First Semester Examination
Academic Session 2018/2019

December 2018/January 2019

EAP315 – Wastewater Engineering
(Kejuruteraan Air Sisa)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **FIFTEEN (15)** pages of printed materials including appendix before you begin the examination.

[*Sila pastikan kertas peperiksaan ini mengandungi **LIMA BELAS (15)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions: This paper contains **FIVE (5)** questions. **PART A IS COMPULSORY**. Answer **THREE (3)** question in **PART B.** All question carry the same marks.

***[Arahan**: Kertas ini mengandungi **LIMA (5)** soalan. **BAHAGIAN A WAJIB DIJAWAB**. Jawab **TIGA (3)** soalan daripada **BAHAGIAN B**. Semua soalan membawa jumlah markah yang sama.]*

You may answer the questions either in Bahasa Malaysia or in English.

[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.*]

In the event of any discrepancies, the English version shall be used.

[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*]

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PART A: Compulsary (40 marks)

BAHAGIAN A: Wajib (40 markah)

(1). (a). By giving a suitable example, define inorganic matter and illustrate its influence on the overall wastewater treatment system.

Dengan memberikan contoh yang sesuai, definisikan bahan tak organik dan terangkan pengaruhnya terhadap keseluruhan sistem olahan air sisa.

[6 marks/*markah*]

(b). Determine the BOD value in gram/person.day for the following domestic wastewater:

Tentukan nilai BOD dalam gram/orang.hari untuk air sisa domestik yang berikut:

Population Equivalent (PE)=100 person
Penduduk Setara (PE)=100 orang

Average flow (Q) =22.5 m^3/day
Kadaralir purata (Q)= 22.5 m^3/hari

BOD=250 mg/L
BOD=250 mg/L

[7 marks/*markah*]

(c). Sketch a typical buffer zone requirement for a closed domestic wastewater treatment plant in Malaysia as recommended in the Malaysia Sewerage Industry Guidelines, 2009.

Lakarkan zon penampan tipikal untuk loji olahan air sisa domestik tertutup seperti disyorkan dalam Garis Panduan Industri Pembetungan Malaysia, 2009.

[6 marks/*markah*]

(d). A secondary sedimentation tank in an activated sludge process receives a design flow of 1,000 m^3/day. If the length to width ratio of the tank is kept at 3:1 and its Surface Overflow Rate (SOR) is 25 m^3/m^2.day, design the width of this tank.

Satu tangki enap sekunder loji olahan enap cemar teraktif menerima kadaralir reka bentuk sebanyak 100 m^3/hari. Sekiranya nisbah panjang ke lebar tangki dikekalkan pada 3:1 dan Kadar Limpah Permukaannya 25 m^3/m^2.hari, rekabentukan lebar tangki ini.

[6 marks/*markah*]

(e). There are many factors that influence the wastewater flowrate. Discuss **FIVE (5)** important factors that influence these flowrates and explain their importance in the design of sewer and wastewater treatment plant.

*Terdapat banyak faktor yang mempengaruhi aliran air sisa. Bincangkan **LIMA (5)** faktor penting yang mempengaruhi kadaralir air sisa dan terangkan kepentingnya dalam mereka bentuk pembentung dan loji rawatan air sisa.*

[10 marks/*markah*]

(f). The 20 ˚C BOD of a domestic wastewater at the end of 7 days was found to be 300 mg/L and the Ultimate BOD was 400 mg/L. Determine the 5-day BOD if the test was conducted at 28 ˚C.

BOD 20 ˚C air sisa domestik pada akhir hari ke 7 didapati adalah 300 mg/L dan BOD muktamad adalah 400 mg/L. Tentukan BOD 5-hari sekiranya ujikaji dijalankan pada suhu 28 ˚C.

[5 marks/*markah*]

PART B: Answer 3 out of 4 questions (20 marks each).

BAHAGIAN B: Jawab 3 dari 4 soalan (20 markah setiap satu).

(2). (a). Sketch a typical sludge flow diagram for an extended aeration wastewater treatment plant in Malaysia.

