RECONNAISSANCE ENVIRONMENTAL GEOLOGY OF NORTHERN SCOTTSDALE

MARICOPA COUNTY, ARIZONA

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WASTE DISPOSAL

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INTRODUCTION*

In dealing with waste disposal and the placement of waste disposal facilities in the north Scottsdale area, a major concern is the geological suitability of the land. Waste disposal facilities that should be considered in planning for urbanization include septic tank systems, sewage treatment plants with waste stabilization ponds, and sanitary landfills. The use of cesspools is prohibited by the State of Arizona Administrative Rules and Regulations R9-8-313B.

As the amount of residential and commercial development in the northern Scottsdale study area increases, an evaluation of waste disposal suitability and siting is necessary. Current (1983) Maricopa County Public Health Department (MCPHD) regulations require percolation tests and test borings before any type of waste disposal system is installed. This map shows the geologic units rated from the most to least favorable for waste disposal in the study area, and lists generalized characteristics for each unit. Specific locations should have an on-site investigation of local conditions prior to any construction.

Waste disposal suitability is determined by several interrelated parameters: permeability of the alluvium, expressed by a percolation rate in minutes per inch, depth to and presence of caliche or bedrock, percent slope of the land, flood hazard, texture of the alluvium and depth to groundwater. Permeability is a measure of the interconnection of pore spaces in a soil, in effect, how quickly water moves through that soil. Percolation tests performed at a suggested disposal site provide information on permeability. The percolation rate is the number of minutes required for water in a test hole to fall one inch and measures lateral movement through the soil. Permeability generally increases with increased grain size, and decreases when caliche or bedrock is encountered. In addition to reducing water percolation, near-surface caliche and bedrock are difficult to excavate and increase the cost of the sewage system.

Slope steepness is another factor. Steep slopes allow liquid wastes to move too rapidly through alluvium for proper leaching, and leach fields are more susceptible to damage from storm runoff and gullying. Flooding is a hazard near the major washes in the study area, and floodwaters could flush wastes out of the disposal site and possibly contaminate present or future water supplies. Sheet flooding prevalent on the middle and lower parts of alluvial fans can introduce extra water into the disposal system, overloading and perhaps overflowing it.

Coarser alluvium is more permeable than finer alluvium and bedrock; however, the faster percolation rates prevent adequate filtering of wastes. Finer material, with some clay, is more favorable because of a slower percolation rate, higher adsorption potential of the clay, and larger surface area for adsorption. Clay particles hold charged cations which are electrically exchanged for pollutants in the wastes. If grain size is too fine, the percolation rate is too slow and ponding of effluent in the disposal area occurs. Sandy soils containing less than 25-30% clay (loam and sandy loam) are the most suitable for disposal systems. If depth to groundwater is great, coarser material may be suitable because percolating wastes would have sufficient time for filtration.

Types of waste disposal systems

Septic tanks are small scale waste disposal systems designed to purify liquid wastes by passing them through soil. The size of the disposal pit or leach field is determined by the percolation rate and the number of bedrooms. If the percolation rate is greater than 60 minutes per inch, the soil is unsuitable for septic tank use. Disposal trenches for septic systems should be constructed parallel to ground contours, and steeper slopes require larger spacing between trenches placed on different contours. Slower precolation rates require larger leach fields for the site. The ground water table and bedrock and other impervious material must be four feet or more below the bottom of the leach field under current (1983) regulations. In addition, MCPHD requires that the system be set back from dry washes, streams, houses, and wells.

Major geologic considerations in the siting of waste stabilization ponds are slopes, permeability, flood hazard and ease of excavation. Areas with caliche provide the reduced permeability necessary to contain the liquids, but are difficult and costly to excavate. In some parts of the study area, relief may be so low that extensive excavation may be needed to provide an adequate reservoir. In other areas, soils are not impermeable enough over large areas to meet the recommended low percolation rates for such ponds, and lining of the ponds would be required.

