

SPD Study Notes – Site Planning & Design Section

15 min Intro
1.5 hr 65 multiple choice
15 min break
15 min intro
2 hr Site grading vignette; Site design vignette
15 min exit questions
4.5 hours total

Critical things to remember:

FAR (Floor Area Ratio) = $\frac{\text{gross floor area}}{\text{Site area}}$
Efficiency factor has no bearing*

One acre = 43,560 sf

27 cubic feet = 1 cubic yard

9 square feet = 1 square yard

43560 square feet = 1 acre (43,560)

Allow 400 sf per car for parking & circulation

Building Efficiency = Net Area / Gross Area

Recommended Grade Slopes:

	Min. slope %	preferred slope %	max. slope %
Ground areas for drainage	2.0	4.0	
Grass areas for recreation	2.0		3.0
Paved parking areas	1.5	2.5	5.0
Roads	0.5		10.0
Sanitary sewers (depending on size)	0.5 - 1.5		
Approach walks to buildings	1.0		5.0
Landscaped slopes	2.0		50.0
Ramps	5.0 (1:20)		8.33 (1:12)

Rules of Thumb:

- Pavement minimum slope = .5% min.
- Soil minimum slope = 1% min.

Site Analysis

US Survey System

- Begun in 1784; Divided land that was not already surveyed into a square grid system of meridians 24 miles apart called checks
 - Check – area 24 miles on a side bounded by parallels & meridians; further divided into 16 townships
 - Township – area 6 miles on a side; further divided into 36 1 mile sections

- Section – 1 mile square parcel of land containing 640 acres
- Quarter Section – area .5 miles on each side
- 1 acre of land = 43,560 SF
- Baseline – parallel used as a primary starting point for the east-west layout of the US Survey system
- Meridian – north-south lines that follow the longitudes of the earth and are used as a basis for the US Survey system
- Guide meridian – meridian between the principal meridians
- Principal Meridian – meridian that serves as the basis for the north-south grid layout of the US Survey system
- Metes-and-bounds property description – verbal description of land that begins at a known point and describes the bearing and length of each side of the property until the point of the beginning is reached
- Parallels – east-west lines that follow the latitudes of the earth
- Range – row of townships running north and south from a principal meridian; given a number to describe where it is located north and south of a baseline
- Standard Parallels – parallels between the baselines in the US Survey system
- Township – the row of townships running east and west from a baseline; given a number to describe where it is located east or west of a principal meridian

Topography & Site Contours:

- Ridge / Crown – contours point “down” toward the lower elevation
- Valley / Swale – contours point “up” towards the higher elevation
- Hills – concentric circles with elevations getting higher towards the center
- Depression – concentric circles with the elevations getting lower towards the center

Topography & Orientation:

- Generally better to orient long side of building parallel to the direction of the contours rather than perpendicular to minimize excavation costs
- Generally better to run drives and roads parallel to contour lines if little or no change in elevation is required

Swale: an elongated depression in the land surface that is at least seasonally wet is usually vegetated and is normally without flowing water.

Riparian Rights

- system of rights and duties that determine the reasonable use, duties, and allocations of water to owners of waterfront property
- rights ensure that riparian owners can make reasonable use of water adjacent to their property while protecting the rights of other riparian owners
- person must own land adjacent to a body of water to be considered a riparian owner
- owner usually has exclusive rights to his bottomland for anchoring docks or rafts, his beach, and his upland, but not to the water itself. The owner cannot infringe upon the rights of other riparian owners or the public to make reasonable use of the water

Detention vs. Retention

- **retention pond**
 - designed to hold a specific amount of water indefinitely. Usually the pond is designed to have drainage leading to another location when the water level gets above the pond capacity, but still maintains a certain capacity
- **detention pond:**
 - low lying area that is designed to temporarily hold a set amount of water while slowly draining to another location. They are more or less around for flood control when large amounts of rain could cause flash flooding if not dealt with properly

Swamp: a wetland that features permanent inundation of large areas of land by shallow bodies of water, generally with a substantial number of hummocks, or dry-land protrusions

Rules of Thumb:

- Pavement minimum slope = .5% min.
- Soil minimum slope = 1% min.

