

The University of Melbourne
Faculty of Land and Food Resources
Semester 2, Assessment 2006

208-308 Irrigation and Water Management – Block

Date: Friday, November 23rd, 2007

Time: 9.00am – 12.00pm

Reading Time: 15 minutes

Examination Duration: 3 hours

This paper has 6 pages including this cover.

Data sheets are also provided.

Examination paper can be deposited in the Library.

Authorized Materials:

Non programmable calculator

Instructions to Invigilators:

Students will require script books only.

Instructions to Students:

This paper contributes 50% of the total subject mark.

All questions are of equal value.

There are 15 questions. Total marks 150

You are to provide answers to all questions, no selection is provided.

1. (a) The Goulburn Valley Foodbowl initiative aims to provide up to 75 GL of water annually to Melbourne through the funding of water savings in the Goulburn Valley. List and describe how the State Government proposes to secure water savings in the irrigation area to access this water.

(b) Based upon the experience of the living Murray Project what are the prospects for success given current drought conditions? (10 marks)

2. An irrigator with a groundwater licence is proposing to irrigate 5 ha of olives . The average annual irrigation requirement for the olives is 950mm and the effective rainfall during the irrigation season is 175mm. If the irrigator plans to apply 8 ML/ha/year of water containing 950 mg/l of salt determine the following system design characteristics:
 - (a) The predicted volume of leachate collected during the irrigation season
 - (b) The mass of salt applied annually to the olives
 - (c) The average salinity of the leachate
 - (d) The potential area of an evaporation basin if the leachate is disposed of by this means and the annual evaporation rate is 1400mm. (10 marks)

3. List and describe at least three techniques for predicting or measuring crop water requirements to assist irrigation scheduling through crop, soil or climatic monitoring and modeling. (10 marks)

4. What techniques are available to control waterlogging , water tables and salinisation in the Goulburn and Murray Valleys and what are their attributes and limitations? (10 marks)

5. What is the function of wetlands in the landscape and why are water resources being devoted to their maintenance at a time of severe drought ? (10 marks)

6. An irrigator plans to purchase 45 ML of temporary water at \$1100/ML for the sprinkler irrigation of a maize crop. If the crop occupies 5.5 ha of land and the projected cumulative crop evapotranspiration is 725 mm determine the following:
- (a) the projected volume of runoff or deep percolation that will accrue if there is no rainfall.
 - (b) the projected irrigation efficiency if all of the water is applied .
 - (c) the water use per hectare of production if the maize yield is projected to be 5 tonne/ha.
 - (d) what measures can be introduced to try and make more effective use of the purchased water?
 - (e) if the projected volume of water needed remains the same but the amount available is reduced by 50%, what options does the irrigator have with the water available? (10 marks)
7. With the aid of diagrams, describe the environmental impact on a waterway of the discharge of effluent containing organic compounds and soluble nutrients in terms of:
- oxygen demand ,oxygen depletion and recovery
 - nitrogen compounds
 - phosphorus in solution
 - energy levels and decomposition
 - population and diversity of microorganisms
- (10 marks)

8. An orchard is planted on sandy loam in a district where the average February evaporation is 220 mm. Allowing for a crop factor of 0.5, a soil field capacity of 120 mm/m and permanent wilting point of 45 mm/m determine the following:
- (a) the predicted monthly evapotranspiration
 - (b) the projected irrigation interval assuming a root zone depth of 0.6 m and adoption of a policy to irrigate when 50% of available soil water is depleted.
 - (c) the projected irrigation water depth assuming that the irrigation system efficiency is 85%.
 - (d) what would the projected pattern of water use be in the 0.6 m root zone
(10 marks)

