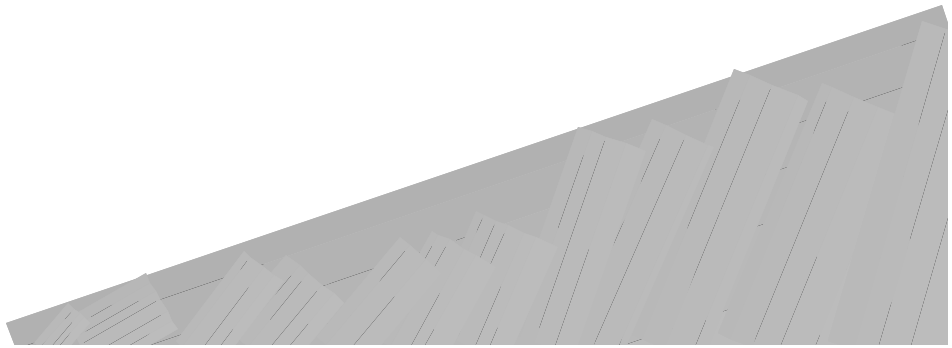
Physical Environment

- Geology
- Soils
- Groundwater
- Surface Water Resources

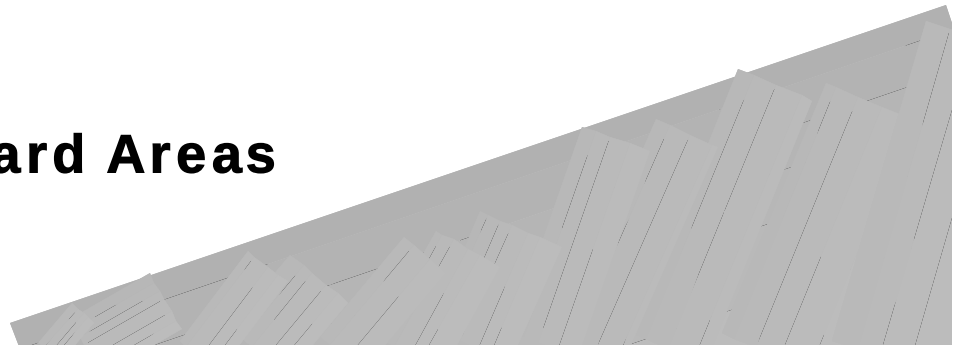


Assessing Impacts to Geology

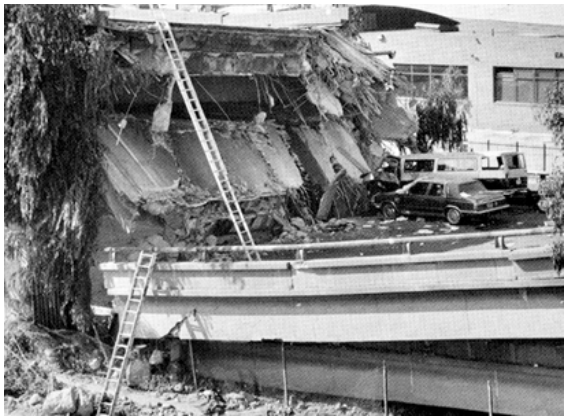
- **Identify Source of Potential Impacts**
  - **Overpumping Groundwater**
  - **Construction of Steep Slopes**
  - **Logging on Steep Slopes**
  - **Construction of Jetties**
  - **Reservoirs**
  - **Hazard Zone Issues - Affect Project**
  - **Mineral Takings**
- **Determine Study Area**
  - **Generally area of direct impact**
  - **Zone of Influence – pumping groundwater**
  - **Down slope**
- **Determine Existing Conditions**
  - **USGS Geological Atlases**
  - **Bureau of Mines**
  - **DOGAMI**
  - **State/Local Planning Studies (Hazard Areas/Seismic)**

Geology (cont.)