Lakarkan rajah tipikal kadaralir enap cemar untuk loji olahan air sisa pengudaraan lanjut di Malaysia.

[6 marks/*markah*]

(b). *Briefly define Sludge Volume Index (SVI) in an activated sludge process and explain its measurement method.*

Terangkan secara ringkas definasi Indeks Isipadu Enapcemar (SVI) dalam proses enap cemar teraktif dan terangkan kaedah penentuannya.

[6 marks/*markah*]

(c). *A group of restaurant discharges oily wastewater into a rectangular collective grease chamber with following data:*

Sekelompok restoran melepaskan airsisa berminyak ke dalam kebuk gris berkelompok segiempat dengan data seperti berikut:

Peak flow=200 m^3/day
Kadaralir puncak=200 m^3/hari

Retention time=3 minutes
Masa tahanan=3 minit

Length:Width=2:1
Panjang:Lebar=2:1

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Depth=2.5 m
Kedalaman=2.5 m

Design the tank and show the dimension, the weir and the skimmer.

Reka bentukkan tangki ini dengan menunjukkan dimensi, empang limpah dan pengekam.

[8 marks/*markah*]

(3). (a). An automatic screen needs to be installed at a new wastewater treatment plant at Q_{peak}. The design data are as follows:

Satu penyaring otomatik perlu dipasang di loji baharu olahan air sisa pada Q_{puncak}. Data reka bentuk adalah seperti berikut:

Population Equivalent (PE)	1,000 people
Penduduk Setara (PE)	*1,000 orang*

Size of opening	25 mm
Saiz bukaan	*25 mm*

Blade thickness	10 mm
Ketebalan bilah	*10 mm*

Maximum flow through velocity	60 m/min
Halaju lepasan maksimum	*60 m/min*

Depth of wastewater in the screen chamber	1.0 m
Kedalaman air sisa di kebuk penyaring	*1.0 m*

Storage period of screenings	3 days
Jangkamasa penstoran bahan saring	*3 hari*

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Water consumption rate 225 Liter/capita.day
Kadar penggunaan air *225 Liter/kapita.day*

(i). Design the width of the screen's chamber

Rekabentukan lebar kebuk penyaring

(ii). Estimate the quantity of screenings using the Chart given in the **Appendix.**

Anggarkan kuantiti bahan saring menggunakan carta di ***Lampiran.***

[10 marks/*markah*]

(b). (i). With the help of a sketch illustration, explain the principle of a low rate trickling filter in wastewater engineering.

Terangkan dengan bantuan lakaran, prinsip turas cucur kadar rendah dalam kejuruteraan air sisa.

(ii). A cylindrical shape low rate trickling filter has the following design data:

Satu turas cucur kadar rendah berbentuk silinder mempunyai data reka bentuk seperti berikut.

Design flow 500 m^3/day
Kadaralir reka bentuk 500 m^3/hari

Hydraulic loading 3 m^3/m^2.day
Beban hidraulik 3 m^3/m^2.hari

Height 4 m
Ketinggian 4 m

% Void 45%
% Rongga 45%

Calculate the net volume of the media that filled the tank.
Kirakan isipadu bersih media yang memenuhi tangki.

[10 marks/*markah*]

(4). (a). Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are two of the indicator parameters of organic matter in wastewater. Discuss **TWO (2)** main differences between these parameters.

*Keperluan Oksigen Biokimia (BOD) dan Keperluan Oksigen Kimia (COD) adalah dua daripada parameter penunjuk kepada bahan organik dalam air sisa. Bincangkan **DUA (2)** perbezaan utama antara parameter ini.*

[5 marks/*markah*]

(b). A township consists of 70 000 PE. The water supplied from this area is at a rate of 230 LPCD. A separate sewer system pipe with 70% full of its maximum flow is needed for this town. The Manning's roughness coefficient for the pipe material is n = 0.013 and permissible slope is 1 in 600. The maximum flow is expected as 3 times the average. With the aid of a partial flow diagram and reasonable assumption, determine the size of the required sewer pipe.

