4.5 SITE AND SOIL EVALUATION CONCEPT

The key to installing a reliable onsite system that minimizes pollution and disease is to identify suitable locations with a thorough site and soil evaluation. The evaluation determines suitability or points out site limitations. Only after a site evaluation has been completed can the proper onsite system be designed.

Reference
15A NCAC 18A. 1935 (40)

As defined in the rules

> **"site means the area in which the sewage treatment and disposal system is to be located and the area required to accommodate repairs and replacement of the nitrification field and permit proper functioning of the system."**

Site and Soil Evaluation Principles

This section provides guidelines for a thorough site and soil evaluation.

Onsite systems must: protect public health, and minimize environmental impacts. To accomplish these goals, the state of North Carolina uses a site and soil evaluation to determine the suitability of a location for an onsite system and the type of system that can be installed. This section discusses the purpose and offers guidelines for making a proper site and soil evaluation for a proposed onsite system.

Purpose of a Site and Soil Evaluation

The purpose of a site assessment is to understand the soil system and the hydrology of the site, to predict wastewater flow through the soil and into subsurface materials, and to design an onsite system to match the soil system and the hydrology of the site. The site and soil evaluation helps to predict how an onsite system will function at a site. How well the system functions depends on the soil's ability to absorb the wastewater, the probable flow paths of water from the site, and the treatment received by the wastewater.

The comprehensive site and soil evaluation used in North Carolina requires considerable expertise by the site evaluator. The site evaluator must have substantial knowledge of soil science, geology, sanitary engineering, and environmental health. Guidelines for a site evaluation are discussed below.

Guidelines for a Site Evaluation

The guidelines for a site evaluation can be grouped into the three components:

1.) Collecting information before the site visit.

2.) Assessing the site and soil at the location.

3.) Recording site evaluation data for system design and relaying the information to the designer of the system and the applicant.

Collecting Information Prior to the Site Visit.

This component of site evaluation consists of preparation. Preparation includes learning about the sites and soils in the region and knowing what types of onsite wastewater systems can best fit a situation, along with gathering information about the site to be evaluated.

FIRST GUIDELINE. ***Know the rules and know how to collect the needed information***. The Laws and Rules for Sewage Treatment and Disposal Systems are established by the Commission for Health Services to protect public health and minimize the environmental damage from onsite systems. These rules provide performance criteria for onsite systems and consider the allowable risks to the environment and public health from constituents in the wastewater, such as bacteria; viruses; nitrate; phosphorus; and other pollutants. The rules also provide the legal support for a site and soil evaluation and set the standards for site suitability.

The standards in the rules determine the amount and level of information that will be collected for each site. An initial site assessment will determine the level of detail for the site investigation and the type of data that should be collected. For example, a site with relatively flat slope and deep, well-drained loamy soils will require less investigation than a site with a more complex slope and several different soil profiles.

SECOND GUIDELINE. ***Determine the wastewater flow rate and characteristics***. Information on wastewater quantity and quality is used to determine the initial size and type of an onsite system to be installed at a particular site. The information for determining wastewater quantity and quality can be obtained from the application for an Improvement Permit.

The type of activity and size of facility that the onsite system serves determines the daily flow and the peak flow of wastewater, or wastewater quantity. Likewise, the strength of the wastewater, or wastewater quality, is determined by the activities in the facility and, to some degree, by the size of the facility and how and when the wastewater is created.

Wastewater quantity and quality affect the level of detail required for a site evaluation. For instance, a site proposed for treatment and disposal of wastewater from a school designed for 400 students would require a more extensive site evaluation than a system for a two-bedroom home.

THIRD GUIDELINE. ***Review preliminary site information***. Existing, published information will help the evaluator understand the types of soils and their properties and distribution on the landscape.

Published documents, such as soil survey reports, soil catena diagrams; geologic, topographic, and plat maps should be used for initial information about the site.

***Warning*: soil survey maps are good for planning, initial decision making, and helping you understand what to expect when you visit the site. However, they are not detailed enough to make siting recommendations. A field investigation is necessary for a proper site and soil evaluation. There is NO substitute for field investigations. [sic]**

FOURTH GUIDELINE. ***Understand the septic system design options***. Site evaluators must understand how onsite systems function in order to assess tradeoffs in design options. The type of site investigation is determined by the system design options appropriate to the particular location. For instance, a different type of site investigation would be required for a modified conventional system using groundwater interceptor drains than for a conventional onsite system.

