

# The Definition of Hazard in Relation to Urban Flooding

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**SUMMARY.** In a series of major storm events in the mid to late 1980s many NSW local government authorities were confronted with extensive urban flood problems. These floods, apart from their damages bills, raised a number of issues including that of how to assess the relative severity of flooding in an urban environment.

In response to these issues - and in recognition of the need to comply with the provisions of Section 149 of the NSW EP and A Act (1979) - Holroyd City Council has developed a set of standards (based on relative depth of floodwaters) which when applied for a designated flood event define certain limiting conditions. If the conditions are exceeded then a flood affectation clause is included on the Section 149 Certificate.

The paper details those standards and examines, by way of proven methodology, the practical approach of how the standards may be applied.

## 1. INTRODUCTION

The very severe Sydney storms of November 1984 and the series of subsequent major urban flood events in the mid to late 1980s (plus very localised major flood events in the early 1980s in urban regions close to Sydney) saw the issue of urban flooding become a very pressing and major concern for both the NSW State and local governments.

For many metropolitan Sydney Councils the 1980s events represented occasions of urban flooding that had never (or at most rarely) been experienced in the 1960s or 1970s. Hence although virtually all Councils had urban trunk drainage system capacities that were quite modest (typically having a theoretical capacity to collect and convey the runoff from a 5 year average recurrence interval (ARI) event but an actual capacity of something less) the lack of major storms in the 1960s through to the mid 1980s had meant that the consequences of significant system surcharge had not been experienced and therefore had not been assessed.

(This contrasts with mainstream flood issues which, partly because of the valley-wide floods experienced in the 1950s and 1960s, had been under review since the mid 1970s. The culmination, following a series of state government circulars that addressed the issues of floodplain development, was the development of a State Government flood prone land policy and the 1986 publication of a Floodplain Development Manual, **Reference 1.**)

Hence in the late 1980s local government authorities were relatively suddenly confronted with the issue of how to address the "new" problem of urban flooding. There were no published guidelines on what constituted potentially hazardous flood conditions in an urban neighbourhood and historical storm details (especially temporal pattern details) and flood depths and levels were either not available or at best sketchy.

For local government authorities there was (and still is) the dilemma of having at best an incomplete dossier of historical flood information throughout their stormwater catchments. How was this data to be used? How was it to be used to assess the nature of hazard for individual properties (where some sort of "flooding" had been reported) or properties adjacent to such "flooded" properties? Indeed what constitutes "flooding"?

## 2. THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT (1979)

The NSW Environmental Planning and Assessment Act (1979) provides the frame work for regulating development and protecting the environment in New South Wales. As stated in **Reference 1** it has the object of encouraging:

- " ♦ the proper management, development and conservation of natural and man-made resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment
- ♦ the promotion and co-ordination of orderly and economic use and the development of land;
- ♦ the protection, provision and co-ordination of communication and utility services;
- ♦ the provision of land for public purposes;
- ♦ the provision and co-ordination of community services and facilities and
- ♦ the protection of the environment".

Within the act (under Section 149) there is provision for a Certificate which specifies various matters relating to any property, e.g. zoning, development controls, road widening proposals, land slip, flooding subsidence, etc. (Members of the public who own property usually are oblivious to the existence of the certificate until they decide to sell their property at which point they need a copy since the Certificate is required to be attached to contracts for the sale of property).

In respect to flooding, Councils are specifically required to advise "whether or not the Council has by resolution adopted a policy to restrict development of the land by reason of the likelihood of...flooding...". (Hence if a Council has not adopted such a policy to date, that needs to be stated on the Certificate).

A further provision of Section 149 of the Act is that "Council(s) may ... include advice on such other relevant matters affecting land of which it may be aware". Legal opinion would suggest that under this provision councils would incur no liability for providing such additional information in good faith. Legal opinion would also suggest that where Councils are aware of information regarding flooding, they should provide what information they have in the Certificate.

In accordance with its duty and moral obligations, Holroyd City Council is providing additional information on Certificates where it is known, or it could be expected, that properties are affected by overland stormwater flow. The following notation is attached to such Certificates:

*"This property may be subject to overland stormwater flow during periods of extreme rainfall. However, Council's information is incomplete and interested persons should make their own enquires in the local area, and/or seek the services of a suitably qualified engineer to ascertain the likely effect, if any, on the property."*

### 3. THE IMPLICATIONS OF A SECTION 149 CERTIFICATE NOTATION

Whilst the above wording was considered to be appropriate under the requirements of the EP and A Act its application to particular properties raised certain problems of its own. This is because the earmarking of a property as possibly having flooding, drainage or overland flow problems can be seen to affect the market value of the property - although it is the flood liability of the land which should really influence the value, not the notation itself. Holroyd City Council found itself in a difficult situation - providing additional information can penalise existing owners, and not advising future owners can penalise new purchasers.

