This task involves estimation of hydrograph in a subcatchment outlet considering storage routing (module 6), urban design discharges (module 7) and yield analysis (module 8). The assignment is divided into three parts:

• Part A – Subcatchment storage routing

• Part B – Estimation of Minor and Major design flows for a residential subdivision

• Part C – Feasibility study of a proposed water supply dam (yield analysis)

2. Part A - Subcatchment Storage Routing

A. Consider a subcatchment area of 6 km2 and its centroid is located at 28.3407 S and 152.3760 E. Extract the 1 in 100 AEP, 60-minute design storm data for the subcatchment from the ARR2016 Design Rainfalls1. Extract the temporal pattern (EventID 1991) from the ARR Data Hub2 for the subcatchment and generate a table showing the 5-minute time interval design rainfall intensity.

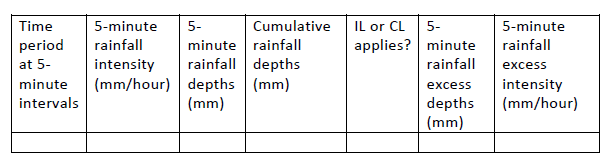
<http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=20162>

<https://data.arr-software.org>

B. The initial and continuing loss (IL-CL) data across Australia is discussed in the ARR 2016 Book 5 – Flood Hydrograph Estimation (Ch 3 Losses)3. The recommended IL (mm) and CL (mm/hour) value across Australia can be found in Figure 5.3.18 and Figure 5.3.19, respectively in ARR 2019. Consider that the subcatchment is located in South East Queensland and the recommended IL is 20 mm and CL is 2 mm/hour. Using the 5-minute intervals design rainfall data estimated for the subcatchment (1% AEP, 1 hour), catchment area of 6 km2, and the recommended IL = 20 mm and CL = 2 mm/hour, you need to perform the following tasks:

<http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/>

1. Provide a table (as shown below) showing the 5-minute rainfall depths (mm), cumulative rainfall (mm), IL or CL applies, 5-minute rainfall excess depths (mm) using the recommended IL-CL values and 5-minute rainfall excess intensity (mm/hour). What is the volumetric runoff coefficient in %?



b) Convert the 5-minute rainfall excess hyetograph to a subcatchment instantaneous discharge hydrograph (in m3/s) using Equation 6.1 provided in the Study Book (section 6.3.2, page 14). You need to provide:

1. A table showing the 5-minute rainfall excess intensity (mm/h) and subcatchment instantaneous discharge (m3/s), and

2. A figure showing the rainfall excess hyetograph (time step vs rainfall intensity in mm/hr) and the instantaneous hydrograph (time step vs discharge in m3/s).

c) Perform a subcatchment storage routing using Equations 6.2 – 6.8 provided in the Study Book (section 6.3.3, pages 16-18). You may assume that at the beginning of storm (time is zero) both storage and subcatchment outlet discharge are zero. You need to provide:

1. A look-up table showing the relation between discharge (Q in m3/s), storage (S in m3) and [2S/Δt + Q] in m3/s. In order to develop the Look-up table, you can assume a series of Q values, and then estimate storage S (using equation 6.2, c= 1.6) and [2S/Δt + Q]. You can provide the first few rows of the look-up table in the report, and keep the long look-up table in the excel file.

2. A table showing your subcatchment routing estimation as shown in Table 6.7 (Study Book).

3. A figure showing the inflow (instantaneous) and subcatchment outlet hydrographs.

4. Report the attenuation (reduction of peak in m3/s) and translation (lag in time unit).

3. Part B – Minor and Major Design Discharges

3.1 Proposed residential subdivision

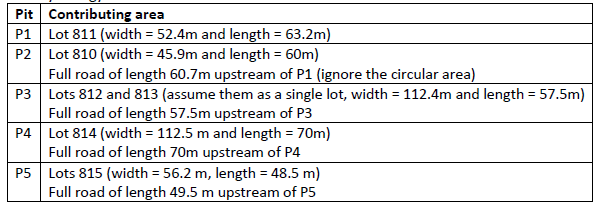
A drainage scheme is to be designed for a residential area located in Brisbane, Queensland. A schematic subdivision layout plan is shown in Figure 3.1 (collected from iplan4). Contour lines (0.5m interval) are shown in the subdivision plan. The subdivision includes 17 lots (numbers 801-816 and 900) and a 20m wide new road as shown in the plan. After development, the fraction impervious of the lots will be 0.3. It is assumed that the pavement width in the proposed new road is 10 m. The road crossfall is 1:40 [vertical 1, horizontal 40] one-way. The road will have a 200 mm high vertical kerb and a 0.45 m wide gutter having a crossfall of 1:10. The kerb and gutter is provided in one side of the road. The drainage scheme includes five on-grade Pits (P1 to P5) as shown in the plan. Pits and their catchments are provided in Table 3.1.

Your task is to prepare a Minor system design check of the stormwater system upstream and including Pit 5 (P1 to P5) based on the preliminary layout shown in the plan and then a Major flood hazard check in the road just downstream of Pit 4 (P4). The Minor system is to cater for the 2 year ARI storm and the Major system for the 100 year ARI storm. The system includes drainage pipes (Pipe 1-2, Pipe 2-3, Pipe 3-4 and Pipe 4-5).