Satu kawasan perbandaran terdiri daripada 70 000 PE. Air yang dibekalkan ke kawasan ini adalah pada kadar 230 LPCD. Satu paip sistem pembetungan berasingan dengan 70% penuh dari aliran maksimum diperlukan untuk bandar ini. Pekali Kekasaran Manning's n = 0.013 untuk bahan paip dan cerun yang dibenarkan adalah 1 dalam 600. Aliran maksimum dijangka sebanyak 3 kali nilai purata. Dengan bantuan rajah aliran separa dan andaian yang munasabah, tentukan saiz paip pembetung yang diperlukan.

[15 marks/*markah*]

(5). (a). The reaction of BOD is directly proportional to the BOD coefficient, *k'.* Explain the relationship between BOD_5, ultimate BOD (L_o) and *k'* profile as shown in **Figure 1**.

Tindak balas BOD adalah berkadaran secara langsung dengan pekali BOD, k'. Jelaskan hubungan antara BOD_5, BOD muktamad (L_o) dan profail k' seperti yang ditunjukkan dalam ***Rajah 1.***

[8 marks/*markah*]

(i). Based on the given L_o and k'_1 value, determine the type of water in **Figure 1.**

Berdasarkan nilai L_o dan k'_1, *yang diberikan, tentukan jenis air dalam* ***Rajah 1.***

[2 marks/*markah*]

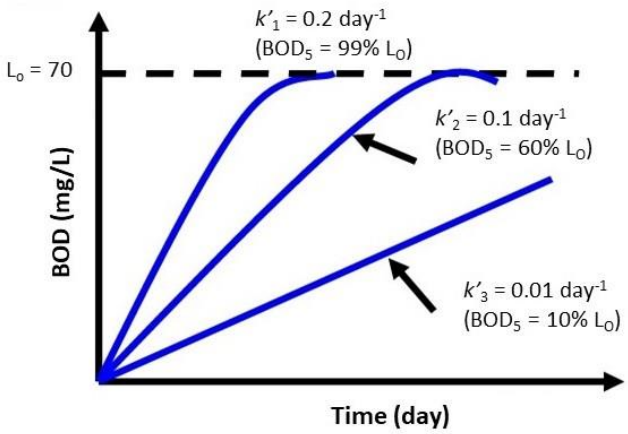

Figure 1: The reaction of BOD at the difference value of *k'*

Rajah 1: Reaksi BOD pada nilai k' yang berbeza

(b). In anaerobic process, slow hydrolysis remains a vital harvest and utilization constraints for useful energy due to the formation of toxic by-products or non-desirable volatile fatty acids formed during the hydrolysis step. Whilst, methanogenesis is the rate-limiting step for easily biodegradable organic matter. Explain **THREE (3)** main important factors that create an imbalance on volatile fatty acid concentration and methane production. Justify the answers.

*Dalam proses anaerobik, hidrolisis perlahan kekal menjadi kekangan utama pada penghasilan dan penggunaan tenaga berguna disebabkan oleh peghasilan bahan toksik atau asid lemak yang tidak diperlukan semasa proses hidrolisis. Sementara itu, methanogensis adalah proses yang menghadkan-kadar bahan organik mudah terurai. Jelaskan **TIGA (3)** faktor utama yang penting dalam mewujudkan ketidakseimbangan pada kepekatan asid lemak dan pengeluaran metana. Huraikan jawapan yang diberi.*

[10 marks/*markah*]

APPENDICES / *LAMPIRAN*

Peak Factor = $4.7\ p^{-0.11}$ (p in thousand)
Faktor Puncak = $4.7\ p^{-0.11}$ (p dalam ribu)

Retention time=Volume/discharge
Masa tahanan = Isipadu /kadaralir

Population Equivalent = $\frac{\text{Organic load from premises}}{\text{Organic load from 1 person}}$
Penduduk Setara = $\frac{\text{Beban Organik Premis}}{\text{Beban Organik 1 orang}}$