The onsite system must be designed to allow a sufficiently deep aerobic zone beneath the treatment and disposal field to properly treat the wastewater before it enters the groundwater.

Major design options include: the depth of the trench bottom or infiltrative surface; the loading rate used for sizing the system at the site; and the type of distribution system, such as gravity or pressure distribution and parallel or serial distribution. The use of pretreatment options may be needed at the site.

Assessing the Site and Soil at the Location.

FIFTH GUIDELINE. ***View the onsite system as part of the soil system and the hydrologic cycle***. Typically, onsite systems serving single-family homes do not add enough water to the site to substantially change the site's hydrology.

SIXTH GUIDELINE. ***Predict wastewater flow through the soil and underlying materials***. The soil morphological evaluation and landscape evaluation are important in predicting flow paths and the rate of wastewater movement through the soil and underlying materials. These two evaluations are used for onsite systems in North Carolina because landscape position and soil morphology greatly influence wastewater flow from the site.

The soil morphological characteristics can be determined if water flow through the soil will occur primarily as vertical movement or as lateral movement in the horizontal direction.

Also, the soil morphological characteristics are used to estimate the long-term acceptance rate, or LTAR. This estimate of LTAR will determine the size of the area you must investigate. For example, if the first estimate of LTAR for a site is 0.1 gallons per day per square foot (gpd/ft^2) then you will need to evaluate four times the amount of land area than if the estimated LTAR had been 0.4 gpd/ft^2. For LTAR calculations see Section 4.6**.**

Site and soil evaluations result in a more reliable prediction of wastewater movement than a percolation or perc test estimates saturated hydraulic conductivity by filling a borehole with water and measuring how quickly the water level falls. North Carolina formerly used the perc test to evaluate sites for onsite systems, but it has been shown that the perc test technique is inaccurate and unreliable for determining wastewater flow. Therefore, North Carolina discontinued the use of the perc test for evaluating sites for onsite systems several years ago.

SEVENTH GUIDELINE. ***Determine if additional information is needed from the site***. Site and soil conditions and the type of onsite system under consideration determine whether additional evaluation is required. Some additional evaluations that may be required are: groundwater mounding analysis; drainage analysis; hydrogeologic testing; linear loading rate evaluation; and hydraulic conductivity measurements.

For example, if a large system serving a school is proposed at a location with groundwater within 7 feet to 10 feet of the soil surface, you would want to identify whether there are any horizons limiting flow. Saturated hydraulic conductivity measurements in the least permeable horizon followed by groundwater mounding analysis would be beneficial. This analysis helps predict whether unsaturated, aerobic conditions will still be present beneath the treatment and disposal field after operation begins and if groundwater mounding occurs beneath the system.

In another example, if the soil is poorly drained but sandy and located on a flat site, it may be possible to modify the seasonal high water table by using drainage. However, since the site is flat, additional investigations must be used to determine whether there is adequate elevation drop from the site to the proposed drainage outlet. This soil and site evaluation is necessary since drainage will not work effectively without an adequate outlet.

EIGHTH GUIDELINE. ***Assess the treatment potential of the site***. The treatment potential of the site depends on the degree of soil aeration and the rate of flow of the wastewater through the soil. Wastewater is treated more effectively in well-aerated soils where wastewater flow is slow, which allows adequate adsorption and degradation of undesirable chemical and biological constituents. Thus, soil depth is crucial in determining the treatment potential of the site because there is a longer flow path through deeper soils. The longer flow path means more contact with the soil and soil organisms, and more time for degradation of pollutants.

North Carolina law requires at least 12 inches of separation between the bottom of the trench and any limiting soil conditions such as restrictive horizons, wetness conditions or bedrock. This separation provides a reasonable flow path and contact time for pollutant removal in these highly permeable soils.

Class I soils are an acceptation, requiring a distance of 18 inches or more between the trench bottom and restrictive horizons, soil wetness conditions or bedrock. These soils have a greater separation distance since wastewater flows more rapidly through them. The 18 inch separation provides more contact time for pollutant removal in these highly permeable soils.

