Module 1: Introduction

Water Resources Sustainability

Conservation of Mass Principle (Handout):

*(See in course website***: STUDY ASSIGNMENT/Handouts/Module 1**

CWR 3540: Water Resources Engineering

FIU Department of Civil & Environmental Engineering

Professor Fuentes

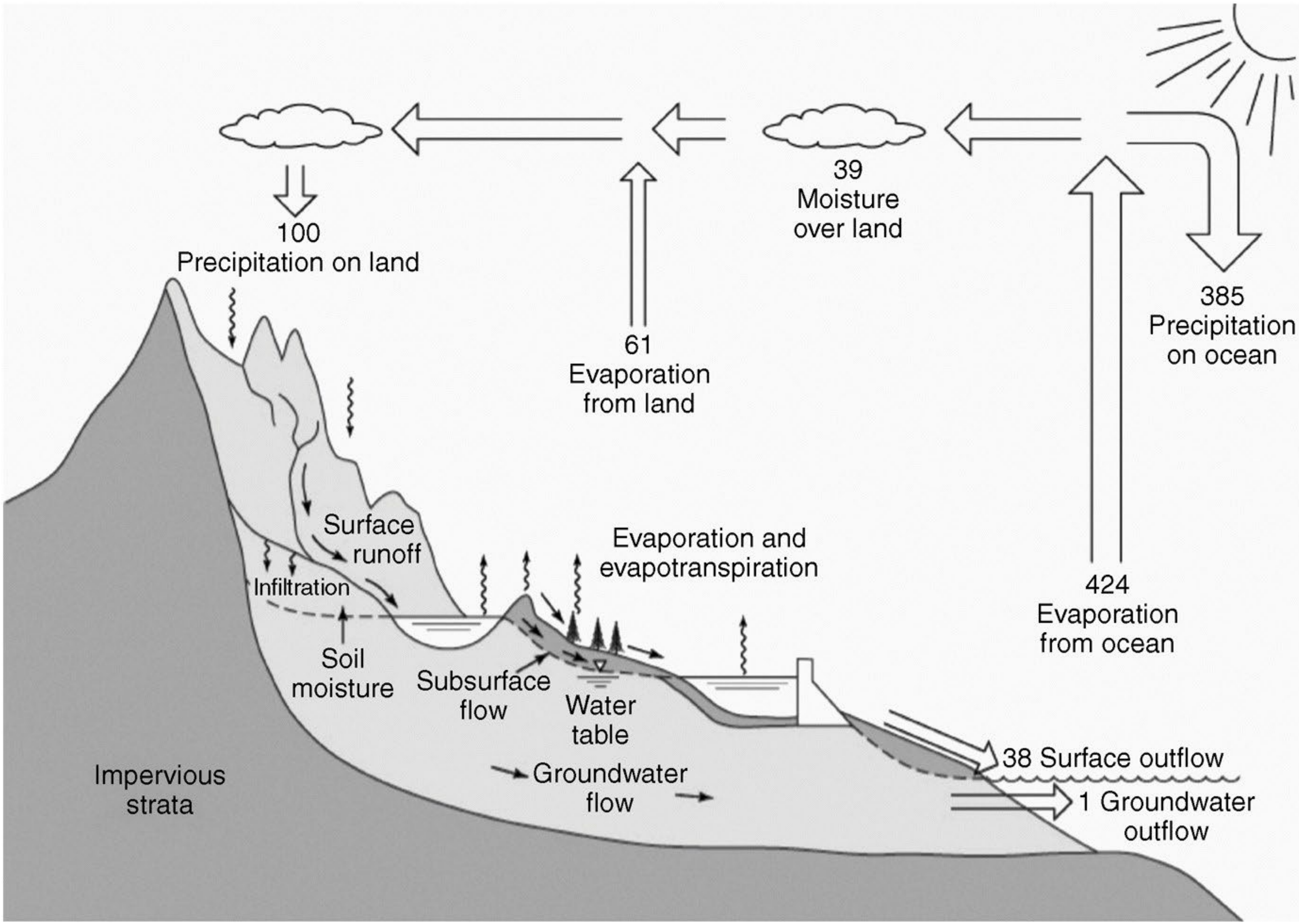


Figure 1.1.1a
