13.00 Miscellaneous matters

13.01 Relief drainage or upgrading works

13.01.1 General

Relief drainage or upgrading works are undertaken under the following circumstances:

(a) To augment an existing drainage system that may have been designed to a lower standard at some time in the past.

(b) To overcome specific drainage problems, which may include localised areas of property flooding or unacceptable road flows.

(c) To improve the performance of the drainage system in relation to safety, water quality, convenience, flow spread criteria or freeboard.

These works are often undertaken following receipt of complaints from the public, especially in relation to property flooding. Complaints may occur because in some cases the original scheme may have been designed to lower design criteria than those now acceptable. In some cases, changes in the intensity or type of land use may have exacerbated the runoff behaviour, whilst changes to the pattern of runoff by diversion or construction works may have directed additional flow to certain areas.

It should also be acknowledged that both hydrology and hydraulics are <u>not</u> exact sciences. It is possible for a drainage system to be designed in accordance with accepted design procedures, and for the final system to fail to deliver one or more of the desired outcomes. In such cases relief drainage may be required. In these circumstances, designers are encouraged to investigate the reasons for the unsatisfactory design outcomes and present their findings to the Department of Natural Resources and Water to assist in future QUDM enhancement, and/or to a stormwater conference.

Designers should also be aware that undertaking relief drainage within a catchment may increase flows and flood levels downstream of the remediation works. Whether this relief drainage is done as a part of a new urban development, or as a local government drainage upgrade, it is important to investigate potential downstream impacts and to ensure, where practical, that the downstream drainage system does not fall below the accepted drainage standard.

13.01.2 Assessment procedures and remedial measures

A number of measures can often be taken to improve the capacity of an existing system without the need for major augmentation works. These should be examined first and include:

(a) Detailed field inspection to ensure that "as constructed" records are correct, blockages or other operational faults are detected, and restrictions such as limitations in overland flow paths are identified.

(b) Assessment of the capacity of the existing drainage system to identify those areas that are deficient. This would involve a detailed hydrologic and hydraulic analysis of all components. Deficiencies frequently identified include inadequate gully inlet capacity, deficiencies in certain pipe sections, insufficiently high footpath profile or restrictions in overland flow paths. Many deficiencies can be easily remedied by relatively inexpensive augmentations or improvements.

(c) Partial augmentation of the underground piped drainage system. This might include upgrading of critical pipe reaches within the catchment combined with the acceptance of reduced standard of service for both major and minor storms. Examples of reduced standards of service include reduced freeboard, a lower ARI for the major storm, less stringent flow width/depth criteria, or lower ARI for minor storm and non-compliance with the depth-velocity criterion. Thus, it may be possible to reduce the occurrence of property flooding through private property while allowing excessive overland flows to persist within road reserves. The local government may choose to accept on, economic grounds, a scheme to overcome property flooding problems whilst allowing a lesser standard of safety and convenience to persist in road reserves other than those outlined in Chapter 7. On this basis, a local government could target funding towards the mitigation of property flooding as its highest priority.

13.01.3 Design alternatives

In the investigation of an individual scheme, the full range of design options should be considered to determine the "most economic" alternative to be chosen. Benefits and costs in both the short and long-term should be considered although least capital cost is commonly the method used to select the "most economic" alternative.

Design alternatives may include:

- doing nothing;
- reduced standard of service and design criteria (Section 13.01.5);
- above and below ground detention storage in parks, road reserves and private properties;
- partial augmentation;
- major augmentation;

– purchase and removal of houses.

13.01.4 Priority ranking

It will usually be necessary not only to justify expenditure on relief drainage or upgrading works but also to have a system of ranking schemes in some form of priority order. In addition, where lesser standards of service are considered acceptable, the choice of the acceptable standard should be determined on a rational basis.

Ranking of schemes has generally been achieved using risk/consequence ranking and benefit/cost analyses. This may be as simple as considering the benefit to be equivalent to the number of properties which will no longer be flooded after implementation of the scheme and the capital cost of the scheme. Recurrent costs such as maintenance and repairs and economic loss to householders are often ignored. The difference between allotment flooding generally and property flooding including inundation of buildings is also often ignored.

Department of Natural Resources and Mines (2002) provides guidance on allotment flooding costs (i.e. backyard flooding with no flooding of habitable rooms) and property flooding costs which includes the flooding of habitable rooms.

Schemes are also commonly ranked on the basis of comparing the costs of the "most obvious" alternatives for each scheme rather than the "most economic" alternatives. This is because of the difficulties involved in comparing schemes with different standards of service between the existing and proposed drainage systems.

One such method which allows comparisons between projects with different design standards is average annual damage (AAD) analysis. AAD analysis determines the total flood damages cost (over the full range of flood probabilities from the initiating event where flood damage commences to the PMF) for a particular catchment. The difficulty in applying this method is the estimation of the flood damage resulting from the PMF flood event.