NINTH GUIDELINE. ***Evaluate the site's environmental and public health sensitivity***. Installing onsite systems in close proximity to community wells, near shellfish waters, in sole-source aquifer areas or other sensitive areas may raise concerns regarding environmental and public health issues. When there are special environmental or public health concerns about a site, it may be necessary to obtain additional site information or perform certain evaluations to determine the degree of impact of the onsite system. In such cases adequate documentation must be kept to show that the site evaluation included the area of concern.

For instance, concerns about public health may be raised when large onsite systems are located adjacent to community wells. Here a detailed assessment of the groundwater flow system is warranted. It is essential to determine whether the plume of wastewater from the treatment and disposal field will be intercepted by the cone of depression in the community well. If the cone of depression of the well is affected, then additional pretreatment of the wastewater may be needed to minimize any chance of polluting the community well.

Recording Site Evaluation Data for System Design and Relaying the Information to the Designer.

This component requires the site evaluator to communicate information gathered from the site evaluation to the person designing the system so that a proper design can be made.

TENTH GUIDELINE. ***Provide the system designer with soil/site descriptions and your recommendations***. Based on the information gathered about the facility, and the actual site and soil evaluation, the last step is to suggest loading rates, highlight site and design considerations, and to point out special concerns in designing the onsite system.

The site evaluator should rank each site for the type of system that can be installed and provide specific soil and site data that will enable selection of the most feasible design options for the site. It is not enough to just provide the recommended loading rate or design. You must provide the data upon which these decisions are based.

In many cases, a single site and soil evaluation will be all that is necessary to design an appropriate system. However, after collecting information about the site, the evaluator may need additional information to determine site suitability and the type of onsite system to be installed.

The process of data collection, evaluation, and design is often an iterative process. This means that new information or a new design is tried until a design fits the site. Some sites may require many repetitions before the final selection of an appropriate onsite system is made.

Site and Soil Evaluation

Six factors must be evaluated for installation of an onsite system. These factors determine the best type of onsite system suited for the site and how well the system will perform. The following section first discusses the six site and soil evaluation factors, and how the site can be classified. Then each evaluation factor is presented in detail, explaining what the factor is and how to evaluate it. NOTE: This applies to design wastewater flows of 3,000 gpd or less.

Site and Soil Evaluation Factors

Six factors must be evaluated to determine the suitability of a site for onsite system installation in the state of North Carolina. The six factors are:

1) Slope and landscape position.
2) Soil morphological characteristics.
3) Soil wetness.
4) Soil depth.
5) Restrictive horizons.
6) Available space.

Reference
15A NCAC 18A.1939(a)

Classification of Factors

One of the factors, soil morphologic characteristics, has four sub-factors which must be evaluated at each site:

1.) Soil Texture.
2.) Soil Structure.
3.) Clay Mineralogy.
4.) The Presence or Absence of Organic Soil.

Overall Site Suitability

After the site and soil evaluation, the local health department will compile the information and classify each factor as SUITABLE (S), PROVISIONALLY SUITABLE (PS), or UNSUITABLE (U), for ground absorption sewage effluent treatment and disposal (Table 4.5.1).

After each of the factors is classified as S, PS, or U, the overall site classification is determined by the most limiting factor that cannot be corrected by design or site modifications. For example, the soil wetness factor is U due to soil wetness at a depth of 32 inches in a loamy soil. The site may then be classified as PS, with the trench bottom installed no deeper than 20 inches.

Table 4.5.1
Site Classification

Table 4.5.1 Site Classification

Suitability	Site and Soil Limitations	Special Considerations for Permitting
SUITABLE	Has no limitations. Has slight limitations.	None. Proper design and installation.
PROVISIONALLY SUITABLE	Has moderate limitations.	Modifications. Careful planning, design, and installation.
UNSUITABLE	Severe limitations.Severe limitations but special investigation indicates that a regular, modified, alternative, or innovative system can be installed and function satisfactorily.*	No permit issued unless site reclassified as PROVISIONALLY SUITABLE.

*The health department must determine that the site specific data from engineering, hydro-geologic,

geologic, or soil studies indicate that a septic system can be installed such that effluent will not be:

1. pathogenic, infectious, toxic, or hazardous;
2. contaminating ground or surface water;
3. exposed on the ground surface or discharged to surface waters where it would come into contact with people, animals, or vectors.

Types of Onsite Systems Allowed for Each Site Classification.