- **Identify Standard**
  - **State**
  - **Local**
- **Impact Prediction**
  - **Engineering Studies**
  - **Similar Projects in Area**
- **Assess Significance of Impacts**
  - **Percentage**
  - **State/Local Policies**
  - **Human and Ecological Down-slope Affects**
  - **Impacts on Project**
- **Mitigation**
  - **Limit Groundwater Use**
  - **Move Project from Hazard Areas**
  - **Seismic Reinforcement**



Hazard Zone Issues



Seismic

Volcanic

Tsunami

Coastal Sloughing

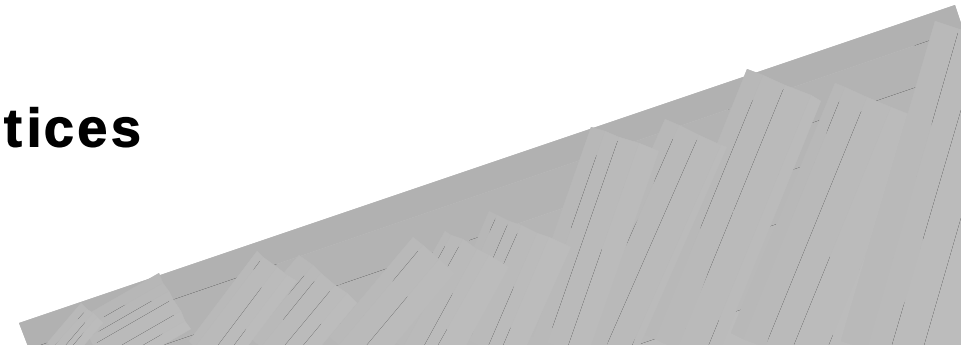
Mass Wasting

Assessing Impacts to Soils

- **Identify Source of Potential Impacts**
  - **Site Clearing**
  - **Compaction**
  - **Change in Land Use**
  - **Hazardous Materials**
  - **Change Nutrients**
- **Determine Study Area**
  - **Generally area of direct impact**
- **Determine Existing Conditions**
  - **Soil Survey (NRCS county surveys)**
  - **Field Testing**
- **Identify Standard**
  - **State**
  - **Local**

Soils (cont.)

- **Impact Prediction**
  - **Erosion (Universal Soil Loss Equation)**
  - **Compaction (Engineering Studies)**
  - **Change in Chemistry (Mass-balance Calculations)**
- **Assess Significance of Impacts**
  - **Percentage**
  - **State/Local Policies**
  - **Ecological (e.g. sedimentation of salmon bearing streams)**
- **Mitigation**
  - **Re-Vegetate Area**
  - **Limit Time of Year**
  - **Barriers**
  - **Best Management Practices**
  - **Line Disposal Area**



Universal Soil Loss Equation (USLE)

- A = R x K x LS x C x P

  where:

  A = long term average annual soil loss in tons per acre per year

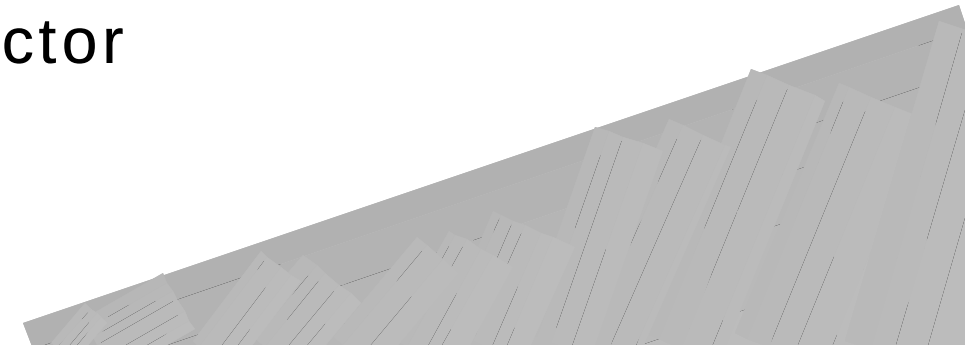
  R = rainfall and runoff factor

  K = soil erodibility factor

  LS = slope length-gradient factor

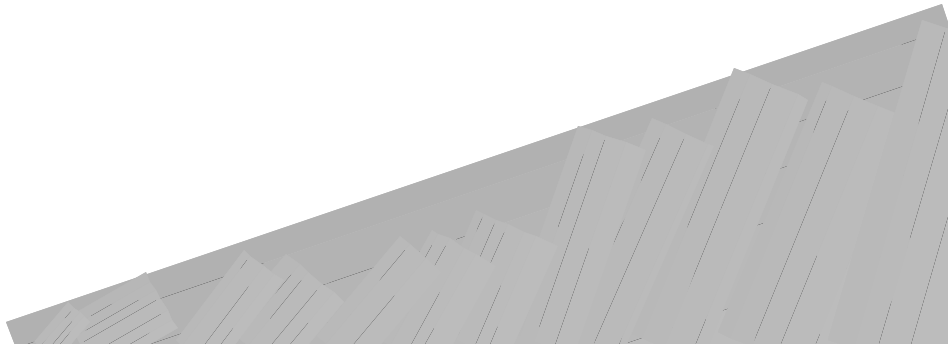
  C = crop/vegetation and management factor