A simplified estimation of the PMF flood damage cost could be based on a pro-rata basis comparing the number of properties affected by a higher flood probability (e.g. 1 in 100 year ARI) to the potential number of properties affected by the PMF flood event and applying this ratio to the known flood damage cost for the higher flood probability. The Department of Natural Resources and Mines (2002) provides guidance in calculating flood damages and determining the AAD for a particular catchment.

A method allowing comparison between projects with different design standards of service is provided in Section 13.04. The method is suitable for comparing alternatives within a given scheme and for comparing schemes on separate catchments.

It is suggested that these methods are inadequate to enable the absolute ranking of schemes but are probably sufficient to allow the determination of priority categories where all schemes within a particular category (say 5 to 10) are considered to have equal ranking. The use of Nett Present Value or similar techniques is not considered warranted in the determination of priority categories. Such techniques however, may be justifiable in the case of schemes of significant cost in order to determine absolute ranking within priority categories.

13.01.5 Design criteria

Whilst the criteria set down in this Manual should be adhered to if possible for relief drainage and upgrading works, economic and physical limitations may require the adoption of less stringent criteria. These may include:

(a) Limitation on pipe size because of easement restrictions;

(b) Reduced cover over pipes;

(c) Increased flow velocities;

(d) Increased pipe grades;

(e) Non-standard gully inlets, structures or pipe geometry;

(f) Reduced clearance to other pipes, services etc.;

(g) Departures from the flow width, $d*V$, freeboard and other criteria detailed in Tables 7.03.1 and 7.04.1.

The adoption of these reduced criteria should take place only after consultation with the appropriate officer of the relevant local government. In some cases public consultation may be required.

13.02 Plan presentation

13.02.1 Design drawings

Examples of design drawings for drainage works are provided in Volume 2 of this Manual. These are intended to portray the suggested main components of the design including the following:

– Plan and general layout of the scheme;

– Structure data table including type, surface level and location;

– Pipe data table showing diameter, length and level information;

– Longitudinal sections of pipes including level and grade information, length of section, size and class of pipe, hydraulic grade line, services crossings etc;

– Structure detail plan for special structures;

– Catchment plan and catchment table;

– Calculation sheets.

Note: It may be possible to omit the structure and pipe data tables if appropriate information is shown elsewhere on the drawings.

13.02.2 Standard plans

Most local governments have standard plans showing details of those drainage components that are repeated regularly within a project. Alternatively the plans may show standard requirements in respect of boundary clearances, allocations, etc. Where applicable, Department of Main Roads standard plans may also be suitable. In addition the Institute of Public Works Engineering Australia (Qld) have a number of standard drawings for road and drainage works.

Designers need to determine from the local government which standard plans are to be adopted for drainage works in its area.

13.02.3 As-constructed plans

Accurate "as-constructed" plans shall be prepared to record any changes or departures from design that may have occurred during the construction phase if such plans are required by a local government.

These plans are usually required by local governments in order that a correct data base is available for record purposes, for asset management and maintenance. They are important as a reference source for other services authorities, future designers as well as police and emergency services.

As-constructed plans should record the following information as well as other details particular to the project:

- pipe sizes and location;
- invert levels and grades;
- surface levels for structures;
- the location and dimensions of structures;
- structure types;
- the location of subsoil drainage and clean-out points;
- details of services that have been relocated.

As-constructed plans should be certified by a Registered Surveyor who was involved in the collection of the as-constructed information.

13.03 Subsoil drainage

It is desirable and, in some cases, essential practice to install subsoil or subsurface drains beneath road pavements and in conjunction with drainage pipes to drain the pavement or subgrade, or to collect seepage.

The construction of an underground stormwater drainage system with associated granular pipe bedding can result in the interception of seepage and the concentration of this intercepted water at drainage structures. The installation of subsoil drains in conjunction with the drainage pipes allows seepage water to be collected and conveyed into the drainage system.

Detailed recommendations in respect of design and installation of subsoil drains have been prepared by the Australian Road Research Board, (Gerke 1987). In addition most Local Authorities have standard drawings and specifications detailing construction requirements. Standard Drawing MR-1116 shows typical details. Brisbane City Council (2003) provides details for subsoil drainage under grass swales.

Notwithstanding the above, it is recommended that a minimum of 3 metres of subsoil drain be installed on the upstream side of and discharging to every manhole, gully inlet or structure. The subsoil drains should be installed adjacent to every pipe leading to the manhole, gully inlet or structure.

Clean-out points should be provided in the subsoil drainage system to permit regular maintenance and the removal of accumulated silt etc.

13.04 Scheme ranking methods

(a) Triple bottom line method

The Triple Bottom Line ranking method allows the incorporation of Financial, Ecological and Social issues within the assessment process. Guidelines on the application of the Triple Bottom Line analysis may be found in Taylor (2005) and Engineers Australia (2005).