Ideally, sanitary landfills should be placed in areas where the soil or subsurface material has low permeability so leachate percolates slowly into underlying material and does not pollute groundwater. The material should not be so impermeable that ponding of the liquids in the landfill wastes occurs. Material that is impermeable when compacted is required to cover refuse daily to hinder the activity of insects, birds and vermin as well as to inhibit the flow of water through the refuse. The cover material should be workable in all weather, not a dust source, and easily compacted. The landfill area must be well drained so that surface water will not enter the landfill and saturate the wastes, and it should be located in a low flood-risk area. Accessibility to the landfill site must be easy, and long distances of refuse transport should be avoided to keep operating costs down. Calichified areas are generally unacceptable due to the difficulty of excavation and the general unsuitability of the excavated material for cover. Proximity to a source of cover must be considered and the material excavated from the landfill pit or trench should be used.

Local waste disposal conditions

The most favorable waste disposal conditions of the study area occur in the thick deposits of fine-grained alluvium of the basin floor and distal edges of alluvial fans. Permeability is high and percolation rates range from less than 1 to 5 minutes per inch. The relatively higher percentage of fines (clays and silts) in such material makes it very effective in adsorbing pollutants as water percolates downward toward the very deep water table. Unit I covers about 25% of the study area (21 square miles or 55 square kilometers) and contains such material. Most of the residential development to date in the study area is in Unit I. However, caliche occurs at moderate depths below the surface, generally 5 to 15 ft (1.6 to 4.6m), which somewhat reduces the suitability for waste disposal.

The degree of development of caliche generally increases from the distal end toward the proximal end of alluvial fans, and becomes generally very strongly developed in colluvium-alluvium areas and in the alluvium of the pediment. Depth to caliche generally decreases from the distal end toward the proximal end of alluvial fans, and is very near the surface in colluvial-alluvial areas. A thin layer of very strong or laminar caliche generally directly overlies the bedrock in areas where the cover is 2 ft (0.6m) or less over the bedrock.

Caliche is not only difficult to excavate, but may reduce the percolation rate to more than 60 minutes per inch where very strongly developed. About 45% (40 square miles or 104 square kilometers) of the study area contains strongly developed caliche at or within 5 ft (1.6m) of the surface. These areas are generally unsuitable for waste disposal systems without modifications.

The depth to the regional groundwater table in the study area ranges from 300 to 500 ft (91.5 to 152.5m) in the basin alluvium; however, perched water may be encountered below the alluvial surface at any depth. Perched water collects above small lenses or zones of material such as clay, having lower permeability than the surrounding material. The zone of lower permeability is similar to a small dam, slowing the descent of water toward the regional water table. The volume of water perched above the low permeability zone is generally small, and usually insufficient in the study area for a dependable supply of water. Groundwater in bedrock exists essentially only in fractures and joints.

Water from waste systems in the study area may pollute perched groundwater if the perched zone occurs only slightly below the alluvial surface. The water generally would have percolated through insufficient subsurface material to have been cleansed or filtered. Groundwater in fractures also may be polluted by waste systems in the study area, and possibly to even greater depths. Permeability along fractures can be very great, and the fractures contain few if any fines for filtering. Increased development and higher population density in the study area may lead to future groundwater contamination from wastes in perched and fractured bedrock zones. Because of the great depth of the regional water table, waste disposal carried out with reasonable care should not become a pollution problem in the basin alluvium.