Runoff coefficient: fraction of total precipitation that is not absorbed into the ground

Soils Testing

Proctor test:

The Proctor compaction test and the related modified Proctor compaction test, named for engineer Ralph R. Proctor (1933), are tests to determine the maximum practically-achievable density of soils and aggregates, and are frequently used in geotechnical engineering. The test consists of compacting the soil or aggregate to be tested into a standard mold using a standardized compactive energy at several different levels of moisture content. The maximum dry density and optimum moisture content is determined from the results of the test. Soil in place is tested for in-place dry bulk density, and the result is divided by the maximum dry density to obtain a relative compaction for the soil in place

Soil sieve analysis:

- (or gradation test) is a practice or procedure used (commonly used in [civil engineering](#)) to assess the [particle size distribution](#) (also called gradation) of a granular material.
- The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil,
- The grain size analysis is widely used in classification of soils. The data obtained from grain size distribution curves is used in the design of filters for earth dams and to determine suitability of soil for road construction, air field etc. Information obtained from grain size analysis can be used to predict soil water movement although permeability tests are more generally used.
- NOT provided in a written subsurface report

Bearing Capacity Tests:

- Borings: typically min. or 4 taken @ corners of building
 - Core borings recorded in a boring log – shows material, depth, moisture content, density
 - SPT standard penetration test – most common borehole test; measures the density of granular soils & the consistency of some clays
 - Auger borings
 - Wash borings
- Test pits – trenches dug at job site allow for visual inspection; practical depth limited to 10'
- Soil load tests

Soil Treatments to Increase Bearing Capacity:

- Drainage
- Engineered Fill
- Compaction
- Densification – vibration, compaction
- Surcharging – preloading ground with fill material to cause consolidation & settlement of underlying soil before building; settlement occurs & fill is removed – time & cost often preclude this treatment
- Mixing – instead of complete replacement a layer of sand or gravel is mixed in with less stable soil

Liquefaction - sudden loss of shearing resistance in a cohesionless soil

Permeability - measure of the ease with which a fluid flows through the voids of soil

Percolation Test- test to determine the suitability of soil for an on site sewage disposal

Cut & fill measured in cubic yards

Water Table – level underground that soil is saturated with water

Frost level -

Soil Types: classified by grain size & either organic or inorganic

- Clay – particles under 0.002 mm; smooth and floury when dry, plastic & sticky when wet
 - Expands when wet
 - Subject to slippage
- Silt – particles from 0.002 to 0.05 mm in diameter; grains are invisible but can be felt as smooth
 - Stable when dry or damp but unstable when wet
 - Swells and heaves when frozen
 - Compresses under load
- Sand – particles from 0.05 to 2 mm in diameter; finest grains visible to human eye
- Gravel – particles over 2 mm in diameter
 - Sands & gravels excellent for construction loads, drainage, sewage drain fields

Groundwater Remediation

- extraction / treatment – most commonly used to remediate groundwater
- in situ aeration
- biological barriers / filters
- gas chromatograph

Ground water, surface water, and leachate:

- [In situ biological treatment.](#)
- [In situ physical/chemical treatment.](#)
- [Ex situ biological treatment \(assuming pumping\).](#)
- [Ex situ physical/chemical treatment \(assuming pumping\).](#)
- [Containment.](#)
 - [Air emissions/off-gas treatment.](#)

Soil Remediation:

Three primary strategies used separately or in conjunction to remediate most sites are:

- Destruction or alteration of contaminants.
- Extraction or separation of contaminants from environmental media.
- Immobilization of contaminants.

Soils Contamination:

- Vapor extraction – cleanup technology used to remediate the unsaturated zone
- Biodegradation - "Naturally occurring biodegradation" means degradation of organic compounds by indigenous microbes without artificial enhancement. Naturally occurring biodegradation may be a suitable remedial action at sites where the contaminants of concern are readily biodegradable, site conditions are favorable, and the time necessary for naturally occurring biodegradation to effect cleanup is reasonable considering the site-specific circumstances
- **In situ incineration**
- Photolysis - chemical decomposition by the action of radiant energy (as light)

Treatment technologies capable of contaminant destruction by altering their chemical structure are thermal, biological, and chemical treatment methods. These destruction technologies can be applied in situ or ex situ to contaminated media.

Treatment technologies commonly used for extraction and separation of contaminants from environmental media include soil treatment by thermal desorption, soil washing, solvent extraction, and soil vapor extraction (SVE) and ground water treatment by either phase separation, carbon adsorption, air stripping, ion exchange, or some combination of these technologies. Selection and integration of technologies should use the most effective contaminant transport mechanisms to arrive at the most effective treatment scheme. For example, more air than water can be moved through soil. Therefore, for a volatile contaminant in soil that is relatively insoluble in water, SVE would be a more efficient separation technology than soil flushing or washing.