A site classified as SUITABLE receives a permit for onsite system installation with few restrictions. A permit with more restrictions is issued for a site classified as PROVISIONALLY SUITABLE. No permit is issued for UNSUITABLE sites unless the site is reclassified as PROVISIONALLY SUITABLE. The three types of site classification are described on the following list:

1) A conventional onsite system can be installed on a SUITABLE site with greater than 4 feet to any restrictions. This system could have 2 feet of backfill over the top of the crushed rock in the trench and the trench bottom would be at least 12 inches above any unsuitable soil layer. See Figure 4.5.1 for a diagram of a conventional trench.
2) A modified onsite system would have to be installed on a site permitted as PROVISIONALLY SUITABLE. For example, in a conventional modified system, the distance between the soil surface and top of the crushed stone in the trench would only be 12 inches instead of 24 inches. See Figure 4.5.1 for a diagram of one type of modified conventional trench.

3) If a soil layer with unsuitable characteristics is located within 36 inches of the surface, the soil is classified as UNSUITABLE. With further investigation and if certain site modifications are made or if certain alternative onsite systems are used; the site may be reclassified as PROVISIONALLYSUITABLE.

Figure 4.5.1
Placement of modified conventional and conventional trenches in the soil.

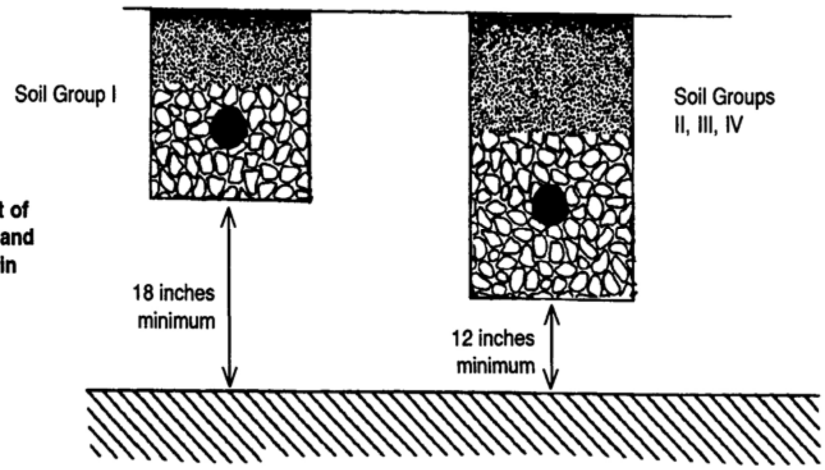


Figure 4.5.1 Placement of modified conventional and conventional trenches in the soil.

Reclassifying UNSUITABLE Sites.

Sites can be reclassified from UNSUITABLE to PROVISIONALLY SUITABLE because of soil wetness or restrictive horizons if the following conditions are met:

- Soils are Group I or II with SUITABLE structure and clay mineralogy;
- If restrictive horizons are present, and fewer than 3 inches thick or less than 12 inches from the soil surface;
- Site modifications can be made so that there is at least one foot of naturally occurring soil between the trench bottom and saprolite, rock, or any soil horizon unsuitable because of structure, clay mineralogy, and wetness. A low-pressure pipe system must be used if the separation between the bottom of the nitrification trench and any soil wetness condition is less than 18 inches and if more than 6 inches of this separation consists of Group I soils;
- Easements are recorded and have adequate width for access to maintain drainage systems serving two or more lots;
- Maintenance of the drainage system is made a condition of any permit issued for the use or operation of a sanitary sewage system;
- Drainage can be used in other types of soil as long as the appropriate engineering, hydrogeologic, geologic, or soil studies; and
- A ground absorption system can be installed so that the effluent will be non-pathogenic, non-infectious, non-toxic, and non-hazardous;

Reference
15A NCAC 18A.1955(m)

- The effluent will not contaminate groundwater or surface water; and
- The effluent will not be exposed on the ground surface or be discharged to surface waters where it could come in contact with people, animals, or vectors.

Evaluating Slope and Landscape Position

Two factors—slope and landscape position—determine whether water will collect at a site or flow away from the site. In general, concave or flat features accumulate water, resulting in wetter soil conditions. Convex sites tend to make water flow away from the site and are typically drier than concave or flat sites. Thus, slope and landscape position are extremely important factors in site evaluation because these factors strongly influence how wet the site is.

Slope positioning also effects the installation of septic systems. It is impossible to operate equipment for system installation on a slope greater than 65 percent.

