

BIBLIOGRAPHY

- ALLEN, M. (1993). *An investigation of appropriate technology on-site water conservation, roof runoff supply and water re-use systems for application within the Adelaide Metropolitan area*. Master of Engineering thesis, School of Civil Engineering, University of South Australia.
- ALLEN, M.D. (1994). *Parametric studies for domestic rainwater tanks : comparison between pluviometric, daily and monthly data*. Consultancy for Engineering and Water Supply Department, South Australia.
- ALLEN, M.D. and ARGUE, J.R. (1998). *Stormwater management and rainwater use in Adelaide households*. Report, UWRC, University of South Australia.
- ALLISON, R.A. and CHIEW, F.H.S. (1995). *Monitoring of stormwater pollution from various land uses in an urban catchment*. Proc. I.E.Aust. 2nd Int'l Symposium on Urban Stormwater Management, Melbourne.
- ANZECC (2000). *Australian water quality guidelines for fresh and marine waters*. National Water Quality Management Strategy. AGPS, Canberra.
- ANZFA (2000). *Food standards code*. Australian and New Zealand Food Authority. AGPS, Canberra.
- ARGUE, J.J. and ARGUE, J.R. (1998). *Total stormwater management at "Figtree Place", Newcastle, NSW*. Proc. 3rd Novatech Conference on Innovative Technologies in Urban Stormwater Drainage, Graie, Lyon, June.
- ARGUE, J.R. (1986). *Storm drainage design in small urban catchments : a Handbook for Australian practice*. Aust. Road Research Board, Special Report, SR 34, South Vermont, Victoria.
- ARGUE, J.R. (1997). *Total stormwater management concept study for inner Newcastle : Stage 1 – concept study for Hamilton Bus Station site*. UWRC, University of South Australia, Adelaide.
- ARGUE, J.R. (2000). *Stormwater 'source control' design procedures for WSUD : some issues and examples*. Proc. 1st National Conf. on Sustainable Drainage Systems for Urban Areas, Melbourne Water, Melbourne, August.
- ARGUE, J.R. (2001). *Testing of infiltration at four sites in the Upper Parramatta River Catchment Trust Area – Progress Report Project 07-67610*. UWRC, University of South Australia, Adelaide, November.
- ARGUE, J.R. (2005). *Strategic planning for stormwater management in urban catchments*. Proceedings, 2005 Adelaide Public works Conf., Institute of Public Works, Australia, August, Adelaide.
- ARGUE, J.R. and PEZZANITI, D. (1999). *Catchment 'greening' using stormwater in Adelaide, South Australia*. Water Science and Technology, Pergamon, Vol. 39, No. 2, pp 177 – 183.
- ARGUE, J.R. and PEZZANITI, D. (2001). *The five 'landmarks' of stormwater management in Adelaide*. Proc. "Water History" Symposium, Hydrological Society of SA, Goolwa, September.
- ARGUE, J.R. and PEZZANITI, D. (2004). *A strategic approach to managing storm runoff in urban/urbanising catchments*. Proc. 5th Novatech Conf. on Innovative Technologies in Urban Storm Drainage, Graie, Lyon, June.
- ARGUE, J.R. and BARTON, A. (2004). *Water-sustainability for Adelaide in 2020 based on stormwater : Options, Opportunities and Challenges*. Proc. Engineers Aust. WSUD 2004 Conference "Cities as Catchments", Adelaide, November.
- ARGUE, J.R., BOUBLI, D. and COOMBES, P.J. (2003). *Innovative water cycle management at a difficult site : "Heritage Mews" in Western Sydney*. Proc. 2nd National Conf. on SUDS, Coventry, June.
- ATV (Abwassertechnische Vereinigung E V, 1990). *Construction and dimensioning of facilities for decentralised percolation of non-harmful polluted surface water*. Standard ATV – A 138E, Hennef, Germany.

BIBLIOGRAPHY

- AUSTIN TEXAS (1988, 1990). *Austin 'first flush' filtration basin*. In *Municipal Storm Water Management* (Debo and Reese, 1995a), CRC Press LLC, Boca Raton, Florida.
- AWRC (1995). *Guidelines for groundwater protection in Australia*. Australian Water Resources Council and National Water Quality Management Strategy. AGPS, Canberra.
- BARTON, A. (2003). *A comparative analysis of the characteristics of domestic water use in metropolitan Adelaide*. Proc. of 2003 Regional Conf., Australian Water Association, Adelaide, August.
- BEECHAM, S. (2003). *Water sensitive urban design – a technological assessment*. “Waterfall”, Journal of the Stormwater Industry Assoc, Issue 17, Sydney.
- BETTES, R. (1996). *Infiltration drainage – manual of good practice*. Construction Industry Research and Information Assoc. CIRIA Report, 156, London.
- BODY, P. (1986). *The contamination of rainwater tanks at Port Pirie*. South Australian Department for Environment and Planning.
- BOND, P.C., PRATT, C.J. and NEWMAN, A.P. (1999). *A review of stormwater quantity and quality performance of permeable pavements in the UK*. Proc. 8th Int'l Conf. on Urban Storm Drainage, I. Joliffe and J. Ball (Eds.), I.E.Aust. IAHR/IAWQ, Sydney, August/September.
- BOUGHTON, W.C. (1966). *A mathematical model for relating runoff to rainfall with daily data..* Civil Engg Trans., I.E.Aust. CE30(4), pp 153 – 162.
- BREN, L., DYER, F., HAIRSINE, P., RIDDIFORD, J., SIRRIWARDHENA, V. and ZIERHOLZ, C. (1997). *Controlling sediment and nutrient movement within catchments*. CRC for Catchment Hydrology, Industry Report 97/9, Melbourne.
- BRESSAN, F (1996). *The relationship between hydraulic conductivity and borehole dimension in selected soils of the Greater Adelaide area*. B Eng thesis, Faculty of Engineering, Civil Engineering Discipline, Univ of South Australia.
- BUILDING RESEARCH ESTABLISHMENT (1991). *Soakaway design*. BRE Digest 365, London.
- CHANDLER, R. (2001). *Turbid relations : managing creeks in an ultra-urban city*. Proc. 4th Novatech Conf. on Innovative Technologies in Urban Storm Drainage, Graie, Lyon, June.
- CIRIA (2001). *Sustainable urban drainage systems : design manual for England and Wales*. Construction Industry Research and Information Association, Report C522, London.
- CHAPMAN, T.G. (1968). *Catchment parameters for a deterministic rainfall-runoff model*. In Stewart, G.A. (Ed) Land Evaluation. Macmillan, Melbourne.
- CHARACKLIS, G.W. and WEISNER, M.R. (1997). *Particles, metals and water quality in runoff from a large urban watershed*. Journal of Environmental Engg, Vol. 123, No. 8, pp 753 – 759.
- COMMONWEALTH EPA (1993). *Urban stormwater – a resource too valuable to waste*. AGPS, Canberra.
- COOMBES, P., FROST, A., KUCZERA, G., O'LOUGHLIN, G. and LEES, S. (2003). *The impact of rainwater tanks in the Upper Parramatta River Catchment*. Australian Journal of Water Resources (Engineers Australia), Vol. 7 No. 2, Engineers Media, Crows Nest, NSW.
- COOMBES, P. and KUCZERA, G. (2001). *Rainwater tank design for water supply and stormwater management*. Stormwater Industry Assoc Regional Conference, Port Stephens, NSW, April.
- COOMBES, P., ARGUE, J. and KUCZERA, G. (2000). *“Figtree Place” : a case study in water sensitive urban development (WSUD)*. Urban Water, 1(4), Elsevier, London, pp 335 – 343.

- COOMBES, P., BOUBLI, D. and ARGUE, J. (2003). *Integrated water cycle management at the “Heritage Mews” development in Western Sydney*. Proc. 28th I.E.Aust. Hydrology and Water Resources Symposium, Wollongong, November.
- CRAWFORD, N.H. and LINSLEY, R.K. (1962). *The synthesis of continuous streamflow hydrographs on a digital computer*. Technical Report No. 12, Dept of Civil Engineering, Stanford University.
- CSIRO (1999). *Urban stormwater : best practice environmental management guidelines*. Victorian Stormwater Committee and Commonwealth Scientific & Industrial Research Organisation. ISBN 0643 06453 2, Melbourne.
- CUNLIFFE, D. (1998). *Guidance on the use of rainwater tanks*. National Environmental Health Forum Monographs – Water Series No. 3. Website : <http://www.dhs.sa.gov.au/pehs/publications/monograph-rainwater.pdf>.
- DATRY, T., MALARD, F. VITRY, L. HERVANT, F. and GILBERT, J. (2003). *Solute dynamics in the bed sediments of a stormwater infiltration basin*. Journ of Hydrology, Vol 273 p 217-233.
- DEBO, T.N. and REESE, A.J. (2003). *Municipal stormwater management*. CRC Press LLC, ISBN0-87371-981-6, Boca Raton, Florida.
- DEBO, T.N. and REESE, A.J. (1995). *Determining downstream analysis limits for detention facilities*. Proc. Novatech Innovative Technologies in Urban Storm Drainage, Graie, Lyon.
- DEPARTMENT OF HOUSING and REGIONAL DEVELOPMENT (1995). *Australian model code on residential development (AMCORD)*. AGPS, Canberra.
- DEPARTMENT OF WATER, WESTERN AUSTRALIA (2007). *Stormwater Management manual for Western Australia*. Dept of Water WA, Perth, August.
- DePINTO, J., YOUNG, T.C. and MARTIN, S.C. (1980). *Aquatic sediments*. Journal of Water Pollution Control Federation, Vol. 52, No. 6.
- DILETIC, A. (2001). *Modelling of water and sediment transport over grassed areas*. Journal of Hydrology, Vol. 248, pp168-182.
- DILLON, P.J. and PAVELIC, P. (1996). *Guidelines for the quality of treated effluent for injection into aquifers for storage and re-use*. Urban Water Research Assoc of Australia, Research Report No. 109, Melbourne.
- DIERKES, C., BENZE, W. and WELLS, J. (2002). *Sustainable urban drainage and pollution source control by infiltration*. “Waterfall”, Journal of Stormwater Industry Association, Vol. 16, Spring, Sydney.
- DLWC, (1998). *The constructed wetlands manual*. NSW Dept. of Land and Water Conservation, Sydney.
- DOYLE, M.W., SHIELDS, D., BOYD, K.F., SKIDMORE, P.B. and De WITT, D (2007). *Channel-forming discharge selection in river restoration design*. ASCE Jour of Hydraulic Engg, Vol 133, No 7, July 1.
- DUNCAN, H.P. (1999). *Urban stormwater quality – a statistical overview*. CRC for Catchment Hydrology, Melbourne.
- EMERSON, C.H., WELTY, C. and TRAVER, R.G. (2005). *Watershed-scale evaluation of a system of storm water detention basins*. Proc. ASCE Journal of Hydrologic Engineering, Vol. 10, No. 3, May 1.
- ENGINEERS AUSTRALIA (1999). *Australian rainfall and runoff – a guide to flood estimation*. This is the 3rd edition (1987) of “Australian Rainfall and Runoff – Volume 1” presented in eight booklets. ISBN 185 825 6878.
- ENGINEERS AUSTRALIA (2005). *Australian runoff quality*. Engineers Australia. Wong, T.H.F. (Editor), Canberra, November.

BIBLIOGRAPHY

- ESPINOSA, R., AL-FAYYAZ, T., ARGUE, J., JOHNSTON, L. and PEZZANITI, D. (2001). *High-performance sediment-retaining device for urban catchments : introducing the UniSATank*. Proc. Novatech Innovative Technologies in the domain of Urban Stormwater Drainage, Graie, Lyon, June.
- FERGUSON, B.K. (1994). *Stormwater infiltration*. CRC Press, Boca Raton, Florida.
- FERGUSON, B.K. (1995). *Stormwater infiltration for peak-flow control*. ASCE Journal of Irrigation and Drainage Engineering, Vol. 121, No. 6, November/December.
- FISCHER, D., CHARLES, E.G. and BAEHR, A. L. (2003). *Effects of stormwater infiltration on quality of groundwater beneath retention and detention basins*. Journ of Environmental Engineering, Vol 129, p 464-471.
- FLETCHER, T., WONG, T. and BREEN, P. (2005). *Buffer strips, vegetated swales and bio-retention systems*. Chapter 10 of Australian Runoff Quality (Engineers Australia, 2005), Canberra, November.
- FRANCE, R.L. (2003). *Handbook of water sensitive planning and design*. CRC Lewis, France (Ed), Boca Raton, Florida.
- FULLER, C.A., MARTIN, T.J. and WALTERS, R.P. (1981). *Quality aspects of rainwater stored in domestic rainwater tanks (a preliminary study)*. Domestic Rainwater Tanks Working Party, South Australia.
- GEIGER, W.F. and DREISEITL, H. (1995). *Neue wege fur das regenwasser*. Oldenbourg, Munchen.
- GILLIARD, G. (2004). *A new solution for stormwater management*. Plan Canada, Spring edition, Vol. 44, No. 1, Robert Shipley (Ed.), Canadian Institute of Planners, Ottawa, Ontario, pp 29 –31.
- GIPPEL, C (2002). *Geomorphic issues associated with environmental flow assessment in alluvial non-tidal rivers*. Aust. Journ of Water Resources, Vol 5 No 1.
- GOETTLE, A. (1978). *Atmospheric contaminants – fallout and their effects on stormwater quality*. Progress in Water Technology, 10 (5/6), pp 455 – 467.
- GUO, C.Y. and URBONAS, B. (1996). *Maximised detention volume determined by runoff capture ratio*. ASCE Journal of Water Resources Planning and Management, Vol. 122, No. 1, January, pp 33 – 39.
- GUTTERIDGE, HASKINS and DAVEY (1981). *Characterisation of pollution in urban stormwater runoff*. AWRC Technical Paper No. 60, EPA of Victoria. AGPS, Canberra.
- HAMMER, T. (1973). *Effects of urbanisation on stream channels and stream flow*. Office of Water Resources Research, US Dept of Interior (Contract No. 14-31-0001-3406), Regional Science Research Institute, GPO Box 8776, Philadelphia, Penn, 19101, November.
- HARDY, M.J., COOMBES, P.J. and KUCZERA, G. (2004). *An investigation of estate level impacts of spatially distributed rainwater tanks*. Proc. Engineers Aust. WSUD 2004 Conference “Cities as Catchments”, Adelaide, November.
- HARSTON, E. and JOLIFFE, I. (1999). *Rationalisation of sediment basin sizing*. Proc. 8th International Conf. on Urban Storm Drainage, I.E.Aust. IAHR/IAWQ, Sydney, August/September.
- HENEKER, T.M., LAMBERT, M.F. and KUCZERA, G. (2001). *A point rainfall model for risk based design*. Journal of Hydrology, Vol. 247, 54 – 71.
- HENEKER, T.M., LAMBERT, M.F. and KUCZERA, G. (2003). *Overcoming the joint probability problem associated with initial loss estimation in design flood estimation*. Australian Journal of Water Resources (Engineers Australia), Vol. 7, No. 2, Engineers Media, Crows Nest, NSW.
- HEYWORTH, J.S., MAYNARD, E.J. and CUNLIFFE, D. (1998). *Who consumes what. Potable water consumption in South Australia*. Water 25(1), 9-13.