Immobilization technologies include stabilization, solidification, and containment technologies, such as placement in a secure landfill or construction of slurry walls. No immobilization technology is permanently effective, so some type of maintenance is desired. Stabilization technologies are often proposed for remediating sites contaminated by metals or other inorganic species.

Soil, sediment, and sludge:

- [In situ biological treatment.](#)
- [In situ physical/chemical treatment.](#)
- [In situ thermal treatment.](#)
- [Ex situ biological treatment \(assuming excavation\).](#)
- [Ex situ physical/chemical treatment \(assuming excavation\).](#)
- [Ex situ thermal treatment \(assuming excavation\).](#)
- [Containment.](#)
- [Other treatment processes.](#)

GeoTextiles:

- High Performance Turf Reinforcement Mats
- Turf Reinforcement Mats
- Erosion Control Blankets
- Nonwoven Geotextiles
- Woven Geotextiles
- Soil Reinforcement Geotextiles
- Silt Fence Fabrics
- Paving Products

Application Information:

- Soil Stabilization
- Storm Water/Erosion Control
- Landfill/Waste Containment

Geotextiles are permeable [fabrics](#) which, when used in association with [soil](#), have the ability to separate, filter, reinforce, protect, or drain. Typically made from [polypropylene](#) or [polyester](#), geotextile fabrics come in three basic forms: woven (looks like mail bag sacking), needle punched (looks like [felt](#)), or heat bonded (looks like ironed felt).

Geotextile composites have been introduced and products such as [geogrids](#) and meshes have been developed. Overall, these materials are referred to as [geosynthetics](#) and each configuration—[geonets](#), geogrids and others—can yield benefits in [geotechnical](#) and [environmental engineering](#) design.

Applications

Geotextiles and related products have many applications and currently support many [civil engineering](#) applications including [roads](#), [airfields](#), [railroads](#), [embankments](#), [retaining structures](#), [reservoirs](#), [canals](#), [dams](#), [bank](#) protection, [coastal engineering](#) and [construction](#) site [silt fences](#). Usually geotextiles are placed at the tension surface to strengthen the soil. Geotextiles are also used for sand [dune](#) armoring to protect upland coastal property from storm surge, wave action and flooding. A large sand-filled container (SFC) within the dune system prevents storm [erosion](#) from proceeding beyond the SFC. Using a sloped unit rather than a single tube eliminates damaging scour. [Erosion control](#) manuals comment on the effectiveness of sloped, stepped shapes in mitigating shoreline erosion damage from storms, and geotextile sand-filled units provide a "soft" armoring solution for upland property protection.

Geotextiles can improve soil strength at a lower cost than conventional [soil nailing](#). In addition, geotextiles allow planting on steep slopes, further securing the slope.

Geotextiles have been used to protect the fossil [hominid](#) footprints of [Laetoli](#) in [Tanzania](#) from [erosion](#), [rain](#), and [tree roots](#).

In building [demolition](#), geotextile fabrics in combination with steel wire fencing can contain explosive debris.^[2]

[Coir](#) (coconut fiber) geotextiles are a popular solution for erosion control, slope stabilization and bioengineering, due to the fabric's substantial mechanical strength. Coir geotextiles last approximately 3 to 5 years depending on the fabric weight. The product degrades into [humus](#), enriching the soil

Radon:

- Fix your home if your radon level is 4 picocuries per liter (pCi/L) or higher.
- Radon levels less than 4 pCi/L still pose a risk, and in many cases may be reduced.
- Radon is estimated to cause thousands of lung cancer deaths in the U.S. each year.
- Radon is a cancer-causing, radioactive gas
- Surgeon General has warned that radon is the second leading cause of lung cancer in the United States today. Only smoking causes more lung cancer deaths.