  P = support practice factor



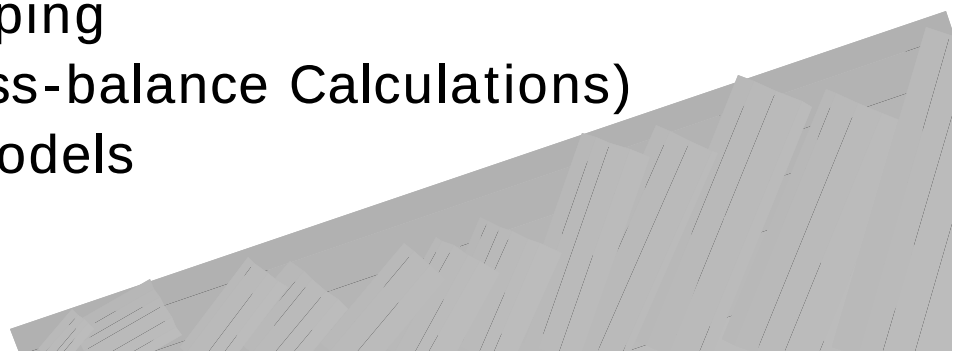
Assessing Impacts to Groundwater

- **Identify Source of Potential Impacts**
  - Quantity
    - Withdrawal
      - Change Recharge Source
      - Draw Down
  - Quality
    - Subsurface Percolation
    - Injection Wells
    - Land Application of Wastes
    - Land Application of Pollutants
    - Storage Tank Leakage
    - Burial
    - Transport of Wastes/Nonwastes (pipelines and overland)
- **Determine Study Area**
  - Zone of influence
  - Zone of contribution
  - Direct impact



Groundwater (cont.)