- HEYWORTH, J., GLONEK, G. and MAYNARD, E. (1999). *The prevalence of gastroenteritis amongst young children and the potential role of drinking water*. Proc. 18th Federal Convention, Aust. Water & Wastewater Assoc., Adelaide.
- HEYWORTH, J.S. (2001). *A diary study of gastroenteritis and tank rainwater consumption in young children in South Australia*. Proc. 3rd Int'l Rainwater Catchment Systems Conf., Mannheim, Germany, September, pp 141 – 148.
- HOPKINS, B. and ARGUE, J.R. (1994). *The New Brompton Estate stormwater management trial : first results*. Water Science and Technology, Vol. 29, No. 1-2, Pergamon, London.
- HORTON, R.E. (1993). *The role of infiltration in the hydrologic cycle*. Trans. American Geophysical Union, Vol. 14, pp 446 – 460.
- HORNER, S. (1999). *Water quality modelling manual*. Bullen and Partners, Bradford, UK.
- I.E.AUST. (1987). *Australian rainfall and runoff – a guide to flood estimation*. Institution of Engineers, Australia, Pilgrim, D. (Editor), Canberra.
- I.E.AUST. (1999). *Australian rainfall and runoff – a guide to flood estimation*. This is the 3rd edition (1987) of “Australian Rainfall and Runoff – Volume 1”, presented in eight booklets. ISBN 185 825 6878.
- I.E.AUST. (2003). *Australian runoff quality (DRAFT)*. Engineers Australia, Wong, T.H.F. (Editor), Canberra, June.
- JACOBS, R.R. (2001). *Development and evaluation of an improved infiltration device technology*. Report, UWRC, University of South Australia, Adelaide, June.
- JEPPESON, B. (1996). *Model guidelines for domestic greywater re-use for Australia*. Research Report No. 107, Urban Water Research Assoc. of Australia, Melbourne.
- JONASSON, A.S. (1984). *Dimensioning methods for stormwater infiltration systems*. Proc. 3rd Int'l Conf. on Urban Storm Drainage, IAHR/IAWQ, Gotenborg, June.
- KING, J. (2003). *Environmental flows for rivers : hydrologically definable, ecologically vital*. Keynote Address, 28th I.E.Aust. Hydrology and Water Resources Symposium, Wollongong, November.
- KOTLAR, E., TARTAKOVSKY, B., ARGAMAN, Y. and SHEINTUCH, M. (1996). *The nature of interaction between immobilised nitrification and denitrification bacteria*. Journ of Biotechnology Vol 51, p 251-258.
- KUCZERA, G., LAMBERT, M., HENEKER, T., JENNINGS, S., FROST, A. and COOMBES, P. (2003). *Joint probability and design storms at the crossroads*. Keynote Address, 28th I.E.Aust. Hydrology and Water Resources Symposium, Wollongong, November.
- LEE, A, HEWA, G and PEZZANITI, D (2007). *Adapting WSUD in an urban catchment to minimise impacts of development on natural stream flow regimes*. Proc 5th Int'l WSUD Conf, “Rainwater & Urban Design 2007”, Sydney, August.
- LEE, G.F. and TAYLOR, S. (1998). *Development of appropriate stormwater infiltration BMPs : Part II – design of infiltration BMPs*. Proc. of Groundwater Protection Council Annual Forum 1998, Sacramento, California.
- LESTER, R. (1992). *A mixed outbreak of cryptosporidiosis and giardiasis*. May 1992. Update. A Quarterly Bulletin of Infectious Diseases. 1(1), 14 – 15. Health Department Victoria.
- LHCCREMS (2002). *Water smart model planning provisions*. Prepared by Planning Plus (Author I. Donovan) for Lower Hunter Central Coast Regional Environmental Management Strategy, Callaghan, October.

- LIEBMAN, M., BROWN, M., GARRAWAY, E. and JONES, C. (2004). Kiama CBD's stormwater treatment and re-use project. SIA 2004 Regional Conference, Shoalhaven, NSW, April.
- LIESKO, J.Z., WHITELY, H.R. and CORSI, R.L. (1993). *Quality of stormwater from residential areas*. In New Techniques for Modelling the Management of Stormwater Quality Impacts, W. James (Ed.), Lewis Publishers, London.
- LINDSAY, G., ROBERTS, L. and PAGE, W. (1991). *Stormwater management practice in Maryland : a second survey*. Maryland Dept. of Environment (Sediment and Stormwater Administration), Baltimore.
- LINSLEY, R.K. and CRAWFORD, N.H. (1960). *Computation of a synthetic streamflow record on a digital computer*. Publication No. 50, International Assoc. Scientific Hydrology, pp 526 – 538
- LLOYD, S., FLETCHER, T., WONG, T. and WOOTTON, R. (2001). *Assessment of pollutant removal in a newly constructed bio-retention system*. Proc. 2nd South Pacific Stormwater Conf., Auckland Regional Council, Auckland.
- LLOYD, S., FRANCEY, M. and SKINNER, L. (2004). *Cost of incorporating WSUD into greenfield site development and application of offset trading scheme*. Proc. Engineers Aust. WSUD Conf. "Cities as Catchments", Adelaide, November.
- MAESTRI, B., JOHNSON, F., BURCH, C.W. and DAWSON, B.L. (1985). *Management practices for mitigation of highway stormwater runoff pollution, Vol. III*. Quoted in Peterson and Batley, 1992.
- MALMQUIST, P. (1978). *Atmospheric fallout and street cleaning – effects on urban stormwater and snow*. Progress in Water Technology, 10 (5/6), pp 495 – 505.
- MARSALEK, J. (1992). *Overview of sediment issues in urban drainage*. Keynote Address, I.E.Aust. 1st International Symposium on Urban Storm Drainage, Sydney.
- MASTERS, G.M. (1998). *Introduction to environmental engineering and science*. Prentice Hall, Sydney.
- McCOMB, A.J. and LAKE, P.S. (1990). *Australian wetlands*. Angus & Robertson, North Ryde, NSW.
- MELBOURNE WATER (2005). *WSUD engineering procedures – stormwater*. CSIRO Publishing, Collingwood, Victoria.
- MILLIS, N.F. (2003). *Water quality relative to end use*. Aust. Journal of Water Resources, Vol. 7, No. 1.
- MIKKELSEN, P.S., HAFLIGER, M., OCHS, M., JACOBSEN, P., TJELL, J.C. and BOLLER, M. (1997). *Pollution of soil and groundwater from infiltration of highly contaminated stormwater – a case study*. Water Science and Technology, Pergamon, Vol 36 (8-9), p 325-330.
- MOURITZ, M., EVANGELISTI, M. and Mc ALISTER, T. (2003). *Water sensitive urban design*. Chapter 4 of Australian Runoff Quality – DRAFT (Engineers Australia, 2003), Canberra, June.
- MOTTIER, V., BRISSAUD, F., NIETO, P. and ALAMY, Z. (2000). *Wastewater treatment by infiltration percolation: a case study*. Water Science and Technology, Pergamon, Vol 41 (1), 77-84.
- NEHRKE, S.M. and ROESNER, L.A. (2004). *Effects of design practice for flood control and BMPs on the flow-frequency curve*. ASCE Jour. of Water Resources Planning & Management, March/April, p 131 – 139.
- NEVILLE JONES & PARTNERS (1993). Queensland urban drainage manual. Prepared for Water Res Comm, LGEA of Queensland and Brisbane City Council, by Neville Jones & Partners and Australian Water Engineering, Brisbane.
- NHMRC/ARMCANZ (2001). *Australian drinking water guidelines*. National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand. AGPS, Canberra.

- NORTHERN ADELAIDE AND BAROSSA CWMB (2000). *Water allocation plan – Northern Adelaide Plains prescribed wells area*. Catchment Water Management Plan – Volume 3, December, Salisbury.
- N.S.W. DEPARTMENT OF HOUSING (1998). *Managing urban stormwater : soils and construction*. 3rd Edition, NSW Dept of Housing, Sydney.
- N.S.W. EPA (1996). *Managing Urban Stormwater : Strategic Framework – Draft 0 7 310 3810 X*. Chatswood, NSW.
- N.S.W. EPA (1997). *Managing Urban Stormwater : Treatment Techniques*. ISBN 07310 3886 X, Chatswood, NSW.
- N.S.W. EPA (1999). *Managing Urban Stormwater : Source Control DRAFT*. Chatswood, NSW, January.
- N.S.W. EPA (2001). *What is urban stormwater?* Webpage : <http://www.epa.nsw.gov.au/stormwater/what-is/index.htm>.
- O'LOUGHLIN, G. and STACK, R. (2001). *DRAINS user manual*. Watercom Pty. Ltd., Sydney.
- ONTARIO MINISTRY OF THE ENVIRONMENT (2003). *Stormwater management planning and design manual*. Available www.ene.gov.on.ca/envision/gp/4329eindex.htm. ISBN 0-7794-2969-9.
- PAVELIC, P., GERGES, N., DILLON, P. and ARMSTRONG, D. (1992). *The potential for storage and reuse of Adelaide's stormwater runoff using the upper Quaternary groundwater system*. Centre for Groundwater Studies, Report No. 40, Adelaide, April.
- PEARCE, F. (2004). *We can't hold back the water anymore*. New Scientist, 10 January, pp 26 – 29.
- PENNSYLVANIA, K. and CLEMENT, P.E. (1987). *Results of the State of Maryland infiltration practice survey*. Maryland Dept. of Environment (Sediment and Stormwater Division), Baltimore.
- PETERSON, S.M. and BATLEY, G.E. (1992). *Road runoff and its impact on the aquatic environment : a review*. CSIRO Investigation Report CET/LH/IRO76, AGPS, Canberra.
- PEZZANITI, D., ARGUE, J. and JOHNSTON, L. (2003). *Detention/retention storages for peak flow reduction in urban catchments : effects of spatial deployment of storages*. Australian Journal of Water Resources (Engineers Australia), Vol. 7, No. 2, Engineers Media, Crows Nest, NSW.
- PITT, R., ROBERTSON, B., BARRON, P., AYYOUBI, A. and CLARK, S. (1999). *Stormwater treatment at critical areas : the multi-chambered treatment train (MCTT)*. USEPA wet weather flow management program, National Risk Management Research Laboratory. EPA/600/017. Cincinnati, Ohio, March.
- PITT, R. (2001). *Full-scale tests of the multi-chambered treatment train (MCTT)*. In Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation, B. Urbonas (Ed.), ASCE, Reston, Virginia.
- PRATT, C., NEWMAN, A. AND BROWNSTEIN, J. (1996). *Bio-remediation processes within a permeable pavement : initial observations*. Proc. 7th Int'l Conf. on Urban Storm Drainage, Hannover, September.
- PRATT, C.J. (1997). *Design guidelines for porous/permeable pavements*. Proc. ASCE Engineering Foundation Conference "Stormwater Management – creating sustainable urban water resources for the 21st Century", Malmo, Sweden, September.
- PRATT, C.J., NEWMAN, A.P. and BOND, P.C. (1998). *Mineral oil bio-degradation within a permeable pavement : long-term observations*. Proc. 3rd International Conf. on Innovative Technologies in Urban Storm Drainage, Graie, Lyon, May, Vol. 1, pp 501 – 507.

