

Introduction / Overview of Environmental Geology

- I. The Topic Defined
 - A. Environmental Geology
 - 1. application of geologic principles to "real-world" problems
 - B. Related Areas
 - 1. Natural Hazards
 - a. flood hazards
 - b. landslide hazards
 - c. seismic hazards
 - d. volcanic hazards
 - 2. Planning / Landuse Management
 - a. Logging
 - b. soil managment / erosion
 - c. agricultural management
 - 3. Earth Materials / Energy Resources
 - a. Raw Materials Extraction
 - b. Fossil Fuels
 - 4. Hydrologic Resources
 - a. Water quality and quantity
 - C. Critical Concept of Environmental Geology
 - 1. The interaction of the biosphere (including humans) with geologic processes and landscape systems
- II. Earth Systems Cycles
 - A. Tectonic Cycle
 - B. Rock Cycle
 - C. Biologic Cycles
 - 1. carbon cycle
 - 2. biogeochemical cycle
 - D. Hydrologic Cycle
- III. Soil Systems
 - A. Soils as a Geologic Surface Material
 - 1. weathered regolith / rock weathering
 - 2. soil development over time
 - 3. The basis of human food chain / agricultural production
 - B. Soil Issues
 - 1. Soil Moisture / Plant Growth
 - 2. Soil Fertility
 - 3. Soil Erosion
 - a. soil loss
 - 4. Soil Contamination

- a. contaminant transfer to water and plants
- 5. Desertification

IV. Geologic Hazards Overview

- A. Hazard - the interaction of geologic process and humans
 - 1. loss of life and property
 - 2. economic / social system impacts
- B. Risk Assessment
 - 1. probability of occurrence
 - 2. recurrence interval
 - 3. hazard forecasting / warning
 - 4. hazard planning / mitigation
 - a. engineering design and construction
 - 5. hazard insurance
- C. River Hazards
 - 1. flooding (loss of life and property)
 - 2. bank erosion / land loss
- D. Landslide hazards (mass wasting / slope failure)
 - 1. loss of life and property
 - 2. Landuse
 - a. logging / clear cutting
 - b. land development
 - c. grazing
 - d. urbanization / building
 - e. landslide warning systems
 - f. engineered solutions
- E. Seismic Hazards
 - 1. Ground shaking, liquefaction, tsunami
 - a. property destruction / loss of life
 - 2. Earthquake Risk Analysis
 - a. mapping / seismic hazards maps
 - b. probability / recurrence intervals
- F. Volcanic Hazards
 - 1. lava flow, tephra fallout, lahar / debris flow
 - 2. atmospheric impacts
 - a. air travel
- G. Coastal Hazards
 - 1. flooding, erosion, mass wasting, tsunami, habitat loss

V. Anthropogenic Influences / Interaction with Earth

- A. Water Supply / Water Resources
- B. Water Pollution / Contamination
- C. Waste Management
 - 1. solid waste refuse
 - 2. municipal waste
 - 3. industrial waste / radioactive waste
- D. Environmental Health
 - 1. asbestos issues
 - 2. heavy metals poisoning
 - 3. radioactive exposure / carcinogens
- E. Mineral / Energy Resources
 - 1. mineral resources / raw materials
 - 2. fossil fuels
 - 3. hydroelectric power generation
 - 4. geothermal energy

ENVIRONMENTAL GEOLOGY OVERVIEW

CLASSIC STUDY = "HAZARDS GEOLOGY" = CATASTROPHIC EVENTS, NATURAL
DISASTERS, ENGINEERING GEOLOGY

"NATURAL HAZARDS"

EARTH QUAKES, SEISMICITY (DEATH AND DESTRUCTION)
INCLUDES TSUNAMIS

VOLCANIC ERUPTIONS (MORE DEATH AND DESTRUCTION)

INCLUDES: CLIMATIC IMPACTS ("DUST VEIL" EFFECT)
POST-VOLCANIC MASS WASTING, MUD
SLIDES

FLUVIAL DYNAMICS

FLOODS, BANK EROSION

CATASTROPHIC MASS WASTING EVENTS

SLOPE INSTABILITY, LANDSLIDES, MUDFLOWS

DYNAMIC COASTAL EVOLUTION

COASTAL EROSION, WAVE EROSION, DUNE EROSION

"ANTHROPOGENIC" PHENOMENA

LAND DEVELOPMENT

URBANIZATION

DISRUPTION OF HYDROLOGIC CYCLE

RUNOFF-FLOODING

EROSION PROBLEMS

ECOSYSTEM DESTRUCTION

TOP SOIL LOSS

LOSS OF AGRICULTURAL LANDS/ARABLE LAND

SOIL AND WATER CONTAMINATION (SURFACE AND GROUND)