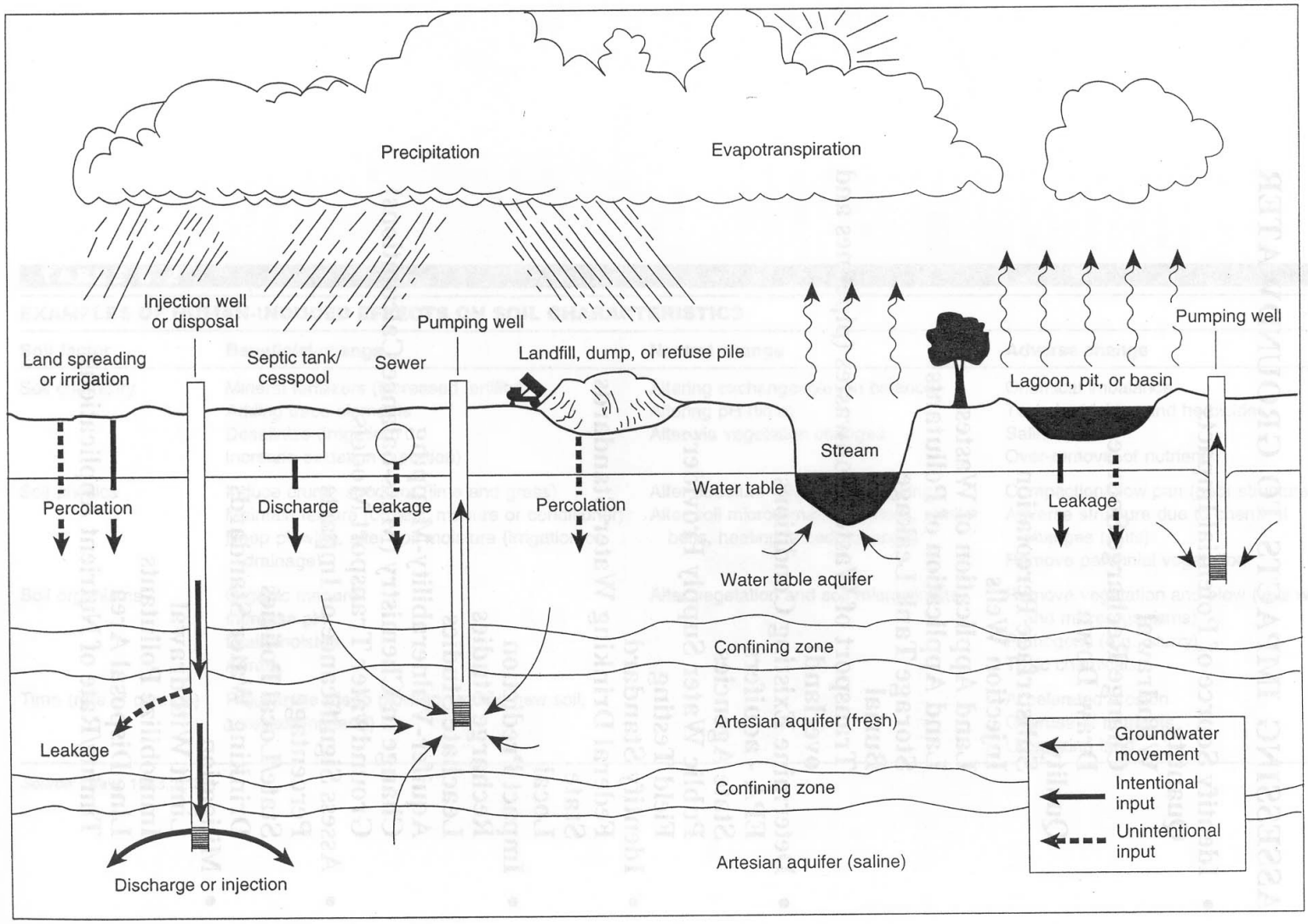
- Determine Existing Conditions
  - EPA - aquifers
  - State Agencies
  - Public Water Supply Providers
  - Field Testing
- Identify Standard
  - Federal Drinking Water Standards
  - State
  - Local
- Impact Prediction
  - Recharge Studies
  - Leachate Studies
  - Aquifer-Vulnerability-Mapping
  - Change in Chemistry (Mass-balance Calculations)
  - Groundwater Transport Models



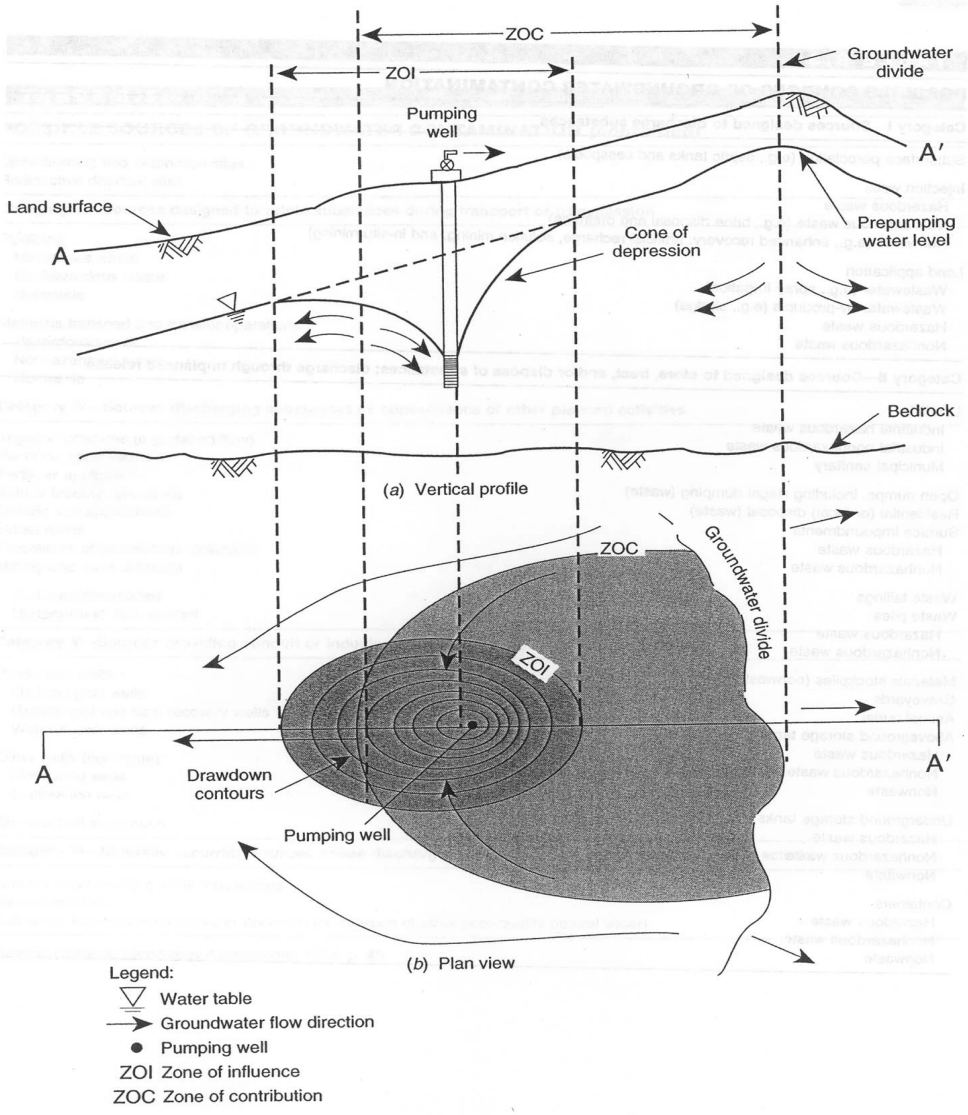
Groundwater (cont.)

