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**THE INTEGRATION OF FLOOD MITIGATION BASINS  
WITHIN A GOLF COURSE**

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# THE INTEGRATION OF FLOOD MITIGATION BASINS WITHIN A GOLF COURSE

## Summary

*Investigation of urban flooding in Greystanes, Sydney revealed significant problems for a number of residential properties. An assessment of flood mitigation options led to the decision to purchase one severely affected house and to construct retarding basins in the local golf course as a means of effectively reducing the flood problems.*

## 1. INTRODUCTION

Bewsher Consulting (Consulting Engineers) were commissioned by Holroyd City Council to conduct a stormwater drainage study of part of the upper Pendle Hill Creek Catchment (**Reference 1**).

Within the study area, the commission was to:

- § assess the extent of historical flooding;
- § define the existing drainage capacity and the extent and depth of overland flooding in a 20 year Average Recurrence Interval (ARI) flood;
- § examine the options for achieving a 20 year ARI capacity pipe system together with the extent and depth of flooding in a 100 year flood.

## 2. CATCHMENT DESCRIPTION

The study catchment is 86 hectares and is shown in **Figure 1**. Its trunk drainage system grades south to north and receives flows from the south, east and west, with its outlet located in Darling Street Park to the north. The area is a well established residential development with several open space recreational areas.

## 3. HISTORICAL FLOODING

Due to a series of recent major flood events (5 August 1986, 30 April 1988, 7 February 1990 and 2 August 1990) residents in the study area were able to provide detailed descriptions of the local flood problems.

### 3.1 Roberta Street to Old Prospect Road

In the lower portion of this area, to the south and east of Roberta Street Park, 40 questionnaires were distributed to residents. Twenty four responses were received. Additional resident interviews were also conducted.

Although residents have lived in the area for up to thirty years they reported that flooding had only occurred since 1986. While considerable overland flows have been experienced in this area, all inundation had been restricted to below house floor level and generally to a maximum property depth of 0.3m.

Exceptions were at 3 properties where backyard flooding reached 0.6m in depth.

The severest inundation to properties occurred in August 1990, although the April 1988, August 1986 and 7 February 1990 events were only marginally less severe.

### 3.2 Old Prospect Road to Darling Street Park

In this area questionnaires on historic flooding had been completed in July/August 1990 by 11 residents.

Additionally, follow-up resident interviews were conducted during this study.

Based on this information flood contours were compiled and findings noted as follows. Some 19 properties had experienced depths of general property inundation exceeding 0.5m. Of those a number experienced garage inundation and one property experienced above floor level flooding.

#### **4. TRUNK DRAINAGE SYSTEM PERFORMANCE**

##### **4.1 Pipe System Analysis**

Physical inspection of the pipelines and pits in the system was conducted to confirm pipe sizes and help assess hydraulic performance of pits. Additionally, all pits with accessible manholes were surveyed to define invert and top of pit levels.

All pit locations and pipe sizes were shown on the 1:500 base plans prepared for the study.

The ILSAX Program for Urban Stormwater Drainage Design and Analysis was adopted for modelling the study area and establishing catchment flows. Only the trunk drainage system itself was comprehensively modelled with sideline inflows lumped in the ILSAX model as "inlet" capacities to the trunk drainage system. The relative "inlet" capacities for the ILSAX model and mainline capacity were established from HGL analysis. For this analysis flows were distributed in accordance with the ILSAX model response for a 1yr ARI storm event assuming unrestricted inlet capacities. Substantial pit losses were determined for a number of pits (and the impact of those losses on the HGL analysis verified local residents' comments about surcharging).

##### **4.2 Drainage System Performance**

Using the ILSAX model, flows were calculated for the historic storm events dated 5 August 1986, 30 April 1988, 7 February 1990, 10 February 1990 and 2 August 1990 using rainfall data from both Pipehead Guildford and South Prospect recorder stations.

Both of the recorders are outside the study area catchment and therefore although they not located far from the study area the ILSAX derived flows based on these recorded storms needed to be carefully reviewed. For the August 1986 and April 1988 events the ILSAX flows for each recorder storm pattern were found to be very similar. It would therefore appear reasonable to assume that the calculated flows for those events are an appropriate definition of study area flows. However based on the collation of flood event comments made by local residents the general consensus was that the April 1988 flood was worse than the August 1986 event and this was at odds with the computed flows.

The ILSAX-derived flows for the August 1990 storms were found to be significantly different for each recorder pattern. To try and resolve such differences the Consultant also reviewed the historical flood data provided by the residents. Based on that review and an assessment made by Holroyd Council staff of flooding in the adjacent eastern subcatchment, it is considered likely that the 2 August 1990 flooding was close to a 20 year ARI event.

## 5. INVESTIGATION AND ANALYSIS FOR PROPOSED DRAINAGE SYSTEM IMPROVEMENT

The following options were considered for increasing the relative capacity of pipe systems and reducing the extent of overland flooding in the catchment area.

### 5.1 Potential Retarding Basins

- § Retarding Basins in Cumberland Country Golf Club: The ILSAX model was restructured to assess two potential basin sites within the golf club. Preliminary stage-storage relationships were developed and Basins 1 and 2 sized and located so as to temporarily store all flows up to the 100yr ARI event. These options were examined in consultation with the Cumberland Country Golf Club committee.
- § Retarding Basin in Roberta Street Park: In conjunction with Golf Club Basins 1 and 2 the impact of a basin (Basin 3) in Roberta Street Park was assessed. A similar method to that adopted for the above mentioned basins was implemented with flows again being controlled up to the 100yr event.
- § Retarding Basin in Beresford Rd: During the course of the study Council requested advice about the potential benefits of building a retarding basin within a currently non-residential site on the corner of Beresford Road and Old Prospect Road.