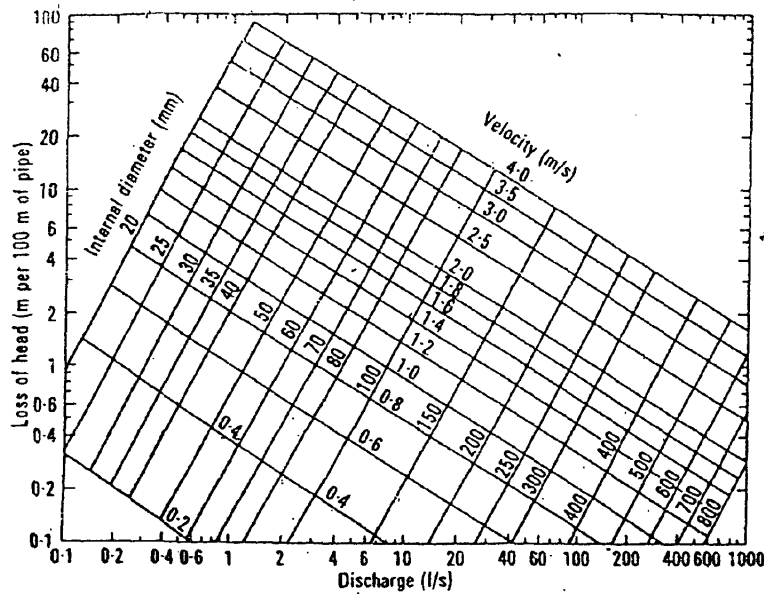
9. A farmer in the Wimmera Mallee pipeline district is to be connected to the regional piped domestic and stock water supply system. They have installed a polyethylene tank 10 m above the proposed location of a trough and installed a 50 mm diameter polyethylene pipe to connect the tank to the trough, which is a 200 m away.
- (a) If a flow rate of 1.5 l/sec is measured through the pipe, what is the likely head and pressure of water at the outlet to the trough?
 - (b) What is the likely velocity of water and is it excessive?
 - (c) The farmer wants to locate another trough a further 200 m away, if the same flow rate is needed to meet projected stock requirements and the trough elevation is unchanged, can it be done?
 - (d) How could the pressure of water at the new trough outlet be increased?
(10 marks)

10. (a) List the advantages and disadvantages of drip/microsprinkler irrigation systems for horticultural applications
- (b) What site characteristics favour border check flood irrigation compared with centre pivot irrigation?
- (c) Why is there such interest in subsurface drip irrigation for urban and rural applications? (10 marks)

11. A channel or rectangular section 8 m wide and 0.25 m deep is to be employed as a grassed waterway for soil erosion control. If the roughness coefficient is 0.03 and the channel slope is 0.08% determine the following characteristics:
- (a) the predicted velocity when the channel is flowing full
- (b) the potential for scour to occur if the waterway is bare and formed in silty sand
- (c) the flow rate when the channel is flowing full
- (d) possible measures to slow the water down even further (10 marks)

12. (a) What are the key water quality concerns for irrigation water?
- (b) What water quality parameters are of a major concern for potable water?
- (c) How can raw water be treated to improve potability and safeguard human health? (10 marks)

13. (a) What is blue green algae and how does it impact on the utilization of water for urban, irrigation or stock and domestic purposes?
- (b) What strategies are being followed to reduce the impact of blue green algae blooms? (10 marks)
14. Describe the mechanism of either dryland or irrigation salinity and identify what measures are being taken to counter the threat of salinity to agricultural production and the diminishing quality of water resources. (10 marks)
15. What measures are being taken by urban and rural water authorities to conserve or supplement water supply during this period of drought? (10 marks)



Friction loss in pipes with low friction
Approximate capacities of pipes of various sizes

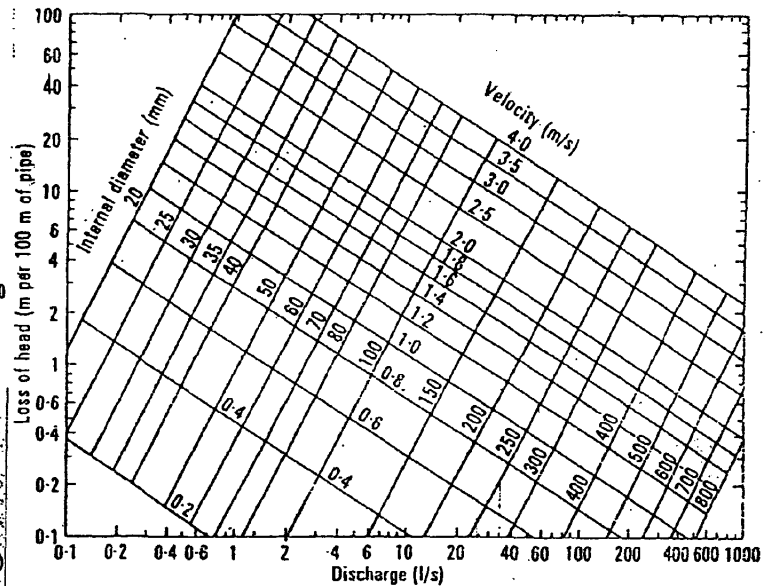
Metric sizes (flow not exceeding 2 m/s)		English sizes (flow not exceeding 6 ft/s)	
Diameter (mm)	Flow (l/s)	Diameter (in)	Flow (gall/min)
50	3	2	48
75	8	2½	75
100	15	3	110
125	20	4	200
150	35	5	300
175	50	6	450
200	60	8	800
225	80	10	1250
250	100	12	1700
300	150	18	3700