When evaluating a site for landscape and slope positioning, the environmental health specialist must locate the best position for the onsite system. To choose the best location, the environmental health specialist must evaluate the property for overall landscape position and for specific features.

Overall topography and landscape position can be determined by walking over the property or standing at a location where the land surface can be seen. Those locations that have convex shapes or that have water flowing away from the location so that the soil is drier are the best locations for onsite systems. For example, it is better to install a treatment and disposal field on a ridge top than in a depressional area. Evaluation of soil properties from borings and pits placed in the best landscape position generally minimizes the time required to evaluate a lot, since the best soils for a system are generally located in the best landscape position.

The specific location on the lot should be evaluated for characteristics important to onsite systems. Some factors that should be investigated are:

- What is the slope?
- Does water flow to or away from the location?
- Are there any depressional areas?
- Are the soil depth and restrictive horizons deep enough to install the trench, given the slope?

In evaluating the slope and landscape position, remember that laying out the system includes locating the system components in appropriate locations. For example, although the slope may not be a limiting factor, it may interfere with placement of some trenches due to the available soil depth.

Suitability for placement of conventional onsite systems, as determined by slope, is shown below:

For low-pressure pipe onsite systems, the slope cannot be greater than 10 percent unless special design procedures are approved to assure proper distribution of effluent over the treatment and disposal field. Area-fill systems cannot be installed on slopes greater than 15 percent.

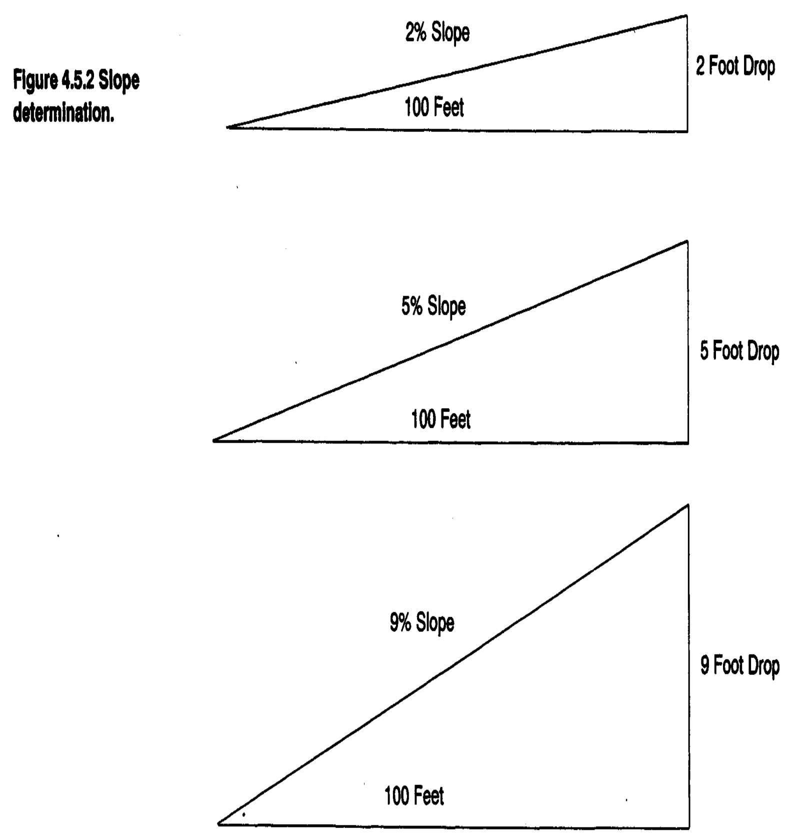
Reference
15A NCAC 18A-1940(a-d)

Slopes < 15%	SUITABLE
Slopes 15% - 30%	PROVISIONALLY SUITABLE
Slopes > 30%	UNSUITABLE However, slopes 31% to 65% may be reclassified PROVISIONALLY SUITABLE if a modified system can be installed.
Complex slope patterns and slopes dissected by gullies and ravines	UNSUITABLE

Slope Determination.

Slope is determined by measuring the change in elevation over a particular distance. Rods are held at the lowest position and the highest position. A surveyor's level is used to read the rod heights. The difference in these heights is the change in elevation. This change in elevation is then divided by the distance between the two rods. Three examples are presented below in Figure 4.5.2.