WASTE DISPOSAL PRACTICES

SOLID, LIQUID, RADIOACTIVE

COMMERCIAL/INDUSTRIAL

GROUND AND SURFACE WATER CONTAMINATION

CHEMICAL DISCHARGES

SALT WATER INTRUSION

HYDROCARBON CONTAMINATION

STORAGE TANKS
OIL SPILLS

SURFACE WATER DISCHARGES

INDUSTRIAL PROCESSING
RESIDENTIAL/SEWAGE

AGRICULTURAL CONTAMINATION

PESTICIDES, HERBICIDES

AIR POLLUTION

ACID RAIN
PARTICULATES
NO_x, SO_x, CO EMISSIONS
GREEN HOUSE GASES

RESOURCE UTILIZATION

MINERAL RESOURCES

OVER-EXTRACTION/SCARCITY

GROUND-WATER MINING

OVER-EXTRACTION/SCARCITY
OVER-DEVELOPMENT
EXTRACTION-RELATED SUBSIDENCE

DESERTIFICATION

DEFORESTATION
OVER-GRAZING

ENGINEERING DISASTERS

DAM COLLAPSE (JOHNSTOWN FLOOD)
POORLY PLANNED BUILDING SITES
UNSTABLE SURFICIAL MATERIALS
MINE SUBSIDENCE

REGULATORY OVERVIEW

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) 1969-

FIRST ENVIRONMENTAL POLICY STATEMENT BY FEDERAL GOVERNMENT

STATUTES NOT ENFORCEABLE

ESTABLISHES POLITICAL FRAMEWORK FOR LATER ENVIRONMENTAL LEGISLATION

ESTABLISHED THAT ENVIRONMENTAL IMPACT STATEMENTS (EIS) REQUIRED FOR FEDERAL PROJECTS

FEDERAL WATER POLLUTION CONTROL ACT 1972

CLEAN WATER ACT (CWA) AMENDMENTS 1977

GUIDELINES FOR RESTORATION AND MAINTENANCE OF CHEMICAL, PHYSICAL, AND BIOLOGICAL INTEGRITY OF NATIONS WATER

"NPDES" PERMITS= NATION POLLUTANT DISCHARGE ELIMINATION SYSTEM SETS WATER QUALITY STANDARDS

SAFE DRINKING WATER ACT 1974

CONTROLS CONTAMINANT LEVELS ALLOWABLE IN SURFACE AND GROUND WATER

RESOURCE CONSERVATION AND RECOVERY ACT 1976 (RCRA)

FIRST ATTEMPT TO DEAL WITH HAZARDOUS WASTE

REGULATES HAZARDOUS AND RESIDUAL WASTE THROUGHOUT PROCESSING STREAM (PRODUCTION, CONVEYANCE, STORAGE AND DISPOSAL)

"SUBTITLE D": GOVERNS CONSTRUCTION AND OPERATION OF LANDFILLS

PERMIT PROCESS: ESTABLISHES SELF-CHECKING AND MONITORING PROCEDURES FOR GOVERNMENT AND INDUSTRY

GOVERNS KNOWN AND RESPONSIBLE OPERATORS

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA, 1980) = "SUPERFUND"

ESTABLISHED TO REMEDIATE AND CLEAN-UP KNOWN CONTAMINATION SITES (ORPHANED INDUSTRIAL SITES)

LITIGATION TO ESTABLISH POTENTIALLY RESPONSIBLE PARTIES (PRP'S)

GOVERNMENT DRIVEN CLEAN-UP, BILLING

SUPERFUND AMENDMENT REAUTHORIZATION ACT (1986)

LIABILITY DECISIONS

TAP INTO SUPERFUND ACCOUNT

REAUTHORIZATION

CERCLA/SARA AREAS OF CONCERN

ESTABLISH CLEAN-UP/REMEDICATION STANDARDS
PERMANENT/LONG-TERM TREATMENT
FOLLOW-UP MONITORING
EPA ESTABLISHES "NPL" = NATIONAL PRIORITIES LIST
HEALTH ASSESSMENTS
RISK ANALYSIS
HOW CLEAN IS CLEAN?
HEALTH AND SAFETY OF HAZ WASTE WORKERS
HAZWOPER (40/8 HR TRAINING)
OSHA REGULATIONS
REMEDIAL INVESTIGATION/FEASIBILITY STUDIES (RI/FS)
3-PHASE APPROACH

PHASE I- ANALYZE EXISTING DATABASE, SCOPE
OF PROBLEMS

PHASE II-ACTIVE FIELD INVESTIGATION, SITE
CHARACTERIZATION

PHASE III-DESIGN AND IMPLEMENTATION OF
REMEDIAL ACTIVITIES

SITE CLOSURE AND FOLLOW-UP MONITORING

SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA)