SELECTED REFERENCES

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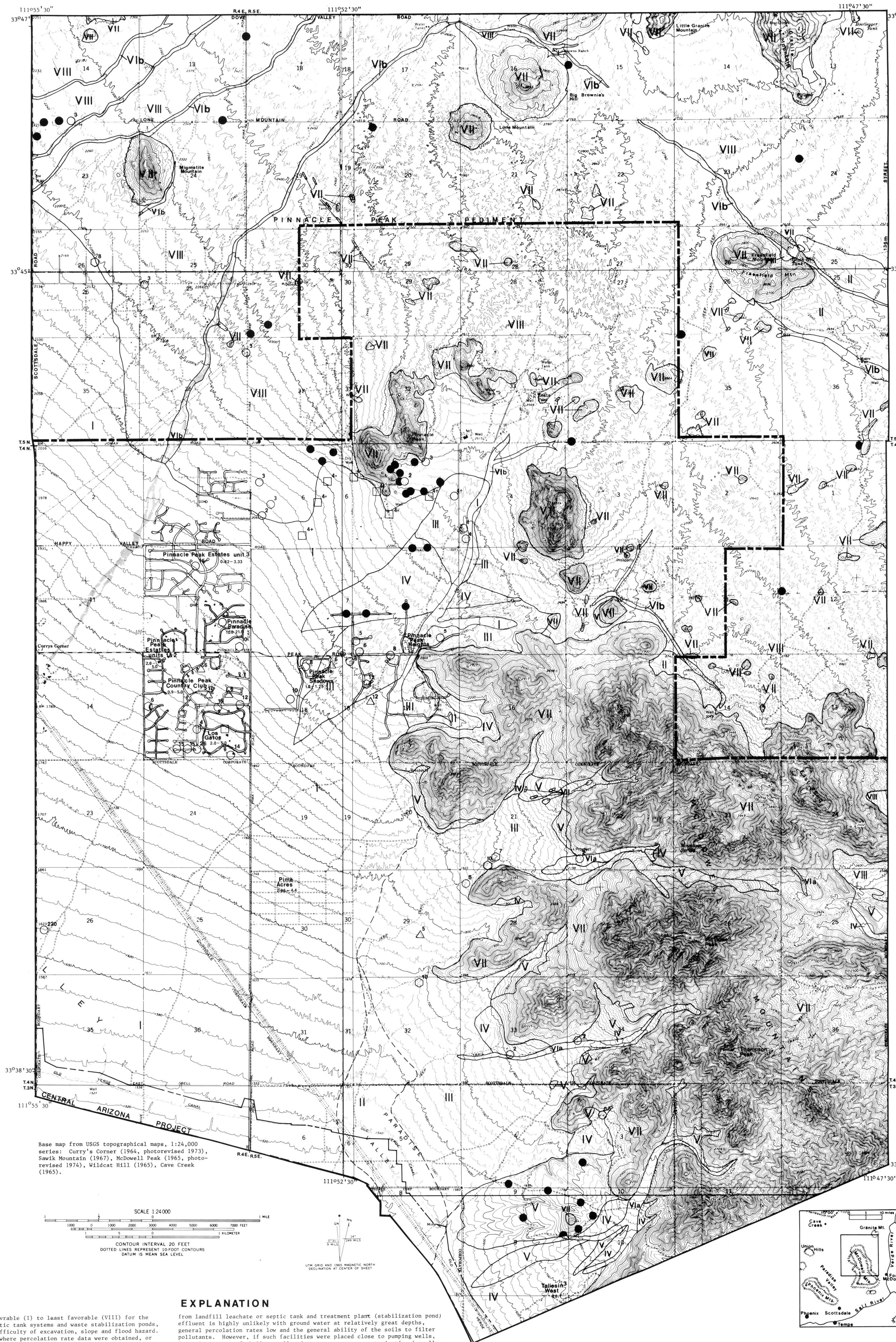
*This map involves a general evaluation on a broad scale and does not preclude the necessity of site investigation.



MAP SYMBOLS

Contact, dashed where inferred.

Caliche:

- strongly indurated, at surface
- strongly indurated, depth in feet
- moderately indurated, depth in feet
- weakly indurated, depth in feet
- weakly to strongly indurated below depth (in feet) given.

Los Gatos 2.0-5.0 — Percolation rate (minutes per inch) for given subdivision.

EXPLANATION

Map areas are rated from most faovrable (I) to least favorable (VIII) for the operation of sanitary landfills, septic tank systems and waste stabilization ponds, on the basis of percolation rate, difficulty of excavation, slope and flood hazard. Names and locations of subdivisions where percolation rate data were obtained, or will be obtained when development begins, are also shown on the map. Contamination from landfill leachate or septic tank and treatment plant (stabilization pond) effluent is highly unlikely with ground water at relatively great depths, general percolation rates low and the general ability of the soils to filter pollutants. However, if such facilities were placed close to pumping wells, lateral movement of shallow, polluted wastes may cause contamination in wells.