Initially it was considered reasonable to apply the notation to all properties that were considered to be affected by overland flow (generated in storms up to the 100 year ARI), along natural depressions that contained a Council stormwater pipe system of 900mm diameter or greater. It was found that this approach generated considerable social and therefore political concern, for the following reasons:

- ✦ A very large number (hundreds) of properties were affected because the existing piped systems generally can only cope with storms of less than 5 year ARI.
- ✦ In many cases, this overland flow would not be "over floor" and would represent only nuisance overland flow conditions through the undeveloped areas of the properties.
- ✦ It would not be feasible in the foreseeable future, to eliminate this overland flow in the majority of the properties, i.e. the notation would not be removed for a large number of years, if ever, and not even a rough idea (re timing) could be given by Council engineering officers.

As a result, the affected residents could readily, and quite correctly, foresee that when they were ready to sell, they would either have problems obtaining a purchaser or the price would be considerably lower, due to the notation. Therefore, Council called for a report from the City Engineer on the subject of overland flow notations on Section 149 Certificates. In the preparation of that report (**Reference 2**), an extensive review was undertaken on a "think tank" approach by the four most senior engineers, including the City and Deputy Engineers, to develop more practical guidelines for when to provide drainage or flooding information on the Certificates.

An important part of that review was trying to define what is meant by "flooding". At what stage is it necessary for Council to bring to notice that "flooding" may be a risk? For example, it would seem reasonable to accept 100mm of overland flow through the rear of a yard on rare occasions as not constituting "flooding" (if there is little damage to property). However, 100mm of water through a house is clearly "flooding" and of concern in the community. The difficult problem is defining the point at which "flooding" is significant enough to become of concern and thus should be notified on the Section 149 Certificate.

A further problem is having incomplete information to know the extent of properties affected by "flooding", once it is defined.

The following sections of this report discuss the design standards that Holroyd Council now seeks to achieve in order to develop guidelines for the provision of information on Section 149 Certificates; and the way that design flood information (essential to the process) can be developed. (It is important to note that while this paper concentrates on the assessment of urban neighbourhood flooding Holroyd City Council has concurrently developed a set of guidelines re mainstream flooding).

### 4. HOLROYD CITY COUNCIL DESIGN STANDARD

The Holroyd City Council area is now substantially developed. The combination of lower system design standards of 20 to 30 years ago (which did not address the "need" for overland surcharge flow paths) and increases in design rainfall intensities result in many existing drainage systems now having inappropriately small capacities.

Whilst in highly developed urban areas such as Holroyd it is difficult and costly to achieve higher standards of

protection, it is still necessary to set standards which Councils aim to achieve when alleviating flooding problems.

Where a stormwater flooding problem is identified, and remedial works are proposed to protect private property Holroyd City Council has determined that the piped drainage system should be designed to achieve a 20 year level of flood protection. This level was selected, as generally the storms in the 1986-1990 period, which caused the extensive flooding in Holroyd, were in the 10 to 20 year ARI range.

(Council's policy re the designated level of protection is however flexible in recognition of exceptions where a higher level of protection (to 1:50 or 1:100 year) should be given. This would apply where 20 year flood protection would still leave a hazardous situation, i.e. serious over-floor flooding would still occur, involving large depth and high velocity overland stormwater flow. In general, Council aims wherever practical and economic, to provide 1:100 year protection to "over floor" flooding, particularly in respect to habitable areas).

## 5. DETERMINATION OF LIMITING HAZARD CONDITIONS

Having adopted the 20 year event as the designated urban flood event Holroyd City Council set about the task of determining what flood conditions would constitute unacceptable levels of risk and/or damage in the designated event. The conditions needed to satisfy the very important objective of Council's policy of bringing to notice the fact that Council is aware of flooding occurring that is of significant concern in the community due to actual or potential loss or damage to property, or in extreme cases, life.

If the conditions were exceeded then (funding permitting) the local trunk drainage system should be upgraded and potential flood affectation wording would not be required to remain on individual property Section 149 Certificates. (Conversely if the flood conditions were not exceeded then local properties would not have a flood notation on their certificates and the capacity of the trunk drainage system would not warrant any increase.)

