Irrigation: water control

Irrigation and Drainage
CT4410

Water Resources Management

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Technische Universiteit Delft

What to do?

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Water control: Main issues

- **Distribution: demand or supply**
  - **Free demand or arranged demand**
- **Control: Upstream or downstream**
- **Type of (configurations of) structures to use**
  - **Sensitivity and flexibility**

Please note that water allocation (and water rights) is a very important issue, but that we do not discuss that now

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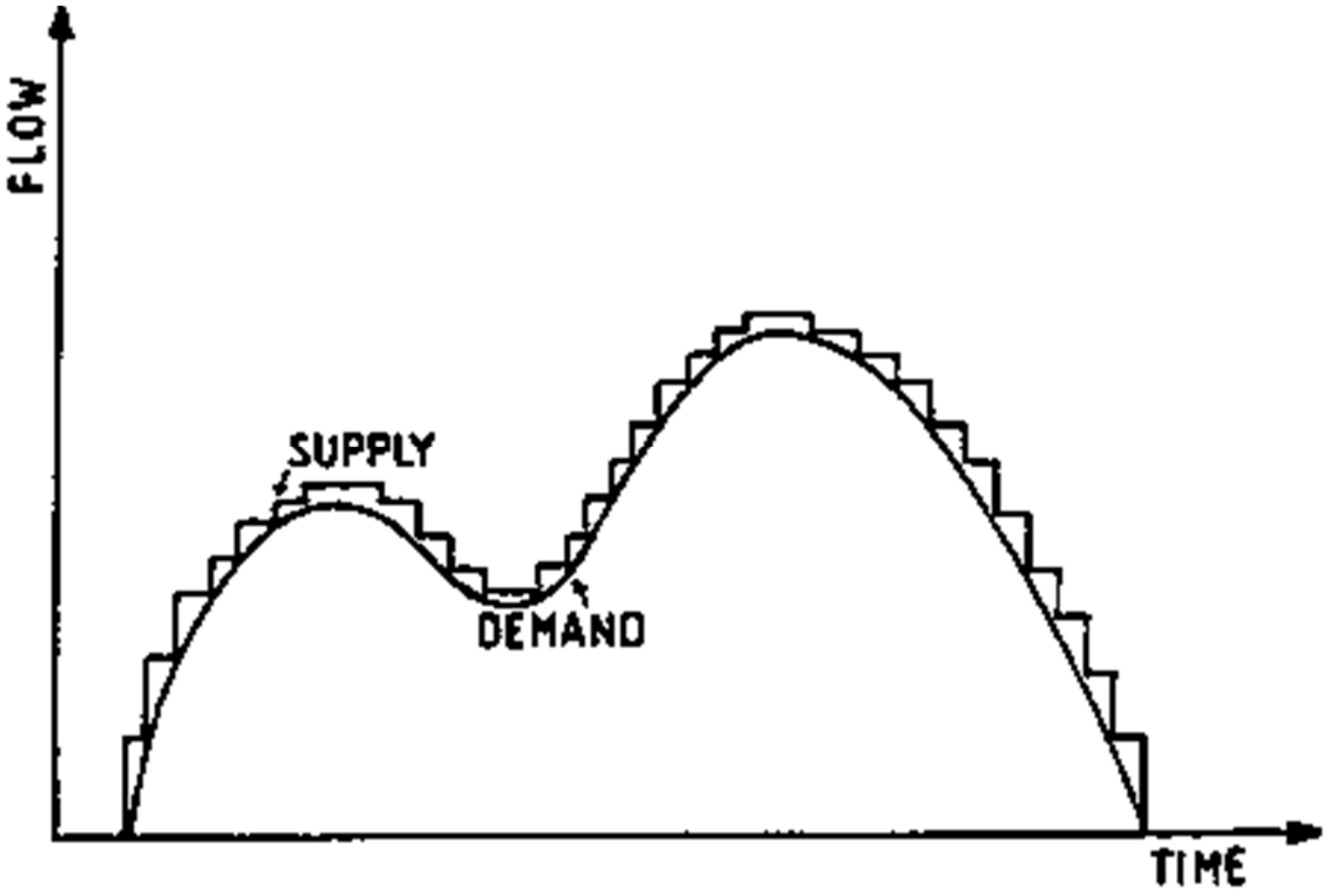
What is desirable on system level



