

BUILDING SERVICES DIVISION SOILS TESTING POLICY

Effective date April 1, 2017

PURPOSE: History and experience indicates that soils within the boundaries of the City of Fredericksburg may contain soil types that are known to be detrimental to structures and other building components. Testing will be required to identify and remediate all soils detrimental to buildings and structures, especially expansive (shrink-swell) soils and acid sulfate soils.

Shrink-Swell Soils

Expansive soils or soils with a high potential for “**shrink-swell**” are those that are high in clay content and change volume with changes in moisture content of the soil. Expansive clay particles swell by absorbing large amounts of water relative to their volume. When these clay particles dry out again, they can shrink. A home built on expansive soil has a high probability to move if the foundation was not designed for construction on this soil type. Movement of the footing or foundation happens when soils expand; typically, when water infiltrates the clay particles and then forcibly moves the foundation. Different parts of the house can move at different rates which can cause cracking of the foundation.

Acid Sulfate Soils

Acid soils are naturally occurring soils that are formed under water saturated conditions. These soils contain iron sulfide minerals and, in an undisturbed state below the water table, acid sulfate soils are harmless. If the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides will react with oxygen to form sulfuric acid. Release of sulfuric acid from the soil can in turn release iron, aluminum, and other heavy metals within the soil. The acid and released metals create a variety of adverse impacts to building components, including, in extreme cases, the degradation to the point of failure of concrete and steel structures, as well as metal piping. Environmental impacts from acid sulfate soils include the killing of stabilizing vegetation and seeping into and acidifying groundwater and water bodies to the point of killing fish and other organisms.

Acid sulfate soils are most commonly the result of exposure of formations containing sulfur that are frequently found at deeper elevations in the City of Fredericksburg. Excavation and grading during subdivision development, lot development and/or basement excavation is the most common cause of exposure of acid sulfate soils. Protective measures are required when this material is identified either in the preliminary soils investigation for site development, lot soils analysis, or discovered at the time of foundation excavation and inspection certification. Upon discovery of highly acidic soils during site investigation by a geotechnical engineer, information shall be provided in the geotechnical engineer’s report identifying the level of acidity and depth of deposit, and the measures that shall be taken to remediate the acid sulfate soil condition to prevent damage to building components and ensure the success of soil stabilization measures. The geotechnical engineers report shall provide detailed recommendations for remediation to protect structures, property and overall site conditions subject to the review and approval of the Building Official.

Shrink-Swell Soils

Projects Requiring Soil Tests

- All new one and two family dwellings.
- All attached additions
- All detached accessory buildings where the building footprint is 600 square feet or larger.
- Any other project that does not fit the above criteria but may be required by the Building Official.
- All commercial buildings and structures

Note: If a soil analysis was completed for an original primary residential structure, at the discretion of the building official, the original report may be used for submittal for permit applications for accessory structures and building additions.

Project not requiring soils report

Unless indicated/warranted by discovery of problem soils on site

- Decks
- Detached accessory buildings less than 600 sq. ft.
- Swimming pools (unless required by pool designer, manufacturer, or design specifies minimum soil type)

Soil Sample Requirements

The following minimum requirements shall be applicable to soils analysis reports prepared for a single lot to obtain a building permit:

- On site soil and underlying parent material evaluations shall be performed by a Virginia licensed Soil Scientist, Engineer, or Geologist. Should a site be determined as having characteristics indicative of acid sulfate soils, testing for soil pH and potential acidity must be performed by a qualified laboratory experienced in the analytical protocols cited below.
- Recommendations for structural measures in identified shrink-swell soils, acid sulfate soils or any other unknown material type that will affect the building, structure or its components shall be prepared and sealed by a Virginia Registered Design Professional licensed in an appropriate discipline.
- A minimum of two soil borings per site shall be taken within the footprint for the structure, at opposite outside corners of the proposed building/structure.
- For townhouse buildings, a minimum of one boring per 1000 sq. ft. of first floor area is required, located at the opposite corners from the previous boring. Not less than two borings per continuous row of townhouse buildings shall be taken.
- Test borings shall start at **footing depth (24")** and shall extend to a **minimum of 2' below footing depth** or auger refusal.
- The poorest quality of material shall be used for testing from each boring location for laboratory testing.
- Additional borings may be required based upon proposed construction, soil encountered or recommendations of the accredited professional.
- The documents that are submitted shall be signed and sealed by the engineer.