BIBLIOGRAPHY

- PRATT, C.J., NEWMAN, A.P. and COUPE, S.J. (2001). *Studies in the mechanisms of bio-remediation within permeable pavement constructions*. Proc. 4th International Conf. on Innovative Technologies in Urban Storm Drainage, Graie, Lyon, June.
- RANDALL, C.W. and GRIZZARD, T.J (1981). *Comparison of pollutant mass loads in precipitation and runoff in urban areas*. Proc. 2nd International Conf. on Urban Storm Drainage, Urbana, Illinois.
- RIGBY, T., BOYD, M., RUSSO, S. and Van DRIE, R. (2003). *Storms, stormbursts and flood estimation : a need for review of the AR&R procedures*. Proc. 28th I.E.Aust. Hydrology and Water Resources Symposium, Wollongong, November.
- RILEY, S, (2001). Proc. SIA Workshop, “*On-site retention : why? when? how?*”, Concord, NSW, 30 May.
- ROMMEL, M., RUS, M., ARGUE, J., JOHNSTON, L. and PEZZANITI, D. (2001). *Hydrological and ‘lifespan’ performances of “Formpave” permeable paving*. Proc. I.E.Aust./IPWEA International Public Works Conference, Perth, WA, August.
- SCHUELER, T.R. (1987). *Controlling urban runoff : a practical manual for planning and designing urban best management practices*. Metropolitan Washington Council of Governments, Washington, DC.
- SCHUELER, T.R., KUMBLE, P.A. and HERATY, M.A. (1992). *A current assessment of urban best management practices – techniques for reducing non-point source pollution in the Coastal Zone*. Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC, March.
- SCHUELER, T.R. (1992a). *Design of stormwater wetland systems : guidelines for creating diverse and effective stormwater wetlands in the Mid-Atlantic Region*. Metropolitan Washington Council of Governments, Washington, DC.
- SCHUELER, T.R. (1992b). *Watershed restoration sourcebook – mitigating the adverse effects of urbanisation on streams*. Metropolitan Washington Council of Governments, Washington, DC.
- SCHUELER, T.R (1995). *Site planning for urban stream protection*. Metropolitan Washington Council of Governments and Centre for Watershed Protection, Washington, DC.
- SCOTT, P., SANTOS, R. and ARGUE, J. (1998). *Performance, environmental and cost comparisons of OSD and OSR in re-developed catchments*. Proc. I.E.Aust. Symposium “HydraStorm ‘98”, Adelaide, October.
- SHACKEL, B. (2000). *Computer-based mechanistic methods for concrete block pavement design*. Proc. 6th International Conference on Concrete Block Paving, Tokyo.
- SHACKEL, B., BALL, J. and MEARING, M. (2003). *Using permeable Eco-paving to achieve improved water quality for urban pavements*. Proc. 7th International Conference on Concrete Block Paving.
- SMAKHTIN, V (2001). *Low flow hydrology: a review*. Journ of Hydrology, Vol 240, pp 147 – 186.
- SOMES, N.L. and WONG, T.H.F. (2000). *Detention time distribution of constructed stormwater wetlands*. Australian Journal of Water Resources (Engineers Australia), Vol. 4, No. 2, Engineers Media, Crows Nest, NSW.
- STANDARDS AUSTRALIA (2003). *Plumbing and drainage – Pt. 3; stormwater drainage*. Standards Australia International Limited, Sydney and Wellington, December.
- STEPHENS, K., REID, D. and GRAHAM, P. (2002). *Stormwater planning : a guidebook for British Columbia*. Greater Vancouver Regional District, Vancouver, BC
- STOCKDALE, E.C. (1991). *Freshwater wetlands, urban stormwater and non-point pollution control : a literature review and annotated bibliography*. 2nd edition, Washington State Dept. of Ecology, Olympia.
- SWAMEE, P.K. and TYAGI, A. (1996). *Design of Class-I sedimentation tanks*. ASCE Journal of Environmental Engineering, Vol. 122, No. 1, January, pp 71 – 73.

- TONKIN, B.C. & ASSOC. (1996). *Comprehensive catchment water management plan : accompanying report*. Patawalonga Catchment Water Management Board, Adelaide, September.
- UPRCT (2004). *Water sensitive urban design technical guidelines for Western Sydney*. Final Report prepared by URS for Upper Parramatta River Catchment Trust, Parramatta, April.
- UPRCT (2005). *On-site stormwater detention Handbook*. 4th Edition, Upper Parramatta River Catchment Trust, Parramatta.
- URBONAS, B.R. (1999). *Design of a sand filter for stormwater quality enhancement*. Water Environment Research, Vol. 71, No. 1, January/February, Washington, DC, pp 102 – 113.
- URBONAS, B.R. and STAHERE, P. (1993). *Stormwater best management practices and detention for water quality, drainage and CSO management*. Prentice Hall, Eaglewood Cliffs.
- URBONAS, B.R., ROESNER, L.A. and GUO, C.Y. (1996). *Hydrology for optimal sizing of urban runoff treatment control systems*. Journal of Water Quality International, London, January/February.
- URRIOLA, H. (1999). *Roof gardens – an environmental asset*. “Waterfall”, Journal of Stormwater Industry Association Ltd, Issue 13, Spring, Sydney.
- US EPA (1987). *The enhanced stream water quality model QUAL2E and QUAL2E-UNCAS, documentation and users manual*. U S Environment Protection Agency, Washington, DC.
- US EPA (1993). *Pollution prevention fact sheet : bridge and roadway maintenance*. Criteria and Standards Division, U.S. Environment and Protection Agency, Washington, DC.
- US DEPT. OF TRANSPORTATION (1996). *Urban drainage design manual – hydraulic engineering circular No. 22*. U.S. Dept of Commerce – National Technical Information Service, Washington, DC, November.
- UWRC (1993). Brochure announcing establishment of Urban Water Resources Centre, Faculty of Natural and Built Environment, University of South Australia, Adelaide, April.
- UWRC (1999). *Arterial road runoff – quality, effects and control : a literature review*. Urban Water Resources Centre, Report to Transport SA (Ms A. Welsh), Authors – J. Argue, D. Pezzaniti, C. Jenkins, J. Gorrie, Adelaide, June.
- UWRC (2002a). Research into ‘effective life’ of permeable pavement source control installation. Study supported by Catchment Management Subsidy Scheme. Website : <http://www.unisa.edu.au/uwrc/permeable.htm>.
- UWRC (2002b). Study into permeable pavements for water quality improvement at Port Adelaide-Enfield Council car park. Study supported by Natural Heritage Trust. Website : <http://www.unisa.edu.au/uwrc/permeable.htm>.
- Van der WEL, B. (2000). *Roof runoff – maximising its use*. Proc. 10th World Water Congress, Melbourne, March.
- Van der WERF, E., ARGUE, J.R. and PEZZANITI, D. (1999). *Some unexpected results from infiltration tests in shallow clay over rock*. Proc. 8th Int’l Conf. on Urban Storm Drainage, I.E.Aust. IAHR/IAWQ, Sydney, August/September.
- WACKERNAGEL, M. and REES, W. (1996). *Our ecological footprint : reducing human impact on the Earth*. The new catalyst bioregional series, Vol. 9, Gabriola Island, BC, and Philadelphia, PA, New Society Publishers.
- WALKER, D., PASSFIELD, F., PHILLIPS, S., BOTTING, J. and PITRANS, H. (1997). *Stormwater sediment properties and land use in Tea Tree Gully, South Australia*. Proc. 17th AWWA Federal Convention, Melbourne.

BIBLIOGRAPHY

- WATER & RIVERS COMMISSION, W.A. (1998). *A manual for managing stormwater quality in Western Australia*. Water and Rivers Commission, Perth.
- WAWA (1987). *Domestic water study in Perth, Western Australia – Working Papers*. Water Authority of Western Australia, Perth.
- WEISNER, M., CHARACKLIS, G. AND BREJCHOVA, D. (1998). *Metals and colloids in urban runoff*. In “Metals in Surface Waters” (Editors H. Allen, A. Garrison, G. Luther), Sleeping Ann Arbor Press, Chelsea, Michigan.
- WEISS, G.D., HONDZA, M. and SEMMENS, M (2006). *Stormwater detention ponds modelling heavy metal removal by plant species and sediments*. ASCE Journal of Environmental Engineering, Vol. 132, No. 9, September 1.
- WHELANS and HALPERN GLICK MAUNSEL (1994). *Planning and management guidelines for water sensitive urban (residential) design*. Dept. of Planning and Urban Development, Water Authority of WA and Environment Protection Authority, Perth, WA, June.
- WOLMAN, M.G., and SCHICK, A.P. (1962). *Effects of construction on fluvial sediment in urban and suburban areas of Maryland*. Water Resources Research, Vol. 3.
- WONG, T.H.F. (2000). *Source control and water sensitive urban design*. Proc. 1st National Conf. on Water Sensitive Urban Design, Melbourne Water, Melbourne, August.
- WONG, T., WOOTTON, R., ARGUE, J. and PEZZANITI, D. (2000). *Bringing order to the pollution control industry : issues in assessing the performance of gross pollution traps*. I.E.Aust. Civil Engineering Transactions, Vol. CE 42, 2000.
- WONG, T.H.F., WOOTTON, R.M. and FABIAN, M D. (1995). *Investigation of the hydraulic performance of the ‘Pollutec’ continuous deflective separation gross pollution trap, Stage 2 report : operating characteristics*. Monash University, Dept. of Civil Engineering, Melbourne, October.
- WRIGHT-McLAUGHLIN, ENGINEERS (1969). *Urban storm drainage*. Criteria manual, volumes 1 and 2. Denver Regional Council of Governments, Denver, USA, March.
- WSROC (Western Sydney Regional Organisation of Councils, 2003). *Western Sydney salinity code of practice*. Prepared by R. Nicholson for Western Sydney Salinity Working Party, WSROC, March.
- WSUD in the Sydney Region (2003). *Water sensitive planning guide for the Sydney region*. Upper Parramatta River Catchment Trust, Parramatta.

APPENDIX A

MEASUREMENT OF HYDRAULIC CONDUCTIVITY IN SOILS FOR USE IN WATER-SENSITIVE DESIGN

INTRODUCTION

One of the most basic techniques included in ‘source control’ practices is that of retaining storm runoff in “leaky” devices such as perforated wells and gravel-filled trenches or “soakaways”. Use of these systems in sandy or sandy-clay soils is well established throughout the world. Their extension into less permeable clay soils needs to be approached with caution, but successful systems constructed in such soils are known in Europe, Japan and in South Australia.

The following notes have been compiled from experience in South Australia and in Auckland (“Stormwater Soakage Design Manual” by P. Nagels) : the latter reference is acknowledged with gratitude.

Soakage Report

Details to be covered in the Report include :

- weather conditions preceding and during the field test : the full test duration may spread over two or three days;
- soil profile : bore log with apparent permeability of the strata encountered, including water table;
- apparent long-term water table (if different from above);
- pre-soaking procedure : duration of pre-soaking.
- data from ‘constant head’ test (head $\approx h_0$) and calculation of hydraulic conductivity from these data;
- graph of ‘falling head’ test (time, t vs depth, h relationship);
- calculation of hydraulic conductivity at time = 60 minutes (clay soils) or depth = $0.85 h_0$ in sandy soils;
- plan of site showing bore positions in relation to buildings, existing soakholes, driveways, overland flow path, boundaries, contours or spot levels, any area intended for on-site retention, future site development, etc.;
- supply a dimensioned drawing showing details of the proposed “leaky” device or system;
- describe the consequences of the “leaky” device or system overflowing, i.e. effect on foundations, neighbouring properties, site stability, etc.; and,
- report signed and dated by either a civil engineer, civil engineering technician, or an engineering geologist experienced in soakage systems.

The bore hole

A minimum of two tests shall be carried out on each site. On large sites a minimum of one test should be carried out per 400 m^2 of site area. Each hole should correspond with the site position(s) of the proposed soakage devices.

Test holes of 100 mm diameter should be bored to a depth of 2.5 m in soil where rock is not encountered; otherwise, terminate drilling at the soil/rock interface. These depths correspond to the dimension, h_0 . The soil profile should be recorded as excavation proceeds and presented with the soakage report.

The hole should be prepared by carefully scratching the sides with a sharp-pointed tool to remove any smeared soil surfaces and to provide a natural soil interface through which water may infiltrate.

The hole must be lined with perforated or slotted PVC pipe (at least 20 holes per metre length of pipe). In sandy soil the perforations/slots should be covered (outside) with geotextile to prevent soil collapse into the bore through the slots or perforations. Any gap between the PVC liner and the wall should be filled with clean sand.

Boreholes drilled at sites where surfaces are waterlogged, indicating the presence of free surface water, should be protected from the entry of surface water during tests. This can be accomplished by forming a low soil mound 50 – 70 mm high around the top of the hole or driving a PVC “ring”, say 300 mm diameter, into the soil at the top of the hole. The ring should be symmetrical about the hole and present a 50 – 70 mm “wall” to surface runoff local to the borehole.

It is of vital importance to record groundwater level if encountered before the 2.50 m depth is reached. In heavy clay soils it is necessary to allow the hole to 'stand' for one or two days after drilling to ensure that the long-term groundwater level is clearly identified.

Pre-soak

After the long-term groundwater level has been established (where a watertable is encountered), the well should be filled with water and left to stand for 24 hours (clay soils). "Pre-soaking" in sandy soils consists of filling and allowing the borehole to drain three times.

Constant head test

The 'constant head' test seeks the flow rate of water into the bore sufficient to maintain water depth constant at h_0 . In fact, despite pre-soaking, there will be a gradual decline in the quantity of inflow required to maintain water depth **constant at h_0** .

In sandy soils, the flow rate is usually small but comfortably supplied from a one litre flask : the time taken to empty each one litre of input must be recorded.