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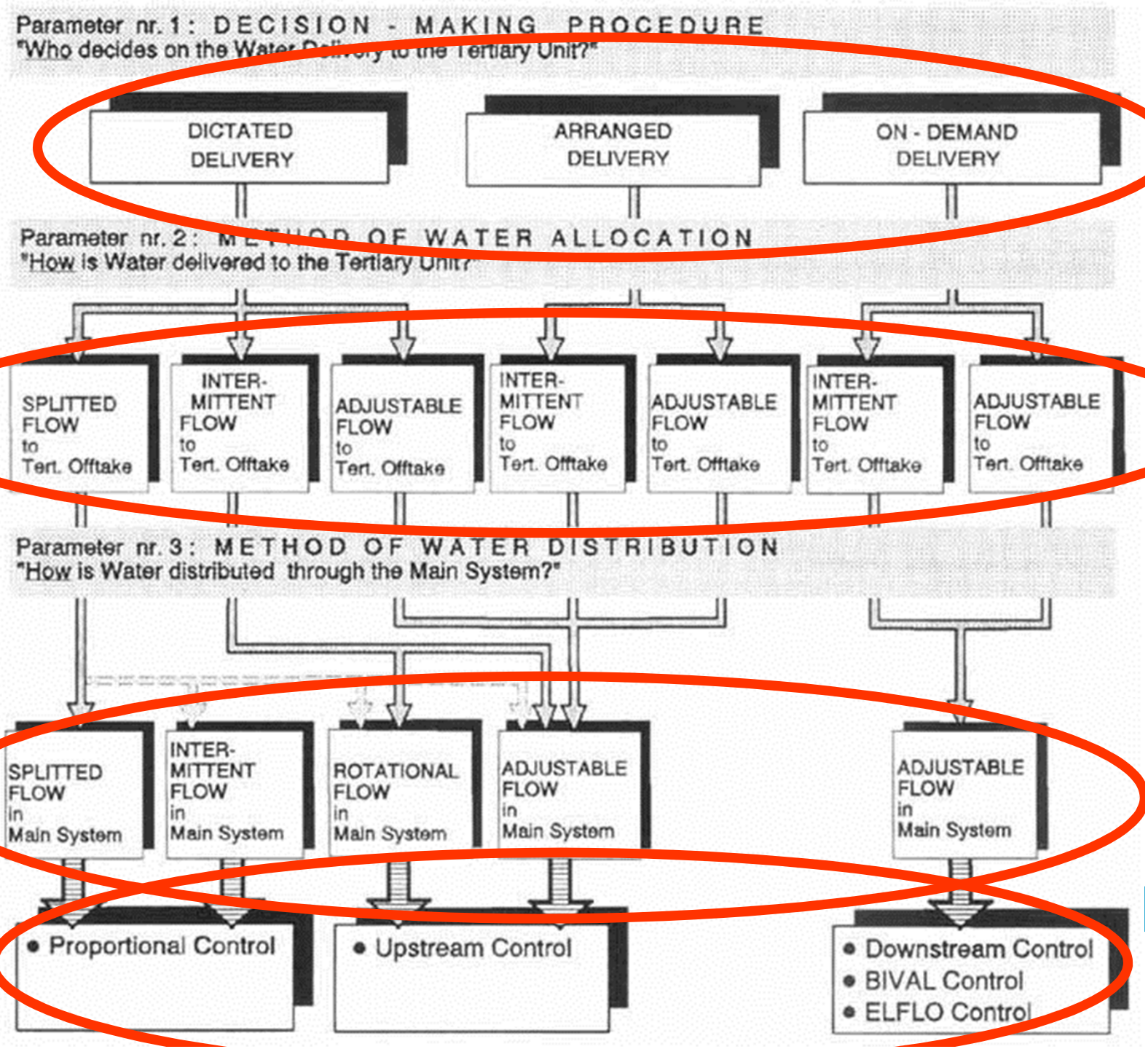
What can be selec-ted



Proportional

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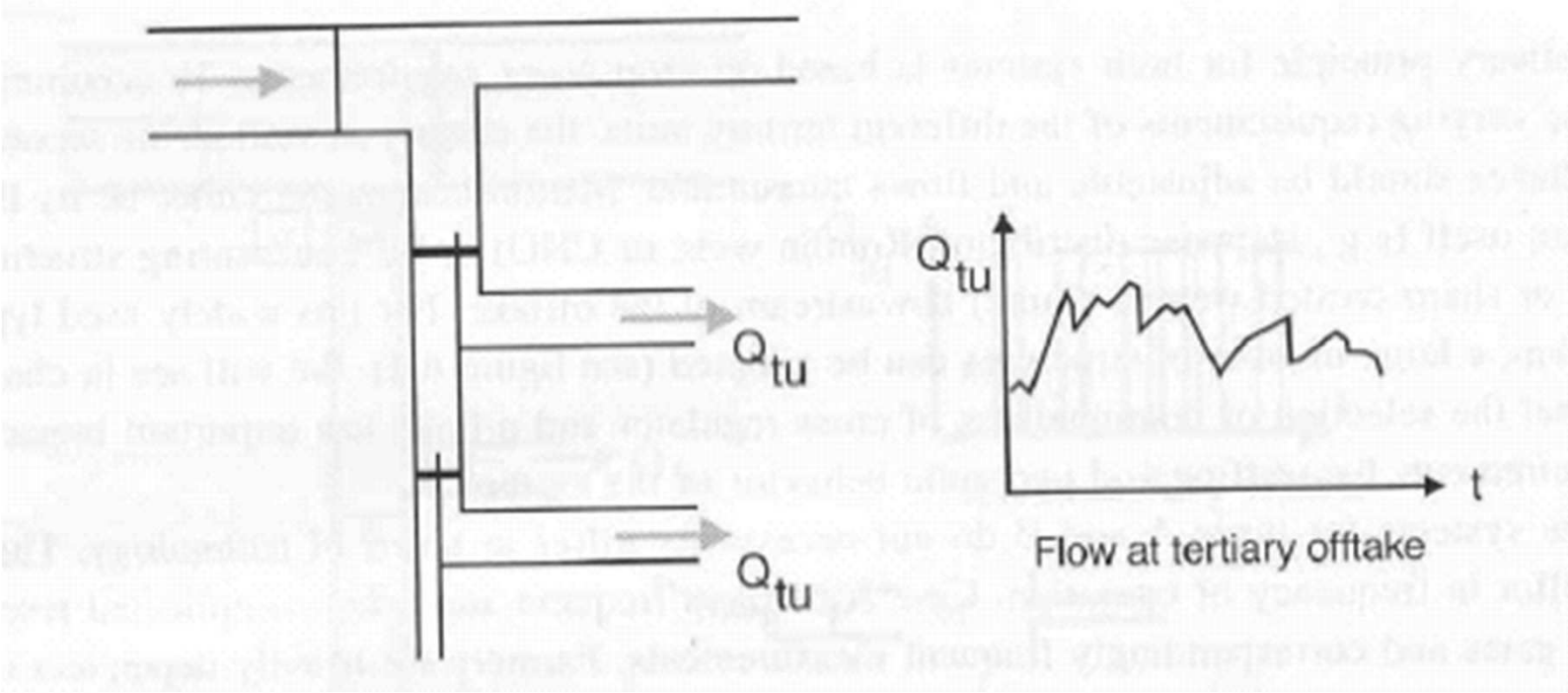
Proportional (splitted)