WASTE DISPOSAL UNIT	LANDFORMS UNIT	GEOLOGIC UNIT	PERCOLATION RATES[1] (minutes per inch)	DEPTH TO CALICHE (DEVELOPMENT)	AVERAGE SLOPE	SOIL TYPE (UNIFIED SOIL CLASS.)	SUITABILITY FOR SEPTIC TANKS	SUITABILITY FOR WASTE STABALIZATION PONDS	SUITABILITY FOR SANITARY LANDFILLS	SUITABILITY FOR USE AS LANDFILL COVER MATERIAL
I	Active alluvial fan segments, basin floor.	Fine-grained alluvium.	0.82 to 5.0[2]	Greater than 6 ft (1.8m) (weak to moderate)	0-2%	Gravelly loam (GC,SC)	Good, permeability sufficient, depth to bedrock great, easily excavated, no caliche problem, flood hazard great, particularly near washes.	Poor, slopes and relief are sufficiently low but permeability and flood hazard great, easily excavated but lining of pond necessary.	Fair to good, local source of cover, depth to bedrock great, excavation easy, flood hazard locally severe near streams, permeability sufficiently low.	Good to poor, good to poor compaction, impermeable when compacted, slight dust problem and difficult to work when wet.
II	Active and inactive alluvial fan segments.	Medium-grained alluvium.	No data.	3 ft (0.9m) (moderate)	2-5%	Gravelly loam (GC,SC)	Good to fair, permeability sufficient, depth to bedrock great, moderately easy to excavate due to only moderately developed caliche, flood hazard moderate but severe near washes.	Poor, slopes and relief sufficiently low, permeability high and flood hazard locally great, excavations easy but lining of ponds necessary.	Fair, excavations moderately easy at depths below 3 ft (0.9m), source of cover within 1 mi (1.6km), depth to bedrock great, flood hazard locally great, permeability moderate.	Fair to poor, fair compaction, impermeable when compacted, workable in all weather, locally too gravelly.
III	Active and inactive alluvial fan segments.	Medium-, coarse-, and very coarse-grained alluvium.	1.0 to 4.5	5-8 ft (1.6-12.4m) (moderate to strong)	2-10%	Very gravelly clay loam (GC)	Good to fair, permeability sufficient, depth to bedrock great, moderately easy to excavate down to 5-8 ft (1.6-2.4m), difficult below this depth due to strong caliche, flood hazard moderate.	Poor, slopes and relief moderate, permeability too great and flood hazard moderate, excavation easy to depths of 5-8 ft (1.6-2.4m).	Fair to poor, permeability sufficiently low below shallow depths, excavation difficult below shallow depths due to caliche and large boulder size, flood hazard moderate, source of cover within 2 mi (3.2km).	Poor, impermeable when compacted but too gravelly, compaction fair.
IV	Active, inactive, and abandoned alluvial fan segments, alluvial-colluvial slopes.	Medium-, coarse, and very coarse-grained alluvium; alluvium-colluvium.	26.7 at 5.5 ft (1.6m) (Taliesin West)[3].	At or within 3 ft (0.9m) of surface (strong)	2-10%	Very gravelly clay loam (SC)	Fair to poor, permeability locally sufficient but generally impaired by near-surface caliche, bedrock locally near-surface (Qac), excavation difficult, flood hazard slight.	Fair, slopes and relief locally prohibitive and excavation difficult, but permeability low due to caliche and flood hazard slight.	Poor, permeability low but excavation difficult due to caliche and large boulder size, flood hazard slight, local near-surface bedrock, source of cover within 5 mi (8km).	Poor, impermeable when compacted but too gravelly and too calichified, excavation difficult, poor compaction due to boulder content and caliche binder.