- Assess Significance of Impacts
  - Percentage
  - State/Local Policies
  - Drinking Water Standards
- Mitigation
  - Limit Withdrawal
  - Immobilize Pollutants
  - Line Disposal Area
  - Timing/Rate of Nutrient Applications

Sources of Groundwater Contamination

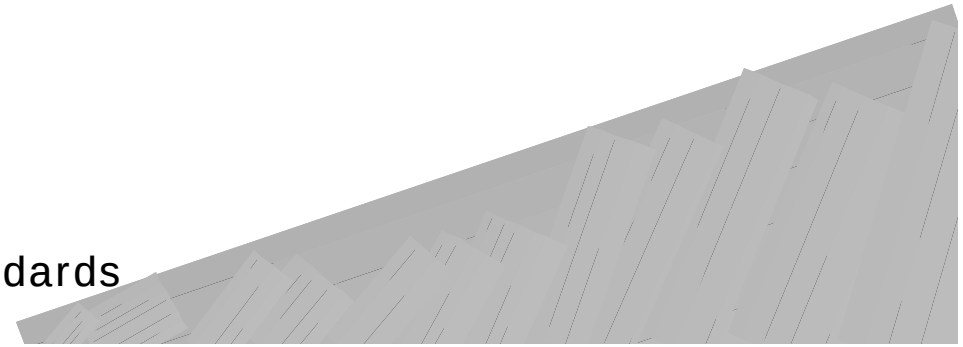


Wellhead Impacts



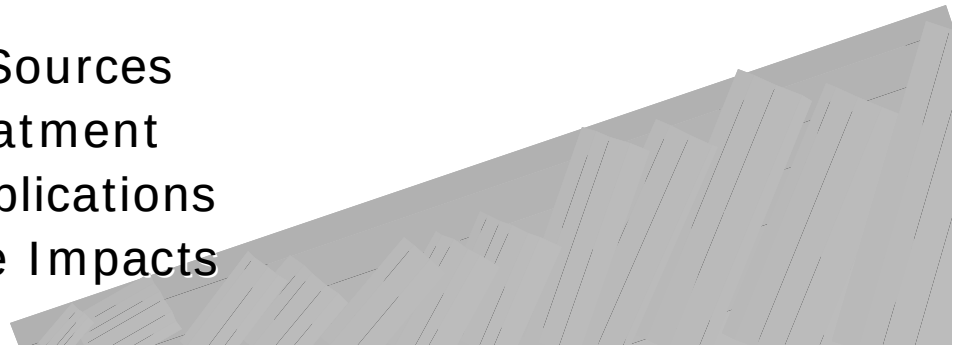
Assessing Impacts to Surface Water

- Identify Source of Potential Impacts
  - Quantity
    - Withdrawal
    - Diversion
  - Quality
    - Point Source
    - Non-Point Source
    - Fill
- Determine Study Area
  - Direct impact
  - Mixing zone
- Determine Existing Conditions
  - EPA (STORET)
  - State Agencies (DEQ, Water Resources Dept.)
  - Public Water Supply Providers
  - USGS - Flow Gauge
  - Field Testing
- Identify Standard
  - Federal Standards
  - State Standards
  - New Source Performance Standards