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What is this?

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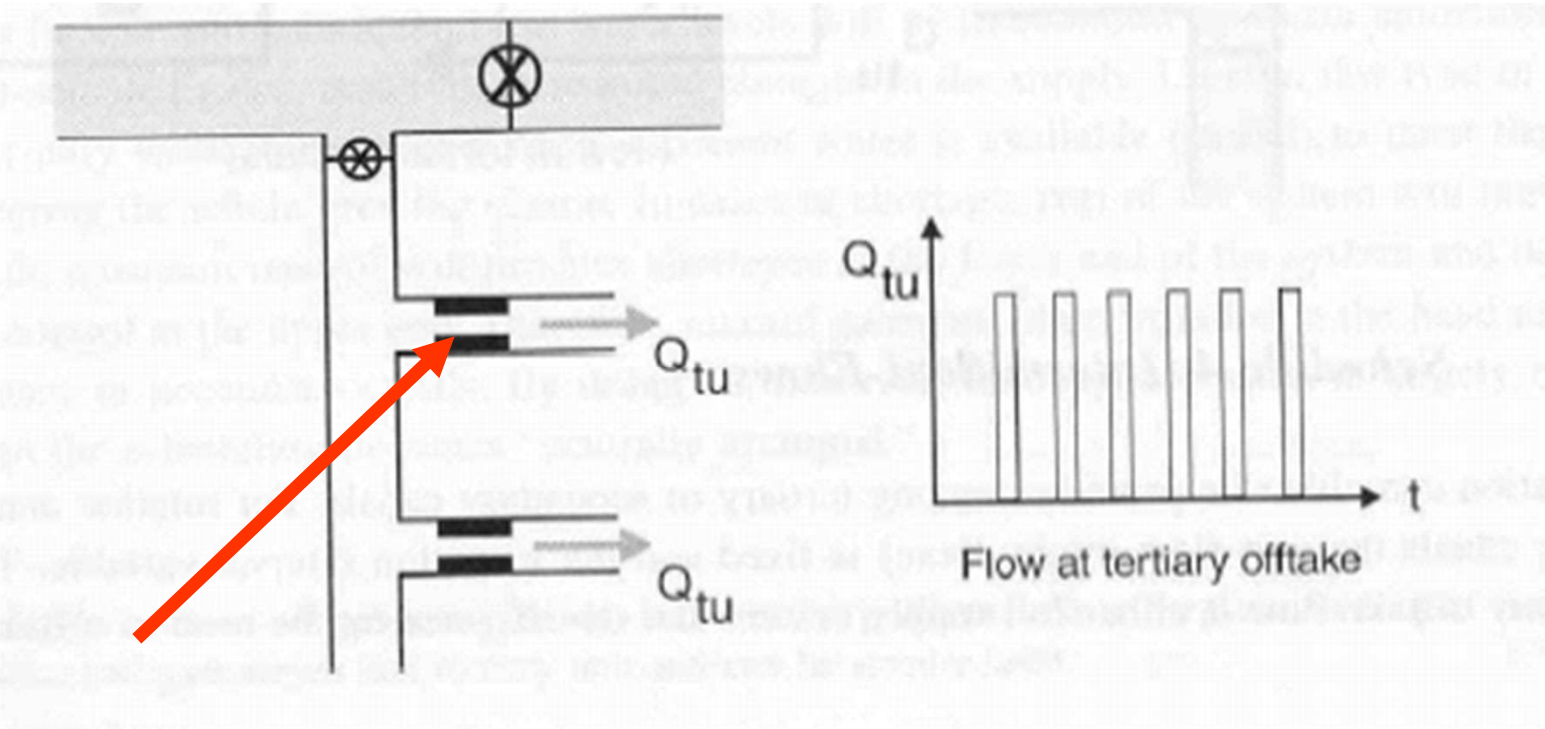
Proportional, but arranged