Figure 4.5.2
Slope determination



Reference
15A NCAC 18A.1940(e,g)

Reference
15A NCAC 18A.1937(c)

Reference
15A NCAC 18A.1940(f)

Two landscape positions that are UNSUITABLE for onsite systems are depressions and wetlands.

Depressions	UNSUITABLE unless the site is specifically approved by the local health department
Wetlands[1]	UNSUITABLE unless approval for on-site system installation is given in writing by the U.S. Army Corps of Engineers or the North Carolina Division of Coastal Management

[1]The applicant is responsible for notifying the local health department of any wetlands on the potential site.

At sites where the landscape position and soil properties cause water to flow over or through the soil at the site of the treatment and disposal field, the local health department may direct the use of landscaping, surface diversions, or groundwater interceptors to reduce the surface or subsurface water flow.

Soil characteristics are critical in determining the suitability of a soil for treating wastewater. In North Carolina, the four soil characteristics evaluated are texture; structure; clay mineralogy; and organic soils. These characteristics are evaluated by using soil borings and soil pits.

Soil Borings and Soil Pits for Soil Evaluation.
Four of the evaluation factors—wetness; depth; soil morphological characteristics; and restrictive horizons—require soil borings or digging a soil pit for proper evaluation. Soil borings are less expensive than soil pits and are sufficient to determine the suitability of the four soil factors for many sites. On sites that require a more detailed evaluation, a soil pit should be dug to determine site suitability. Pits provide a much better means to view and evaluate the soil than soil borings and should be used when a detailed soil description is necessary for site suitability determination.

Evaluating Soil Morphological Characteristics

Soil borings are identical 4 inch-diameter holes in the soil used to view the soil at a site. The borings or pit should be at least 48 inches deep or a depth at which an uncorrectable soil factor is encountered.

Soil pits are holes large enough for a person to enter and view the soil closely. Backhoe-dug pits are an excellent diagnostic tool for soil depth, wetness, and restrictive horizons. Because a pit allows the evaluation of a larger cross-section than does the soil auger, the soil may be found to have different characteristics than those identified through auger sampling alone.

Since the use of a backhoe-dug pit allows a more thorough soil evaluation, it may be possible to reclassify a site as PROVISIONALLY SUITABLE that would have been considered UNSUITABLE from auger borings alone prior to the pit evaluation.

For example, a restrictive horizon at a site may be discontinuous. A soil pit analysis would probably reveal this discontinuity whereas a soil-auger test might not. By using soil pits, the site might be reclassified to reflect the restrictive layer discontinuity.

Another situation in which pits are useful is for soils with stony or gravelly layers found in the Piedmont or Mountains. For these soils, a soil boring may lead the evaluator to think that a stony layer is impervious bedrock. A soil pit, on the other hand, may reveal that the layer is a stony or gravelly horizon that will not impede water flow.

A soil pit, in conjunction with soil borings, must always be used when evaluating saprolite.

The site factor called soil morphologic characteristics has four sub-factors which must be evaluated at each site:

1.) Soil Texture.
2.) Soil Structure.
3.) Clay Mineralogy.
4.) The Presence or Absence of Organic Soils.

Soil Texture.

Soil texture is defined as the relative proportions of the various soil separates in a soil. Texture is a soil morphological property that affects a site's suitability for treating and safely disposing of wastewater. Texture influences the hydraulic conductivity, the porosity, and the structure of the soil. Soils with poor drainage due to heavy texture, such as clay soils, may not allow wastewater to move rapidly enough through the soil to dispose of the needed volume of wastewater. Soil texture is used to assign an acceptable loading rate of sewage to the site. Accurate determination of soil texture is critical to the determination of soil absorption system size.

According to the rules

> **"Soil textural classes means soil classification based upon size distribution of mineral particles in the fine-earth fraction less than two millimeters in diameter. The fine-earth fraction includes sand (2.0-0.05 mm in diameter), silt (less than 0.05 mm-0.002 mm or greater in diameter), and clay (less than 0.002 mm in diameter) particles. The specific textural classes are . . . as shown in Soil Taxonomy, Appendix I, which is hereby adopted by reference in accordance with G.S. 150B-14(c) . . ."**

Texture in each soil horizon is most often determined by hand. Table 4.5.2 presents the criteria used to determine soil textural class by hand as described in *Soil Taxonomy* (USDA-SCS, 1975).