McGraw Hill

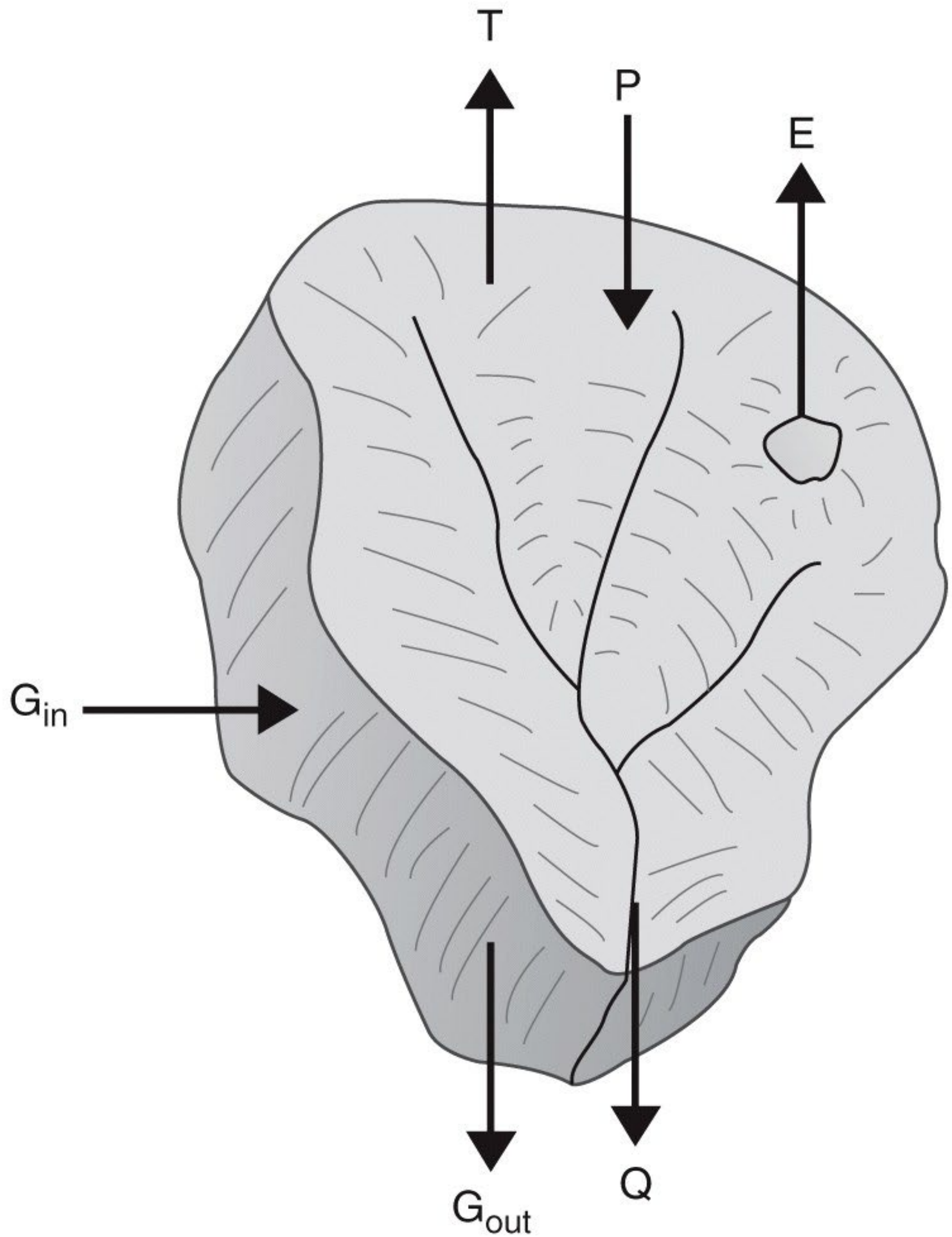


Figure 1.5.1

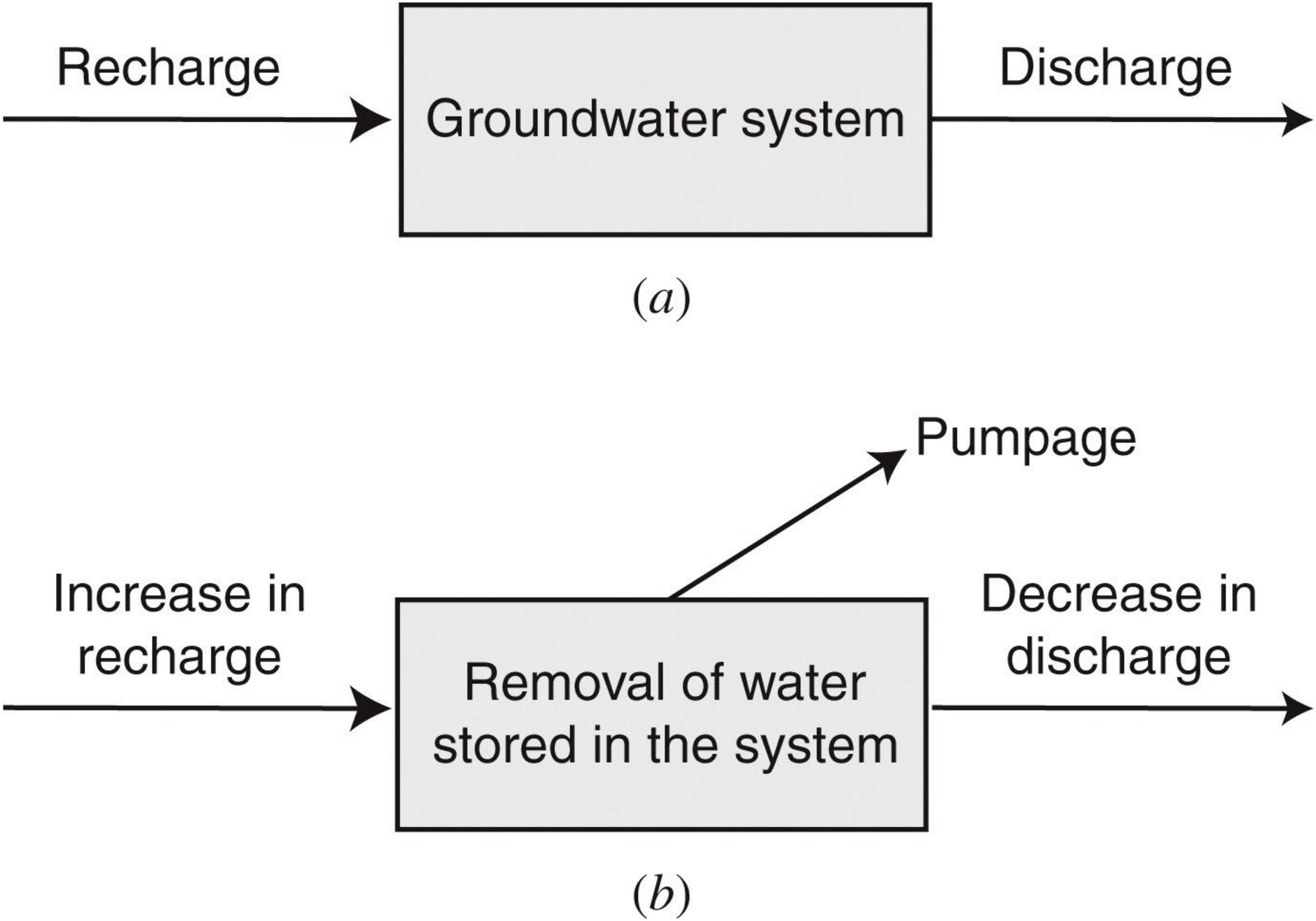
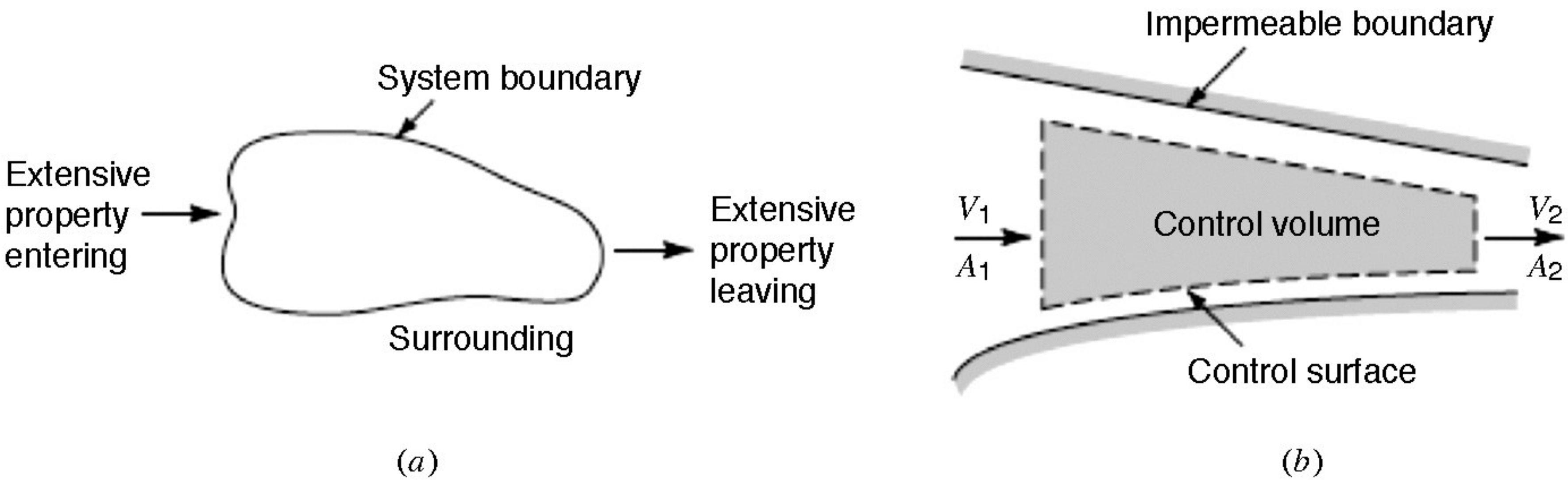

Recharge
Groundwater system
Discharge
(a)
Pumpage
Increase in recharge
Removal of water stored in the system
Decrease in discharge
(b)

Figure 1.5.2



System boundary
Extensive
property
entering
Extensive
property
leaving
Surrounding
(a)
Impermeable boundary
V_1
A_1
Control volume
V_2
A_2
Control surface
(b)

Figure 1.1.6

SUSTAINABILITY

- *"Sustainable Development"* to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987)
- Initiated by the *Bruntland Commission* (General Assembly of the United Nations in 1984).