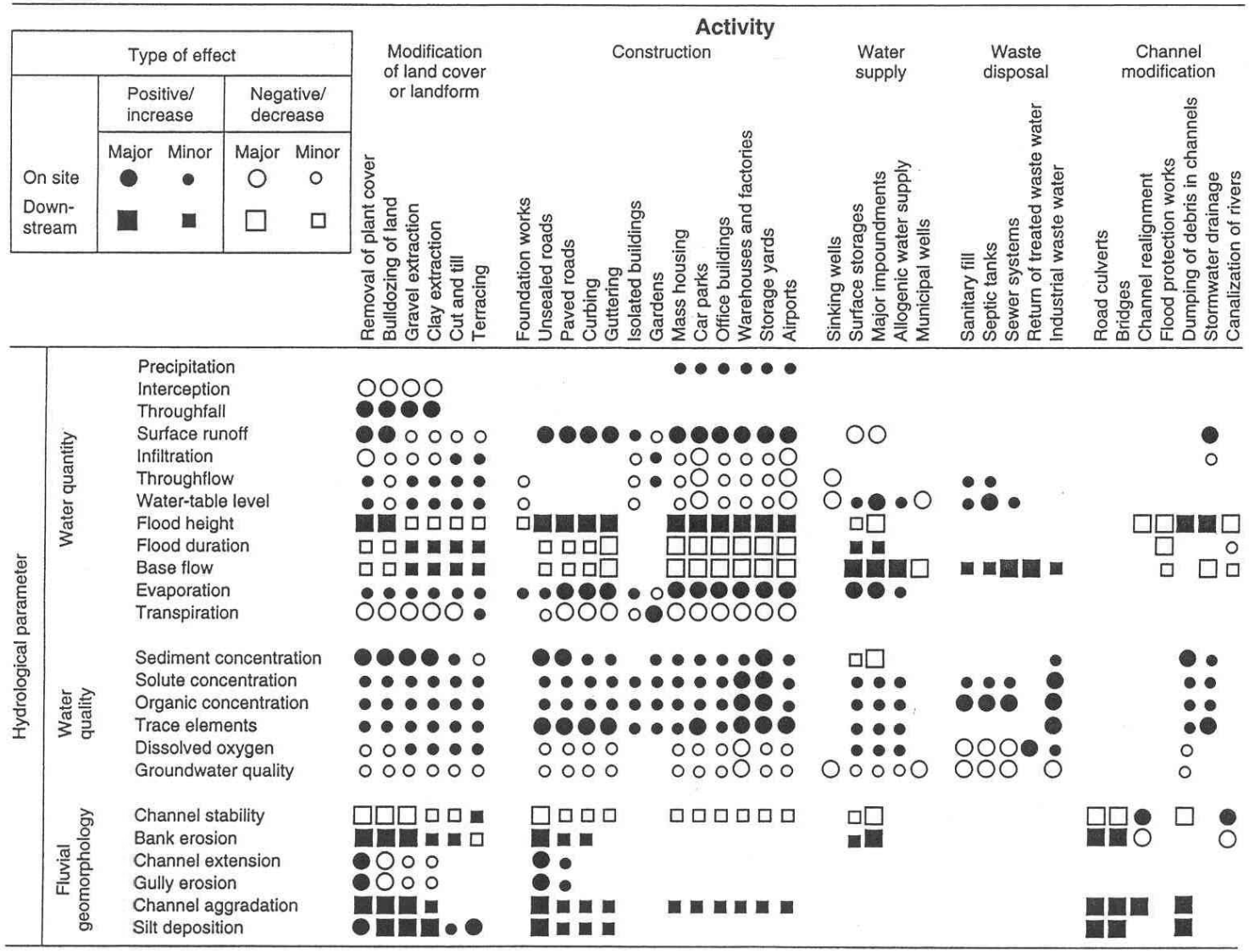


Surface Water (cont.)