Manning: $Q=(1/n)\ (A)\ (R)^{2/3}\ (s)^{1/2}$

$V=(1/n)\ (R)^{2/3}\ (s)^{1/2}$

$R=A/P$

Width of screen = $\frac{\text{(width of blade + opening)}}{\text{opening}} \quad \frac{\text{(Discharge)}}{\text{(velocity) (depth of wastewater)}}$
Lebar saring = $\frac{\text{(Lebar bilah + saiz bukaan)}}{\text{Saiz bukaan}} \quad \frac{\text{(Kadaralir)}}{\text{(Halaju) (Kedalaman air sisa)}}$

Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{\text{(Pumping rate-Dry Weather Flow)}}$
Sela pengepaman = $\frac{\text{Isipadu sebenar}}{\text{Kadaralir Cuaca Kering}} + \frac{\text{Isipadu sebenar}}{\text{(Kadar pam-Kadaralir Cuaca Kering)}}$

Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$
Kadar Beban Permukaan = $\frac{\text{Kadaralir}}{\text{Luas Permukaan}}$

Solids Loading Rate = $\frac{\text{(Discharge) (Mixed Liquor)}}{\text{Surface Area}}$
Kadar Beban Pepejal = $\frac{\text{(Kadaralir) (Likur Tercampur)}}{\text{Luas Permukaan}}$

Weir Loading Rate = $\frac{\text{Discharge}}{\text{Length of weir}}$
Kadar Beban Empang Limpah = $\frac{\text{Kadaralir}}{\text{Panjang Empang Limpah}}$

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Volume of pyramid = (1/3) (base area) (height)
Isipadu Piramid = (1/3) (luas dasar) (tinggi)

Organic Load = (Discharge) (BOD)
Beban Organik = (Kadaralir) (BOD)

Keluasan Tangki enap primer = $\frac{\text{(Kadaralir + Kadaralir Pusing Balik) (Likur Tercampur)}}{\text{Fluks}}$

Fluks Pepejal = $\frac{\text{Halaju enapan}}{\text{(1/Kepekatan Pepejal) - (1/Kepekatan Pepejal Terenap)}}$

Kinetik BOD $BOD_t=Lo(1-10^{-k.t})$
$=Lo(1-e^{-k.t})$

$k_T=k_{20}(1.047)^{(T-20)}$

$L_T=L_{20}[1+0.02(T-20)]$

Thomas: $(t/BOD)^{1/3} = (kL_o)^{-1/3} + (k^{2/3}/6L_o^{1/3})\ t$

Beban Organik = (Kadaralir) (BOD)

Beban Organik Isipadu = $\frac{\text{(Kadaralir) (BOD)}}{\text{Isipadu}}$

Makanan: Microorganism = $\frac{\text{(Kadaralir) (BOD)}}{\text{(Isipadu) (Likur Tercampur)}}$

Beban Organik Kawasan = $\frac{\text{(Kadaralir) (BOD)}}{\text{Luas Permukaan}}$

Keperluan Oksigen = $\frac{Q \times BOD_5}{BOD_5/BOD_L} - 1.42\ Px$

Pertambahan Likur Tercampur = $\frac{y}{1+kd\theta c}$(Kadaralir)(BOD)

Nisbah enap cemar kembali $R=\frac{\text{Kadaralir kembali}}{\text{Kadaralir}}$

$X_a=X_R(R/1+R)$

...12/-

Keperluan Oksigen = aLr + bSa
a = Pekali penyingkiran BOD

Lr = BOD tersingkir
b = pekali endagenous enap cemar

Sa = Jisim Likur Tercampur

Kadar Bekalan Oksigen = Oksigen Diperlu / BOD tersingkir

Umur = (Isipadu) (Likur Tercampur) / E.C. (Kadaralir Disingkir)(Likur Tercampur Pusing Balik) + (Kadaralir Efluen)(Pepejal Terampai Efluen)

$1/\theta = yu - k_d$

$\theta_c = \frac{V.MLSS}{Q_w.SS}$

Indeks Isipadu Enap cemar (SVI) = (Isipadu MLSS mengenap dalam 30 minit)/MLSS

Tangki Septik, C=225P

Pond design:

$L_e/L_i = 1/(1+k_1t)$

$A = Q/Dk_1 [L_i/L_e-1]$

$k_T = 0.30 (1.085)^{T-20}$

Organic Loading = L_iQ/A
Beban Organik = L_iQ/A

Maximum Organic Loading = $7.5 (1.054)^T$
Beban Organik Maksimum = $7.5 (1.054)^T$

