. We understand that consideration is being given by Mid Murray Council to temporarily reopening the closed areas of the Caravan Park in March 2012.

### **Background Information**

Much of Mannum occupies the top or side slopes of the cliffs that bound the River Murray to the northwest. There is an area of lower lying land in the middle of the township, alongside the River. The Mannum Caravan Park is on Purnong Road, towards the northern end of this low-lying land. The cliffs to the west of Purnong Road are composed of Mannum Limestone, the soils of the near-River areas generally comprise mainly fine grained sand and sandy clay of the Coonambidgeal Formation.

We understand from our 2010 discussions with, Mr Gavin Pitman, the Park's Manager that the area in which the Caravan Park stands was probably used for camping from the 1940's. Aerial photographs of the area taken in 1954, 1963, 1976 and 1979 presented in Attachment A indicate that development of a caravan park from the informal camping area commenced between 1954 and 1963, possibly after this area and most of the lower-lying portions of Mannum were flooded in 1956. Filling to extend the land into the original swamp area towards the northeast is visible in 1976. In the 1979 photograph, the land is close to its present area.



The layout of the Caravan Park is shown on the map below, reproduced from the Caravan Park's website.



The areas where probable landsliding was thought to have occurred are along the northeastern frontage of the site - along Marion Way adjoining the swampland of the Hermann Gass Bird Sanctuary and along Ariel Street and Bogan Street adjoining the River Murray. All of these were built by the 1970's filling of the swamp.

### Monitoring 2009 – 2010

Monitoring in 2009 and 2010 included measurement of the lengths of the block paving hard stands on some of the camping sites along Marion Way and Ariel Street between March 2009 and July 2011. A graph of the increase in measured length over time is attached.

The graph indicates ongoing horizontal movement of the ground surface, with the majority of sites experiencing at least 140 mm horizontal extension over approximately 6 m measurement length. The graph may provide an indication of the repeatability and reliability of these measurements, which might on that basis be inferred to be accurate to about  $\pm 5$  mm.

In 2010 we judged that there was a risk that landsliding was occurring in this area. The sharp increase in the measured rate of movement during December 2009 might have been associated with the corresponding sharp increase in measured water level during that time. We considered that the increased rate of movement might have indicated an increase in the risk of landsliding during this period. Although the measured ground movements subsequently slowed during a period when the River level rise also slowed, they did not cease over that time.

## Monitoring 2011 – 2012

We have been provided with the results of survey measurements of reference points within the Mannum Caravan Park. The surveys by Alexander Symonds between September 2011 and February 2012 measured both horizontal and vertical ground movements at a series of points near the north eastern boundary of the Caravan Park. The monitoring points are either 150 mm deck spikes in the road bitumen or 450 mm star droppers concreted in the ground so that the measurements are repeatable.

We understand that the scope of monitoring – the positions of the points and the frequency of survey measurement - was determined by the Department for Water in conjunction with Mid Murray Council.

The monitoring points were installed and their positions and levels were measured on 6 September 201 by Alexander Symonds. Golder Associates has been provided with the results of position and level surveys of those points conducted by Alexander Symonds on 20 October 2011, 21 November 2011, 12 December 2011, 18 January 2012 and 16 February 2012. Alexander Symonds documents indicate that the design coordinate accuracy is  $\pm 3$  mm and the design level accuracy is  $\pm 2$  mm.

Vectors of the measured movements relative to the initial survey in September 2011 have been calculated by Alexander Symonds. The attached plots show the vectors for the 18 January 2012 and 16 February 2012 monitoring rounds.

## Review of data

The measurement data indicates measured changes in level and position no greater than about 5 mm:-

- between any two successive surveys
- between the baseline survey on and any individual successive survey

The average change in position and level across all points surveyed between the baseline survey and each of the other surveys was either zero or 1 mm.

The vector plots indicate that the measured movements are not generally consistent between nearby points: in some places in some surveys vectors on adjoining points are in opposite directions. Commonly the vectors from successive surveys differ in size and direction although the measured differences in size are generally less than 2 mm.