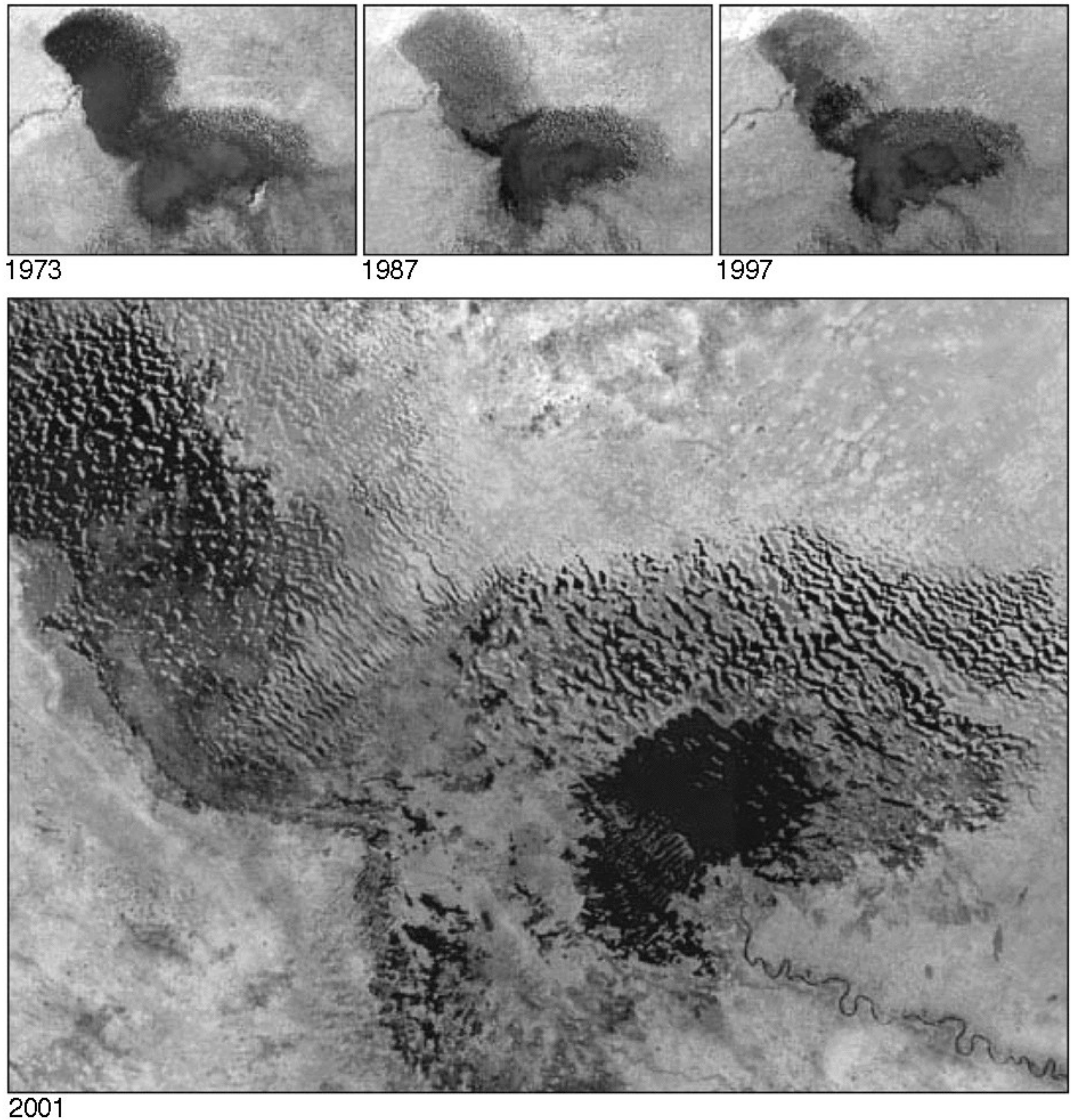


Figure 1.4.1
Images courtesy of NASA GSFC Scientific Visualization Studio and Landsat-7 Project

Module 1: Introduction
Water Demand *versus* Supply

CWR 3540: Water Resources Engineering

FIU Department of Civil & Environmental Engineering

Professor Fuentes

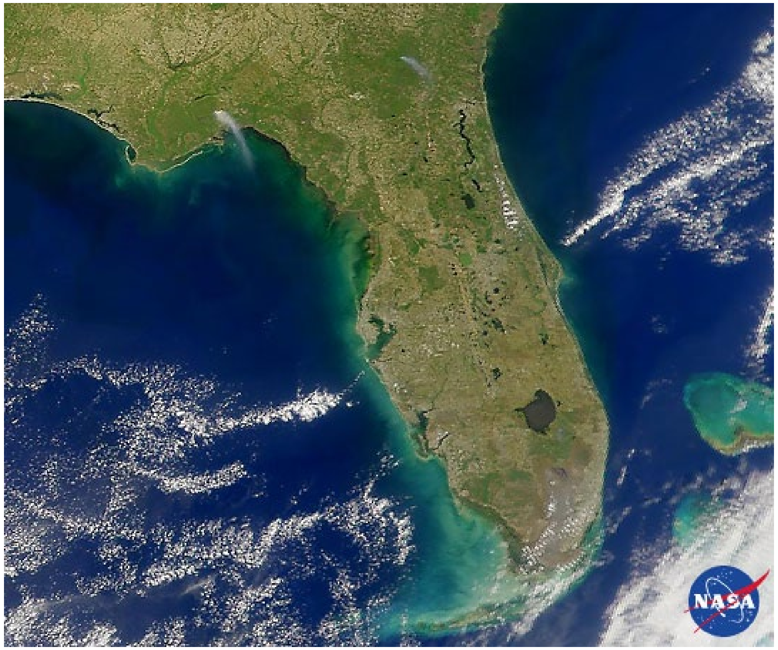
Issues

- Development of water resources
  - Needs of **users** (or demand) ***versus*** supply(ies)?
  - Project Purposes:
    - *Use:*
      - *water supply from surface and/or groundwater to meet user needs*
    - *Control:*
      - *ensuring recharge of groundwater and*
      - *managing precipitation-driven flood control)*
- Questions
  - How much water is needed? How can it be reduced?
  - How much water is available? Is it impacted by droughts? And
  - How can the needs be met by supply(ies)?
  - How should the used-up water be safely “disposed” of? Re-used?
  - How to control flooding in cities after “extreme” storms

Issues (Cont.)