V	Abandoned alluvial fan segments, alluvial-colluvial slopes, smooth alluvium-colluvium covered bedrock surfaces.	Coarse- and very-coarse-grained alluvium; alluvium-colluvium.	No data.	At or within 3 ft (0.9m) of surface (strong to very strong)	Generally greater than 10%	Gravelly clay loam (GC,SC)	Poor, impermeable to slightly permeable due to caliche, degree of consolidation, and local near-surface bedrock, very difficult to excavate, flood hazard slight but locally slopes generally prohibitive.	Poor, slopes prohibitive and relief great, excavation difficult and permeability low due to caliche, flood hazard slight.	Extremely poor, impermeable but piping possible in fractures of near-surface bedrock, excavation very difficult, slopes prohibitive, flood hazard slight except in valley bottoms, no local source of cover.	Extremely poor, too gravelly and calichified, difficult to excavate, poor compaction due to boulder content and caliche binder.
Va/VIb	a) Modern stream channels.	a) Boulder alluvium and very coarse-grained alluvium.	No data.	a) Absent	a) 2-10%	a) Gravel (GP)	a) Poor, permeability great, subject to piping through gravel, no caliche but locally difficult to excavate due to large boulder size, flood hazard severe.	a) Poor, slopes locally prohibitive, excavation easy but permeability high and flood hazard severe.	a) Extremely poor, high permeability, subject to piping, flood hazard severe, local shallow bedrock.	a) Poor, very permeable even when compacted, poor compaction, easily excavated but boulder content great, no binding material.
	b) Modern pediment stream channels.	b) Fine- to medium-grained alluvium.	No data.	b) Absent	b) 2-5%	b) Sandy gravel (SG)	b) Fair to poor. Alluvium easily excavated, no caliche, permeability high to very high. Flood hazard great, areal extent limited, bedrock shallow.	b) Poor, permeability and flood hazard high, slopes and relief low, easily excavated, limited areal extent, shallow bedrock.	b) Extremely poor, high permeability, alluvium easily excavated, shallow bedrock, severe flood hazard, limited area.	b) Poor, low permeability when compacted, but too gravelly, alluvium easily excavated, compaction fair, little binding material.
VII	Bedrock highlands, fault-block hills.	Bedrock units.	No data.	Absent except in fractures and in slope debris	Generally greater than 15%	---	Poor, impermeable except in open fractures with piping and plugging possible, no filtering or cleansing of effluent, very difficult to excavate, flood hazard slight.	Poor, slopes prohibitive, excavation very difficult, impervious except for fractures, no flood hazard.	Extremely poor, impermeable but piping of leachate possible, very difficult to excavate, slopes prohibitive.	Extremely poor, very difficult to excavate, crushing necessary.
VIII	Pediment.	Pediment alluvium; thin grus cover, bedrock at or near surface.	No data. Grus is highly permeable, bedrock and calichified areas impermeable.	At or within 5 ft (1.6m) of surface (strong).	2-10%	Gravel (G)	Fair to poor, grus highly permeable, bedrock or calichified areas impermeable, shallow to surface bedrock, excavation of grus easy, excavation of bedrock and caliche may require blasting, strong caliche at or near surface, flood hazard slight except near major washes. Locally grus may be up to 15 ft (4.6m) thick.	Fair to poor, slopes and relief low to moderate, permeability of grus high, bedrock and calichified areas impermeable, flood hazard slight except near major washes, grus easily excavated, but bedrock and caliche difficult to excavate.	Extremely poor, little local cover available, bedrock at or near surface, excavation of grus easy, excavation of bedrock or caliche difficult, flood hazard slight except near major washes.	Extremely poor, not compactible, no binding material, excavation of bedrock and caliche difficult, excavation of grus easy.

1. Percolation rates generalized from Maricopa County Public Health Department data; for specific rates for individual subdivisions, see map.
2. A subdivision, at T. 5 N., R. 4 E., section 12, SE¼ has abnormally low rates of 10.0 to 21.0 minutes per inch.
3. Taliesin West is about 660 ft (201m) south of the study area, in T. 3 N., R. 5 E., section 16, NE¼.