The monitoring data and the vectors do not suggest a trend in the vectors or the measurements from which they are derived

## Discussion and Recommendations

At the time our 2010 report was in preparation, the river water level was rising from the depressed level it had experienced for several years. Subsequently the water level has generally been above or close to the nominal pool level. We understand from recent discussions with DfW that the level in the Lower Reaches is predicted to remain at or above normal pool level for the next year.

In each survey in 2011 and 2012 the average change in position and level between the baseline and the particular survey across all points surveyed was 1 mm or less. Similarly the average change in position and level across all points between successive surveys was 1 mm or less. From that, we infer that the individual differences measured between baseline and survey and between successive surveys (to a maximum of about 3 mm) represent the ordinary 'noise' present in all sets of measured data. On the basis of the data available to date we judge that the repeatability and reliability of the survey measurements is probably around  $\pm 3$  mm. This is consistent with Alexander Symonds measuring accuracy of between around  $\pm 2$  mm and  $\pm 3$  mm.

That judgement suggests that 'negligible' movement might be defined (consistently with our previous report) as:

- no detectable trend of movement, and
- successive measurements at a point or group of points not differing by more than 3 mm.

Under that definition the measured movements to date would be considered negligible.

On the basis of the monitoring measurements made between 6 September 2011 and 16 February 2012 we see no impediment to the monitored areas of the Mannum Caravan Park being temporarily reopened while the river level remains at pool level subject to continued monitoring demonstrating that ground movements remain negligible.

However, any decision to reopen the Mannum Caravan Park can only be taken by the landowner which we understand to be the Mid Murray Council.

If the monitored areas of the Caravan Park are reopened we recommend ongoing survey monitoring. Review of the data may allow measurements to be taken at longer intervals, although we would expect that substantially more data than is currently available would be necessary to confirm that. We recommend a review of the monitoring in June 2012 and September 2012. We expect that after a year of monthly measurements it may be possible to assess the scope of future monitoring, which might allow opening the interval between measurements to two or possibly three months, again dependent on the water level in the River remaining close to pool level.

Experience from round the world (presented and discussed at the meetings of the South Australian Riverbank Collapse Hazard Expert Panel Workshop; two members of this panel are Golder Associates employees) indicates an increase in landslide risk whenever river water levels rise or fall quickly. That is, there is an observed increase in landsliding for a period near the start of a high water event and for a period after the event peaks and begins to subside. The recent rainfall in various up-catchment areas suggests that there may be a significant rise of river level in the coming months. We are not aware of any current reliable predictions of the size of that rise or the time frames over which it might occur.

If there is a significant rise predicted in river water level (we consider that the trigger is likely to be a rise of around 0.75 m or so, depending on the rate of rise and fall) we recommend that the survey monitoring be conducted at fortnightly or closer intervals. Depending on the results of the monitoring, it might be prudent to close the monitored areas. We recommend that the results should be reviewed by Golder Associates if successive measurement differ by more than 5 mm or the measured movement since September 2011 exceeds 15 mm.

Similarly, if the river water level at Mannum is predicted at any time to fall below +0.2 m AHD (ie about 0.5 m below the nominal pool level) we recommend that survey monitoring be conducted at fortnightly or closer intervals and that consideration be given to closing the monitored areas of the Caravan Park. The decision to close those areas is likely to be illuminated by the data gained from survey monitoring.

## Limitations

Your attention is drawn to the document – "Limitations", which is attached to this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

## Closure

We would be pleased to discuss the matters presented in this report. Should you require clarification please call Lyndon Sanders on 8213 2100.

## GOLDER ASSOCIATES PTY LTD



Lyndon Sanders  
Principal Geotechnical Engineer

LJS/THH/ljs:kd

Attachments: Limitations (LEG04 RL1).

