

# SOIL CONSIDERATIONS IN POND CONSTRUCTION

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Selection of the location for a pond is of major importance in reducing time, labor, and expense involved in construction and maintenance. Careful planning initially, with full consideration of the types of soil materials involved, will pay huge dividends and save countless frustrations. A considerable amount of information is available about soils, most of which is free-of-charge from public agencies. Understanding soil properties and knowing where to find information is important to anyone interested in pond construction or renovation.

## POND TYPES

Ponds can be classified in two groups—embankment ponds and excavated ponds. Embankment ponds impound water primarily above the ground level. This type of pond is best suited to sloping locations. Surface water is usually relied on to fill these ponds.

Excavated ponds are dug into the soil so that water is impounded primarily below ground level. Such ponds normally are constructed on relatively flat lands where embankment ponds would be impractical. Either surface water or ground water seepage fills the excavated reservoir.

Pumped water can be used as a primary or supplemental source of water for either pond type. However, because of the expenses involved, it is usually best to choose a site where pumping can be minimized if not avoided altogether.

Successful construction of either type of pond depends on the capability of the soils in the reservoir area to hold water and to provide stable side-slopes and dams. Sites must be carefully selected.

## SOIL CONSIDERATIONS FOR EMBANKMENTS

Ratings of soils for embankments usually are made on the basis of soil mixtures to a depth of about 5 feet. Unsuitable material beneath the dam or embankment is generally discovered during the necessary on-site geologic investigations.

Problem soil characteristics for embankments include:

- a. Ice—This is not considered a major restrictive feature in Texas, but is included here for

completeness. In some areas of the U.S., it is of major importance.

- b. Thin soil—This restriction relates to the difficulty of obtaining sufficient soil material to form the embankment, as well as to problems encountered with the operation of equipment.
- c. Seepage—This characteristic is a major consideration throughout most of the state. Seepage affects the stability of the embankment, as well as the safety of people and structures downstream. Seepage, in this case, does not refer to loss of water through the bottom pond, but to that moving through the embankment.
- d. Piping—This term describes a characteristic of soils with relatively high contents of silts and/or very fine sands. When these materials become saturated they tend to flow, which results in mass wasting either at the surface or in tunnels through the embankment. Entire embankments may be lost due to this process.
- e. Excess humus—Soils which contain an excess of organic matter do not compact well, thus create an unstable embankment. Excess grass, leaves, stumps or like material likewise, should be kept out of the embankment.
- f. Compaction problems—Soil materials which do not compact to maximum density, for whatever reason, will not form a stable and usable embankment. Compaction is necessary to reduce the permeability of the embankment and to prevent settling problems following construction. Organic materials, poorly graded soils or other similar materials may cause problems. Rocks and stones also may interfere. Soil should have a favorable moisture content for compaction—not too wet and not too dry.
- g. Large stones—Stones present a problem for equipment during construction and also lead to poor compaction. Because of the cost of removing stones, soils containing many large stones are rated as having severe limitations.
- h. Ponding and wetness—Soils which retain excess moisture create problems in constructing embankments. Adequate compaction is usually impossible to obtain under such conditions, and trafficability is greatly reduced. There also may be other equipment problems.

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- i. Excess sodium or other salts—Soils with high levels of sodium or other salts may be easily dispersed, highly erosive, and susceptible to piping. Salts also create severe problems in establishing vegetation on the embankment and cause corrosion of metal structures. Resultant water quality also may be poor.

### SOIL CONSIDERATIONS FOR POND RESERVOIR AREAS

The pond reservoir area is that area which holds the water behind an embankment or in an excavated pit. For this use, soils generally are rated on their properties within the upper 60 inches. Soils are evaluated as to their permeability against seepage losses without regard to cutoff trenches or other features that may be installed under the pond embankment.

Important soil characteristics for pond reservoir areas include (Table 1):

- a. Permeability—This term describes the potential for loss of water by seepage downward or laterally.
- b. Coarse-textured layer—Even though the overall permeability of the soil material may be low, the occurrence of a thin, highly permeable layer such as a sand or gravel lense may cause serious seepage problems.
- c. Cemented pan—Such restrictive layers frequently interfere with equipment usage, reservoir excavations, and compaction. Cemented pans frequently overlie more permeable materials and, once fractured, commonly become a source of continuing seepage losses.
- d. Bedrock—Hard rock can be a severe problem, particularly in the use of construction equipment. Fractured bedrock is very difficult to seal against seepage losses.
- e. Slope—Steep slopes present many problems. If the slope is perpendicular to the embankment, the storage capacity of the reservoir area will be reduced greatly. Steep slopes also causes excessive runoff during heavy rainstorm, which can create safety problems. Equipment usage may be restricted.
- f. Marl/gypsum—These relatively soluble soil materials frequently cause both water quality problems and seepage losses.

### SOIL CONSIDERATIONS FOR AQUIFER-FED EXCAVATED PONDS

The ponds are created by excavating a pit which intersects an aquifer. Therefore, underground water is the primary source of water to fill such ponds. Important characteristics of aquifer-fed excavated ponds are (Table 2):

- a. Water depth—The depth to the aquifer water is an important consideration. Where water is

too deep to be intersected easily or is unreliable, severe limitations exist. Perched water tables frequently result in an unreliable water source.