Laboratory analysis is more accurate than hand determination of texture and is sometimes required. Laboratory determination of texture must follow the American Society for Testing Materials D-422 procedures for soil textural testing, but use the USDA particle size system for classifying the textural category. Additionally, fine loamy and clayey soils (Groups III and IV) should be soaked in a dispersing agent for 12 hours prior to the hydrometer analyses.

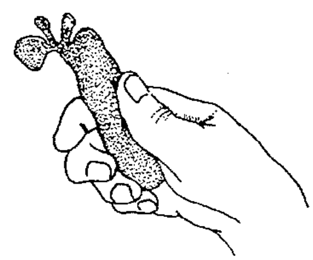
4

Table 4.5.2
Criteria for Soil Textural Class Determination

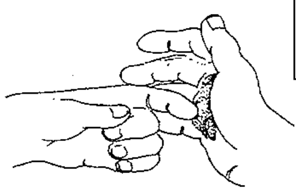
START

Place approximately 25g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.

Does soil remain in a ball when squeezed?
- NO → Is soil too dry?
  - YES → Place approximately 25g soil in palm…
  - NO → Is soil too wet?
    - YES → Add dry soil to soak up water → Place approximately 25g soil in palm…
    - NO → SAND
- YES → Place a ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.



Does soil form a ribbon?
- NO → LOAMY SAND
- YES → Does soil make a weak ribbon less than 2.5 cm long before breaking?
  - NO → Does soil make a medium ribbon 2.5-5 cm long before breaking?
    - NO → Does soil make a strong ribbon 5 cm or longer before breaking?



YES (from each ribbon question) → Excessively wet a small pinch of soil in palm and rub with forefinger.

Weak ribbon:
- Does soil feel very gritty? YES → SANDY LOAM
- NO → Does soil feel very smooth? YES → SILT LOAM
- NO → Neither grittiness nor smoothnes predominates → YES → LOAM

Medium ribbon:
- Does soil feel very gritty? YES → SANDY CLAY LOAM
- NO → Does soil feel very smooth? YES → SILTY CLAY LOAM
- NO → Neither grittiness nor smoothnes predominates → YES → CLAY LOAM

Strong ribbon:
- Does soil feel very gritty? YES → SANDY CLAY
- NO → Does soil feel very smooth? YES → SILTY CLAY
- NO → Neither grittiness nor smoothness predominates → YES → CLAY

Table 4.5.3
State of North Carolina
Soil Texture Groupings
For Onsite Systems.

Table 4.5.3 State of North Carolina Soil Texture Groupings for On-Site Wastewater Systems

Suitable Soils		Provisionally Suitable Soils	
Group I Sandy Soils	Sand Loamy Sand	**Group III Fine Loamy Soils**	Silt Loam Silt Sandy Clay Loam Silty Clay Loam Clay Loam
Group II Coarse Loamy Soils	Sandy Loam Loam	**Group IV Clayey Soils**	Sandy Clay Silty Clay Clay

Once determined, soil texture is placed into one of the 12 textural classes found in the textural triangle that was discussed in section 4.4.

In North Carolina, for the purpose of onsite wastewater evaluation, the 12 classes are combined into four textural groupings:

- Group I — Sandy Texture Soils;
- Group II — Coarse Loamy Texture Soils;
- Group III — Fine Loamy Texture Soils; and
- Group IV — Clayey Texture Soils

Table 4.5.3 shows how all 12 soil textural classes are assembled into these four groupings:

- Soils in Group I and II are SUITABLE for onsite systems; and
- group III and IV soils are PROVISIONALLY SUITABLE for onsite systems.

Soil Structure.

Soil structure is a way to describe how individual soil particles are arranged into larger groupings of particles called aggregates. Structure affects the rate of water movement through the soil, the amount of air that can get into the soil, and the soil's ability to treat wastewater. Table 4.5.4 describes soil structure categories, as designated in the rules, and assigns suitability classes to different soil structures.

Reference
15A NCAC 18A.1941(a)(2)(A-F)

Five different soil categories are recognized for site evaluation purposes:

1) Crumb and granular.
2) Block-like.
3) Platy.
4) Prismatic.
5) Absence of structure: a) single grain, and b) massive.

Granular, block-like and single-grained structure types are classified suitable, because they promote internal drainage and soil separation.

