Environmental Geology Spring 2017 Final Exam Study Guide *Final – Tuesday June 13, 2017 – 12 PM, NS218*

The Final Exam will be in 2 parts. Part 1 is closed book with short answer and long answer essay questions. Part 2 involves the open book lab skills portion. You will be able to use your notes, conversion charts, answer keys, etc. to work on Part 2 lab-style problems. Make sure you go over the groundwater problem answer keys before the exam, if you are still uncertain how to solve the problems, see me ASAP. Be prepared to make sketches of diagrams to illustrate your answers.

Key Words Landfills / Coffin Butte **RCRA** Subtitle D landfill solid waste liquid waste municipal waste residual waste hazardous waste industrial waste composting sludge ponds leachate soil contamination water contamination seepage surface runoff sediment erosion erosion control air emissions fugitive dust methane generation anerobic bacterial decay methane groundwater monitoring system upgradient downgradient liner system double liner system geomembrane impermeable barrier leachate containment methane collection system air pollution monitoring vector control erosion and sedimentation borrow fill erosion / sedimentation pond, landfill closure, daily cover,

disposal cell, active life. fault / seismic activity, seismic impact zone, surface water, methane monitoring system, primary liner, secondary liner, drainage layer, cover liner. leachate treatment, gas collection, rock quarrying, leachate lagoon, waste screening. biomedical waste, quarterly water sampling, monitoring wells, wastewater treatment system, clay liner, fire hazard, Coffin Butte bedrock setting / hydrogeology (fractured basalt, pillow basalt, regolith/soil), methane extraction well, leachate collection system,

Geologic Framework of Willamette Lowland Aquifer System

Cacadia subduction zone Cascadia volcanic arc Coast range Willamette Valley Arc volcanism Accretionary uplift Subducting slab Juan de Fuca plate NAM plate Siletz river volcanics

Tyee Formation Yamhill formation **Spencer** Formation Western Cascade Volcanism High Cascade volcanism Fault-fold Willamette Aquifer System Basement confining unit Columbia river basalt Willamette confining Willamette Aquifer Willamette Silt Unconsolidated valley fill Valley-fill alluvium Fractured basalt aquifer Gravel aquifers Missoula flood silt Bedrock / Basement **Basin-fill sediment** Floodplain sediment Terrace sediment Active channels Holocene Quaternary Missoula flood deposits Terrace gravels Willamette alluvium Isopach maps Willamette Silt Portland Basin Gravels Central-Southern Valley silts Gravel aquifer

Groundwater

groundwater meteoric water connate water juvenile water porosity permeability

horizontal permeability vertical permeability intergranular porosity fracture porosity solution cavities total porosity vield porosity primary vs. secondary porosity Darcy's law Q=KIA hydraulic gradient cross-sectional area specific yield specific retention zone of aeration vadose zone zone of saturation phreatic zone water table groundwater flow cone of depression aquifer aquitard artesian aquifer water table aquifer confined aquifer unconfined aquifer water table potentiometric surface piezometer unconsolidated aquifer consolidated aquifer infiltration groundwater contamination contaminant plume well monitoring well static water level depth to water drawdown hydraulic head specific capacity pumping rate

Water Wells / Drilling

Hollow stem auger Cable tool drilling Air rotary drilling "Casing"

"Well Screen" Grout Slotted screen Riser pipe Sand pack Tri-cone rotary bit Well log Drillers log Total depth Bore-hole diameter Annular diameter **SWL** TD Static water level DTW Depth to water Datum

know what a well installation looks like (be able to sketch it)

drill rig hollow stem auger well screen well riser well diameter static water level pumping water level

Willamette Aquifer-Willamette Silts Case Study (Nitrate Problem Willamette silt Willamette aquifer Gravel aquifer Willamette Confining Unit Aquifer vs. aquitard "buffer" basalt aquifers river alluvium alluvial aquifers Missoula flood gravels **Erratics** Pumping / drawdown Pump tests Slug test Permeability Storativity Chemical buffer

Oxidation / reductions Denitrification Denitrifying bacteria

Sources of Ground Water Contamination Reading Heavy metals Organic chemicals Chlorinated solvents Industrial processes Agricultural pesticides /herbicides Underground storage tanks Petroleum hydrocarbons Land fills Migration pathways Risk assessment Surface impoundments Deep disposal wells Septic / sewage wastes NAPL's DNAPL's LNAPL's

Overview of Site Investigations and Groundwater Remediation Site history Site geology Site hydrogeology Aquifer characterization Contamination assessment Contaminant characterization Contaminant distribution **LNAPLs DNAPLs** Soil sampling Water sampling Monitoring well construction Contaminant plume Groundwater plume Vapor phase Liquid phase Soluble phase "free product" Analysis Risk assessment Remediation study Passive vs. active remediation

