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

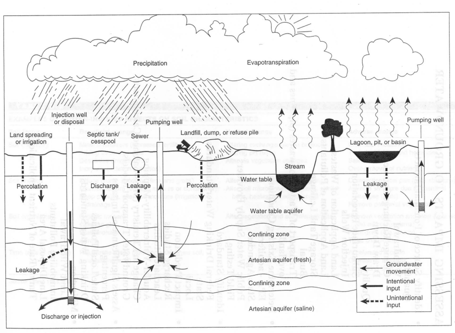
Groundwater (cont.)

- 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

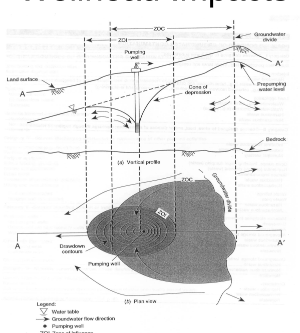
Groundwater (cont.)

- 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



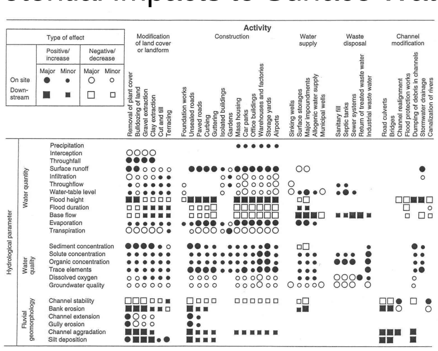
Assessing Impacts to Surface Water

- 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

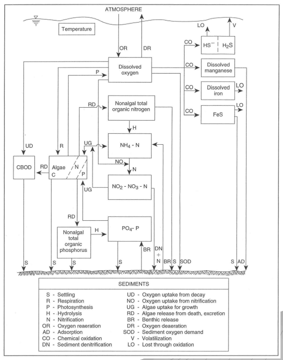
  Q_i = flow
- Non Point Discharge

  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