In clay soils, the inflow rate is likely to be very small and the task of maintaining a constant water depth not easy to accomplish. An acceptable procedure for achieving a 'constant head' test result under these circumstances is to allow the water level to fall over a period of, say, 15 – 30 minutes and then to fill the hole to the initial level. The time (t_c) of water level fall should be noted as well as the volume of water required (V_c) to restore the level.

Tests in both sandy and clay soils should be repeated at least four times.

Falling head test

The 'falling head' test follows immediately completion of the 'constant head' test and involves, simply, allowing the borehole to drain without further addition of water.

In the case of sandy soils, the rate of fall may be quite rapid and the task of recording water depth below the top of the PVC liner (used as datum) and the corresponding time, is a two-person operation. In such circumstances an acceptable depth vs time curve may be obtained from the average of three or more 'runs'. A light staff with scale supported by a float can be used to obtain more accurate readings of borehole water depth.

In clay soils the rate of fall may be very slow and early values hard to distinguish. This is of little consequence as the most critical time/depth conditions are those around $t = 60$ minutes, in particular, between $t = 45$ minutes and $t = 75$ minutes. Some 'scatter' of points is to be expected and a curve of best fit should be applied to the data. Again, the depth of water in the borehole can be obtained from measurements taken from the top of the PVC liner used as datum or, for greater accuracy, with a scale supported by a float. A typical t versus h curve is shown in Figure A-1.

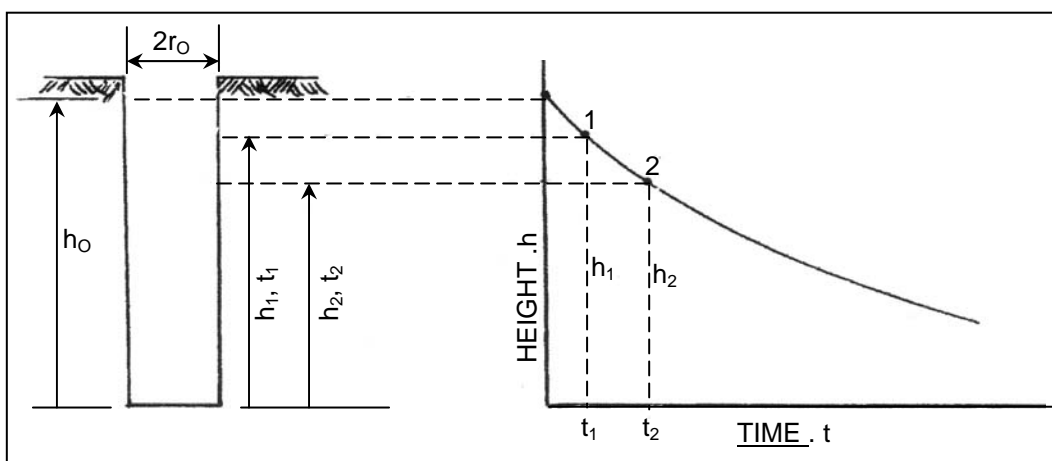


FIGURE A-1 : Inverse augerhole test – definition of terms and typical 'h' versus 't' relationship

ANALYSIS OF RESULTS

Constant head test : The hydraulic conductivity of soil given by the constant head test comes from calculating the average flow rate, $Q = V_c / t_c$ expressed in units of m^3 per second, and substituting this into the formula :

$$k_h = \frac{Q}{[\pi r_o^2 + 2\pi r_o h]}$$

where r_o = radius of the **borehole** (not PVC liner) in metres;

h_o = initial water depth in metres.

Falling head test : In this case, data from two water depth conditions taken from the ‘falling head’ curve illustrated in Figure A-1 are required. In the case of clay soils :

$$t_1 = 45 \text{ minutes} = 2,700 \text{ seconds; and, } t_2 = 75 \text{ minutes} = 4,500 \text{ seconds.}$$

The corresponding depths, h_1 and h_2 are measured in metres.

The values for t_1 , t_2 , h_1 and h_2 are substituted into the following expression :

$$\text{Hydraulic conductivity } k_h = \frac{1.15r_o}{(t_2 - t_1)} \log_{10} \left[\frac{h_1 + \frac{r_o}{2}}{h_2 + \frac{r_o}{2}} \right] \text{ m/s} \tag{3.13}$$

In the case of sandy soils which show very rapid fall in water level, two positions corresponding to t_1 and t_2 should be chosen such that the average of the corresponding values of h_1 and h_2 is about $0.85 h_o$. The same formula as above may be used, this time for the chosen values of t_1 and t_2 (in seconds) and corresponding values of h_1 and h_2 in metres.

Where the test borehole intercepts groundwater, the depths h_o , h_1 and h_2 are measured from the **long-term** level of the groundwater (see Figures A-2). Substitution t_1 , t_2 , h_1 and h_2 , similar to the above, is then made into the following formula :

$$\text{Hydraulic conductivity, } k_h = \frac{1.15r_o}{(t_2 - t_1)} \log_{10} \left[\frac{h_1}{h_2} \right] \tag{3.14}$$

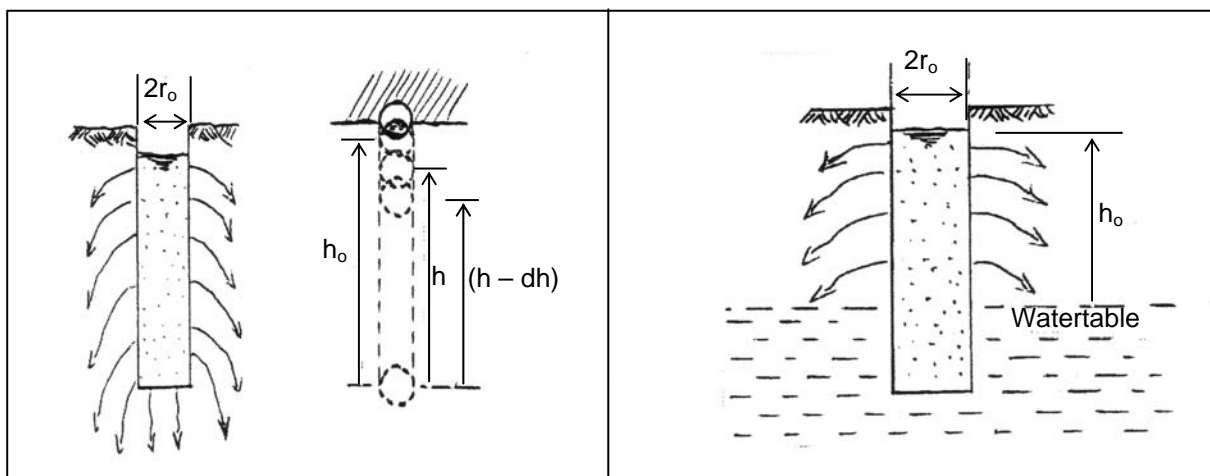


FIGURE A-2 : Boreholes with watertable intersection : definition of h_o and other water depths

HYDRAULIC CONDUCTIVITY RANGES FOR COMMON SOILS

The values of ' k_h ' derived from the above processes should fall into the following ranges for commonly encountered soils :

Sandy soil :	$k_h > 5 \times 10^{-5}$ m/s;
Sandy clay :	k_h between 1×10^{-5} and 5×10^{-5} m/s;
Medium clay :	k_h between 1×10^{-6} and 1×10^{-5} m/s;
Heavy clay :	k_h between 1×10^{-8} and 1×10^{-6} m/s.

APPENDIX B

RAINFALL I-F-D CHARTS FOR TYPICAL NORTHERN, INTERMEDIATE AND SOUTHERN AUSTRALIAN LOCATIONS

The Tables of IFD data included in Appendix B are representative only of rainfall in the stated locations, and are provided for illustrative purposes only and for use in tutorial exercises included in Appendix F. **Under no circumstances should these data be used for design purposes in the Adelaide, Newcastle or Brisbane regions.** Competent design requires the use of IFD data for specific locations with a resolution of 2.5 km, available from the Bureau of Meteorology or other competent sources. (See www.bom.gov.au/hydro/has/ifd.shtml and follow the link to IFD Request Form.)

TABLE B-1
RAINFALL INTENSITY DURATION DATA
ADELAIDE, SOUTH AUSTRALIA

Geographic Location : 34.9333° South; 138.6° East

AUSIFD Version 2.0

DURATION	1 YEAR ARI (mm/hour)	2 YEAR ARI (mm/hour)	5 YEAR ARI (mm/hour)	10 YEAR ARI (mm/hour)	20 YEAR ARI (mm/hour)	50 YEAR ARI (mm/hour)	100 YEAR ARI (mm/hour)
Minutes :							
5	42.9	58.0	81.0	98.0	121.0	155.0	186.0
6	40.0	54.0	75.0	91.0	112.0	144.0	172.0
7	37.6	51.0	70.0	85.0	105.0	135.0	161.0
8	35.5	47.9	67.0	80.0	99.0	127.0	151.0
9	33.8	45.5	63.0	76.0	94.0	120.0	143.0
10	32.2	43.3	60.0	72.0	89.0	114.0	136.0
11	30.8	41.5	57.0	69.0	85.0	109.0	129.0
12	29.6	39.8	55.0	66.0	81.0	104.0	124.0
13	28.5	38.3	53.0	64.0	78.0	100.0	119.0
14	27.4	36.9	51.0	61.0	75.0	96.0	114.0
15	26.5	35.6	49.1	59.0	72.0	93.0	110.0
16	25.7	34.5	47.5	57.0	70.0	89.0	106.0
17	24.9	33.4	46.0	55.0	68.0	86.0	103.0
18	24.2	32.4	44.6	53.0	66.0	84.0	99.0
19	23.5	31.5	43.3	52.0	64.0	81.0	96.0
20	22.8	30.6	42.1	50.0	62.0	79.0	94.0
25	20.2	27.1	37.1	44.4	54.0	69.0	82.0
30	18.2	24.4	33.6	39.9	48.7	62.0	73.4
35	16.7	22.3	30.6	36.3	44.3	56.3	66.6
40	15.4	20.6	28.1	33.4	40.7	52.0	61.0
45	14.4	19.2	26.1	31.0	37.8	47.9	57.0
50	13.5	18.0	24.4	29.0	35.3	44.7	53.0
55	12.7	17.0	23.0	27.3	33.2	41.9	49.5
Hours :							
1.0	12.0	16.1	21.7	25.8	31.3	39.6	46.6
1.5	9.4	12.5	16.8	19.9	24.0	30.2	35.5
2.0	7.9	10.5	14.0	16.4	19.8	24.8	29.1
3.0	6.1	8.1	10.7	12.5	15.1	18.8	21.9
4.0	5.1	6.7	8.9	10.4	12.4	15.4	17.9
5.0	4.4	5.8	7.7	8.9	10.7	13.2	15.4
6.0	4.0	5.2	6.8	7.9	9.4	11.6	13.5
7.0	3.6	4.7	6.1	7.1	8.5	10.5	12.1
8.0	3.3	4.3	5.6	6.5	7.8	9.6	11.1
9.0	3.1	4.0	5.2	6.0	7.2	8.8	10.2
10.0	2.88	3.76	4.86	5.62	6.67	8.20	9.47
11.0	2.71	3.54	4.57	5.28	6.26	7.68	8.86
12.0	2.57	3.35	4.32	4.98	5.90	7.23	8.34
14.0	2.29	3.00	3.86	4.45	5.27	6.45	7.44
16.0	2.08	2.72	3.50	4.03	4.77	5.84	6.74
18.0	1.91	2.49	3.21	3.69	4.37	5.35	6.17
20.0	1.77	2.31	2.97	3.42	4.04	4.94	5.70
24.0	1.54	2.01	2.59	2.98	3.52	4.31	4.96
36.0	1.13	1.48	1.90	2.18	2.58	3.15	3.62
48.0	0.90	1.18	1.51	1.73	2.04	2.49	2.87
60.0	0.75	0.98	1.25	1.43	1.69	2.06	2.37
72.0	0.64	0.83	1.06	1.22	1.44	1.75	2.02

The rainfall intensities shown above are calculated in accordance with Chapter 2, Australian Rainfall and Runoff – 1987 Edition.