Bioremediation Chemical treatment Natural attenuation Waste Isolation Pump-and-treat systems Capping and isolation Bioremediation Soil vapor extraction Academic Showcase: ES407 **Tectonic Framework of** Western U.S. Subduction Farallon Plate Juan de Fuca Plate Pacific Plate North American Plate Flat-slab subduction Colorado Plateau Laramide Orogeny San Andreas Transform GPS – GIS – Lidar InSAR, Paleomag Sierra Nevada Batholith Arc Volcanism Pluton **Rocky Mountain Front** Nevada Plano Altaplano Plateau Uplift Ignimbrite Storm Caldera Eruptions Basin and Range Crustal extension **Block Fault Mountains** Graben – Horst **Extensional Faulting** Yellowstone Hotspot Hotspot track Mantle plume Cascade Volcanic Arc Western Cascades High Cascades Plate retreat

Source removal Plume confinement

Key Concepts / Skills / Possible essay questions and other concepts

What is the difference between geologic hazard and risk?

List and discuss anthropogenic vs. natural environmental geology problems.

List and discuss the types of environmental hazards (natural and manmade) in Oregon / PNW

What are the range and types of anthropogenic groundwater and soil contaminant sources in the western Oregon region..

What is the nature of the Willamette Valley "nitrate problem", where does it occur and why? What are the geologic controls?

Be able to apply basic physics and geology principles to quantitative-style problem solving. Be able to do unit conversions from English to metric units? Be able to problem solve using your notes and calculator.

Know how to work the groundwater well and aquifer equations. Can you calculate seepage velocity? Porosity? Permeability? Hydraulic gradient?

Can you work volume and rate problems? Discharge and flow? Can you solve Darcy's law? Can you sketch Darcy's experiment?

what is the difference between a "confined aquifer" and "unconfined aquifer"? How are porosity and permeability related? What types of earth materials are associated with what types of porosity and permeability? (unconsolidated vs. bedrock?, examples (e.g. gravel vs. clay)).

What are the sources of environmental contamination in the Dallas-Monmouth area? What are the controlling factors of groundwater flow in the area? What are the aquifers?

Do you know how a monitoring and production well are constructed? Can you draw a diagram showing well construction?

Do you know how to work the groundwater flow problems?

Can you list and discuss the sources of contaminants, types of contaminants, and remediation strategies as applied to the Willamette Valley?

Can you discuss (in an essay question) the hydrogeologic setting of the mid-Willamette Valley?

Can you discuss the geologic setting associated with the Missoula floods?

Can you relate Willamette Valley Hydrogeology to nitrate contamination problems?

Can you discuss the environmental setting and issues associated with the Willamette basin?

Groundwater Hydrology Lab Exercise – Key Words

Groundwater, hydrologic cycle, water quality, water quantity, primary porosity, secondary porosity, permeability, hydraulic conductivity, darcy's law, effective porosity, water table, unconfined aquifer, confined aquifer, artesian well, flowing artesian well, aquifer recharge, till, gravel, sand, clay, shale, limestone, regolith, depth, elevation, well log, water table map, geologic map, geologic cross-section

LANDFILLS

What are the primary elements of a Subtitle D landfill? How does the liner system work? How is methane managed? How is leachate managed? Why are the active landfill cells covered with plastic? What is a groundwater monitoring system and how does it work? Why are some types of wasted accepted at Coffin Butte, but others are not? What is a monitoring well and why is it important to measure water depth? Do you think it a good idea to actively excavate in old, unknown, military waste? What would be some alternative approaches to determining the type of military waste at Coffin Butte? Why are the basalts underlying Coffin Butte so fractured, faulted, and folded? What is the primary source of permeability in the basalts underlying Coffin Butte?

Possible essay questions and other concepts

Describe, sketch, map, draw cross-sections of the regional hydrogeologic setting of the Willamette Valley. Include concepts of Willamette Aquifer, Willamette Confining Unit, Willamette Silts, Basement Confining Unit, CRB's, Marine Sedimentary Units.

Identify, list, and describe the major aquifer / aquitard units in the Willamette Valley. Discuss the Missoula Flood history and deposits of the Willamette Valley.

List and discuss the types of environmental hazards (natural and manmade) in Oregon / PNW.

List and discuss the sources of anthropogenic contaminants in the Willamette Valley

Expect a summary essay questions from the AEG student night, WOU Academic Showcase and the Senior Seminar Presentations.

List and discuss examples of remediation technology used at Hanford