

23 April 2007

Manildra Group
PO Box 123
Nowra NSW 2541

Attention: Ian Waters

Dear Sir,

**RE: GEOTECHNICAL ASSESSMENT
RIVER BANK STABILITY
PROPOSED NEW SILOS AND FLOUR MILL BUILDING
MANILDRA PLANT, BOLONG ROAD, BOMADERRY**

1 INTRODUCTION

This report provides a geotechnical assessment of the stability of a section of the northern bank of the Shoalhaven River in the vicinity of proposed new structures at Manildra's plant in Bomaderry. The purpose of this assessment was to advise on the current stability of the river bank in these areas, effect of the development on stability of the river bank and stability of the bank where conditions change (e.g. flooding or oversteepening of the bank). The report discusses measures that would reduce the risk of failure of the river bank in some circumstances. In the event of failure of the bank occurring the possible effects on the proposed structures (if developed in the positions shown on the plan) have also been considered.

This report does not address foundation conditions for any of the new structures proposed and no additional subsurface investigation was carried out for this assessment.

2 SCOPE OF WORK

The scope of work for this assessment included the following:-

- Site visit and observations of surface conditions by a principal geotechnical engineer from Coffey.

- Discussion with Manildra engineers in relation to the proposed expansion works near the river. Manildra have provided Coffey with a general layout plan of the proposed structures (Drawing Ref MAN68-001A).
- A review of available reports (by Coffey and Golder), including borehole or piezocone penetrometer testing
- A survey of the northern bank of the Shoalhaven River to plot the profile from about 4m on the land side of the top of bank and extending about 20m out from the high water mark over the lower bank and bed of the river. The survey was recommended by Coffey and was carried out by Allen Price and Associates, Ref No 24741-01, Sheets 1 to 5, dated 23/3/07.
- Stability analyses to assess Factors of Safety at sections adjacent to the proposed structures, assuming current conditions and possible flood up to RL4.0, followed by rapid drawdown from the flood level to about RL0.8m. We note that soil parameters can vary within the plant area and estimated values only for the parameters, based on previous subsurface investigations of nearby structures, have been used in the analyses.

3 PROPOSED DEVELOPMENT

The proposed expansion of the Manildra plant at Bomaderry includes two new silos and a new flour mill.

The silos are shown on the site plan provided and are located adjacent to the existing silo. The larger silo is shown only a few metres from the top of the river bank. The flour mill building is about 10m from the top of the riverbank. Part of an existing building is to be demolished to make way for the new flour mill.

The sites for the new silo and mill sites presently have either flexible or concrete pavements and are near level, apart from the raised levee bank between the paved area and the top of the river bank. The southern most silo will encroach into the levee bank area.

The section of the river bank assessed in this report lies between the recently constructed rock wall (where a local failure of the river bank occurred) and the existing jetty about 100m upstream. The survey plan view of this section of the bank with contours (as prepared by Allan Price) is shown in Figure 2.

Most of the river bank has a cover of trees, comprising mainly coral trees, located both on the bank and on the crest of the levee bank. There is also some thick undergrowth over the lower part of the river bank. The larger trees appear to be at least 20years old.

The existing river bank (above the high tide mark) generally has a maximum slope of about 1H:1V and has a relatively uniform surface.

There were a number of rocks in the water along the toe of the bank, with some finer sediments observed below the shallow water at the edge of the river at high tide. There is a gabion wall on the downstream side of the jetty.

Recently emergency stabilisation work has been carried out on the river bank immediately to the south of the area assessed in this report. The emergency rectification works consisted of large rocks stacked against the bank extending from below the water line to about 2m below the top of the bank.

4 STABILITY ANALYSIS

4.1 Soil Parameters

The Manildra plant at Bomaderry is underlain by deep alluvial soils to depths ranging from about 15m to 25m. A range of soil parameters have been used in the stability analysis based on information from the nearest boreholes (Golder Report, Boreholes S2 and S5), however no new boreholes or soil samples have been taken along the river bank or at the sites of the proposed new structures.

4.2 Methods of Analysis

A number of different parameters and various water level scenarios were assessed at survey Sections 8 and 19 using the program Slope-W and factors of safety (FOS) in relation to stability of the river bank were determined for each case.