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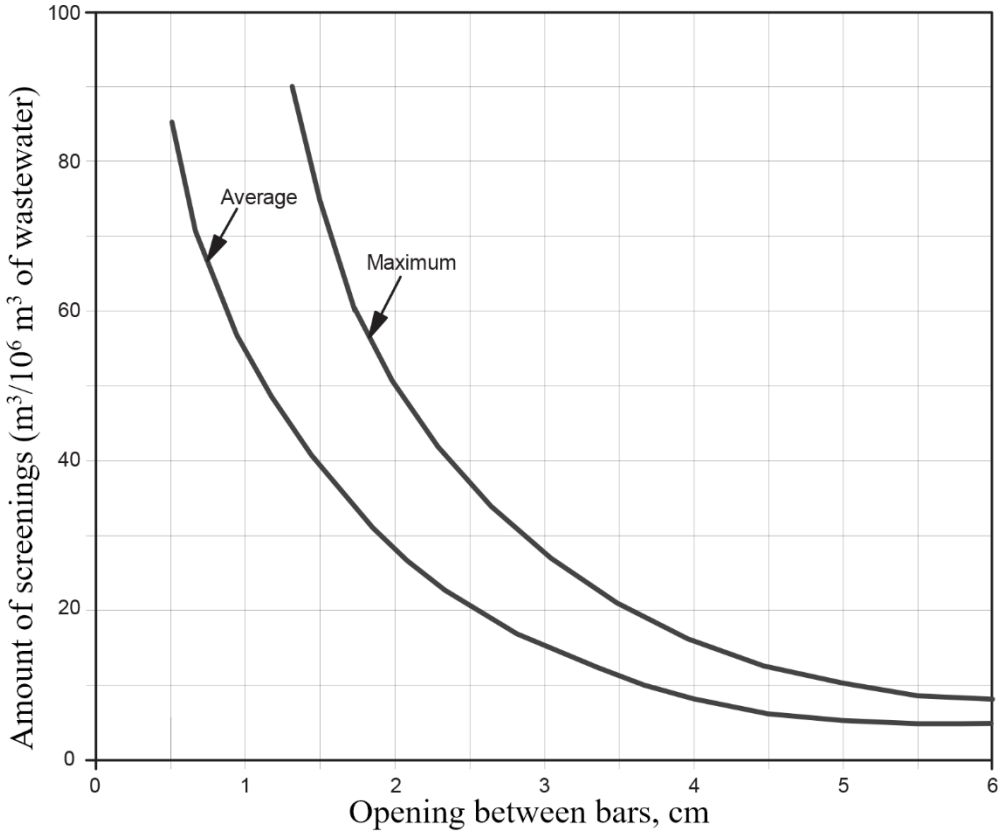

Screenings chart

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Recommended Population Equivalent (Source: Malaysian Standard 1228)

Type of Premises/Establishment	**Recommended Population Equivalent (PE)**
Residential	5 per house
Commercial: Includes offices, shopping complex, entertainment/recreational centres, restaurants, cafeteria, theatres	3 per 100 m^2 gross area
Schools/Educational Institutions: - Day schools/Institutions - Fully residential - Partial residential	 0.2 per student 1 per student 0.2 per non-residential student 1 per residential student
Hospitals	4 per bed
Hotels with dining and laundry facilities	4 per room
Factories, excluding process water	0.3 per staff
Market (wet type)	3 per stall
Market (dry type)	1 per stall
Petrol kiosks/Service stations	15 per toilet
Bus terminal	4 per bus bay
Taxi terminal	4 per taxi bay
Mosque/Church/Temple	0.2 per person
Stadium	0.2 per person
Swimming pool/Sports complex	0.5 per person
Public toilet	15 per toilet
Airport	0.2 per passenger 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf course	20 per hole

The water consumption rate (q) is 225 Liter/capita.day.