Head losses in pipe fittings

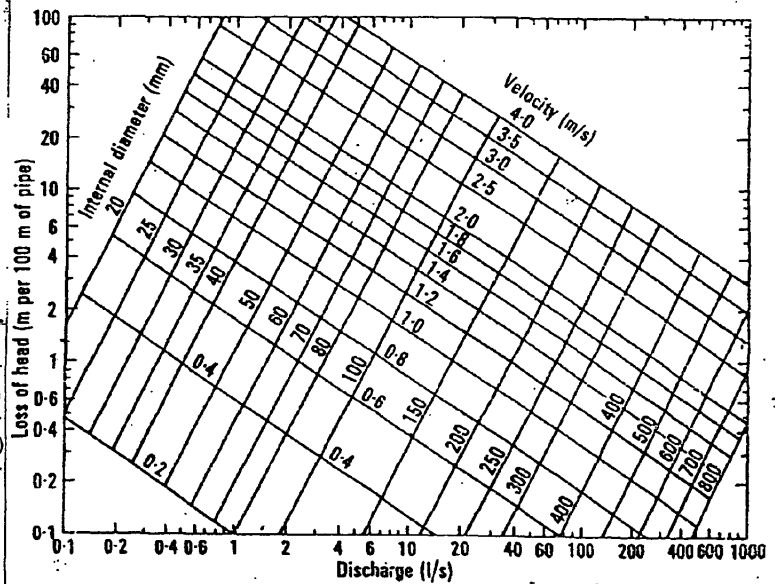
Pipe size (mm)	50 mm	75 mm	100 mm
	Length of straight pipe with similar head loss (m)		
Elbows and bends	1.25	1.75	3.0
T-junctions	3.0	4.5	6.0
Quick couplers	1.50	1.5	1.5
Semi-quick couplers			

Roughness characteristics of pipes of various materials

Roughness category	Material				
	Plastic	Asbestos/cement	Aluminium	Galvanized	Concrete
Low friction	No constriction at joints, for example, taper-fit or solvent-welded	With smooth joints	Permanent	New	
Medium friction	Some constriction at joints, for example, butt-welded		Portable		Spun concrete with gasket joints
High friction				Old	(a) Precast with gasket joints (b) Cast in situ



Friction loss in pipes with medium friction



Friction loss in pipes with high friction

Values of Manning's roughness coefficient *n*

(a) Channels free from vegetation

- Uniform cross-section, regular alignment free from pebbles and vegetation, in fine sedimentary soils
- Uniform cross-section, regular alignment, free from pebbles and vegetation, in stiff clay soils or hardpan
- Uniform cross-section, regular alignment, few pebbles, little vegetation, in clay loam
- Small variations in cross-section, fairly regular alignment, few stones, thin grass at edges, in sandy and clay soils, also newly cleaned, ploughed, and harrowed channels
- Irregular alignment, ripples on bottom, in gravelly soil or shale, with jagged banks or vegetation
- Irregular section and alignment, scattered rocks and loose gravel on bottom, or considerable weeds on sloping banks, or in gravelly material up to 150 mm diameter
- Eroded irregular channels, channels blasted in rock

- n*
- 0.016
- 0.018
- 0.020
- 0.0225
- 0.025
- 0.030
- 0.030

(b) Vegetated channels

- Short grass (50-150 mm)
- Medium grass (150-250 mm)
- Long grass (250-600 mm)

- 0.030-0.060
- 0.030-0.085
- 0.040-0.150

(c) Natural stream channels

- Clean and straight
- Winding, with pools and shoals
- Very weedy, winding, and overgrown

- 0.025-0.030
- 0.033-0.040
- 0.075-0.150

AGRICULTURAL ENGINEERING DEPARTMENT

HYDRAULICS SECTION

OPEN CHANNEL FLOW

Maximum non-scouring velocities for open channels

Material	Maximum velocity on cover expected after two seasons					
	Bare		Medium grass cover		Very good grass cover	
	m/s	ft/s	m/s	ft/s	m/s	ft/s
Very light silty sand	0.3	1.0	0.75	2.5	1.5	4.5
Light loose sand	0.5	1.5	0.9	3.0	1.5	5.0
Coarse sand	0.75	2.5	1.25	4.0	1.7	5.5
Sandy soil	0.75	2.5	1.5	4.5	2.0	6.5
Firm clay loam	1.0	3.5	1.7	5.5	2.3	7.5
Stiff clay or stiff gravelly soil	1.5	4.5	1.8	6.0	2.5	8.0
Coarse gravels	1.5	5.0	1.8	6.0	Unlikely to form very good grass cover	
Shale, hardpan, soft rock, etc.	1.8	6.0	2.1	7.0		
Hard cemented conglomerates	2.5	8.0				

Intermediate values may be selected.