AUS-IFD Ver.2.0, 2001 : <http://www.ens.gu.edu.au/eve/research/AusIfd/AusIfdVer2.htm>

TABLE B-2
RAINFALL INTENSITY DURATION DATA
NEWCASTLE, NEW SOUTH WALES

Geographic Location : 32.917° South; 151.8° East

AUSIFD Version 2.0

DURATION	1 YEAR ARI (mm/hour)	2 YEAR ARI (mm/hour)	5 YEAR ARI (mm/hour)	10 YEAR ARI (mm/hour)	20 YEAR ARI (mm/hour)	50 YEAR ARI (mm/hour)	100 YEAR ARI (mm/hour)
Minutes :							
5	88.0	113.0	142.0	159.0	181.0	210.0	232.0
6	83.0	106.0	133.0	149.0	170.0	197.0	218.0
7	78.0	100.0	126.0	141.0	160.0	186.0	206.0
8	74.0	95.0	119.0	133.0	152.0	177.0	195.0
9	71.0	90.0	114.0	127.0	145.0	169.0	186.0
10	68.0	87.0	109.0	122.0	139.0	162.0	178.0
11	65.0	83.0	105.0	117.0	134.0	155.0	171.0
12	63.0	80.0	101.0	113.0	129.0	149.0	165.0
13	60.0	77.0	97.0	109.0	124.0	144.0	159.0
14	58.0	75.0	94.0	105.0	120.0	140.0	154.0
15	57.0	72.0	91.0	102.0	117.0	135.0	149.0
16	55.0	70.0	89.0	99.0	113.0	131.0	145.0
17	53.0	68.0	86.0	96.0	110.0	128.0	141.0
18	52.0	66.0	84.0	94.0	107.0	124.0	137.0
19	51.0	65.0	82.0	91.0	104.0	121.0	134.0
20	49.3	63.0	80.0	89.0	102.0	118.0	130.0
25	44.1	56.0	71.0	80.0	91.0	106.0	117.0
30	40.1	51.0	65.0	72.0	83.0	96.0	106.0
35	37.0	47.3	60.0	67.0	76.0	88.5	97.5
40	34.3	43.9	56.0	62.0	71.0	82.0	91.0
45	32.2	41.2	52.0	58.0	66.0	77.0	85.0
50	30.3	38.8	49.0	55.0	63.0	73.0	81.0
55	28.7	36.8	46.5	52.0	59.0	69.0	76.0
Hours :							
1.0	27.3	35.0	44.2	49.5	57.0	66.0	73.0
1.5	21.1	27.1	34.3	38.4	43.9	51.0	57.0
2.0	17.6	22.5	28.5	32.0	36.6	42.6	47.2
3.0	13.5	17.3	21.9	24.6	28.2	32.9	36.4
4.0	11.1	14.3	18.2	20.4	23.4	27.3	30.3
5.0	9.62	12.4	15.7	17.7	20.3	23.7	26.3
6.0	8.54	11.0	14.0	15.7	18.0	21.1	23.4
7.0	7.72	9.91	12.7	14.2	16.3	19.1	21.2
8.0	7.07	9.08	11.6	13.1	15.0	17.5	19.4
9.0	6.55	8.41	10.8	12.1	13.9	16.3	18.0
10.0	6.11	7.86	10.1	11.3	13.0	15.2	16.9
11.0	5.74	7.38	9.45	10.6	12.2	14.3	15.9
12.0	5.43	6.98	8.93	10.1	11.6	13.5	15.0
14.0	4.96	6.39	8.19	9.24	10.6	12.4	13.8
16.0	4.59	5.91	7.6	8.58	9.88	11.6	12.9
18.0	4.29	5.52	7.11	8.04	9.26	10.9	12.1
20.0	4.03	5.2	6.7	7.58	8.74	10.3	11.4
24.0	3.62	4.67	6.04	6.84	7.89	9.27	10.3
36.0	2.83	3.66	4.76	5.41	6.26	7.37	8.23
48.0	2.36	3.06	3.99	4.55	5.27	6.22	6.95
60.0	2.04	2.64	3.46	3.95	4.58	5.42	6.06
72.0	1.79	2.33	3.06	3.5	4.06	4.81	5.39

The rainfall intensities shown above are calculated in accordance with Chapter 2, Australian Rainfall and Runoff – 1987 Edition.

AUS-IFD Ver.2.0, 2001 : <http://www.ens.gu.edu.au/eve/research/AusIfd/AusIfdVer2.htm>

TABLE B-3
RAINFALL INTENSITY DURATION DATA
BRISBANE, QUEENSLAND

Geographic Location : 27.4667° South; 153.0167° East

AUSIFD Version 2.0

DURATION	1 YEAR ARI (mm/hour)	2 YEAR ARI (mm/hour)	5 YEAR ARI (mm/hour)	10 YEAR ARI (mm/hour)	20 YEAR ARI (mm/hour)	50 YEAR ARI (mm/hour)	100 YEAR ARI (mm/hour)
Minutes :							
5	117.0	151.0	191.0	215.0	247.0	290.0	324.0
6	110.0	141.0	180.0	202.0	233.0	274.0	305.0
7	104.0	134.0	170.0	192.0	221.0	260.0	290.0
8	99.0	127.0	162.0	183.0	210.0	248.0	277.0
9	94.0	121.0	155.0	175.0	201.0	237.0	265.0
10	90.0	116.0	148.0	168.0	193.0	228.0	255.0
11	86.0	111.0	143.0	161.0	186.0	220.0	246.0
12	83.0	107.0	138.0	156.0	180.0	212.0	237.0
13	80.0	104.0	133.0	151.0	174.0	206.0	230.0
14	78.0	100.0	129.0	146.0	169.0	199.0	223.0
15	75.0	97.0	125.0	142.0	164.0	194.0	217.0
16	73.0	94.0	121.0	138.0	159.0	188.0	211.0
17	71.0	92.0	118.0	134.0	155.0	184.0	206.0
18	69.0	89.0	115.0	131.0	151.0	179.0	201.0
19	67.0	87.0	112.0	127.0	148.0	175.0	196.0
20	66.0	85.0	110.0	124.0	144.0	171.0	192.0
25	59.0	76.0	98.0	112.0	130.0	154.0	173.0
30	53.0	69.0	90.0	102.0	119.0	141.0	159.0
35	49.2	64.0	83.0	94.5	110.5	131.0	148.0
40	45.7	59.0	77.0	88.0	103.0	123.0	138.0
45	42.8	56.0	73.0	83.0	97.0	116.0	130.0
50	40.4	53.0	69.0	79.0	92.0	110.0	124.0
55	38.2	49.8	65.0	75.0	87.0	104.0	118.0
Hours :							
1.0	36.4	47.4	62.0	71.0	83.0	100.0	113.0
1.5	27.4	35.7	47.1	54.0	63.0	76.0	86.0
2.0	22.3	29.1	38.5	44.4	52.0	62.0	71.0
3.0	16.6	21.8	28.9	33.4	39.2	47.2	53.0
4.0	13.5	17.7	23.6	27.2	32.1	38.6	43.8
5.0	11.5	15.1	20.1	23.3	27.4	33.1	37.5
6.0	10.1	13.2	17.7	20.5	24.1	29.1	33.1
7.0	9.0	11.8	15.8	18.4	21.7	26.2	29.7
8.0	8.18	10.7	14.4	16.7	19.7	23.9	27.1
9.0	7.51	9.86	13.3	15.4	18.2	22.0	25.0
10.0	6.96	9.15	12.3	14.3	16.9	20.5	23.3
11.0	6.5	8.54	11.5	13.4	15.8	19.2	21.8
12.0	6.1	8.02	10.8	12.6	14.9	18.0	20.5
14.0	5.58	7.33	9.86	11.5	13.5	16.4	18.7
16.0	5.16	6.77	9.1	10.6	12.5	15.1	17.2
18.0	4.81	6.32	8.48	9.84	11.6	14.0	16.0
20.0	4.52	5.93	7.95	9.22	10.9	13.1	14.9
24.0	4.06	5.32	7.12	8.24	9.71	11.7	13.3
36.0	3.17	4.15	5.52	6.38	7.5	9.02	10.2
48.0	2.64	3.45	4.57	5.27	6.19	7.43	8.41
60.0	2.27	2.97	3.92	4.51	5.29	6.35	7.18
72.0	2.0	2.61	3.44	3.95	4.63	5.54	6.26

The rainfall intensities shown above are calculated in accordance with Chapter 2, Australian Rainfall and Runoff – 1987 Edition.

AUS-IFD Ver.2.0, 2001 : <http://www.ens.gu.edu.au/eve/research/AusIfd/AusIfdVer2.htm>

TABLE B-4
RAINFALL INTENSITY DURATION DATA
PERTH, WESTERN AUSTRALIA

Geographic Location : 31.95° South; 115.85° East

DURATION	1 YEAR ARI (mm/hour)	2 YEAR ARI (mm/hour)	5 YEAR ARI (mm/hour)	10 YEAR ARI (mm/hour)	20 YEAR ARI (mm/hour)	50 YEAR ARI (mm/hour)	100 YEAR ARI (mm/hour)
Minutes :							
5	59.0	78.0	103.0	120.0	145.0	181.0	213.0
6	55.0	73.0	95.0	111.0	134.0	167.0	196.0
7	52.0	68.0	89.0	104.0	124.0	155.0	181.0
8	48.7	64.0	84.0	97.0	117.0	145.0	170.0
9	46.2	61.0	79.0	92.0	110.0	137.0	159.0
10	44.0	58.0	75.0	87.0	104.0	129.0	151.0
11	42.0	55.0	71.0	83.0	99.0	123.0	143.0
12	40.3	53.0	68.0	79.0	94.0	117.0	136.0
13	38.7	51.0	65.0	76.0	90.0	112.0	130.0
14	37.2	48.8	63.0	73.0	87.0	107.0	124.0
15	35.9	47.1	61.0	70.0	83.0	103.0	119.0
16	34.8	45.5	58.0	67.0	80.0	99.0	115.0
17	33.6	44.0	56.0	65.0	77.0	95.0	111.0
18	32.6	42.6	55.0	63.0	75.0	92.0	107.0
19	31.7	41.4	53.0	61.0	72.0	89.0	103.0
20	30.8	40.2	51.0	59.0	70.0	86.0	100.0
25	27.2	35.4	44.9	52.0	61.0	75.0	86.0
30	24.4	31.7	40.1	46.0	54.0	66.0	76.0
35	22.3	28.9	36.4	41.6	48.9	59.5	68.5
40	20.5	26.6	33.4	38.0	44.6	54.0	62.0
45	19.1	24.7	30.9	35.1	41.1	49.9	57.0
50	17.8	23.0	28.8	32.7	38.2	46.2	53.0
55	16.8	21.7	27.0	30.6	35.7	43.2	49.3
Hours :							
1.0	15.9	20.5	25.4	28.8	33.6	40.5	46.2
1.5	12.3	15.8	19.5	22.1	25.7	30.9	35.2
2.0	10.2	13.1	16.2	18.2	21.2	25.0	28.9
3.0	7.83	10.1	12.3	13.9	16.1	19.2	21.9
4.0	6.49	8.31	10.2	11.4	13.2	15.8	17.9
5.0	5.61	7.18	8.75	9.81	11.3	13.5	15.3
6.0	4.98	6.36	7.75	8.67	10.0	11.9	13.5
7.0	4.5	5.75	6.99	7.81	9.02	10.7	12.1
8.0	4.12	5.27	6.39	7.14	8.23	9.78	11.1
9.0	3.82	4.88	5.91	6.6	7.6	9.02	10.2
10.0	3.57	4.55	5.51	6.14	7.08	8.39	9.48
11.0	3.35	4.28	5.17	5.76	6.63	7.86	8.97
12.0	3.17	4.04	4.88	5.43	6.25	7.41	8.36
14.0	2.87	3.66	4.43	4.95	5.7	6.77	7.64
16.0	2.63	3.36	4.08	4.56	5.26	6.25	7.07
18.0	2.44	3.12	3.79	4.24	4.9	5.83	6.6
20.0	2.28	2.91	3.55	3.98	4.6	5.48	6.2
24.0	2.02	2.59	3.17	3.55	4.11	4.91	5.57
36.0	1.54	1.98	2.43	2.74	3.19	3.83	4.35
48.0	1.26	1.62	2.0	2.27	2.64	3.18	3.63
60.0	1.07	1.38	1.71	1.94	2.26	2.73	3.13
72.0	0.93	1.2	1.49	1.7	1.99	2.4	2.75

Supply of these rainfall Intensity-Frequency-Duration data by Western Australia EPA is greatly appreciated.

APPENDIX C

POLLUTION CONTROL/RETENTION DEVICES (“soakaways”) FOR FIVE AUSTRALIAN CLIMATE ZONES

[Climate zones are based on $i_{10,1}$ rainfall intensities*]

See Figure 3.8

* $i_{10,1}$ rainfall intensity is that given by I.E.Aust. (1987) for
ARI, Y = 10-years, duration 1-hour.

Graph for Southern Australia is found in Figure 7.1 in Section 7.2.