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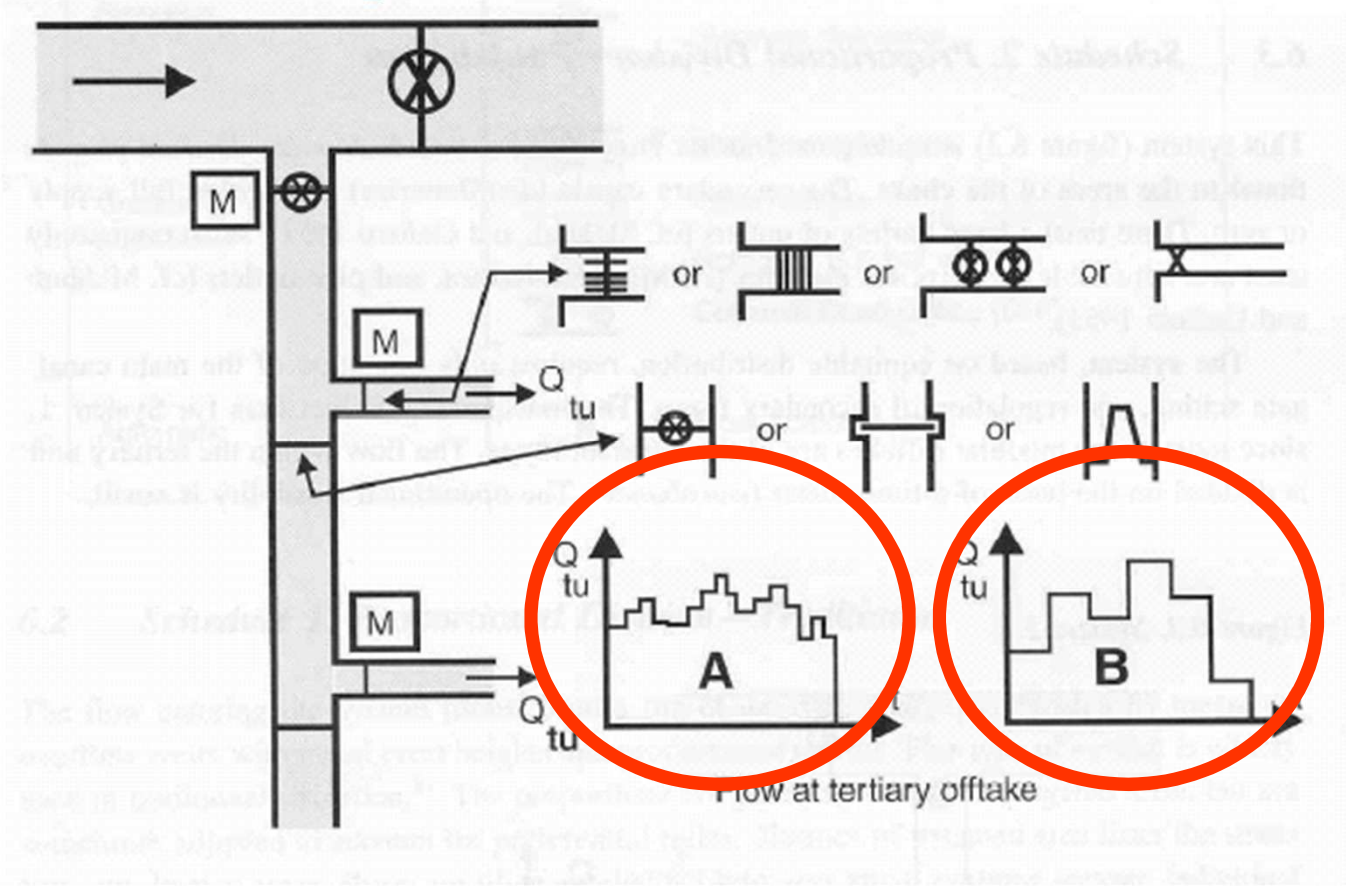
Variable (adjustable) flows: continuously