Design velocities for grass waterways (m/s)

	Slope 0.5 per cent	5-10 per cent	10 per cent
Soil resistant to erosion	2.0	1.75	1.50
Erodible soils	1.75	1.50	1.25

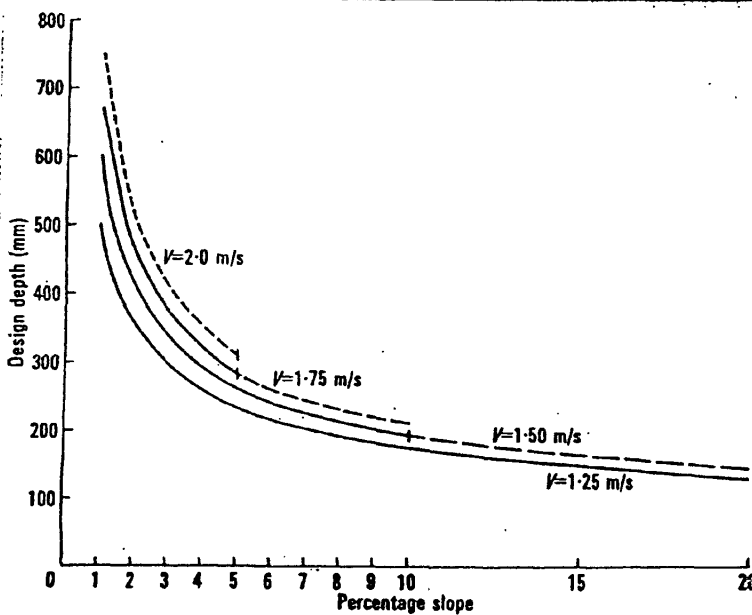
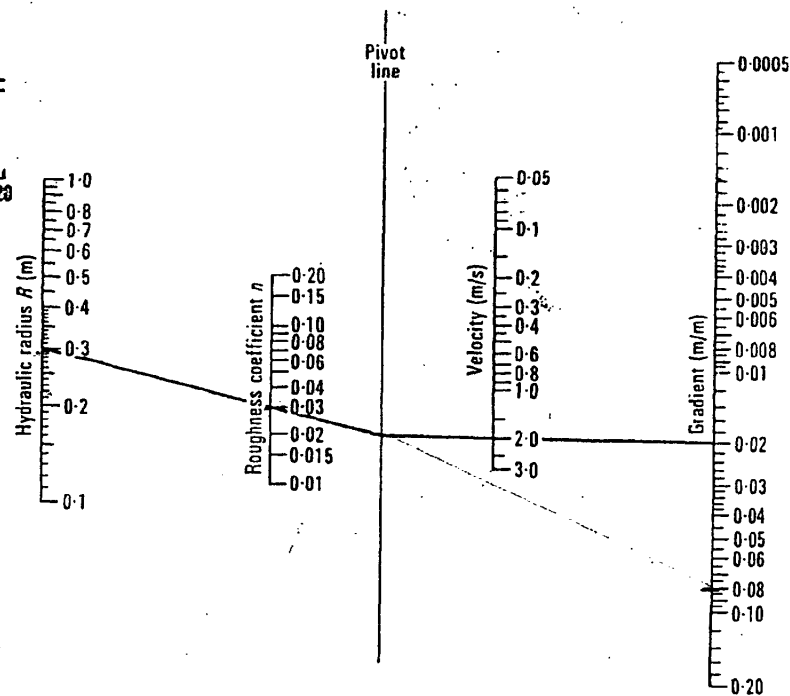


Chart for obtaining the design depth of shallow grassed drains and waterways. Dotted lines show values which should only be used on soils resistant to erosion.

	Area (a)	$bd + Zd^2$
	Wetted perimeter	$b + 2d\sqrt{1 + Z^2}$
	Hydraulic radius	$\frac{bd + Zd^2}{b + 2d\sqrt{1 + Z^2}}$
	Top width	$t = b + 2dZ$ $T = b + 2dZ$
	Area (a)	$\frac{2}{3}td$
	Wetted perimeter	$t + \frac{8d^2}{3t}$
	Hydraulic radius	$\frac{t^2 d}{1.5t^2 + 4d^2}$ (approx.) $\frac{2d}{3}$
	Top width	$t = \frac{3e}{2d}$ $T = t(\frac{D}{d})^{\frac{1}{2}}$

Basic dimensions of common channel sections.



A nomograph for the solution of Manning's equation. If any three variables are known, the fourth can be found.

Example. Given $R = 0.3$ m, $n = 0.03$, gradient = 2 per cent or 0.02 m per m, find velocity V .

Solution. Join $R = 0.3$ and $n = 0.03$ and project to the pivot line. Join the point on the pivot line to gradient = 0.02. Intersection of the velocity scale gives $V = 2.0$ m/s.