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1954 aerial photograph



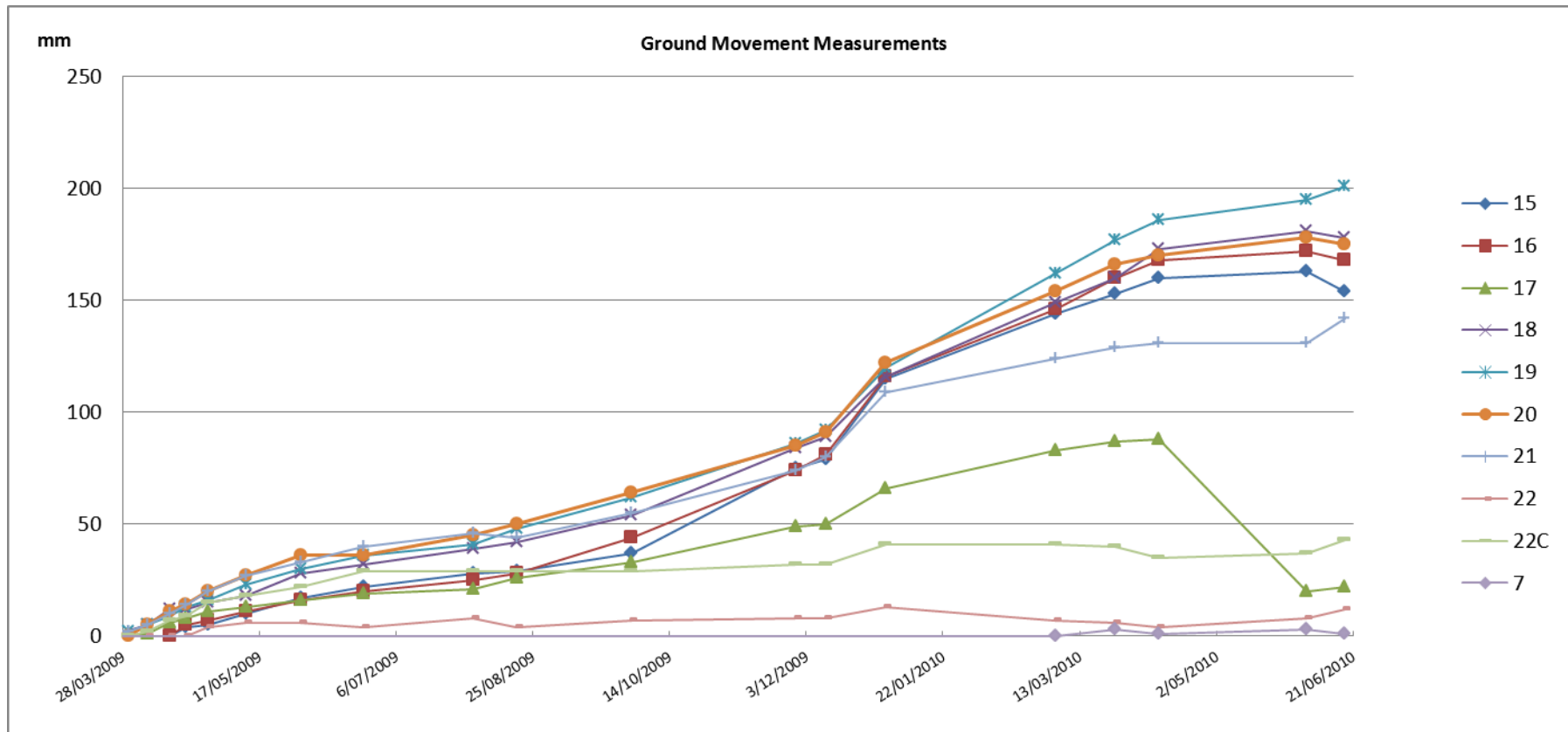
1963 aerial photograph



1976 aerial photograph