- Impact Prediction
  - Change in Chemistry (Mass-balance Calculations)
  - Dispersion Models
  - Ecological Models
- Assess Significance of Impacts
  - Water Standards
  - Percentage
  - Ecologically - Sensitive Species
  - State/Local Policies
- Mitigation
  - Limit Use of Surface Water
  - Limit Erosion
  - Treat Point and Non-Point Sources
  - Construct Wetlands for Treatment
  - Timing/Rate of Nutrient Applications
  - Operate Project to Minimize Impacts



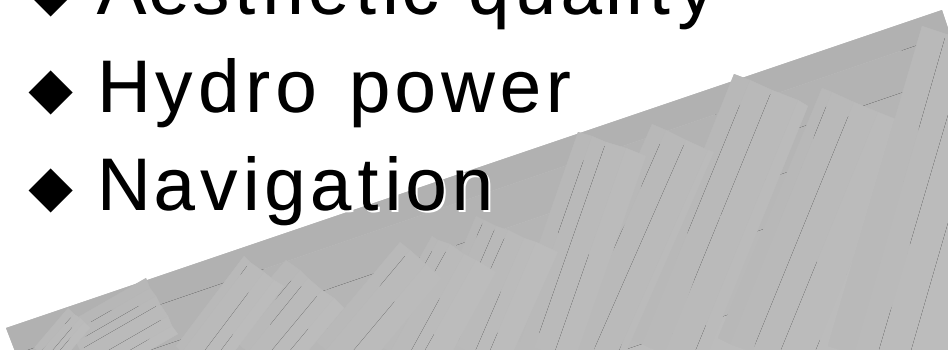
Potential Impacts to Surface Water



State Water Quality Standards

(Beneficial Uses)

- Public domestic water supply
- Private domestic water supply
- Industrial water supply
- Irrigation
- Livestock watering
- Anadromous fish passage
- Salmonid rearing
- Salmonid spawning
- Resident fish
- Wildlife/Hunting
- Fishing
- Boating
- Water contact rec.
- Aesthetic quality
- Hydro power
- Navigation