- Types of water supplies
  - Surface waters (also important path of recharge from precipitation):
    - streams,
    - rivers,
    - lakes,
    - ocean, etc.)
  - Groundwater:
    - unconfined and confined aquifers
    - with shallow and deep wells

Florida Water Supplies: Examples



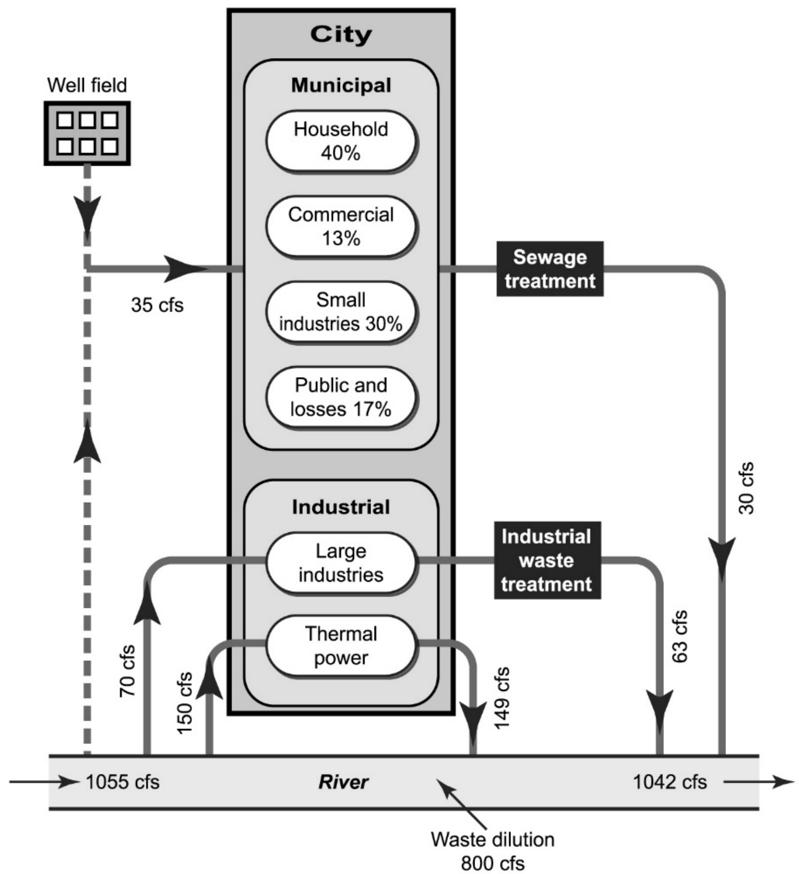
Issues (Cont.)

- Assessment of demand versus supplies
  - Withdrawal (off-site import, e.g., out of stream)
  - Non-withdrawal (use on site, e.g., navigation)
  - Consumptive use (supply not longer available, e.g., water incorporated in crops)
- Municipal requirements (See concept in Fig. 1)
  - Requirement (i.e., volumetric flow rate, L^3/t))
    - = (Population at <u>end of design period</u>) x <u>per capita</u> use

Example: Water Use in City

(Population = 150,000)

Figure 1.1 Water requirements of a city of 150,000 population.



USA Sectors: Water Users

(Example 2005)
https://water.usgs.gov/watuse/

- Public supply (12%)↑ from 2005 to 2010
- Domestic (1%)
- Irrigation (33%) ↑
- Thermoelectric power (49%)
- Industrial (4%)
- Mining (1%)
- Livestock (1%)
- Aquaculture (3%) ↑

Population Forecasting

(Trend analysis)

- Short-term estimates (i.e., 1-10 years) (Fig. 1.2)
  - Graphical extension method
  - Arithmetic growth method (Eqs. 1.2-1.3 & Ex. 1.1)
  - Geometric growth method (Eqs. 1.4, 1.5 & Exs. 1.2, 1.4)
  - Declining growth rate method (Eqs. 1.6, 1..7 & Ex. 1.3)
- Long-term estimates (i.e., 10-50 years)
  - Graphic comparison method (Fig. 1.3)
  - Mathematical logistic curve method (Eq. 1.8-1.11, Ex. 1.5)
  - Ratio and correlation methods (Eqs. 1.12,1.13)
  - Components methods (based on birth, death and migration rates, Eq. 1.14)