Holroyd Council's engineering staff subsequently developed the following limiting flood depth criteria (for the designated flood event):

- (a) "inundation of enclosed floor areas of main buildings (eg dwellings, factories); or
- (b) inundation of minor improvements (eg garages, pools, storages areas, etc) and the average depth of the overland flow is generally greater than 200mm. Minor improvements is defined as minor development in Council's Draft Development Control Plan and the Floodplain Development Manual (**Reference 1**). (The 200mm depth is based on the depth at which vehicles start to float as per the Manual); or
- (c) inundation of the undeveloped part of a property (eg, rear yards) or an undeveloped property, where overland flow depth is greater than 500mm, able bodied adults would have difficulty in wading due

to depth and velocity, there would be danger to life and limb, or damage potential to existing or future yard improvements (eg, fences, aviaries, pergolas, etc)". (**Reference 2**)

## 6. ASSESSMENT OF 20 YEAR FLOOD CONDITIONS

Holroyd Council recognised that the above criteria would assist in identifying lengths of drainage systems that are of significant concern but that it would be more difficult to apply the test to individual properties due to incomplete information being available. It would therefore be necessary to use the best information readily available, and using engineering judgement, identify properties for notation.

As with almost all other Councils the information available to Holroyd Council on urban flooding is generally incomplete. Council has some knowledge of affected areas due to complaints received, observations made, or in limited cases, because of more detailed investigations by Council. Flood depths are not well defined or recorded, and anyway in many cases flood depths affect different properties in different ways. In some cases, it is known water has gone through houses and/or garages, but in neighbouring properties little information may be known although flooding could be expected.

Such flooding is not as easily defined as mainstream flooding because: the piped drainage network is significantly more extensive, investigation of all systems is beyond Council's resources, analysis is difficult due to the complex interaction of fences and other obstructions on overland flow, and detailed survey information is not readily available.

For urban flooding it is therefore often necessary to use engineering judgement to assess the extent of flooding on properties (without the benefit of detailed calculations or first hand knowledge of historical floods). In Holroyd this judgement is made against the standard of protection that Council would generally seek, that is the limiting 20 year flood conditions where stormwater flows traverse residential properties. However, it must be stressed that this judgement is not easy to apply, even though it must only be applied by very experienced engineers. Often, the decision is very difficult, in which case, a second experienced engineer is involved.

In certain neighbourhood localities where Holroyd Council was generally aware of severe historical flood problems Council has determined that detailed investigations are necessary. Once again the aim of the investigations would be to define the extent of the historical problems and to adequately define the potential 20 year event conditions (so that the need or otherwise to apply Section 149 flood notations could be resolved).

In discussions with Council's officers Bewsher Consulting, consulting engineers proposed a methodology for the neighbourhood investigations and that methodology has been successfully used in several studies. As listed below, there are seven steps in the methodology:

1. The delivery of a detailed flood questionnaire (with accompanying covering letter) to all households in the study area

2. The commissioning of detailed ground survey through the study area and subsequent generation of survey base plans. (The survey typically includes spot levels at house and garage locations, property boundaries, road kerbs and centrelines, definition of major and minor building footprints and floor levels and the definition of boundary fence types. If not already available the survey also defines the trunk system pipe diameters and levels, pit levels, etc)

3. The careful review of historical flood information contained in the returned questionnaires, with follow-up telephone and field interviews as required.

4. Based on the compilation of flood depths throughout the study area, historical flood contours are plotted on to the survey base plans. (Ideally the contours represent the levels corresponding to the two or three best documented floods.)

5. The use of Hydraulic Grade Line (HGL) analysis to define the capacity of the pipe system.

6. The generation of a hydrological model (preferably ILSAX given its ability to define separate pipe and overland flow hydrographs) of the catchment encompassing the study area with the subsequent calculation of historical flood hydrographs and design 20year and 100year flood hydrographs. The historical flood hydrographs are generated from storm temporal patterns obtained from the nearest rainfall recorder station(s). The historical and design flood overland flows are compared so that the historical floods can be assigned approximate average recurrence intervals. Hence the historical flood contours are adjusted to achieve the best approximation of a 20 year flood event.

7. The 20 year flood depths through each floodprone property are then determined (by comparing the flood contours with the surveyed spot levels) and hence it is possible to determine which properties have flood depths that exceed Council's limiting depth criteria.

In one such study of a neighbourhood in the suburb of Greystanes (**Reference 3**) the consultant determined that of some forty properties that had experienced some form of historical flooding only nineteen would be expected to experience excessive property inundation (as defined by Council's depth criteria) in a 20 year flood event. As part of the study a number of flood mitigation alternatives were then examined. Each of the alternative schemes were assessed on the basis of the number of properties still subject to a Section 149 flood notation, the number of houses flooded in a 20 year event and the number of houses flooded in a 100 year event.

On the basis of the assessed benefits (in terms of numbers of affected properties) and estimated flood mitigation costs Council adopted a two stage scheme of which the first stage involved the purchase of the worst flood affected property and the commitment of funds for detailed design and construction of upper catchment flood retarding basins. The second stage consists of a duplicate pipeline (which will serve to protect the balance of properties not sufficiently protected by the basins scheme).