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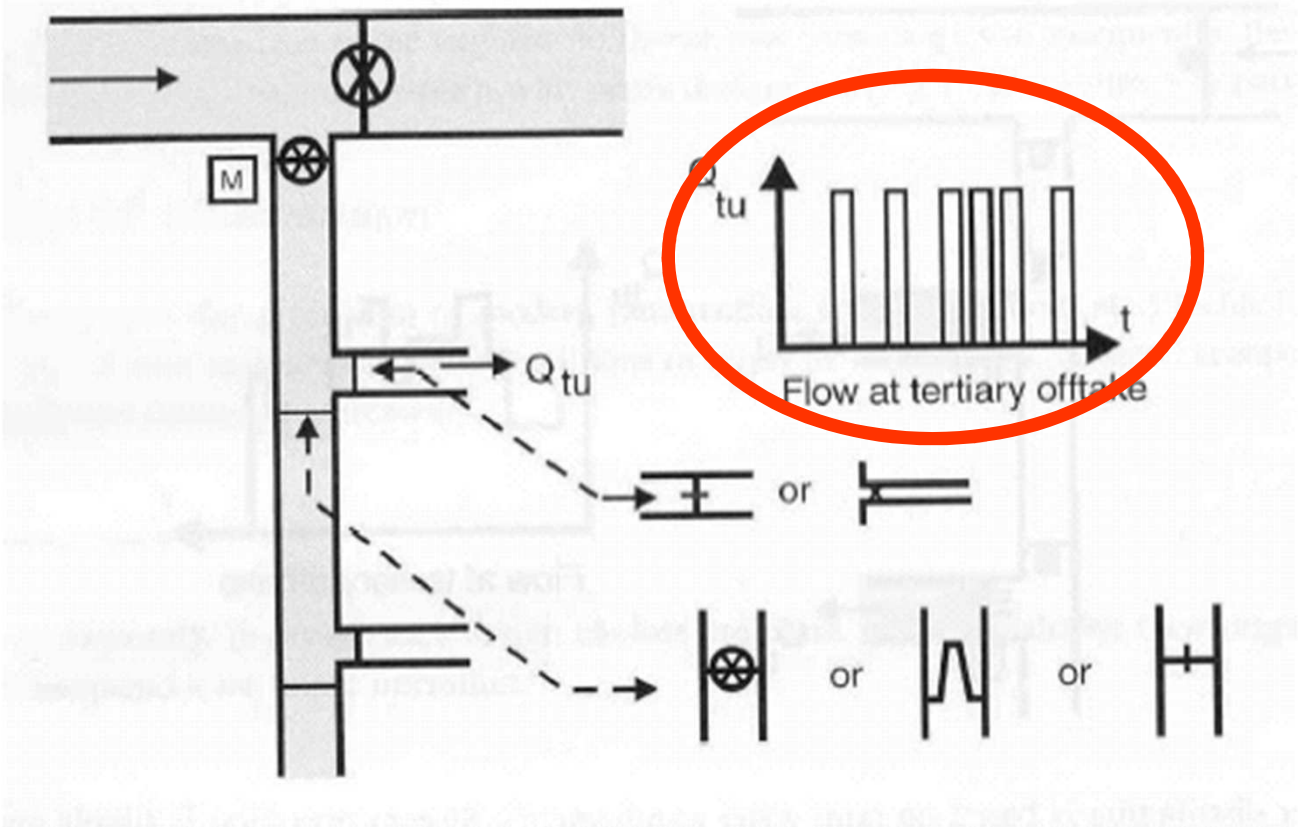
Variable flow: intermittent



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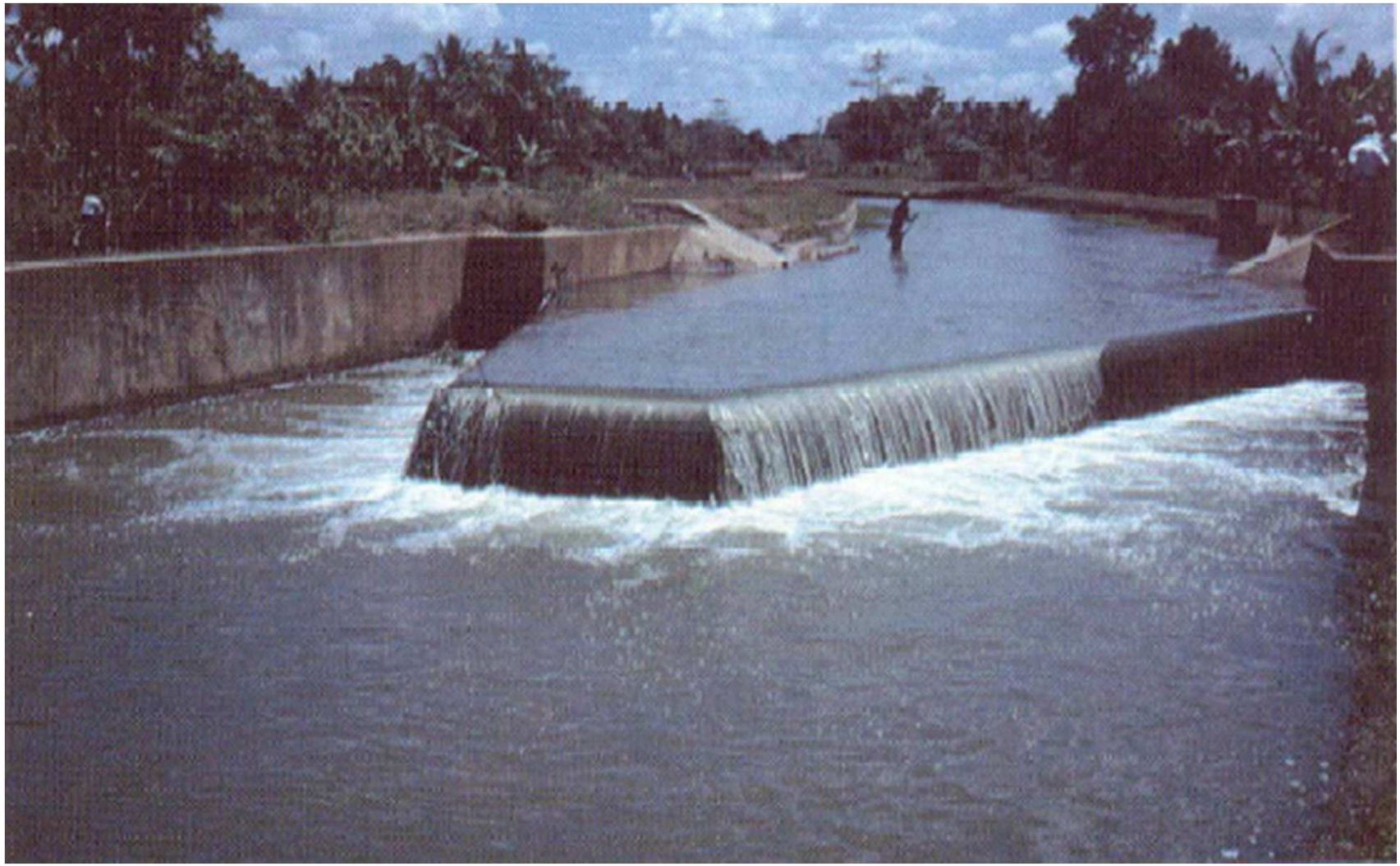