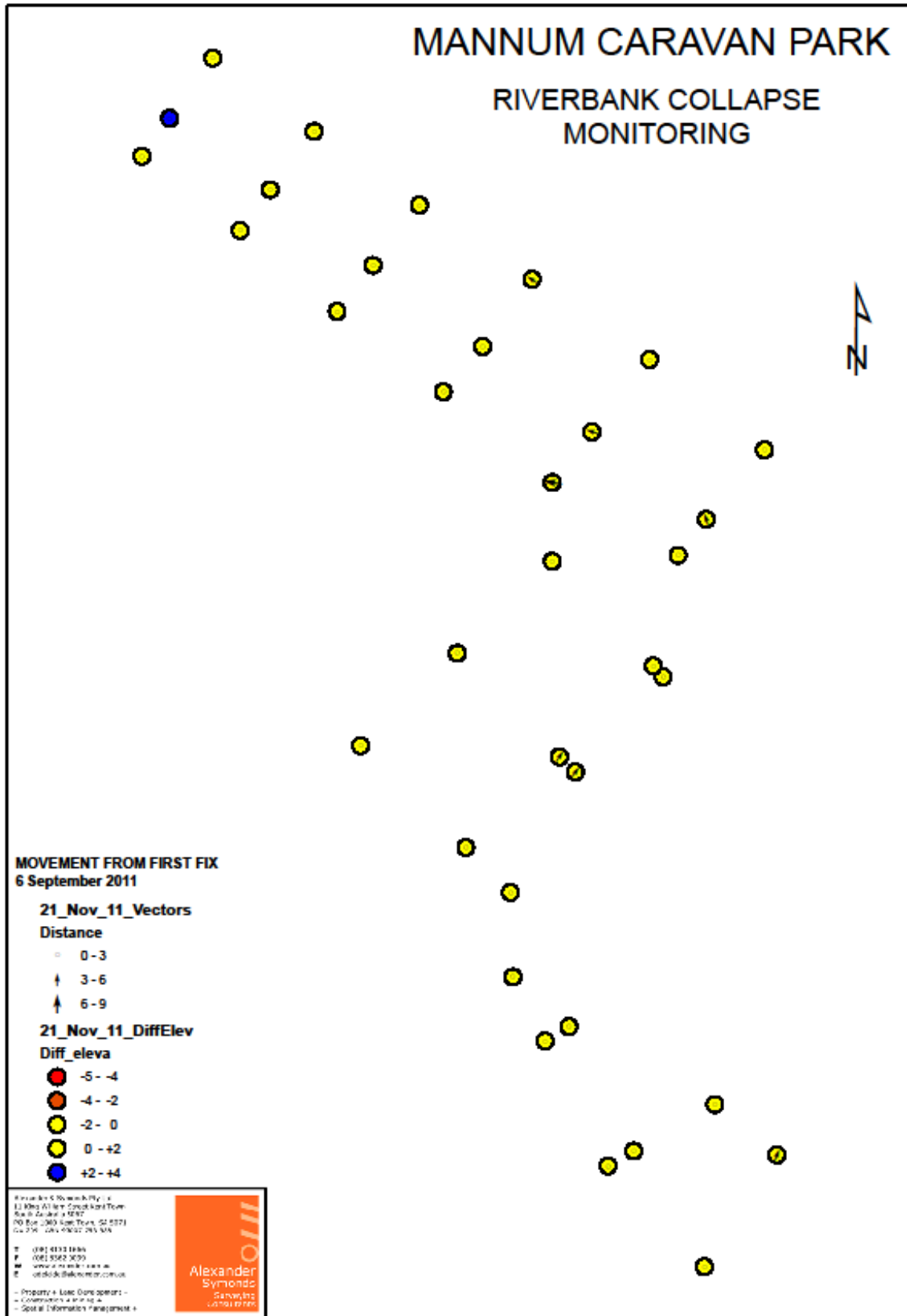


1979 aerial photograph

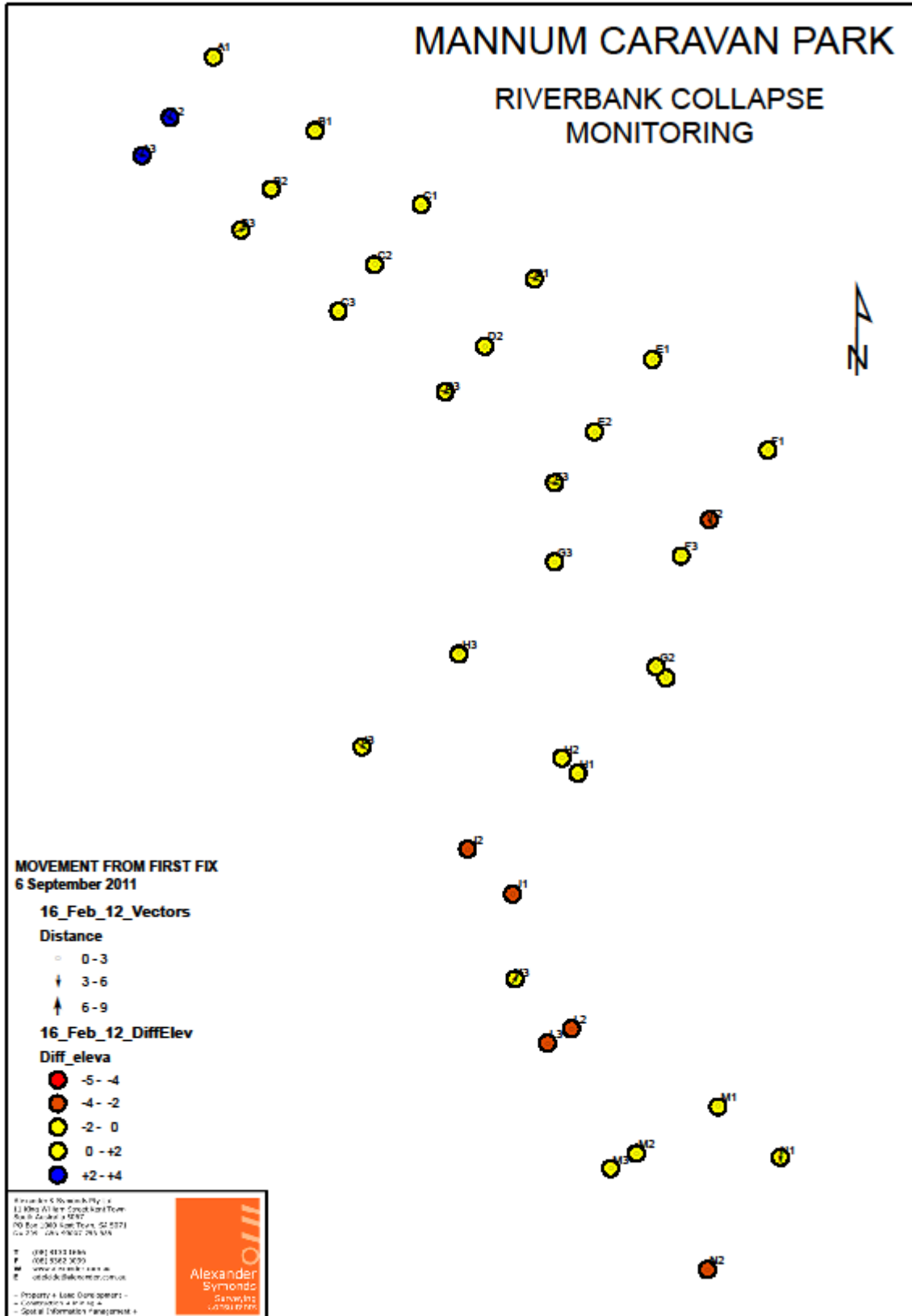


Monitoring data 2009 – 2010





Vectors of survey measurements - 18 January 2012 relative to 6 September 2011



Vectors of survey measurements – 16 February 2012 relative to 6 September 2011

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