Population Forecasting

Short-Term Estimates: Growth Methods

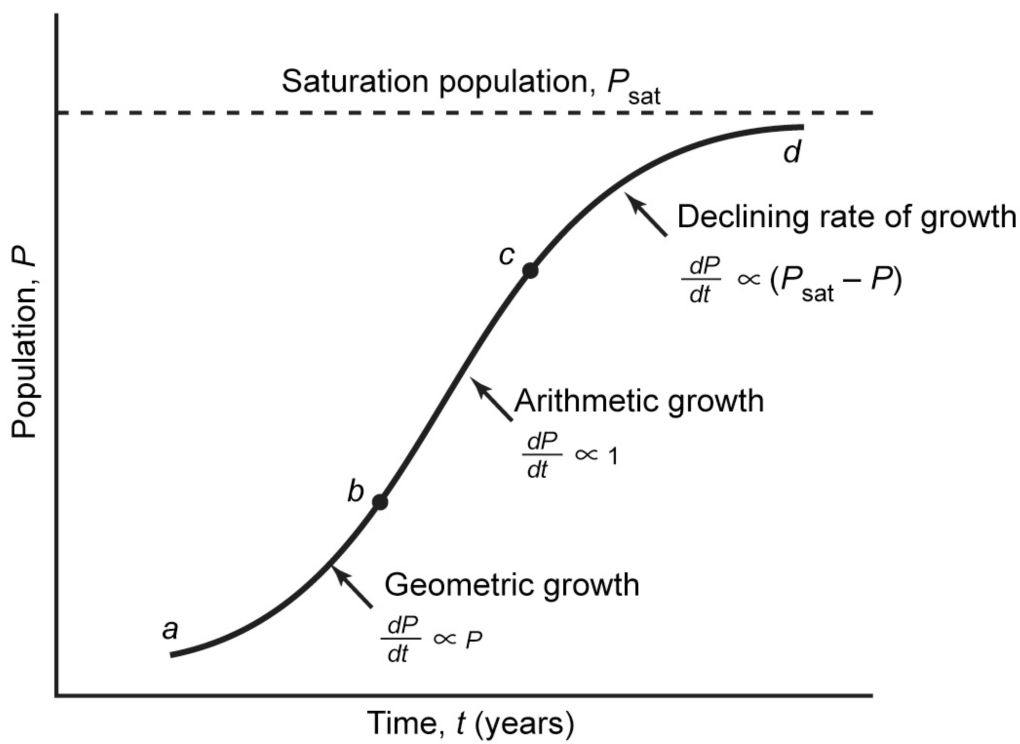
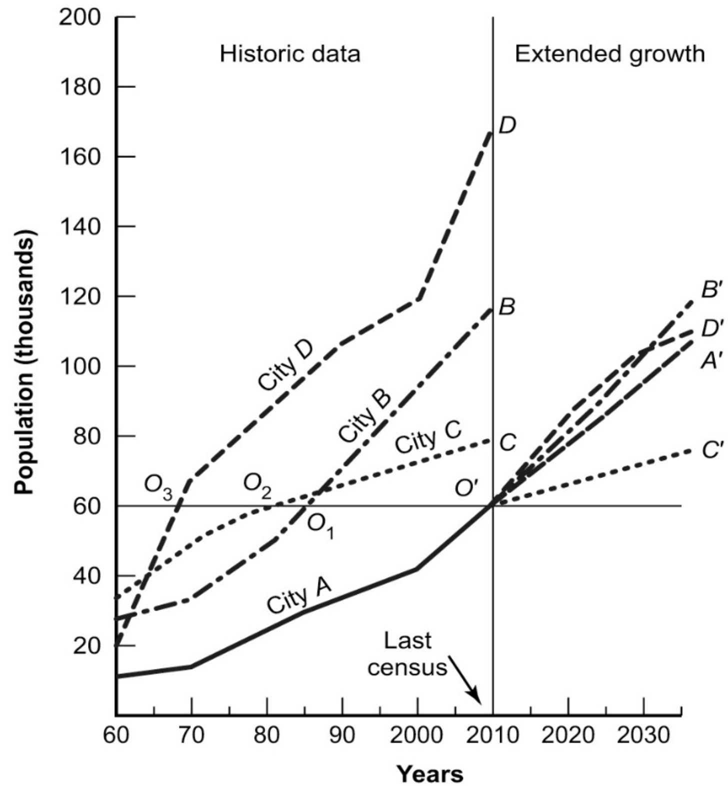


Figure 1.2 Population growth curve.

Population Forecasting

Long-Term Estimates: Growth Methods

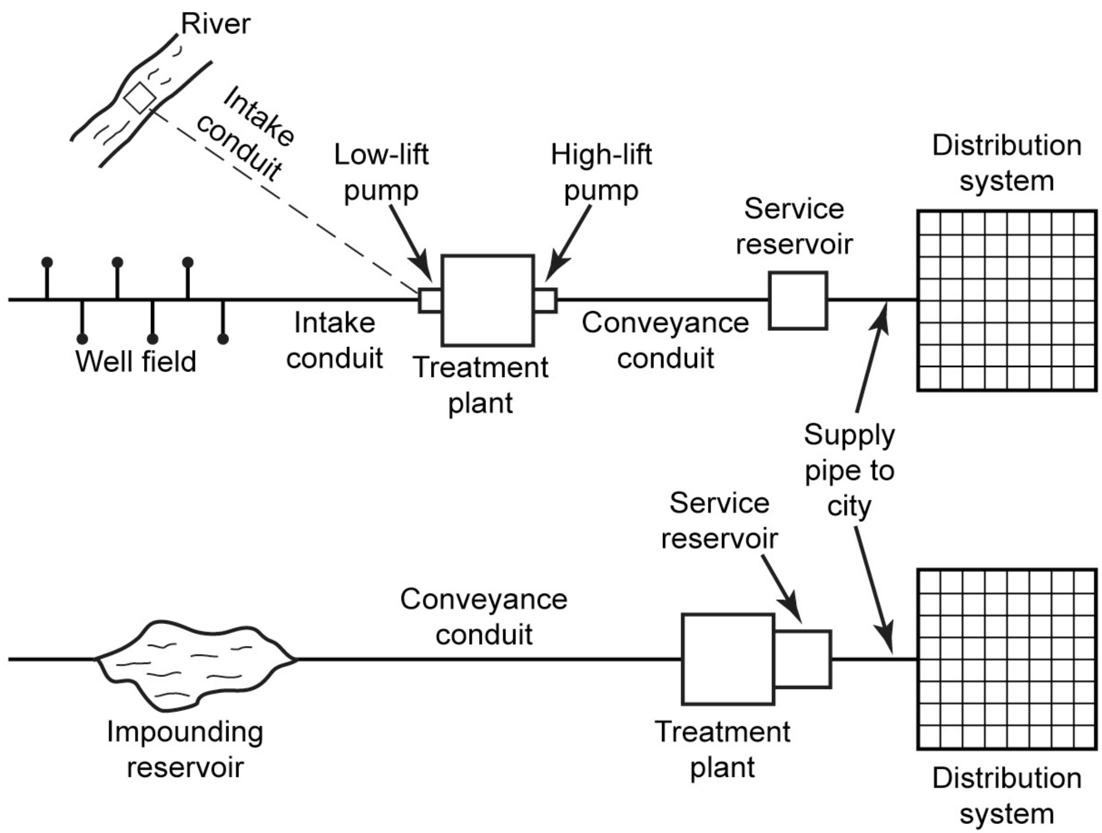
Figure 1.3 Graphical projection by comparison.