Soil Report

The written soils report shall include, but not limited to the following minimum information. **The soils report shall be submitted and obtain approval prior to the release of the permits.**

- The building plat which shows the location of the test borings.
- A complete record of the soil samples, including existing fill material.
- Reason for auger refusal during sampling if applicable
- Soil profiles, including identification of soil types.
- Elevation of water table, if encountered, 24hr. water table if available. Subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet below the elevation of the lowest floor level where the floor is located below the finished ground level adjacent to the foundation (i.e. basement floors).
- Shrink-swell potential of soil, including swell pressure.
- Determination of the presence of acid sulfate soils shall be the responsibility of the Registered Design Professional, i.e.: Virginia licensed Soil Scientist, Geotechnical Engineer, Geologist or RDP with appropriate credentials. If the RDP suspects acid potential soils or low pH within the clearing limits, additional tests shall be completed and the results included in the soils report for the lot. If active pH and potential acidity levels are not acceptable, an Acid Sulfate Soil Remediation Plan shall be prepared by a Virginia licensed Soil Scientist, Geotechnical Engineer, Geologist, RDP with appropriate credentials. This plan shall be approved by Fredericksburg's Building Services Division prior to issuance of a building permit. The plan shall address remediation strategies to protect building components as well as vegetative restoration and environmental protection.
- Special design based on soil analysis for footings, foundations or slabs.
- Certify laboratory test procedures, at a minimum, contain one set of index parameters using ASTM test procedures.
- Original signatures and professional seals of soils professional who performed /supervised the soil sampling, conducting lab tests, and/or evaluation and prepared report.

Shrink-Swell Level Identification

When a soils analysis/report identifies a **zero** or **low** potential for shrink-swell conditions:

- Prescriptive requirements identified in the International Residential Code (IRC), based on soil types identified in the soils report for foundation requirements. The plan must show and design based on soil type per report, and foundation type per code tables.
- All sub grade inspections (ex. Footing, wall, slab, backfill, waterproofing) may be performed by a City inspector or an approved third-party inspections agency.

When the soils analysis/report identifies a **moderate** or **high** potential for shrink-swell conditions, a foundation design is required.

- Structural design shall be prepared and sealed by a Virginia licensed professional engineer, or a Virginia licensed architect.
- Sub grade inspections (footing, wall, slab, backfill, waterproofing) shall be performed by an approved third-party inspection agency with a specialty in geotechnical inspections.
- If soils are encountered during excavation that are other than those described in the soils report, additional testing may be required by a soils professional at the discretion of the building official.

Soil Classification: Included in the geotechnical /soils report, the material must be classified in accordance with ASTM D2487.

IRC Section 403.1.8.1 and the Virginia Construction Code (VCC 1803.5.3) Expansive Soils Classification. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with items 1, 2 and 3 shall not be required if the test prescribed in item 4 is conducted.

- 1. Plasticity Index(PI) of 15 or greater, determined in accordance with ASTM D 4318
- 2. More than 10% of the soil particles pass a No. 200 sieve, determined in accordance with ASTM D 422.
- 3. More than 10% of the soils particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.
- 4. Expansion index greater than 20, determined in accordance with ASTM D 4829

Foundation Design Requirements

IRC Section R403 - Foundations on expansive soils. Footings, Foundations, and floor slabs for buildings located on expansive soils shall be designed, by a Virginia licensed engineer or architect, in accordance with **Virginia Construction Code (VCC) Section 1808.6 design for expansive soils.**

Projects not requiring a soil investigation and projects found to contain zero to low potential to shrink- swell through laboratory testing shall be designed and constructed in accordance with the prescriptive minimum requirements of the IRC.