$i_{10,1}$ is less than or equal to 25 mm per hour

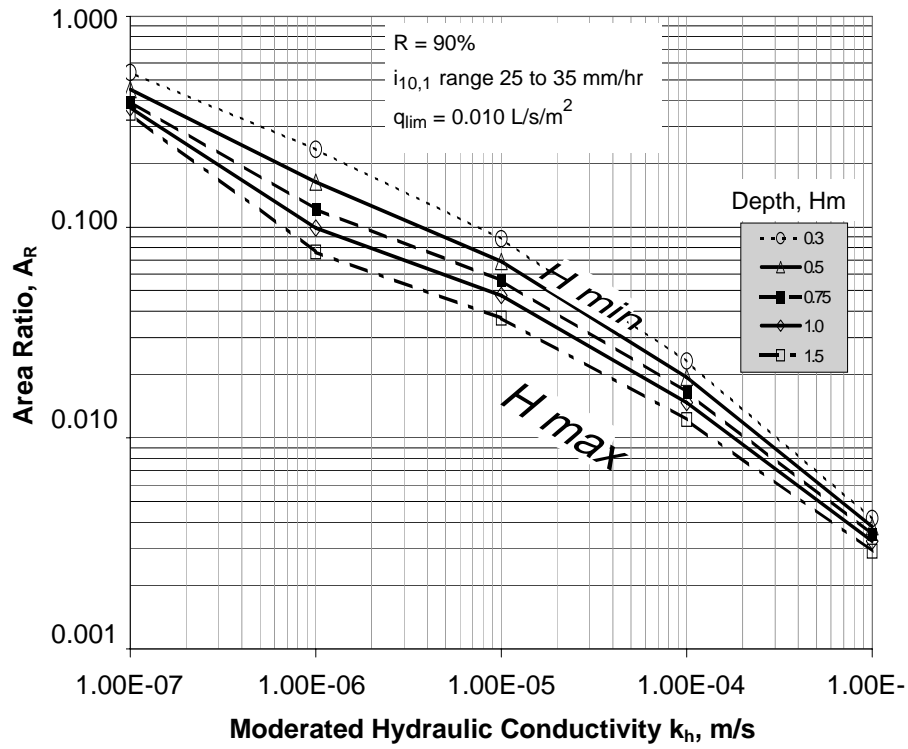


FIGURE C-1 : $i_{10,1}$ range, 25 mm/h to 35 mm/h – Lower-Intermediate Zone
Soils with moderated $k_h > 1.0 \times 10^{-4} \text{ m/s}$ are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

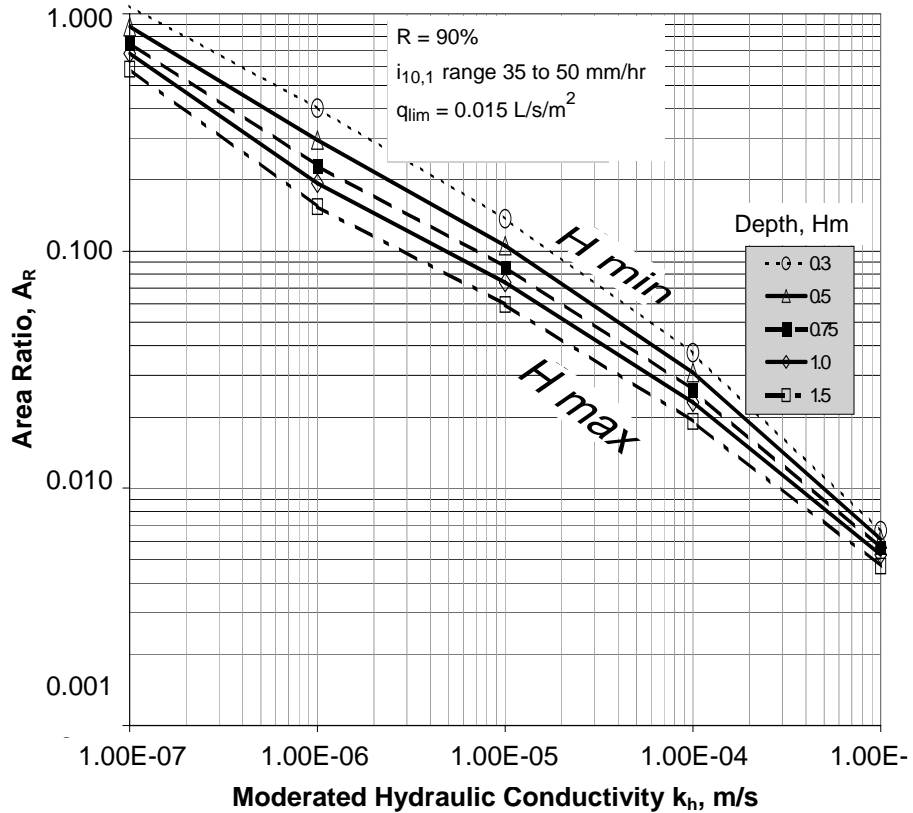


FIGURE C-2 : $i_{10,1}$ range, 35 mm/h to 50 mm/h – Mid-Intermediate Zone
Soils with moderated $k_h > 1.0 \times 10^{-4} \text{ m/s}$ are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

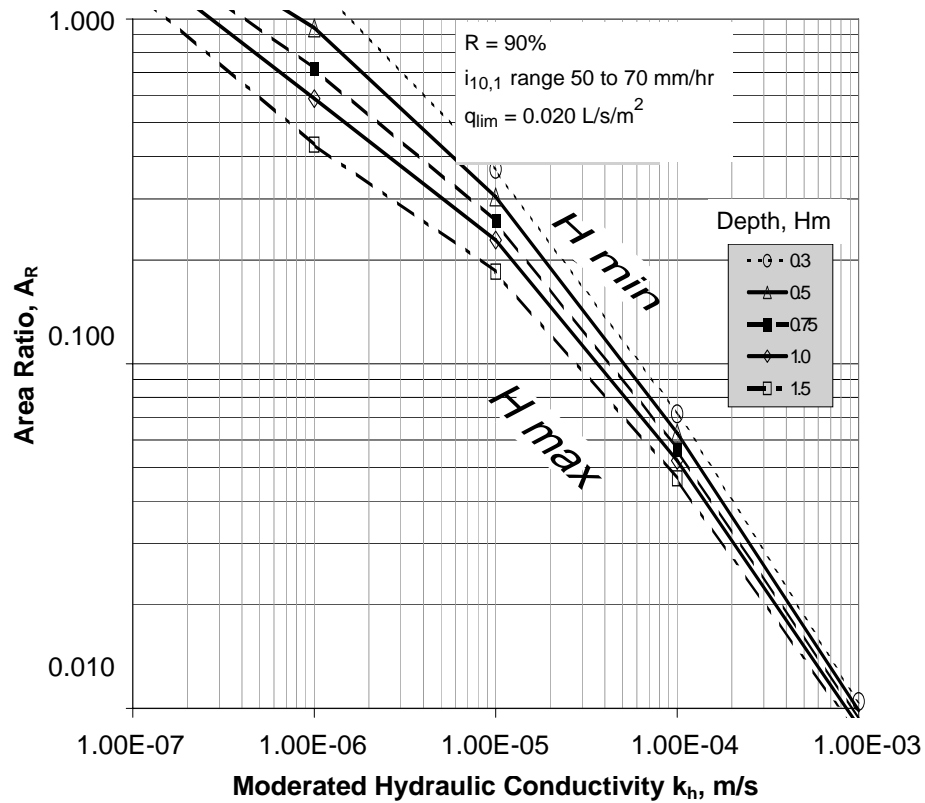


FIGURE C-3 : $i_{10,1}$ range, 50 mm/h to 70 mm/h – Upper-Intermediate Zone
 Soils with moderated $k_h > 1.0 \times 10^{-4}$ m/s are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

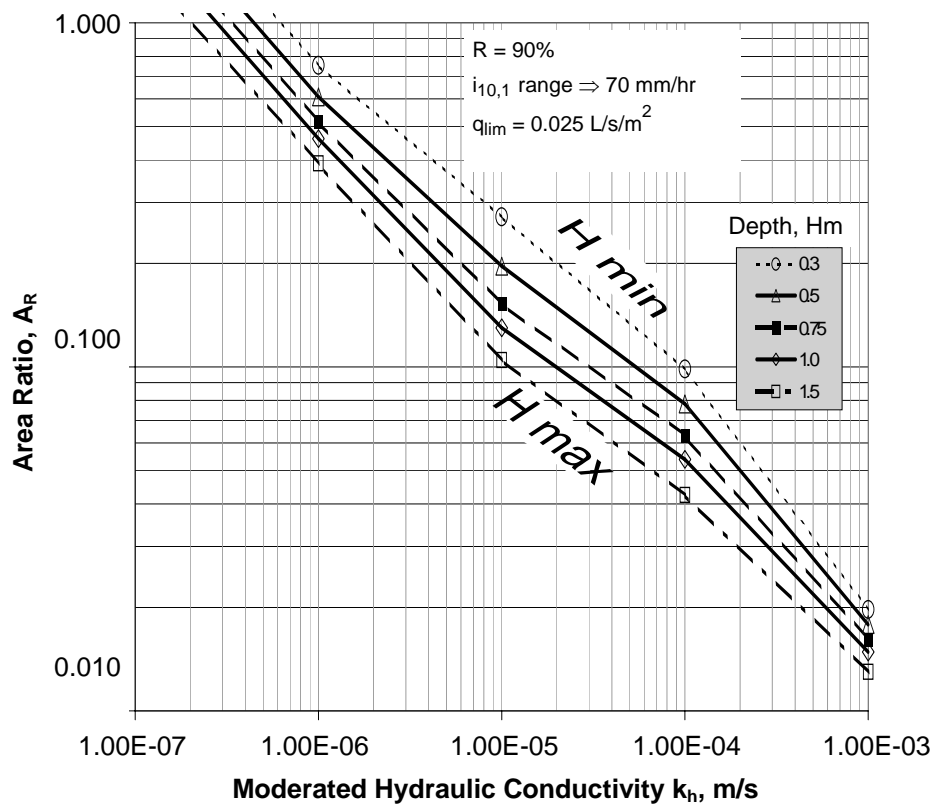


FIGURE C-4 : $i_{10,1}$ range, 70 mm/h and above – Northern Australia Zone
 Soils with moderated $k_h > 1.0 \times 10^{-4}$ m/s are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

APPENDIX D

DESIGN GRAPHS FOR 'FILTER STRIP' SWALES FOR FIVE AUSTRALIAN CLIMATE ZONES

[Climate zones are based on $i_{10,1}$ rainfall intensities*]
See Figure 3.8

* $i_{10,1}$ rainfall intensity is that given by I.E.Aust. (1987) for
ARI, Y = 10-years, duration 1-hour.

Graph for Southern Australia is found in Figure 7.7 in Section 7.8.

$i_{10,1}$ is less than or equal to 25 mm per hour

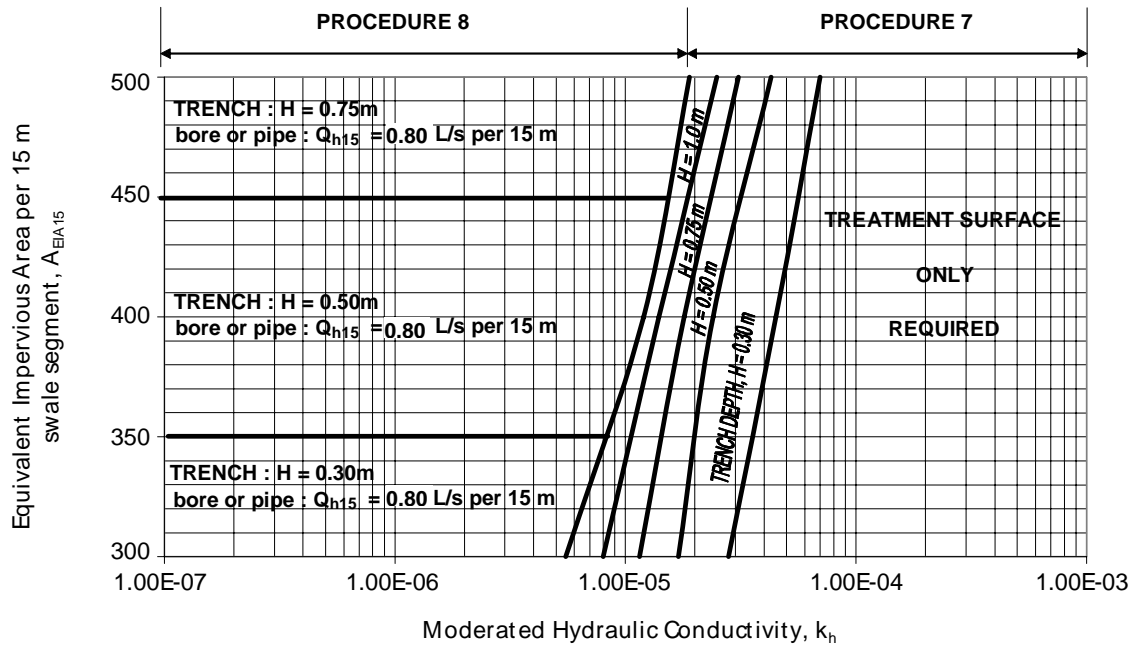


FIGURE D-1 : $i_{10,1}$ range, 25 mm/h to 35 mm/h – Lower-Intermediate Zone

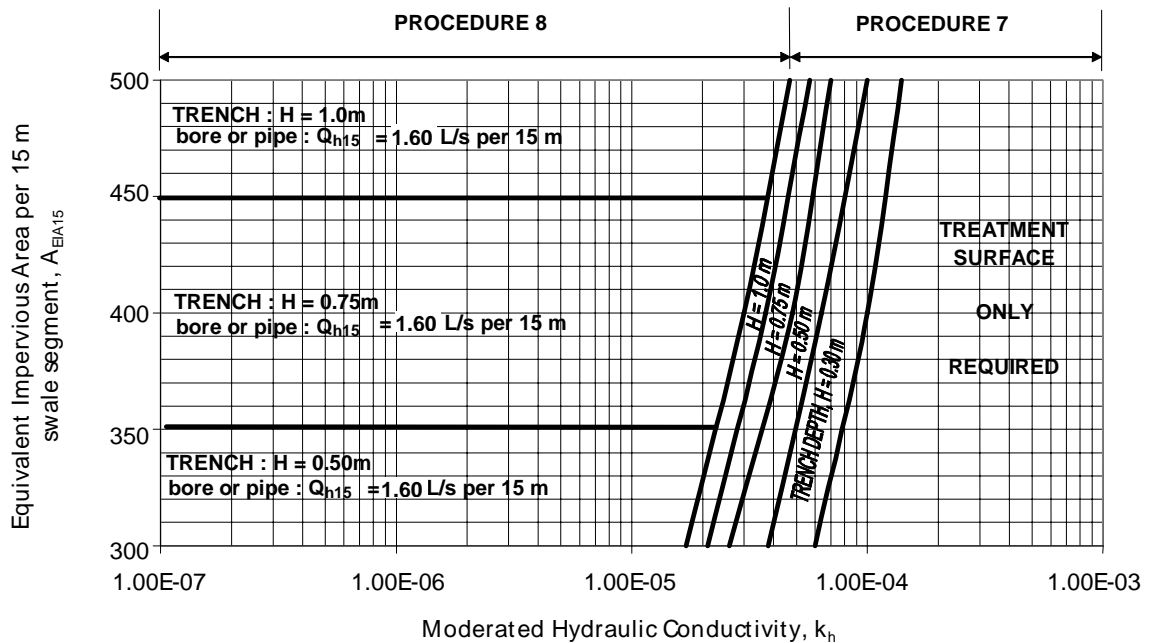


FIGURE D-2 : $i_{10,1}$ range, 35 mm/h to 50 mm/h – Mid-Intermediate Zone

Important Note: Soils with moderated $k_h > 1.0 \times 10^{-4}$ m/s are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

