PILOT HILL - Executive Summary

The study area at Pilot Hill in Yamba has been a point of contention between Council and the residents of Pilot Street Yamba for several years. The area has been the subject of a number of investigations by the NSW Department of Public Works and by private consultants on behalf of Clarence Valley Council and residents wishing to develop their properties.

Monitoring of the site has been active for 11 years and has shown minor movement of the subsoil down slope and significant perching of the water table within the subsoil between Pilot Street and the cliff face at Main Beach. Over the monitoring period during heavy rainfall, minor land slips have been identified but no major failure of the hillside has been recorded. Further, no major movement has been detected by the monitoring inclinometers, although a slow downslope movement has been detected. Several minor landslips have occurred during 2011 which are discussed in **Section 6** of this report

Historical records of landslips at Pilot Hill show that landslips have occurred between 50% and 70% of the rainfall events above the Red Alert Level. This is significant and has proved to be the case in recent rainfall events during 1999, 2005, 2010 and 2011, the last being June 2011.

Detailed survey work was undertaken for the entire catchment of Pilot Hill which extended from the water supply reservoir to the beach. **Attachment 9** to this report provides copies of the detailed contour plans generated from the survey. As well as generating land contours, the plans identify any drainage and services infrastructure that may have an effect on the ingress of surface stormwater into the subsoil. The effect of services on groundwater was found to be negligible.

As there appeared to be minimal influence from external sources in the high levels of groundwater within the subsoil after rainfall, it was identified that the natural infiltration from the catchment was the most significant source.

To confirm that natural infiltration was the source of groundwater, the catchment was broken up into three (3) discrete sub-catchments being:

1. The water reservoir reserve and Pilot Street catchment @ 1.44Ha
2. The residential properties within the study area @ 0.849Ha
3. Marine Parade and the land to the top of the cliff face @ 0.397Ha

The rational method for stormwater estimation was used to determine the surface runoff and the theoretical infiltration into the subsoil for various storm frequencies and times of concentration. This enabled an estimate to be made as to the volume of water entering the aquifer over the duration of each storm event.

Calculations were also undertaken of the volume of water stored within the aquifer from the levels provided in the piezometers for similar storm events. The results were compared, and showed a good correlation in the volumes of storm water perched within the aquifer for similar rainfall events. This indicates that the

monitoring procedures being employed at Pilot Hill provide a good indication of what is actually happening within the aquifer as a result of antecedent rainfall and follow up rainfall events.

The proportion of each catchment contributing to the charging of the Pilot Hill aquifer was estimated for a 100 year rainfall event and for a series of times of concentration. It was found to be 67% from the reservoir reserve, 22% from Pilot Street and the residential lots and 11% from Marine Parade and the public land adjacent to it. This is useful information as the proportion of costs needs to be estimated for recommended capital works.

On the morning of Thursday 16 June 2011 after red alert conditions had been recorded, reconnaissance of the cliff face below the study area revealed that two land slips had occurred in the lower part of the soil above the rock cliff faces. Minor flows were being released from the subsoil with each flow estimated to be less than 0.5 litres per second. This reinforces the view that large volumes of water are being stored in the subsoil above the cliff faces without a path to escape, thereby increasing the risk of possible land slip.

Of further concern is that the storm was only a 1 in 12 year event, and it follows that the 1 in 50 year and 1 in 100 year events would result in much more severe landslips and that statistically a landslip event may occur at least once in 12 years.

Clearly, the risk of landslip occurrence needs to be reduced to allow residents and occupiers of Pilot Street within the study area to enjoy the amenity of their properties, with reasonable confidence that their properties and lives are not at risk due to major landslip.