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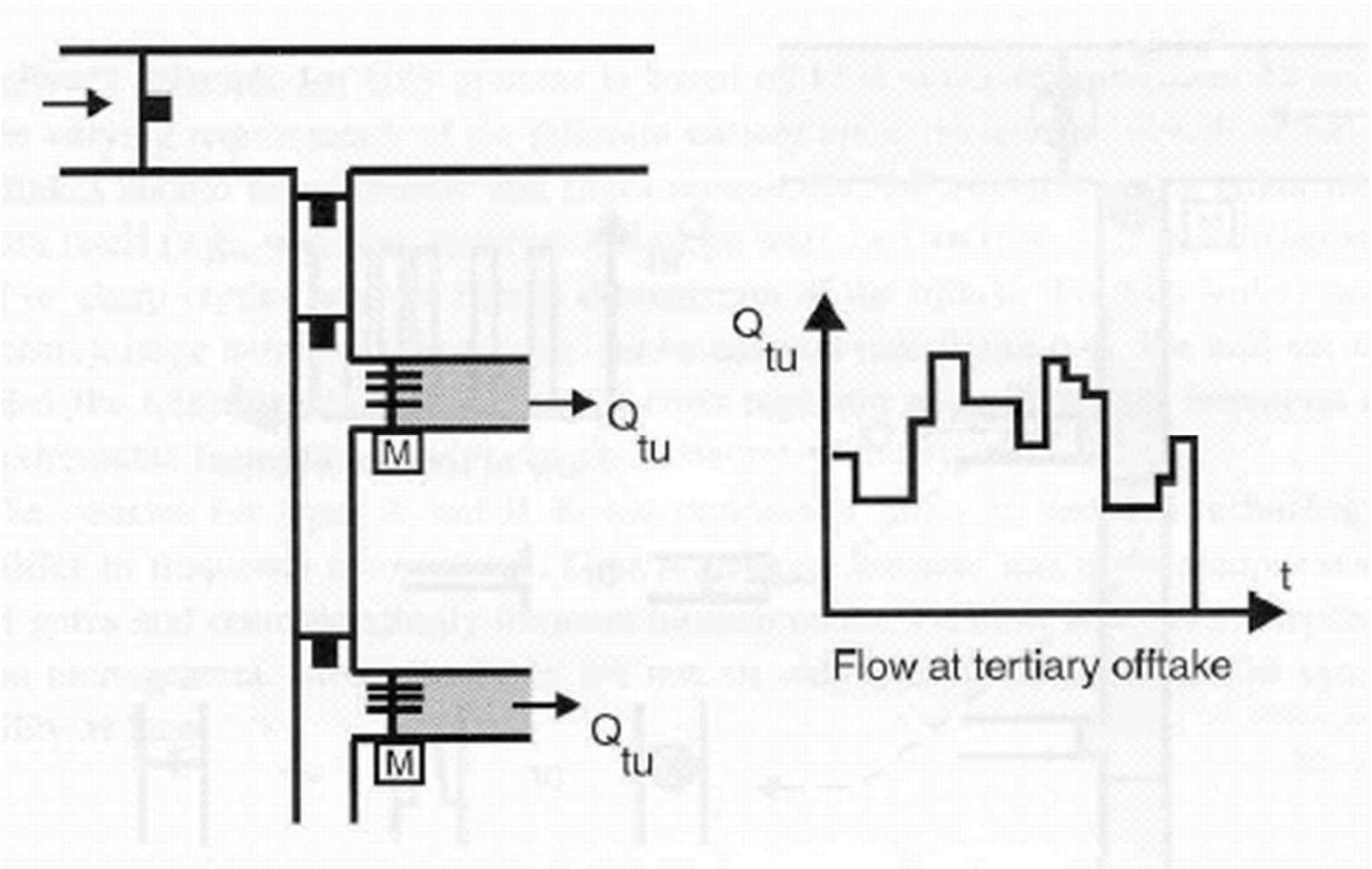
Demand based, downstream control



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Which element supports downstream control and which element does not?