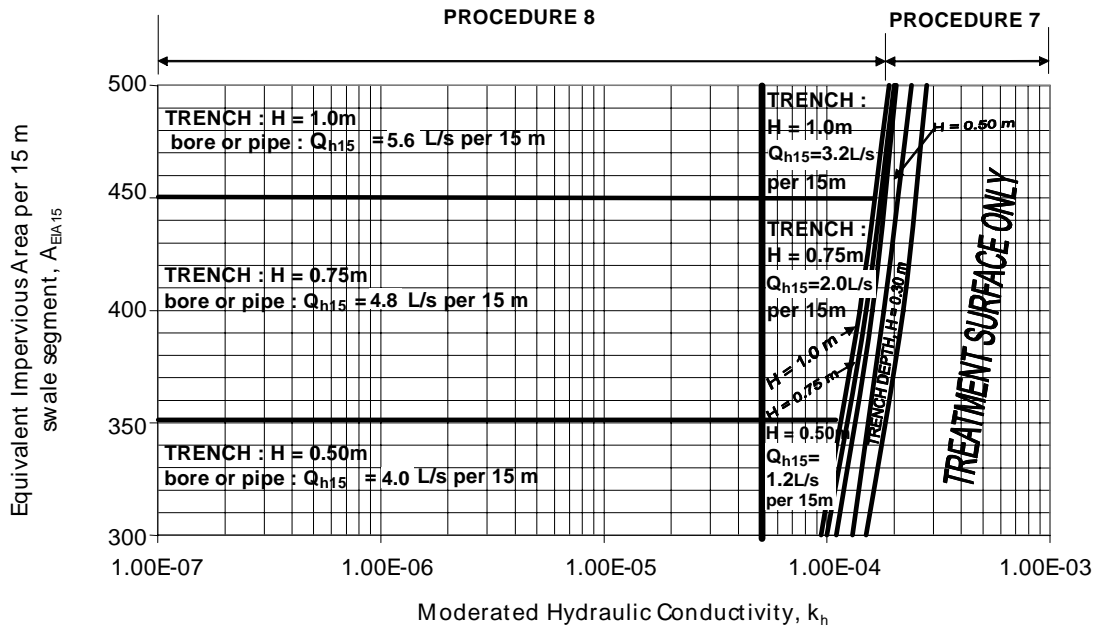


FIGURE D-3 : $i_{10,1}$ range, 50 mm/h to 70 mm/h – Upper-Intermediate Zone

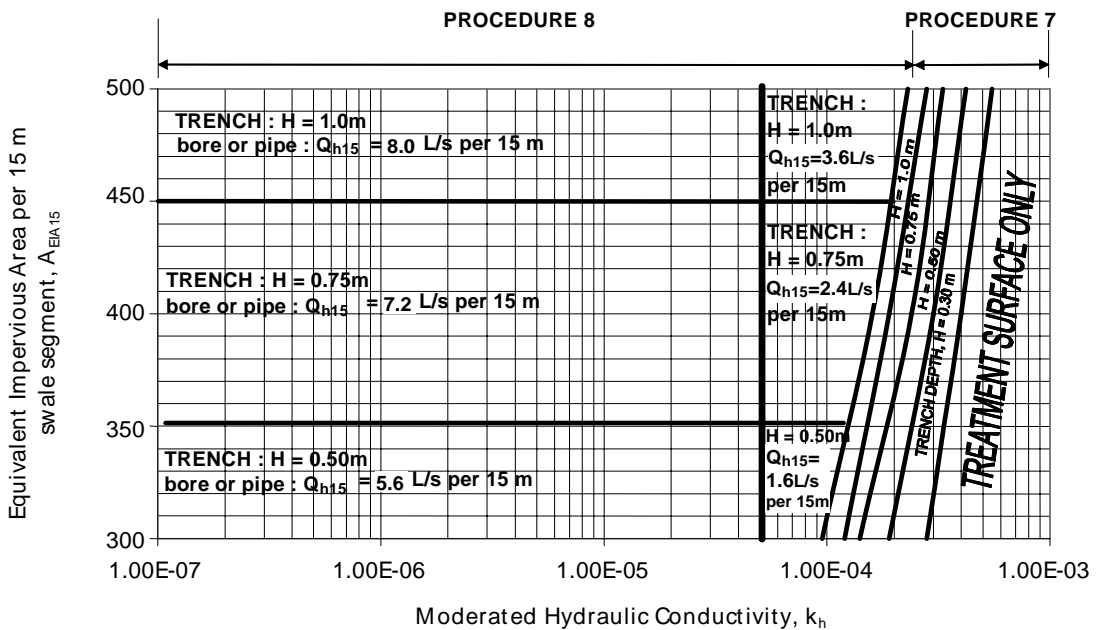


FIGURE D-4 : $i_{10,1}$ range, 70 mm/h and above – Northern Australia Zone

Important Note: Soils with moderated $k_h > 1.0 \times 10^{-4}$ m/s are, typically, unsuitable for treating *dissolved pollutants* in catchment runoff (see Mikkelsen et al, 1997; Fischer et al, 2003)

APPENDIX E

GRAPHS FOR A REGIONAL STORMWATER HARVESTING MODEL FOR FIVE AUSTRALIAN CLIMATE ZONES

[Climate zones are based on $i_{10,1}$ rainfall intensities*]

See Figure 3.8

* $i_{10,1}$ rainfall intensity is that given by I.E.Aust. (1987) for
ARI, Y = 10-years, duration 1-hour.

Graph for Southern Australia is found in Figure 8.5 in Section 8.6.

$i_{10,1}$ is less than or equal to 25 mm per hour

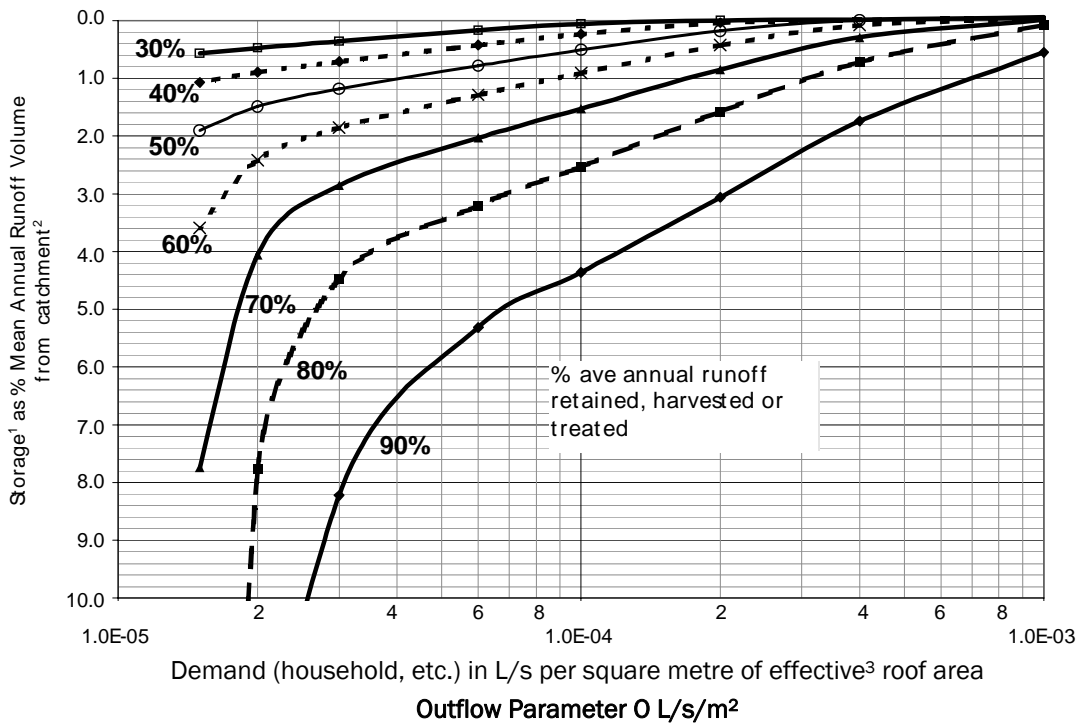


FIGURE E-1 : $i_{10,1}$ range, 25 mm/h to 35 mm/h – Lower-Intermediate Zone

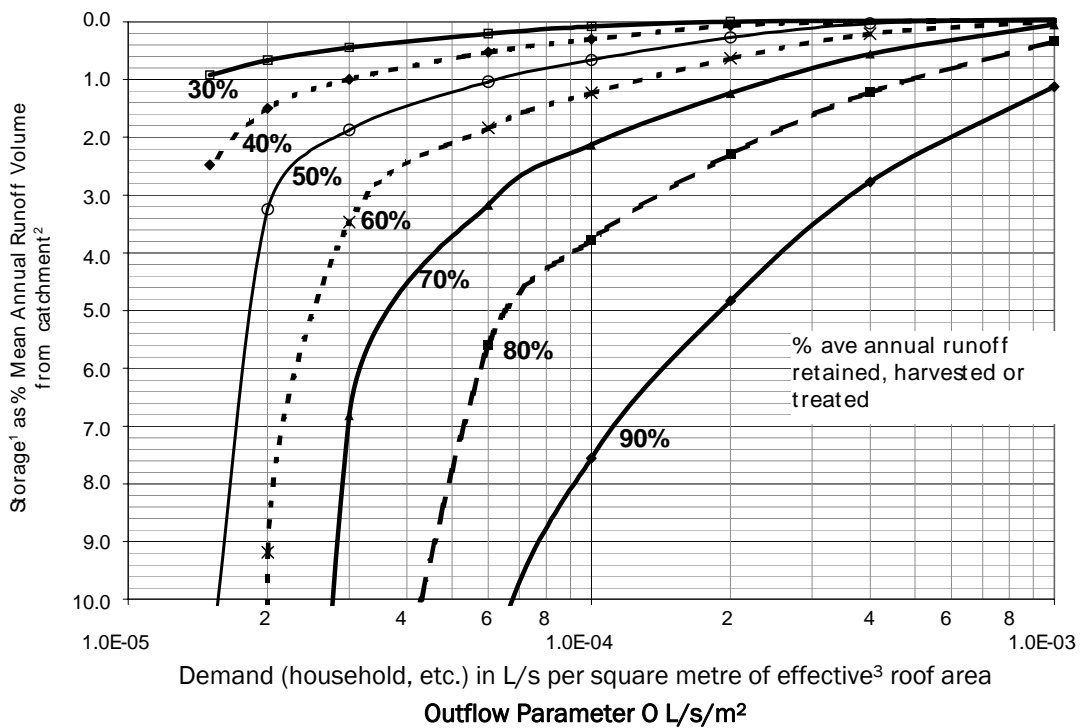


FIGURE E-2 : $i_{10,1}$ range, 35 mm/h to 50 mm/h – Mid-Intermediate Zone

- NOTES :1 : Device may be a pond or a rainwater tank.
 2 : Catchment may be a ground-level paved area or a roof.
 3 : Effective roof area for rainwater tanks may be as low as 80% of nominal roof area (see Section 8.3.3).