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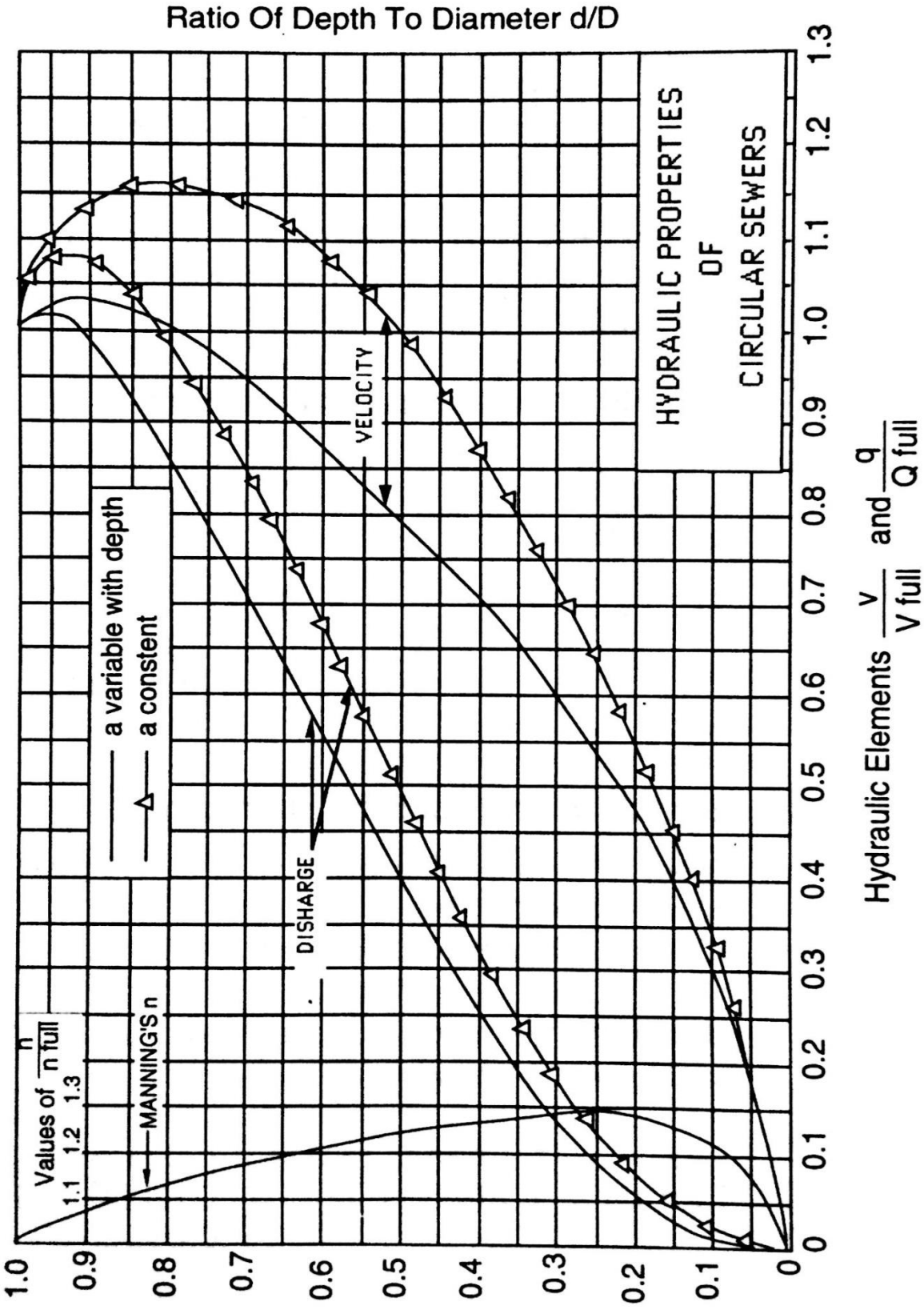
Ratio Of Depth To Diameter d/D
HYDRAULIC PROPERTIES OF CIRCULAR SEWERS
VELOCITY
DISHARGE
a variable with depth
a constent
MANNING'S n
Values of n / n full
1.1 1.2 1.3
Hydraulic Elements v / V full and q / Q full
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0

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