- b. Permeability—The refill rate for aquifer-fed ponds is directly related to the permeability of the soil. Permeability may be so slow that inflow outpaces evaporation and consumption. However, permeability of the basin must be adequate to prevent excess seepage losses.
- c. Salinity—Highly saline water may be toxic to fish and restrict other uses accordingly.
- d. Stones—The occurrence of large stones hampers the use of equipment for excavation or embankment or dike construction.
- e. Bedrock—The dept of bedrock is an important concern because of its limitations for equipment use.
- f. Stability—In some cases, the soil may be so unstable that the bank caves and pit depth cannot be maintained.

### SEEPAGE CONTROL

When ponds lose water because of excessive seepage, it is usually because a poor site with high soil permeability has been selected. However, seepage losses can be ameliorated in several ways, such as:

- a. Compaction—Compaction is a particularly effective technique of reducing seepage, especially where the soil being compacted is well-graded, (that is, it contains all particle sized from small gravel to fine sands, silts and clays). This is also an inexpensive method of pond sealing. This practice involves mixing the soil to a depth of 8 to 10 inches with a disk, rototiller or similar equipment, removing rocks, roots limbs and stumps, and then compacting the loosened soil with a sheep's foot roller or similar equipment.
- b. Clay blankets—When a pond has been constructed in relatively coarse-grained soils, clay can be layered over the soil and compacted to reduce seepage losses. The blanket should cover the entire impoundment basin. The thickness of the blanket is determined by the depth of the water anticipated and the characteristics of the material used for the blanket.
- c. Bentonite—This is a special type fo clay which swells greatly when wet. This material is used to blanket the impoundment basin. The rate of application depends upon the nature of the soil being covered and the depth of the water anticipated.
- d. Chemical additives—There are various kinds of chemicals designed to breakdown aggregates and disperse clay particles, thus sealing the ponds. Such treatments are effective primarily for medium to fine-textured soils.

Table 1. Pond Reservoir Area\*

Property	Slight	Limitations Moderate	Severe	Restrictive Feature
1. USDA texture	--	--	Ice	Permafrost
2. Permeability (in/hr) (20-60)	<0.6	0.6-2.0	>2.0	Seepage
3. Depth (in.) to layer with perm. > or = 2.0	>60	40-60	<40	Seepage
4. Depth to bedrock (in.)	>60	20-60	<20	Depth to rock
5. Depth to cemented pan (in.)	>60	20-60	<20	Cemented pan
6. Slope (PCT)	<3	3-8	>8	Slope
7. USDA	--	--	Marl Gyp	Seepage

\*Taken from National Soil Handbook, USDA-Soil Conservation Service.

Table 2. Excavated Ponds (Aquifer-fed)\*

Property	Slight	Limitations Moderate	Severe	Restrictive Feature
1. Depth to high water table (ft.): apparent	<2	2-5	>5**	depth to water
Perched			any entry**	no water
2. Permeability (in/hr) (Below 10 in.)	>2.0	0.6-2.0	<0.6	slow refill
3. Salinity (mmhos/cm)	0-8	8-16	>16	salty water
4. Fraction >3 in. (wt. pct)***	<25	25-50	>50	large stones
5. Depth of bedrock (in.)	>60	40-60	<40	dept to rock
6. USDA texture	--	COS, G, SG	S, FS, VFS, LOS, LS, LFS, LVFS	cutbank cave

\* Taken from National Soil Handbook, USDA-Soil Conservation Service.

\*\* If NO WATER, disregard other properties.

\*\*\* Weighted average to 40 inches.

- e. Flexible membranes—It also is possible to cover the impoundment basin with polyethylene, vinyl, or rubber sheets. Each material has its own advantages and disadvantages. Generally, expenses and length of effectiveness are limitations.

### SUITABILITIES OF TEXAS SOILS FOR PONDS

Figure 1 provides a generalized interpretation of the suitability of Texas Soils for pond reservoir areas. More than 90% of the soils in the Coast Prairie, Claypan area, Blackland Prairies, and High Plains have slight to moderate limitations for pond reservoir areas. This indicates that the majority of these areas are suitable for pond construction. Conversely, less than 10% of the soils in the Edwards Plateau are suitable for ponds. Careful selection of pond sites in that area would be a necessity. Likewise, sites are limited in the Grand Prairie and Central Basin areas where only 30% to 40% of the soils are suitable for pond reservoir areas. Such information gives an idea of the likelihood of finding a suitable pond location in the several areas of the State. Use of more detailed information from available sources will assist in more specific location within these general geographic locations.

### INFORMATION SOURCES

A wealth of information about the soils in local areas can be obtained from the standard county soil survey reports available from the county Soil Conservation Service offices. Secondary sources for that information are the county Extension offices, State Office of the Soil Conservation Service, and the State Offices of the Texas Agricultural Extension Service. These county soil survey reports include soil maps on which the delineations show the extent and distribution of individual soil, tables listing interpretation of the soil properties for pond reservoir areas, suitability for fill material, and other considerations important to pond construction. Although such information does not take the place of an on-site inspection, it will save many hours of site investigations.

For those areas where standard soil survey reports are not available, general county soil maps are available. Such information is available for every county in Texas. These map data combined with specific interpretations and knowledge of the characteristics of individual soils can be used for general planning purposes and overall site location. This information, while not as site specific as that to be found in the soil survey reports, still offers great advantages in locating potential suitable sites for ponds. The county general soil maps and other soils studies, where available, can be obtained from the county Soil Conservation Service or Texas Agricultural Extension Service offices.