4.3 Results of Analysis

The results of the stability analyses are presented in Figures 3A to 3F, together with a summary of results for the various parameters and water levels for the river.

The results show that the river bank under the site conditions of the time of the survey has a marginal factor of safety (FOS) based on the soil parameters adopted. The FOS actually increases if the water level increases but does not overtop the bank during a moderate flood event, provided the bank is not steepened by erosion. However assuming the flood waters dissipate such that there is rapid drawdown of the flood water level back to the high tide mark or possibly lower, then the FOS can fall below 1.0 indicating that failure of the bank could occur during or following drawdown.

4.4 Possible Failure Mechanisms

The river bank would be at significant risk of failure if a significant flood event (PMF) was to occur where water would rise above the existing bank. This would potentially cause collapse of the bank on saturation, even if bank protection (rock facing/revetment) was in place.

The recent failure of the river bank over a section about 20m in length, (immediately at the downstream end of the section of the river now being assessed), appears to have failed due to oversteepening of the river bank below the high tide level. Stronger flows in the river, possibly due to a combination of runoff and tidal flows may also have caused the oversteepening of the bank.

Excessive loading of the bank can also increase the risk of failure, however for the proposed development we understand buildings will be independently supported on deep piles to rock.

Removal of vegetation and subsequent erosion scouring causing oversteepening of the bank could also result in instability of the bank.

5 RISK OF RIVER BANK FAILURE

Under normal flow/tidal conditions and with the present river bank profile above and below the high tide mark the risk of failure is considered low. As discussed above, there are a number of mechanisms that could result in failure of the river bank occurring near or adjacent to the proposed site for development. The most likely cause of failure would be flooding or significant increase in flows in the river, causing erosion and oversteepening the bank, and rapid drawdown of water levels following flooding.

Given the proximity of existing and proposed structures within the Manildra Plant relative to the river bank, there is always some risk of buildings being affected by failure of the river bank.

The risk of failure can be mitigated to some extent by river bank erosion/scour protection and founding of all structures independently on piles to rock, assuming that the piles could survive some undercutting of the bank and loss of lateral support.

6 RECOMMENDATIONS

The sites for the proposed silos are close to the river bank and the one nearest the bank is closer to the river than most other permanent buildings in the plant. We understand that no other sites for the silos were suitable. The development of the silos in the positions proposed will involve some risk to the long term performance of the structures. The proposed flour mill is set back further from the bank and is located partly within the site of the structure that is to be demolished.

The following measures are recommended to reduce the risk of river bank failure affecting the proposed structures close to the river bank:-

- Continue the recent rock revetment along the river bank using large rocks. The rocks are only to be considered as a lining to reduce the risk of undercutting or oversteepening of the bank and do not act as a retaining wall. The rock lining should extend from the recent works upstream to the jetty. Additional strengthening of the rock lining and erosion protection (e.g. using concrete) and concrete apron around the base of the silo nearest the river may be required. Construction of the rock lining would involve removal of vegetation from the banks. This should be carried out in stages (say 10m to 15m at a time) as the rock lining advances and should not significantly disturb or loosen the soils in the bank. Large rocks should not be stockpiled on any part of the bank during this work. Rocks should also not be concentrated in any one part of the river bank, as this could result in localised failure occurring.
- The new structures should be founded on piles to rock. The silo nearest the river bank should be supported on stiffer piles that allow for possible loss of lateral soil support through the upper 5m to 6m. We would not expect the piles to resist a large deep seated failure of the bank, however in the event of gradual undercutting of the soil below the silo, the stiffer piles could support the silo until remedial works were carried out to restore eroded or failed sections of the bank.

The attached document titled "Important Information about your Coffey Report" should be read in conjunction with this report.

Should you have any questions in relation to the above advice please contact the undersigned.

For and on behalf of

COFFEY GEOTECHNICS PTY LTD



JON THOMPSON CPEng

Wollongong Manager

Attachments:

Important Information about your Coffey Report

Survey Levels

Stability Analyses of River Bank, Sections 8 and 19

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by

earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey Report**

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.

Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.