(b) Pseudo benefit cost analysis

The following method is a pseudo-benefits/costs method which may be used to rank schemes relative to each other in order to assist decision-makers to determine the optimum allocation of drainage funds. The method also provides a means of comparing schemes that are not of a like nature. For example, existing drainage works within competing relief drainage schemes may have been designed to different standards and the proposed augmentations may also be to different standards.

Using the following method, the cost of each scheme is apportioned as a cost per "flooded" allotment with the benefit simply being measured as the removal of flooding from the allotment. In order to account for flooding of a house (as distinct from flooding of an allotment only) a weighting is applied to those allotments where the house is also flooded. The unit cost is then determined by apportioning the total cost over the weighted number of allotments from which flooding can be removed by the scheme.

The unit cost is then adjusted by multiplying by a "standard normalisation factor" so that the unit cost comparison is made on the basis of a common standard. Schemes are then ranked in order of increasing unit cost with the lowest unit cost scheme being the preferred one, all other aspects being equal.

For scheme i

Cost for Scheme = C_s^i

Number of flooded allotments on which the house is flooded and which will be no longer flooded upon completion of the scheme = N_h^i

Number of flooded allotments where house is not flooded and which will be no longer flooded upon completion of the scheme = N_a^i

Weighted number of flooded allotments = N_w^i

$$= W_i \,.\, N_h^i + N_a^i$$

where: W_i = 5 to 100 (typically 20)

Note: The value of Wi is based upon the relative damage costs between the situation where a house is flooded and the situation where an allotment is flooded but the house on it is not. On an allotment where the house on it is flooded, flooding of the allotment is likely to occur more frequently than on an allotment where the house is not flooded. This combination of house flooding and more frequent allotment flooding leads to a higher relative damage cost than for the less frequently flooded allotment with no house flooding.

Unit cost of Scheme $= C_u^{\,i} = \dfrac{C_s^{\,i}}{N_w^{\,i}}$

Normalised Unit Cost of Scheme $= C_n^{\,i} = S_i \, . \, C_u^{\,i}$

where:

$$S_i = \frac{\left(\frac{1}{y_b} - \frac{1}{y_d}\right) . \left(1 + x - \frac{x}{2}\left(\frac{1}{y_b} + \frac{1}{y_d}\right)\right)}{\left(\frac{1}{y_e} - \frac{1}{y_p}\right) . \left(1 + x - \frac{x}{2}\left(\frac{1}{y_e} + \frac{1}{y_p}\right)\right)}$$

and y_b = ARI (years) for the base system (usually the lowest ARI of all the schemes being compared or a default value of 1).

y_d = ARI (years) for the design standard required, (e.g., 100 years Table 7.02.1).

y_e = ARI (years) for the existing drainage system ($y_e \Leftrightarrow y_b$).

y_p = ARI (years) for the proposed drainage system (see section 13.01)

x = Skewness factor (usually 0.5)

Rank schemes in order of increasing values of $C_n^{\,i}$ with the scheme with the lowest value being the preferred.

Note: This procedure is indicative of priority only since it ignores the many recurrent costs to property owners as a result of flooding. In addition, with y_p equal to, say 20 years, some of the properties would be flooded more than once in those 20 years while some would only be flooded once.

(c) Hurrell and Lees procedure

An alternative procedure for scheme ranking is given in Hurrell and Lees (1992). In assessing the cost of flooding the procedure takes into account the regularity of flooding and ascribes a monetary value to the severity of flooding. It also includes a social impact factor for residential properties which are regularly flooded and a Frequent Flooding Factor for industrial and commercial properties. The benefits of mitigation proposals are determined by subtracting the post-mitigation costs of flooding in each case from the pre-mitigation costs. The certainty of construction cost estimates are factored depending upon the extent to which investigation, design and detailed estimates have been completed. A variety of ranking procedures are suggested.

13.05 References

Brisbane City Council 2003, *Water Sensitive Road Design Guidelines.* Release 2 (CD-ROM), Brisbane City Council, Brisbane.

Department of Natural Resources and Mines 2002, *Guidance on the Assessment of Tangible Flood Damages*, Queensland Department of Natural Resources and Mines, Brisbane, Queensland.

Engineers Australia 2005, *Australian Runoff Quality – A Guide to Water Sensitive Urban Design*, Engineers Australia, Canberra.

Gerke, R.J. 1987, *Subsurface Drainage of Road Structures*, Special Report No. 35, Australian Road Research Board, Vermont South, Vic.

Hurrell, G.L. and Lees, S.J. 1992, *Setting Priorities for Urban Stormwater Management on an Integrated Catchment Basis*, Proc. Int. Symp. on Urban Stormwater Management, Sydney, N.S.W.

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