<https://i-plan.com.au/projects/>



Figure 3.1: Preliminary layout of stormwater drainage system in a residential subdivision (a good resolution figure has been uploaded separately)



Use the following information:

1. The approximate location of the subdivision is 27.6897° S, 153.0881° E. You can use this coordinate to download rainfall IFD data from

<http://www.bom.gov.au/water/designRainfalls/revised-ifd/>

2. Consider ‘Type E Kerb and Channel, 2400 lintel’ as the pit inlet. The hydraulic capture charts (BSD-8079) for this type of inlet can be downloaded from:

<https://www.brisbane.qld.gov.au/planning-and-building/planning-guidelines-and-tools/planning-guidelines/standard-drawings> (8000 series)

The pavement width of the new road is 9 m and 1m wide footpath will be provided on one side of the road. Therefore, the road reserve is 50% impervious.

3. The proposed lots will be developed to ‘low density residential’ with an expected percentage impervious within the lot area of 30%.

4. Soil permeability can be classed as ‘Medium’. Pervious parts of the subdivision can be classed as ‘Medium density bush’ or “Good grass cover’.

5. Assume no flow of stormwater runoff into lots from neighbouring lots (i.e no flow across shared lot boundaries).

6. The minimum travel time to a pit is 5 minutes and the maximum is 20 minutes. Reminder: Partial Area check is based on the most remote, directly connected impervious area to the pit. The travel time may be longer than 5 minutes.

7. It is acceptable to scale up the CA values based on the frequency factor ratio F100/F2– this will simplify the calculations for the Major Storm analysis (C is discharge coefficient, A is catchment area and F is frequency factor).

8. For pipe flow travel times for Design Sheet 2, use a minimum pipe gradient of 0.3% otherwise the road slope calculated from contour lines.

9. Gutter flow width in the street during the Minor storm should not exceed 1 m. The maximum flow depth at the road kerb during the Major storm should contain flooding to within the road reserve. This corresponds to a maximum water depth of 0.25m. dV product should not exceed 0.3 m2/s for both minor and major storm discharges.

10. Undertake the Major design flow check for Road at just downstream of pit 4 (P4).

11. Use Design Sheets 1, 2 and 3 to perform the major and minor storm discharges to pits and pipes, and use the Izzards equation (available as a spreadsheet in ENV3105StudyResources.xlsx) for flood hazard checks.

4. Part C – Feasibility Study of a Proposed Water Supply Dam (Yield Analysis)

Oakey is a rural town in the Darling Downs region of Queensland, Australia. It is situated 29 kilometres west of the regional city of Toowoomba. The population of Oakey is about five thousands. Oakey has been supplied with water from the Mt Kynoch Water Treatment Plant since the commissioning of the Toowoomba-Oakey pipeline in December 1997. In order to augment the water supply security in the Oakey town, a proposal has been submitted to the Toowoomba Regional Council to construct a dam (reservoir capacity is 150 ML when full). The preliminary location of the Dam is near to the Gowrie Creek at Oakey (site number 422332B). When full, surface area of the reservoir is 18,000 m2 and the maximum volume is 150,000 m3. The Toowoomba Regional Council has engaged you to provide them a preliminary feasibility study report to justify this plan. Therefore, you are requested to perform a daily yield analysis for the year 2023 (365 days). As a preliminary feasibility study, you are requested to estimate a maximum daily water demand (in ML/day) that can be diverted (or extracted) from the reservoir with a reliability of 99%.

• You can download the Gowrie creek at Oakay (422332B) daily streamflow volume (ML/day) from the water monitoring portal <https://water-monitoring.information.qld.gov.au/>. The streamgauge site is located under the Balonne-Condamine Basin. Use the mean daily discharge value for this analysis.

• Daily rainfall total data for the location can be extracted from the BOM’s Climate Data Online service, rainfall station 041359 (Oakey Aero QLD). Any missing value for the year 2023 can be assumed as zero rainfall. <http://www.bom.gov.au/climate/data/>

• The average pan evaporation data is provided below in Table 4.1. You can consider a constant daily evaporation rate for all the days in a month. A pan coefficient of 0.8 is applicable.

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• On 31st December 2022, storage volume in the dam was 39 ML.

• Ignore seepage losses for this preliminary feasibility study.

• Neglect the change in surface area with storage height/volume and you may consider a constant surface area of 18,000 m2 for all the cases in this preliminary assessment.

• Table 8.5 in the Study Desk (Mod 8 Table 8.5 in the ENV3105StudyResources.xlsx) can be used to solve this yield analysis

• Apply the trial and error method (by changing daily demand and by checking reliability) to estimate the maximum diverted water (demand) at 99% reliability.

5. Submission Requirements

• A marking scheme is provided as Table 6.1. Use this marking scheme to check that you have addressed the full scope of the work. If an element of the assignment has not been documented in the file report then no marks will be given for that element. Please prepare a report and provide the answers to all the sections listed in the Assignment task sheet. Wherever required, please include the screenshot of Excel answers while substantiating the answers in the report.

• An EXCEL spreadsheet containing your hydrological computations. Multiple spreadsheets will not be accepted – instead put your workings in separate sheets within the one EXCEL file. Include a list indicating the contents of each sheet to aid marking in the above report.

• Part of the available marks has been allocated to reward reporting that is well set out and easy to follow. Submissions that are untidy and/or poorly structured and thus difficult to assess will attract less marks for this element.

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