O′B′ is parallel to O_1B
O′C′ is parallel to O_2C
O′D′ is parallel to O_3D
O′A′ is a projected curve

Municipal Water Supply Systems

Figure 1.4 Layout of typical water supply systems.



Water Usage and Municipal Water Supply Infrastructure

(Ex. 1.6)

Table 1.1 Design Periods and Capacity Criteria for Constituent Structures

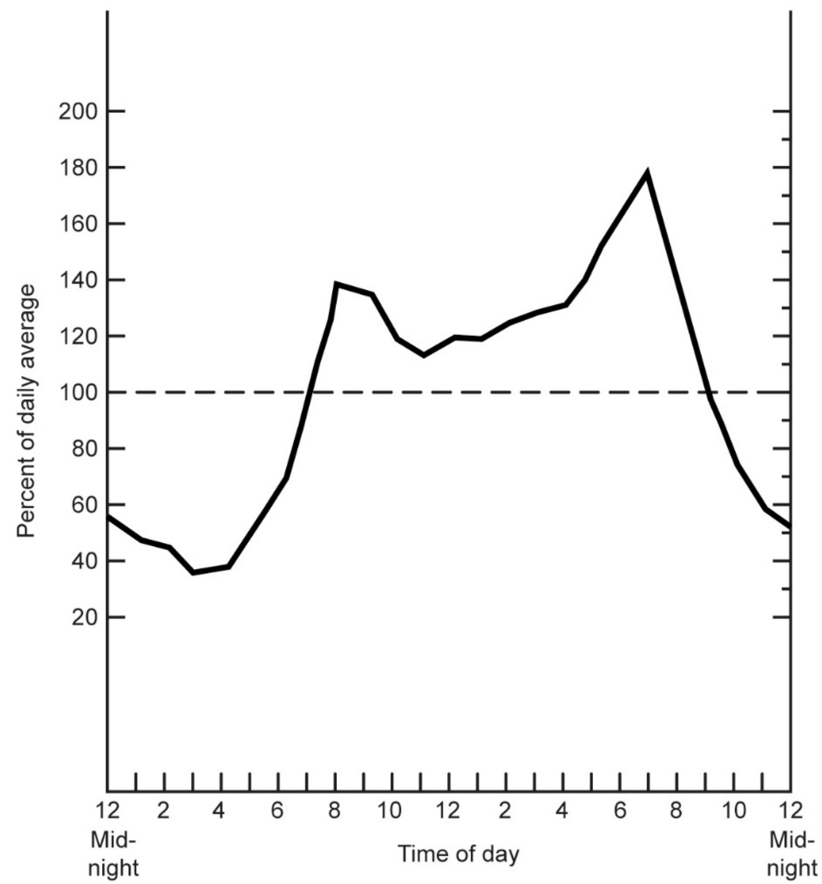
Structure	Design Period[a] (years)	Required Capacity
1. Source of supply		
a. River	Indefinite	Maximum daily (requirements)
b. Well field	10–25	Maximum daily
c. Reservoir	25–50	Average annual demand
2. Conveyance		
a. Intake conduit	25–50	Maximum daily
b. Conduit to treatment plant	25–50	Maximum daily
3. Pumps		
a. Low-lift	10	Maximum daily plus one reserve unit
b. High-lift	10	Maximum hourly plus one reserve unit
4. Treatment plant	10–15	Maximum daily
5. Service reservoir	20–25	Working storage (storage capacity computation, Sect. 13.10) plus fire demand for a specified duration (Table 1.2) plus emergency storage
6. Distribution		
a. Supply pipe or conduit	25–50	Greater of (1) maximum daily plus fire demand of a day or (2) maximum hourly requirement
b. Distribution grid	Full development	

[a] "Design period" does not necessarily indicate the life of the structure. A design period takes into account other factors, such as subsequent ease of extension, rate of population growth and shifts in community, and industrial/commercial developments.

Variations in Usage

- Average daily
- Variability in time
  - Hour
  - Week
  - Month
  - Season
  - year(s)
  - etc.
- Variability in space
  - hour,
  - week days,
  - seasons
  - etc.