Compacted Fill Material:

Where footings will bear on compacted fill material, the compacted fill shall comply with the provisions of an approved fill lot monitored and certified by a geotechnical engineering firm. The report shall contain the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material
2. Specifications for the material to be used as compacted fill.
3. Test method to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill
4. Maximum allowable thickness of each lift of compacted fill material
5. Field test method for determining the in-place dry density of the compacted fill
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with item 3.
7. Number and frequency of field tests required to determine compliance with item 6

Backfill

The foundation wall design, and the type of material used as backfill material on the foundation wall, shall correspond to the minimum code requirements as set forth in section IRC section 404 and Chapter 18 of the Virginia Construction Code. The wall design and backfill material shall be specified on the approved construction documents.

If a foundation design was required to be submitted by a licensed professional engineer or architect, the design shall specify the type of material to be used for backfilling the foundation walls. The backfill placement inspection certification must be completed by the engineer.

If a foundation design specifies that the existing on-site soils is to be mixed with an outside soil source, in order to obtain a “blended backfill” suitable for placement against the foundation wall, then the design professional shall be responsible for the inspection of such “blending of soils” as well as the placement of the backfill

Acid Sulfate Soils Identification

REQUIRED TIME OF TESTING: If Acid Sulfate Soils have been identified or suspected during the initial subsurface examination by the RDP, testing shall be completed in conjunction with the shrink-swell testing described above and prior to the submission of a building permit application. Test results shall be submitted with the soil and geotechnical report that is submitted as a component of the building permit application. If suspected Acid Sulfate Soils are found after footing excavation or once the footing is formed, the RDP must make evaluations at that time and proper testing completed prior to approval of the footing and placement of concrete.

TESTING PROCEDURES: On site soil and underlying parent material evaluations shall be performed by a Virginia licensed Soil Scientist, Geotechnical Engineer, Geologist or RDP with appropriate credentials. Laboratory testing for soil pH and potential acidity must be performed by a qualified laboratory experienced in the analytical protocols cited below.

Sobek, A.A., W.A. Schuller, I.R. Freeman, and R.M. Smith. 1978. Field and Laboratory Methods Applicable to Overburden and Mine Soils. EPA Pub. 600/2-78-054. U.S. Government Printing Office, Washington, D.C.

ACCEPTABLE LEVELS: The soil-water pH test shall register between pH 5.5 and 7.5 and the measured potential acidity (via Acid Based Accounting or Hydrogen Peroxide Oxidation Method) shall be greater than or equal to -5 tons of calcium carbonate lime demand per thousand tons of material tested.

Should soil test results indicate pH or potential acidity levels not in conformance with the requirements listed above, an Acid Sulfate Soil Remediation Plan shall be prepared by a Virginia licensed Soil Scientist, Engineer, Geologist or RDP with appropriate credentials. This plan shall be approved by Fredericksburg's Building Services Division prior to issuance of a building permit. The plan shall address remediation strategies to protect building components as well as vegetative restoration and environmental protection.

Baseline testing on undisturbed materials shall be in conformance with the requirements listed above and shall consist of at least one boring to the maximum depth of excavations with contrasting soils horizon and/or geologic units described, logged, and composite sampled.

- Soil pH testing is required for backfill material prior to backfill work being completed.
- Potential acidity testing is required when the material found in soil samples or visual identification during excavation for all layers deeper than 49" are predominately gray or black in color (Munsell color chroma <3), or considered necessary by the RDP.

These are minimum testing requirements. The individual or firm responsible for soil testing may perform more borings should site conditions warrant. The documents that are submitted shall be signed and sealed by Registered Design Professional (RDP).

When a remediation plan is recommended or required the RDP shall submit a **"final inspection report"** stating that the remediation plan has been implemented and the soils stabilized in accordance with such plan. The remediation process shall be witnessed by the **RDP**. The final inspection report shall be submitted and approved by the Building Services Division prior to scheduling any final inspections.