### 5.2 Parallel Pipeline Downstream of Old Prospect Road

As an alternative for achieving a 20yr capacity system, a parallel pipeline downstream of Old Prospect Road (to augment the existing system) was examined. The impact of such a line was assessed firstly in conjunction with the proposed Basins 1,2 and 3, then secondly with proposed basins 1 and 2 only.

## 6. REVIEW OF DRAINAGE IMPROVEMENT OPTIONS AND FLOOD AFFECTATION

One of the principal objectives of the study was to assess the extent of flood problems between Old Prospect Road and Darling Street Reserve for a 20yr ARI flood event under existing catchment conditions (that is, with no additional trunk drainage works in place). That is, Council required advice as to how many properties were suffering sufficient depths of floodwaters within their properties such that a flood affectation clause needed to be placed on the Section 149 (EPA Act) Certificates. This is in accordance with Council's policy (which is documented in **Reference 3**).

Adopting the historic flood of 2 August 1990 as approximating a 20yr ARI flood event the Consultant made a careful review of the flood data collected for that particular event such that a house-by-house assessment could be made of depths of flooding in backyards/frontyards, garages and houses.

The works required to achieve a 20 year ARI capacity trunk drainage system from Roberta Street to Darling Street were found to consist of the construction of two retarding basins in Cumberland Country Golf Club, a retarding basin in Roberta Street Park, and a parallel drainage line from Old Prospect Road to Darling Street Park.

The very high cost of constructing such a scheme (\$2.6 million), in view of the limited number of properties inundated in the area downstream of Old Prospect Road, indicated that this option is not feasible.

Rather, construction of the two basins in the Cumberland Golf Course plus a (smaller) parallel drainage line (at a total cost of \$1.2 million) and purchase of one badly affected house would substantially reduce the extent of overland flooding in a 20 year ARI event. That is, such a scheme would eliminate Section 149 Certification notations from all properties.

Hence construction of Basins 1 and 2 within the Cumberland Golf Club became the recommended first priority works to reduce the extent of the hazardous flooding.

To eliminate hazardous flood conditions from all properties downstream of Old Prospect Road the construction of a duplicate pipeline (between Old Prospect Road and Darling Street Basin No. 2) became the second priority works.

The threat of hazardous flooding (which includes above house floor level flooding) at the worst affected property was removed by purchase of that property and demolition of the dwelling and garage.

## **7. DETAILED DESIGN OF THE GOLF COURSE BASINS**

Preliminary sketches of two alternative options to accommodate the proposed basins within the golf course layout were discussed with the senior management of the club. They expressed general agreement with the nature of the works while emphasising their requirement for the flood mitigation scheme to also provide additional irrigation storage for the club. Since the need for the scheme to incorporate irrigation volumes would impact on the size of the basins it was realised that clear boundaries for the basin locations should be determined at an early stage. Hence the club used an aerial photograph of the course to define the areal extent which the works could occupy. It was agreed that a more detailed plan of the proposed works should be prepared and discussed with the club.

Detailed survey of the proposed works area was undertaken and the position of the two proposed basins were added to the base plan. It was found that the club's requirements re the areal extent of works meant that there was insufficient room to accommodate the two basins. The scheme basis was then reviewed and it was found (and confirmed by ILSAX modelling) that equivalent benefits to the original two basin scheme would be able to be achieved by a three basin proposal. (In this proposal one of the three basins was "designed" to accommodate a sizeable irrigation storage compartment.)

When shown the preliminary design plans for the three basin scheme the club management still expressed reservations about the extent of the works due to their potential impact on the adjacent golf course holes (such as reduced fairway widths - due to the extent of earthworks - and potential inundation of one green during very major storm events).

The club was also very keen to see further irrigation storage benefits accruing from the works.

It was apparent that the club would need further information prior to them agreeing "in principle" with the scheme. In order to further refine the basin scheme it was recognised that additional specialist inputs (that were always recognised as being required for the detailed design of the works) should be brought forward.

Hence a golf course architectural firm was engaged to assess the impact of the basins on the golf course layout and geotechnical advice was commissioned to define subsoil factors (including advice as to how deep the basins could be feasibly excavated in order to maximise irrigation storage volumes).

The results of work undertaken by these two subconsultants was such that the club management were able to be convinced that:

- (a) the works could be designed and constructed such that they would not adversely impact on the golf course layout (indeed some significant improvements to the course layout were able to be identified), and
- (b) the maximum possible irrigation storages were being built into the scheme. (One of the revisions of the original three basin layout was the provision of irrigation storage compartments in two of the three basins.)

Having achieved approval "in principle" from the club management, detailed design of the basins then proceeded. Detailed cost estimates of the works were prepared and they formed the basis of a cost sharing formula between Council and the golf club. A final agreement (covering the cost sharing formula and easement protection of both the basin works and the extent of 100 year ponding in the basins) was signed by Council and the club.

The basins (as shown in **Figure 2**) were constructed in late 1993 within the tight timetable requirements of the golf club. (During the construction the works area was defined by temporary fencing to exclude golf course users and the club constructed temporary greens and tees to preserve an eighteen hole course.)

## **8. REFERENCES**

1. BEWSHER CONSULTING (1991) "Upper Pendle Hill Creek Drainage Study" Commissioned by Holroyd City Council.
2. INSTITUTION OF ENGINEERS AUSTRALIA (1987) "Australian Rainfall and Runoff" Volumes 1 and 2. Published by the Institution of Engineers, Australia.
3. STILL, D.C. & RITCHIE, P (1992) "The Definition of Hazard in Relation to Urban Flooding" International Symposium on Urban Stormwater Management, Sydney 4-7 February.