COVERS SURFACE AND UNDERGROUND MINING
WATER SUPPLY REPLACEMENT BY MINING COMPANIES
EROSION CONTROL
AMD CONTROL

TOXIC SUBSTANCES CONTROL ACT (TOSCA)

CONTROL OF CHEMICALS IN INDUSTRY, ACADEMIA AND GOV'T
RISK ANALYSIS OF TOXIC POTENTIAL (TOXICOLOGY)

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

CONTROLS USE OF AGRICULTURAL CHEMICALS
MANUFACTURING, USE AND DISPOSAL

USE RESTRICTIONS

CLEAN AIR ACT (1990)

PHASED IN OVER NEXT FEW YEARS
CONTROL OF GREENHOUSE GASES
CFC'S - OZONE DEPLETING GASES
INDUSTRIAL EMISSIONS

ACID RAIN
NO_x, SO_x, CO, PARTICULATES
STACK TESTING AND MONITORING
"SCRUBBERS"/EMISSIONS SYSTEMS
AUTOMOBILE EMISSIONS

SOURCES OF ANTHROPOGENIC CONTAMINATION

LAND DISPOSAL OF SOLID WASTES

RESIDENTIAL (SEWAGE, HOUSEHOLD CHEMICALS, HOUSEHOLD WASTE)
INDUSTRIAL (DISCHARGE, METALS, CHEMICALS, ORGANICS, ACIDS)
"LEACHATE" CONTROL

LAND APPLICATION OF SEWAGE

SEPTIC TANKS/CESS POOLS (29% OF US POPULATION)
MUNICIPAL SEWAGE TREATMENT
SEWAGE SLUDGE- LAND APPLICATION (NITROGEN/NITRATES)

AGRICULTURAL ACTIVITIES

SYNTHETIC/CHEMICAL FERTILIZERS, HERBICIDES, PESTICIDES

GOLF COURSES

PETROLEUM/HYDROCARBON LEAKS AND SPILLS

UST's, GAS STATIONS, TRANSFER STATIONS, STORAGE TANKS,
REFINERIES, PRIVATE AND PUBLIC (MILITARY BASES)

INCLUDES: OIL, GASOLINE, KEROSENE (LNAPL'S = "LIGHT NON-
AQUEOUS PHASE LIQUIDS = FLOATERS)

DNAPL's = DENSE NON-AQUEOUS PHASE LIQUIDS = SINKERS
(HEAVY LIQUIDS, HALOGENATED HYDROCARBONS
(CHLOROFORM, BROMOFORM), KREOSOTE)

INDUSTRIAL PROCESSING

CHEMICAL PLANTS, STEEL MILLS, PAPER MILLS, TEXTILES, FOOD
PROCESSING, PLASTICS, ELECTRONICS

INDUSTRIAL WASTE LAGOONS

"DRY WELLS" OR DEEP WELL INJECTION

MINING ACTIVITIES

COAL, METALS, MINERALS

TAILINGS/SPOIL PILES

AMD = ACID MINE DRAINAGE, ACIDIFYING CONDITIONS

HEAVY METALS CONTAMINATION

RADIOACTIVE WASTES

U-MINING, NUCLEAR REACTORS, TAILINGS

PRIMARY COURSE TOPICS/READINGS

OVERVIEW OF ENVIRONMENTAL CONCERNS, REGULATORY HISTORY

COAL, COAL MINING, MINE-RELATED PROBLEMS

SOLID WASTE AND LANDFILL TECHNOLOGY

SYNTHETIC LINER SYSTEMS

UNDERGROUND STORAGE TANKS/ISSUES IN HYDROCARBON CONTAMINATION

ENVIRONMENTAL PROPERTY ASSESSMENTS

GROUNDWATER ISSUES

SOIL AND WATER REMEDIATION TECHNIQUES

FOCUS ON SPECIAL REGULATORY ASPECTS

BASICS OF FIELD AND ANALYTICAL TECHNIQUES

WETLANDS ISSUES: DELINEATION AND REGULATIONS

HEALTH AND SAFETY CONCERNS

CONSULTING PRACTICE AND BUSINESS

II. DISTRIBUTION OF ACTIVITIES AT SUPERFUND (NPL) SITES

Activity/Type of Site	Percent of Sites (229 total)
Landfill	20%
Surface Impoundment	17
Well Field	14
Chemical Mfg.	13
Electrical Mfg.	6
Waste Oil	5
Leaking Containers	5
Wood Preserving	5
Asbestos	3
Manufacturing	3
Plating	3
Metal Working	3
Drum Recycling	2
Mining	1
Radioactive Tailings	1
TNT Processing	< 1