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Sensitivity

$$Q = c.h^u$$

The Sensitivity S of a structure depends on the power u and the head h. It is commonly expressed as the fractional change of discharge caused by the unit rise of the upstream head:[20]

$$S = \frac{\Delta Q}{Q} = \frac{\left(\frac{dQ}{dh}\right).\Delta h}{Q}$$

or with $Q = c.h^u$:

$$S = \frac{c.u.h^{u-1}.\Delta h}{c.h^u} = \frac{u}{h}\,\Delta h$$

Sensitivity

$$S = \frac{u}{h}\,\Delta h$$

Summarizing, the most common values for u are:

Sensitivity requirements depend on the purpose of the structure:

- To minimize upstream head fluctuations, the Sensitivity should be high. In other words, the structure should have the highest possible factor u/h:

  u large: weir or flume (u = 1.5).
  h small: weir with long crest (e.g., duck bill weir).

- To minimize fluctuations of discharge through the structure, caused by varying upstream water levels. In this case, the factor u/h should be as small as possible (undershot type: u = 0.5 and h as large as possible, entrance as narrow as possible).

- To measure discharges. Here also the Sensitivity should be small (small variation in Q should result in a relatively large variation in h to enable accurate reading).

Hydraulic flexibility

The Hydraulic Flexibility can be expressed as:

$$F = \frac{S_o}{S_s} = \frac{\frac{u_o}{h_o}.\Delta h}{\frac{u_s}{h_s}.\Delta h} = \frac{u_o\ h_s}{u_s\ h_o}$$

where,

u = power u of $Q = c.h^u$

h = head

o = offtake

s = supply (ongoing) flow

S = Sensitivity

(cf. Bos ed. 1978)

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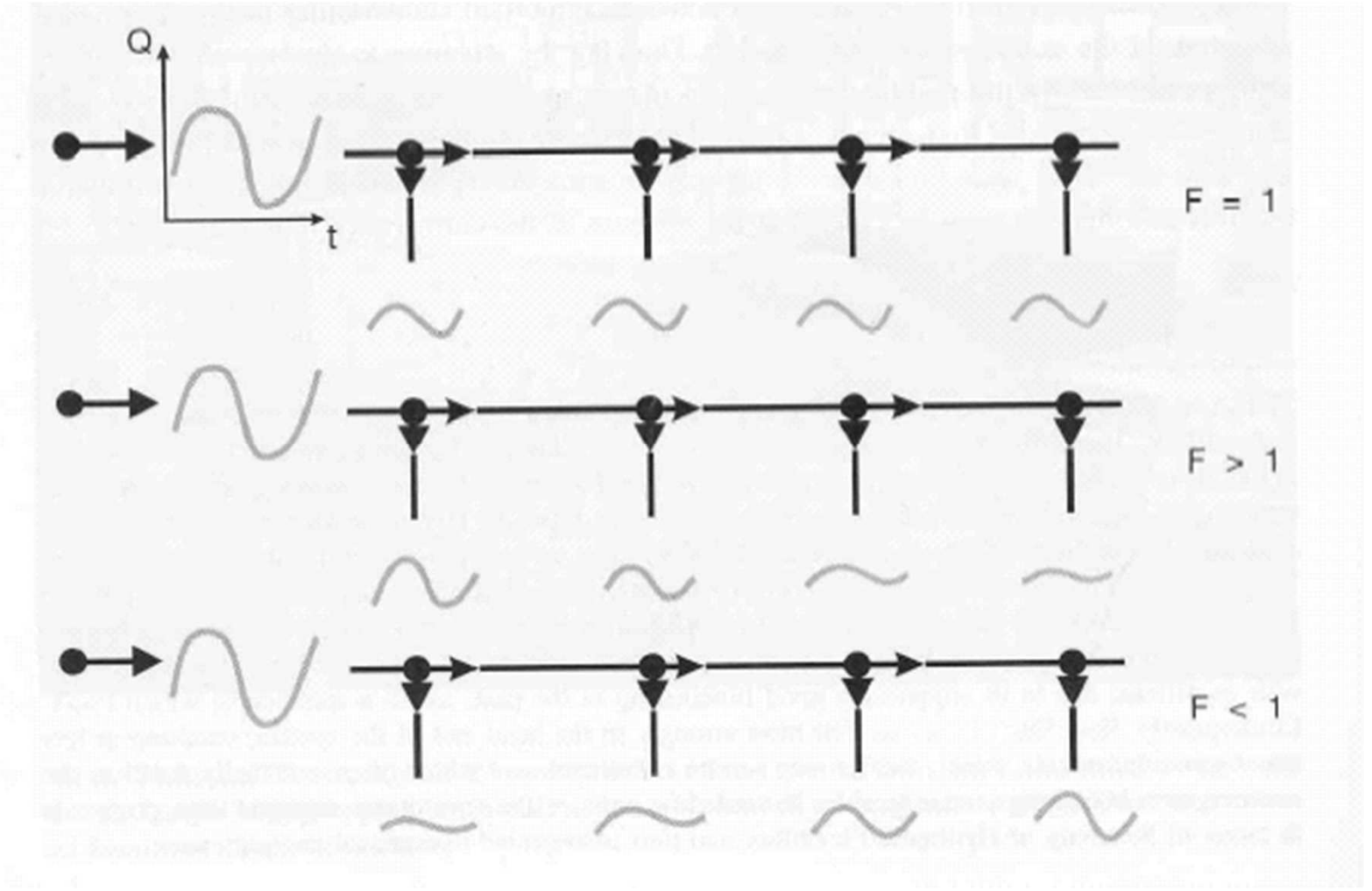
Fluctuations in the system