Figure 1.5 Typical variation in usage in a day.



Fire Demands for Municipal Use

(1.9, p. 15)

- Estimation Methods
  - International Fire Code
  - National Fire Protection Association (NFPA)
  - Others
- Types of Construction
  - I through V (demand decreases from I to V)
  - A and B (i.e., A has higher fire resistance rating)
  - Floor area (see definition, p. 16)
- Requirements and Duration (Table 1.2 and Ex. 1.7)

Industrial Requirements

(1.10, p. 19)

Processes such as material processing, fabricating, incorporating in product, diluting, washing, transporting, cooling, etc.

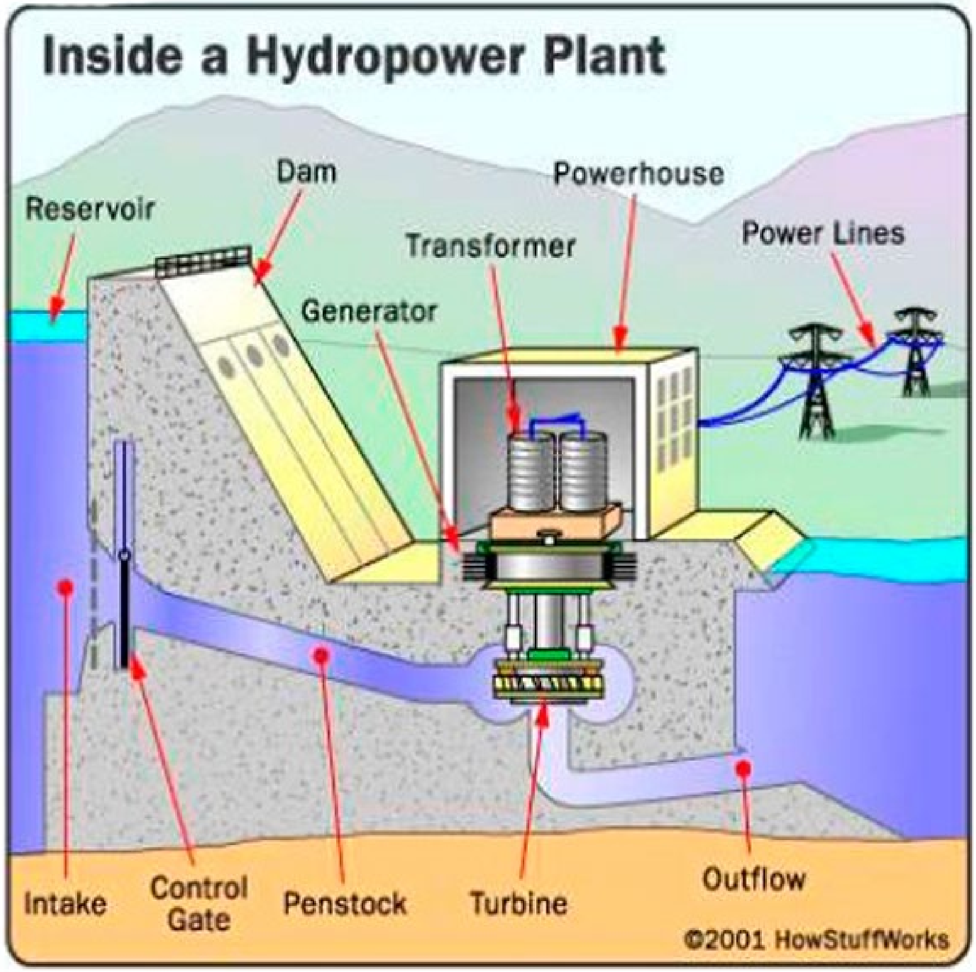
Table 1.3 Requirements of Major Industries

Industry	Average Water Use
Thermoelectric power	19 gal/kWh or 600 gpcd
Steel	62,000 gal/ton
Paper	39,000 gal/ton
Organic chemicals	55,000 gal/ton
Woolens	140,000 gal/ton
Coke (coal byproduct)	3,600 gal/ton
Petroleum refining	1850 gal/barrel
Plastic	24,000 gal/ton
Cement	36,500 gal/ton

Other Demands

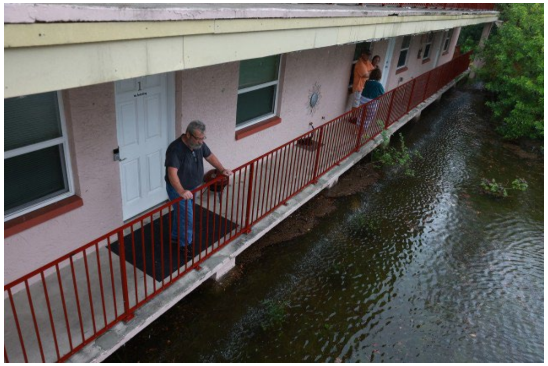
- Irrigation (1.12, p. 22)
  - Consumptive Use of Crops
  - Effective Rainfall
  - Farm Losses
- Conveyance and Waste (1.16, p. 25)
- Hydropower (1.18, p. 30)
- Navigation (1.19, p. 33)

Hydroelectric Power Generation (Example)



Florida H-Idalia: Flooding & Control

(Control: structural *and* non-structural control



Any Questions?

See Syllabus for Official Assistance Hours