- Radon comes from the natural (radioactive) breakdown of uranium in soil, rock and water and gets into the air you breathe. Radon can be found all over the U.S. It can get into any type of building—homes, offices, and schools—and result in a high indoor radon level. But you and your family are most likely to get your greatest exposure at home, where you spend most of your time.
- EPA and the Surgeon General recommend testing all homes below the third floor for radon. EPA also recommends testing in schools.
- Radon reduction systems work and they are not too costly. Some radon reduction systems can reduce radon levels in your home by up to 99%.
- If radon levels are still in excess of 4 pCi/L, the passive system should be activated by having a qualified mitigator install a vent fan.
- Radon is a radioactive gas. It comes from the natural decay of uranium
- that is found in nearly all soils. It typically moves up through the ground
- to the air above and into your home through cracks and other holes in the
- foundation. Your home traps radon inside, where it can build up.

There are Two General Ways to Test for Radon:

SHORT-TERM TESTING:

The quickest way to test is with short-term tests. Short-term tests remain in your home for two days to 90 days, depending on the device. “Charcoal canisters,” “alpha track,” “electret ion chamber,” “continuous monitors,” and “charcoal liquid scintillation” detectors are most commonly used for short-term testing. Because radon levels tend to vary from day to day and season to season, a short-term test is less likely than a long-term test to tell you your year-round average radon level. If you need results quickly, however, a short-term test followed by a second short-term test may be used to decide whether to fix your home (see also page 7 under Home Sales).

LONG-TERM TESTING:

Long-term tests remain in your home for more than 90 days. “Alpha track” and “electret” detectors are commonly used for this type of testing. A long-term test will give you a reading that is more likely to tell you your home’s year-round average radon level than a short-term test.

The average indoor radon level is estimated to be about 1.3 pCi/L, and about 0.4 pCi/L of radon is normally found in the outside air.

RADON IN WATER

The radon in your water supply poses an inhalation risk and an ingestion risk.

There are several proven methods to reduce radon in your home, but the one primarily used is a vent pipe system and fan, which pulls radon from beneath the house and vents it to the outside. This system, known as a soil suction radon reduction system, does not require major changes to your home. Sealing foundation cracks and other openings makes this kind of system more effective and cost-efficient. Similar systems can also be installed in houses with crawl spaces.

Septic Systems:

Components:

A typical septic system has four main components:

1. a pipe from the home,
2. a septic tank,
3. a drainfield,
4. and the soil.

Microbes in the soil digest or remove most contaminants from wastewater before it eventually reaches groundwater.

Pipe from the home

All of your household wastewater exits your home through a pipe to the septic tank.

Septic tank

The septic tank is a buried, watertight container typically made of concrete, fiberglass, or polyethylene. It holds the wastewater long enough to allow solids to settle out (forming sludge) and oil and grease to float to the surface (as scum). It also allows partial decomposition of the solid materials. Compartments and a T-shaped outlet in the septic tank prevent the sludge and scum from leaving the tank and traveling into the drainfield area. Screens are also recommended to keep solids from entering the drainfield.

Drainfield

The wastewater exits the septic tank and is discharged into the drainfield for further treatment by the soil. The partially treated wastewater is pushed along into the drainfield for further treatment every time new wastewater enters the tank. If the drainfield is overloaded with too much liquid, it will flood, causing sewage to flow to the ground surface or create backups in plumbing fixtures and prevent treatment of all wastewater. A reserve drainfield, required by many states, is an area on your property suitable for a new drainfield system if your current drainfield fails. Treat this area with the same care as your septic system.

Soil

Septic tank wastewater flows to the drainfield, where it percolates into the soil, which provides final treatment by removing harmful bacteria, viruses, and nutrients. Suitable soil is necessary for successful wastewater treatment.

With one-fourth of U.S. homes using septic systems, more than 4 billion gallons of wastewater per day is dispersed below the ground's surface. Inadequately treated sewage from septic systems can be a cause of groundwater contamination. It poses a significant threat to drinking water and human health because it can contaminate drinking water wells and cause diseases and infections in people and animals. Improperly treated sewage that contaminates nearby surface waters also increases the chance of swimmers contracting a variety of infectious diseases. These range from eye and ear infections to acute gastrointestinal illness and diseases like hepatitis.

Care for your drainfield

Your drainfield is an important part of your septic system. Here are a few things you should do to maintain it:

- Plant only grass over and near your septic system. Roots from nearby trees or shrubs might clog and damage the drainfield.
- Don't drive or park vehicles on any part of your septic system. Doing so can compact the soil in your drainfield or damage the pipes, tank, or other septic system components.
- Keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from the drainfield. Flooding the drainfield with excessive water slows down or stops treatment processes and can cause plumbing fixtures to back up.