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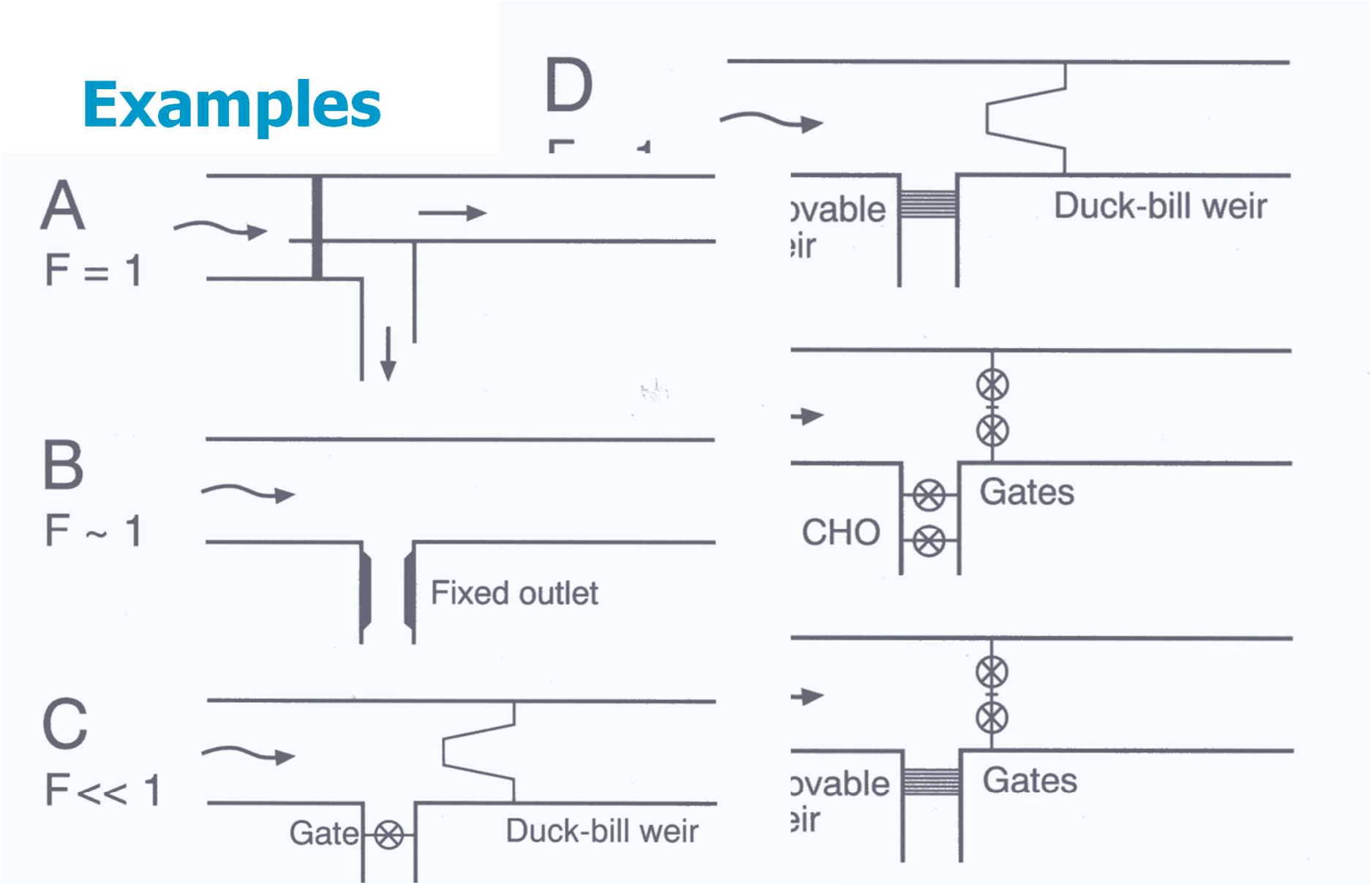
Examples



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