In order to reduce the risk, a number of options have been proposed with the first option to do nothing and to continue with the monitoring for the foreseeable future and the most effective option (Option 4) to undertake capital works within the reservoir reserve, in Pilot Street, within private properties and along Marine Parade. The options are discussed in **Section 9** of this report and are summarised as follows:

- Option 1 - Do nothing except continue monitoring aquifer and ground movement. This option does not provide any additional factor of safety against landslip and does not reduce the risk of landslip occurring thus the current restrictions on development would remain indefinitely.
- Option 2 - AG drains within private land and stormwater drain in Marine Parade. The provision of AG drains within the private land of the dwellings would accelerate the drawdown of perched water and reduce the time that water is stored within the soil mass but does not address the water entering from the upstream catchment.
- Option 3 - Construct large diameter slotted concrete drain at bottom of reserve. The works include the provision of a 300 mm diameter slotted FRC pipe AG drain to draw water down out of the porous sandy soil and allow for the free flow of captured water to some point of discharge away from the site and into the reticulated stormwater system or directly to the beach. It is

estimated that this would remove 65% to 69% of infiltrated water thus relieving the soil of excessive load and reducing the chance of landslip.

- Option 4 - Construct large diameter slotted concrete drain at bottom of reserve and AG drains within private land and stormwater drain in Marine Parade. This option is a combination of Option 2 and Option 3 and has the potential to remove up to 90% of the infiltrated water from the subsoil.
- Option 5 - Provision of a series of wells and pumps. This was considered problematic with respect to maintenance and cost and was not considered as a viable option

Estimates of cost for each of the options have been prepared and Net Present Value (NPV) analysis for 4% and 6% discount rates undertaken on each option. This is done to determine the whole of life costs of each option expressed in current day dollars over a 30 year life cycle.

The results indicate that to retain the status quo and do no capital works but continue with monitoring for 30 years will cost a minimum of $507,001 whereas undertaking the recommended high level capital works and continuing with monitoring for 5 years will cost $362,281. Clearly, maintaining the status quo is not an attractive option and would not reduce the risk of the occurrence of landslip.

It is recommended that Option 4 be adopted for implementation and that a scheme be developed where costs are apportioned to each stakeholder in accordance with the volume of water infiltration into the subsoil from each sub-catchment.

ITEM 13.081/12 - 4

0 5 10 15 20 25 METRES

(1:500 - A3)
(1:250 - A1)

REPAIR & REINFORCE EXISTING OPEN SWALE
PROVIDE DROP STRUCTURES & WALK OVER
OR REPLACE BY PIPELINE WITH ENERGY
DISSIPATOR AT OUTLET

JP = JUNCTION PIT 900 X 900
GP = GRATED PIT 900 X 900
E3 = EASMENT 3M WIDE
IO = INSPECTION OPENING

RC SLOTTED
300Ø
GP 1/03
GP 3/02
GP 2/02
300Ø RRJ
OUTF
IO
PIT
JP
E3
GP 7/01
GP 6/01
GP 5/01
GP 4/01
GP 3/01
300Ø RRJ
LOCATION OF LINE 1 TO BE CONFIRMINED IN THE FIELD
TO MINIMISE AFFECT ON GROUND STABILITY
ROCK BEACHING & DROP STRUCTURES
FOR SCOUR PROTECTION
JP 2/01
OUTFALL 1/01
REMOVE & MAKE GOOD EXISTING
OUTFALL LINE
LOCATE OUTFALL TO MINIMISE
AFFECT ON BEACH AMENITY

Issue	Description	Date	App
0	Preliminary Issue	09/03/12	SPMc

SCALE: AS SHOWN
SURVEY: -
DATUM: -

Stephen P McElroy and Associates Pty Ltd
22 Pratt St Kyogle NSW 2474
Consulting Civil and Structural Engineers
PH (02) 6632 1181 **MOB** 0412 136 680 **EMAIL** steve@australis.net

Drawn: J. Davison	Date: 09/03/12	Job Title: **Proposed Drainage Design** Pilot Hill, Yamba NSW	Job Number: 08/48V
Designed: -	Date:		Drawing No.: 08/48V-02
Checked: -	Date:	Client: **Clarence Valley Council**	Revision: 0