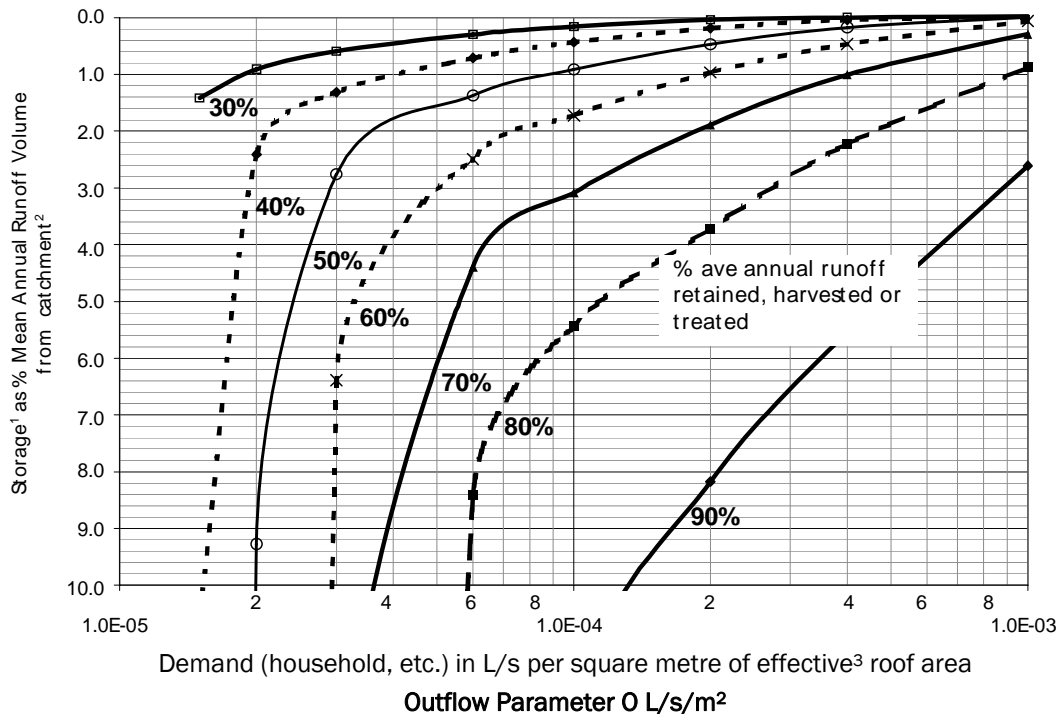


FIGURE E-3 : $i_{10,1}$ range, 50 mm/h to 70mm/h – Upper-Intermediate Zone

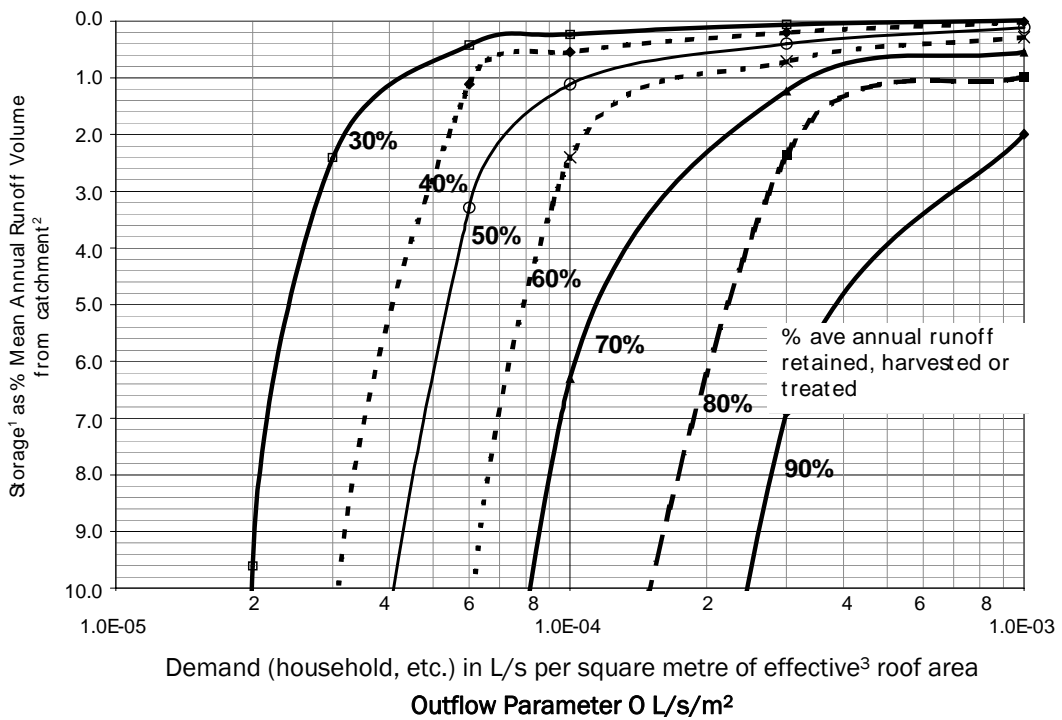


FIGURE E-4 : $i_{10,1}$ range, 70 mm/h and above – Northern Australia Zone

- NOTES** : 1 : Device may be a pond or a rainwater tank.
 2 : Catchment may be a ground-level paved area or a roof.
 3 : Effective roof area for rainwater tanks may be as low as 80% of nominal roof area (see Section 8.3.3).

APPENDIX F

TUTORIAL EXERCISES

TUTORIAL EXERCISES

EXAMPLE 1 :

The derivation of Equations 3.13 and 3.14, Section 3.2.1, includes one typographical error. Find and correct it.

EXAMPLE 2 :

Study the derivations of Equations 3.30, 3.31 and 3.32 in Section 3.5.2. Are there any typographical errors? If so find and correct them.

CHAPTER 5 : Procedures 1 – 4

One of the gravest errors which occurs in the design of storage-related flood control installations in Australia and, one suspects, overseas, arises from misunderstanding about the critical storm duration which should be used in each design context. This matter is addressed in the Handbook in Section 4.2. For this reason, the following exercises provide, typically, three ‘alternative’ critical storm durations : it is part of the design task to select which of these is (are) relevant to the exercise and which is (are) not.

EXAMPLE 3 :

Determine the area, A_S of a “Grasspave” vegetated porous treatment surface required for a car park with total area $A = 2,500 \text{ m}^2$, located in Newcastle; the treatment surface must be part of (included within) the car park area. The car park is to be designed for ARI, $Y = 5$ -years flood conditions. Also determine the expected ‘lifespan’ of the surface : the car park is located in an “average suburb – site with some trees” (see Table 3.1).

The alternative critical storm durations, in accordance with Section 4.2 of the Handbook are :

$$t_C = 10 \text{ minutes}; (T_C)_{\text{local}} = 60 \text{ mins}; (T_C)_{\text{total}} = 2 \text{ hours}; \text{ARI} = 5 \text{ years.}$$

The sand/gravel base for the “Grasspave” surface has “as constructed” hydraulic conductivity :

$$k_h = 2.5 \times 10^{-4} \text{ m/s.}$$

The blockage factor for “Grasspave” is $\Psi = 0.1$.

[Ans: $1,440 \text{ m}^2$; 65 years]

EXAMPLE 4 :

Design an on-site stormwater retention system for runoff from a roof, $A = 400 \text{ m}^2$, located, firstly in Perth and secondly in Brisbane : the **yield-minimum** strategy is to be applied (see Section 4.2.1 and Example 5.6 in Section 5.2). “Leaky” wells or a gravel-filled “soakaway” ($e_S = 0.35$) or “Atlantis” boxes ($e_S = 0.95$) may be used in soil of hydraulic conductivity $k_h = 1.6 \times 10^{-4} \text{ m/s}$ (Perth, sandy loam) and $1.0 \times 10^{-6} \text{ m/s}$ (Brisbane, clay). **Local** sub-area flooding is the main design consideration :

$$\text{site } t_C = 15 \text{ minutes}, (T_C)_{\text{local}} = 30 \text{ minutes}; (T_C)_{\text{total}} = 60 \text{ minutes}; \text{ARI} = 2 \text{ years.}$$

Use the following to start your design :

- the well effective height, $H = 2.30 \text{ m}$;
- “soakaway” depth, $H = 0.40 \text{ m}$;
- “Atlantis” boxes have alternative dimensions of 0.60 m or 0.40 m .

[Ans: Perth: $D = 1.50 \text{ m}$; $a = 13.6 \text{ m}^2$; $a = 8.14 \text{ m}^2$; Brisbane: 12 wells...; $a = 224 \text{ m}^2$; $a = 216 \text{ m}^2$;]

HELPFUL HINT! The main purpose of this exercise (for Brisbane) is to show that ‘source control’ solutions using wells and trenches, only, sometimes lead to very impractical solutions. When you consider you have learned this lesson stop and go on to Example 5.

EXAMPLE 5 :

Repeat Example 4 (Brisbane), this time using the wells and trenches **with ‘slow-drainage’** to a local waterway to solve the problem (for guidance, see Section 5.1.5 and Example 5.7, Section 5.2). [Ans: 2 wells, $D = 1.70$ m, $q_r = 0.060$ L/s; $a = 71$ m², $Q_r = 0.12$ L/s; $a = 27$ m², $Q_r = 0.12$ L/s]

EXAMPLE 6 :

Determine the plan area, A_p , of infiltration or “dry” pond required to accept, without overflow, storm runoff from a newly developed urban area, previously a 10.0 ha “greenfields” site, near the bottom of a minor catchment in Adelaide. The **regime-in-balance** strategy is to be applied (see Section 4.2.1 and Example 5.3 in Section 5.2). When fully developed, the 10 ha site will have 5.0 ha equivalent paved area and 5.0 ha open space. ARI, $Y = 100$ years is to be used. Downstream flooding of local and total catchment drainage paths is considered unlikely. Relevant critical storm durations are :

$$\text{site } t_c = 30 \text{ minutes; } (T_C)_{\text{local}} = 30 \text{ minutes and } (T_C)_{\text{total}} = 60 \text{ minutes.}$$

The soil at the pond site has long-term hydraulic conductivity, $k_h = 5.0 \times 10^{-5}$ m/s. Maximum pond depth, under design condition, $d = 0.50$ m.

EXAMPLE 7 :

The “Grasspave” treatment surface considered in Example 3 (Newcastle) is underlain by a gravel-filled “soakaway” ($e_s = 0.35$) which receives the flow, provides temporary storage and transfers the cleansed stormwater to an aquifer. Its plan area is the same as that of the treatment surface. The “soakaway” is to be designed for **yield-minimum** conditions (see Section 4.2.1 and Example 5.5 in Section 5.2). Flooding of the “soakaway” is required to be once, **only**, in every five years, on average.

- The site soil is clay for which $k_h = 1.0 \times 10^{-7}$ m/s.
- The recharge rate for the bore is estimated at $q = 0.5$ L/s.
- Determine a suitable depth, H , for the “soakaway”.
- Alternative design storm conditions are : $t_c = 30$ minutes; $(T_C)_{\text{local}} = 60$ minutes; $(T_C)_{\text{total}} = 2$ hours; ARI = 5 years.

HINT! You will find the Equation which you need to solve this exercise in Section 5.1.5.

EXAMPLE 8 :

Determine the area, A_s of a “Hydrapave” permeable paving treatment surface required for a Council car park with **total** area $A = 2,000$ m², located in Brisbane; the treatment surface must be part of (included in) the car park area. Average recurrence interval for the facility is ARI, $Y = 5$ -years. The following special circumstances must be taken into account in determining the area :

- The car park will be in service for a maximum of 10 years (after which time the area will become the site of a library building).
- The proposed (temporary) car park will also receive roof runoff from a Council building, area 1,000 m².
- “As constructed” hydraulic conductivity of “Hydrapave” permeable paving is 1.0×10^{-3} m/s.

The alternative critical storm durations are :

$$t_c = 10 \text{ minutes; } (T_C)_{\text{local}} = 60 \text{ mins; } (T_C)_{\text{total}} = 2 \text{ hours.}$$

CHAPTER 7 : Procedures 5 and 6

EXAMPLE 9 : Given the following data :

Location :	Adelaide, Southern Australia zone
Soil :	medium clay, $k_h = 3 \times 10^{-6}$ m/s; Moderation factor, $U = 2.0$
Catchment :	paved area, $A_{EIA} = 4,000$ m ²
Space available :	$A_{avail} = 600$ m ²
Retention device :	gravel-filled “soakaway”, $e_s = 0.35$.

Determine, for R = 90% and Strategy A compliance :

- treatment system capacity flow (bypass flow);
- recommended plan area of “soakaway”;
- “soakaway” depth, H.

EXAMPLE 10 : Given the following data :

Location :	Newcastle, Mid-Intermediate zone
Soil :	medium clay, $k_h = 3 \times 10^{-6}$ m/s; Moderation factor, $U = 2.0$
Catchment :	paved area, $A_{EIA} = 4,000$ m ²
Space available :	$A_{avail} = 200$ m ²
Retention device :	gravel-filled “soakaway”, $e_s = 0.35$.

Determine, for R = 90% and Strategy A compliance :

- treatment system capacity flow (bypass flow);
- recommended plan area of “soakaway”;
- “soakaway” depth, H.

EXAMPLE 11 : Given the following data :

Location :	Brisbane, Northern Australia zone
Soil :	medium clay, $k_h = 3 \times 10^{-6}$ m/s; Moderation factor, $U = 2.0$
Catchment :	paved area, $A_{EIA} = 4,000$ m ²
Space available :	$A_{avail} = 80$ m ²
Retention device :	gravel-filled “soakaway”, $e_s = 0.35$.

Determine, for R = 90% and Strategy A compliance :

- treatment system capacity flow (bypass flow);
- recommended plan area of “soakaway”;
- “soakaway” depth, H.

Provision for ‘slow-drainage’ may be made if the space available is too small for satisfactory emptying by ‘natural’ drainage. In this event, determine the magnitude of ‘slow-drainage’ which must be provided.

EXAMPLE 12 :

Stormwater runoff from an Adelaide residential sub-division, plan area 3.0 ha, for which equivalent impervious area, $A_{EIA} = 1.50$ ha, is required to be treated to Strategy B standard, that is, 'first flush' treatment, only (Council specification). Local soil is sandy-clay, so a 'dry' pond appropriate to the pollution control/retention requirements of Council is to be designed (ARI, $Y = 0.25$ -years). Given the following data :

Location :	Adelaide, SA	
Soil :	sandy-clay, $k_h = \times 10^{-5}$ m/s; Moderation factor, $U = 1.0$	
Catchment :	paved area, $A_{EIA} = 15,000$ m ²	
Time of concentration :	$t_C = 20$ minutes	
Rainfall intensity :	$i_{0.25} = 0.5 \times i_1$	(3.38)
Space available :	$A_{avail} = 150$ m ² .	

Determine :

- recommended plan area of 'dry' pond;
- recommended depth of 'dry' pond;
- emptying time for 'dry' pond – compare with interim criterion (Table 3.3).