Pollutant Discharges

- Point Discharge

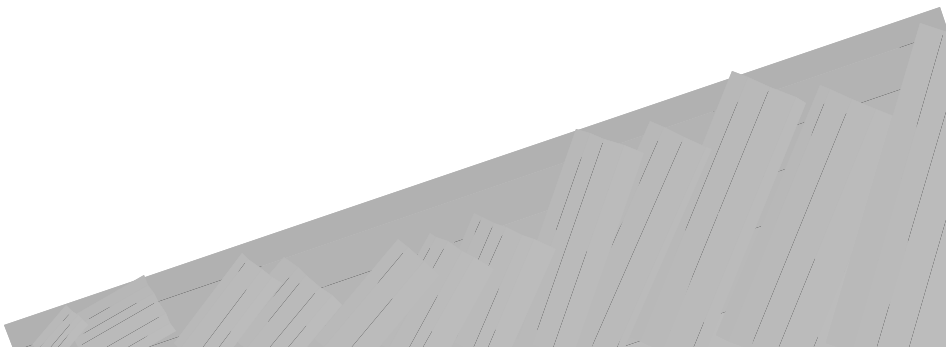
  $C_{avg} = SC_iQ_i/SQ_i$

  C_i = concentration of constituent i

  Q_i = flow

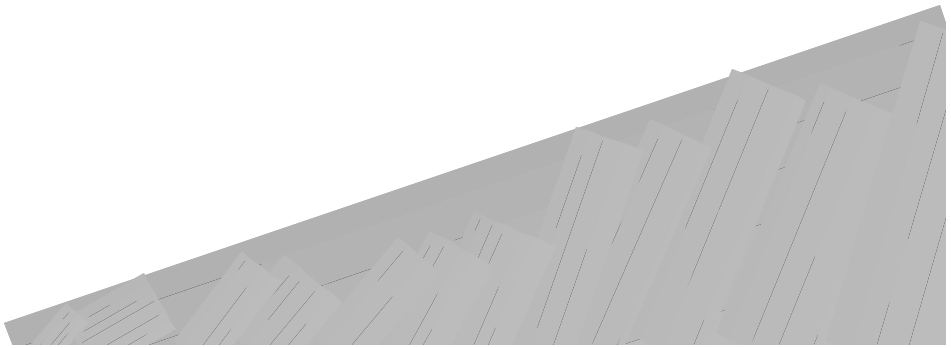
- Non Point Discharge

  Loadings from activities

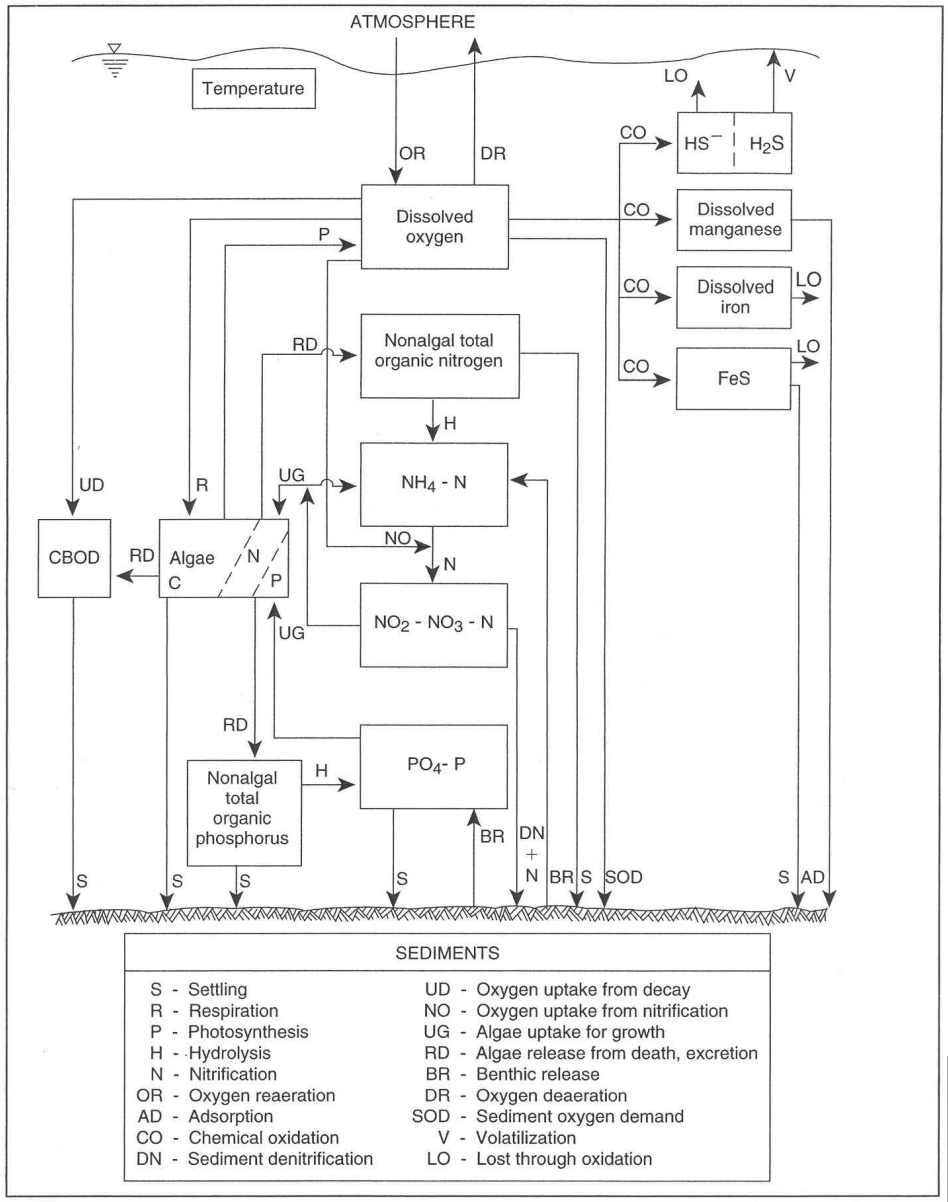


Models

- Dispersion
- Compartment
- Ecological
- Instream Flow Incremental Method



Compartment Model



Best Management Practices

- Agriculture
  - Fertilizer Management
  - Pesticide Management
  - Conservation Tillage
  - Irrigation Management
  - Manure Management
  - Livestock Exclusion
- Silviculture
  - Buffer Strips
  - Haul Road Maintenance
  - Selective Forest