The worst affected property was a house that had been flooded three times in five years and the cost to provide protection by a piped drainage system (the only solution),

was three times the cost to purchase the house/property, and this was additional to the cost of protecting all the other affected properties. Hence, the economic solution was purchase and demolition of this one dwelling (now in progress).

## 7. COMMUNITY REACTION

The reaction by the community to this system, has after about twelve months operation, been very positive and promising, with the majority accepting the notation, after an experienced engineer has diplomatically, patiently, and clearly explained the reasons. Consequently, no political problems have arisen. The important points stressed in such discussions are:

- ♦ It would be improper for Council not to advise a prospective purchaser of the flooding; just as the owner would want to be advised if he/she was considering purchasing a similarly affected property.
- ♦ Council did not previously apply the notation, eg. when the present owner purchased the property, as it did not realise the flood affect, nor did the community require such advice, i.e. community requirements have changed.
- ♦ It is Council's intention to implement drainage improvements to reduce the flood affect and remove the notation, in the near future, and preferably an idea of timing is given (e.g. 1-2 years, less than 5 years, etc) though such comments must be conditioned by indicating that it is subject to continuation of existing funding, government grants, etc.
- ♦ Councils' funds are not limitless and that drainage projects are based on a priority of the worst locations first, i.e. first priority is where houses have been flooded, and priority within this group is based on the numbers of houses affected at any one location and/or the severity (depth and velocity) of the flooding.
- ♦ Council did not previously advise the owner, of the application of the notation to the property, as it is only applied, where relevant, and when a 149 Certificate is requested. The notation does not appear on the property title and is only relevant when the property is being sold.

These true and honest comments are difficult to counter by a reasonable person and most people are reasonable - therefore, with some reluctance, but with a good understanding of the reasons, the majority of the affected people accept the notation.

## 8. CONCLUSIONS

The paper has addressed the following issues:

- ♦ Information available on urban flooding is typically incomplete. It is therefore necessary to use the best information available and engineering judgement to assess the extent of flooding on properties.

- ♦ Guidelines have been developed by Holroyd City Council for the provision of drainage or flooding information on Section 149 (NSW EP and A Act, 1979) Certificates. The objective being to bring to notice where flooding occurs that is of significant concern in the community (due to potential for loss or damage to property, or in extreme cases, life). The existing property owners are not notified beforehand nor is the matter advertised.
- ♦ Under Council's policy the notations on Section 149 Certificates would be no longer necessary where drainage or flood mitigation works are carried out to reduce urban flooding to less than the criteria given in this paper for the 20 year flood.
- ♦ The wording of the notations on Certificates has been carefully chosen to better reflect the reliability, accuracy or otherwise, of the information. (Where Council information is incomplete, this will be so stated).
- ♦ Removal of Notation - As far as resources permit, Council is endeavouring to investigate and carry out construction of flood mitigation and drainage works to reduce the impact of flooding and flood liability in Council's existing development areas. (A methodology used successfully in the detailed investigation of the worst affected urban neighbourhoods is presented.)
- ♦ It is considered that where Council does carry out works to mitigate or control flooding, and the property no longer comes under the guidelines for notations on Certificate (as outlined in this paper), it would be appropriate for the notation not to be placed on subsequent Section 149 Certificates.
- ♦ Each situation would need to be considered on its merits. However generally if a 20 year protection could be provided to a property, previously affected by stormwater flooding, the notation would no longer be necessary as the drainage then meets Council's standard. In cases where the drainage improvements do not totally remove the 20 year ARI affect, mainly in respect to the depth in garages or more particularly, through the undeveloped areas of the property (but the improvements have reduced the affect), Council requires the drainage study to define the inundation depths. This more detailed information is then available (on request) to the owner or prospective purchaser as a result of the Section 149 notation.
- ♦ Holroyd Council engineering officers certainly do not consider that this system is perfect, nor that it is easy to apply, particularly in regard to the "judgement" issue. However, it is considered to be a step in the right direction, and hopefully it will stimulate further thought and comment to provide a better system for the benefit of the community and the engineers who serve the community.

## 9. REFERENCES

1. NSW Government (1986) Floodplain Development Manual PWD Report No. 86101 ISBN 724030115
2. Holroyd City Engineers Report No. 90/88 Section 149 Certificates and Drainage Notation endorsed by Holroyd City Council on 17 July 1990.
3. Bewsher Consulting (1991) Upper Pendle Hill Creek (Old Prospect Road, Greystanes) Drainage Study Commissioned by Holroyd City Council. January