Platy, prismatic and massive structure types are classified unsuitable. Platy and massive types restrict internal drainage and aeration, while prismatic structure may provide a direct flow path for untreated wastewater from the trench bottom to a water table.

No matter what structure type is found at a site, if the peds are very large, the structure is unsuitable, because there will be few structural voids per unit total volume of soil. Internal drainage will then be insufficient to maintain soil aeration and ad treatment.

Reference
15 NCAC 18A.1941(a)(3)(A-B)

The presence of block-like structure is particularly important in some Piedmont and Mountain soils, since water flow around these block/peds allows these soils to be used for onsite waste management (refer back to the section on soil structure in the Basic Soil Concepts chapter for more details).

For more information on soil structure, refer to *Soil Taxonomy*; Appendix I (*USDA-SCS, 1975*) and the *Field Book for Describing Soils* (*USDA-NRCS, 2002*).

Clay Mineralogy.

The type of clay mineralogy and the amount of clay in a soil influence water movement. There are different types of clays. The two major types of clay are 2:1 and 1:1 clays. 2:1 clays expand when wet, whereas 1:1 clays expand only slightly when wet. These concepts are important to the performance of soil absorption systems as discussed below.

Clays with a 2:1 mineralogy, such as montmorillonite, shrink when dry and swell upon wetting. When a soil swells, the soil particles expand into the structural voids, reducing the size of the openings, and reducing total porosity. The hydraulic conductivity of the soil is therefore reduced, which limits the movement of wastewater through the soil. Soils with 2:1 clay mineralogy are generally not suitable for onsite systems because the soil swells and restricts the flow of water.

Table 4.5.4
Description of Soil Structure Types and Suitability

Table 4.5.4 Description of Soil Structure Types and Suitability

Soil Structure Type	Description (if needed)	Suitability
Crumb and granular		SUITABLE
Block-like	peds ≤ 2.5 cm (1 inch) in diameter	PROVISIONALLY SUITABLE
	peds > 2.5 cm (1 inch) within 36 inches of the naturally occurring soil surface	UNSUITABLE
Platy	within 36 inches of the naturally occurring soil surface	UNSUITABLE
Prismatic	within 36 inches of the naturally occurring soil surface	UNSUITABLE
Absence	single grained and exhibit no structural aggregates	SUITABLE
	massive and exhibit no structural peds within 36 inches of the naturally occurring soil surface	UNSUITABLE

Soils with 1:1 clays, such as kaolinite, have less shrink/swell potential. Soils with 1:1 clay mineralogy are suitable for onsite systems because the soils do not swell and restrict the water flow.

If the clay fraction of the soil has between 10 percent and 50 percent 2:1 clays, the soil has mixed mineralogy. Some soils with mixed clay mineralogy can be used for onsite systems; some cannot. Soils with mixed mineralogy are not suitable for onsite systems if the consistence is very firm, extremely firm, very sticky, or very plastic, because those types of consistence indicate will expand when sewage is applied to the soil. Each soil in this class must be evaluated to determine if it is suitable for onsite wastewater disposal.

Soils with predominately 1:1 clays and less than 10 percent 2:1 clays are usable for onsite systems, because they expand very little when sewage is applied to them, so they will maintain good internal drainage and aeration.

If laboratory is substituted for field determination of clay of clay mineralogy, the American Society for Testing and Materials (ASTM) procedures must be used to determine liquid limit, plastic limit, and the plasticity index of the soils. If the Liquid limit exceeds 50 and the plastic limit exceeds 30, the sample is classified as having expansive mineralogy.

Soil Consistence.

Clay mineralogy can be determined in the field by evaluating soil consistence. Soil consistence is a measure of how well soil forms shapes and how well it sticks to other objects. Consistence can be determined when a soil is dry, moist or wet. The best test for soil consistence in North Carolina is when the soil is moist or wet. In a moist soil, consistence is determined by looseness, friability, and firmness. If the soil has very firm or extremely firm moist consistence, the soil contains expansive mineralogy, and is classified UNSUITABLE for an onsite soil absorption system.

In a wet soil, two consistency factors, soil stickiness and plasticity, should be determined. Stickiness, how well the soil adheres to other objects, is determined by pressing the soil between the fingers and thumb. Plasticity, how well the soil forms shapes, is determined by rolling the soil between the thumb and forefinger to determine whether a thin rod or wire of soil can be formed. See Table 4.4.9 in the section on Basic Soil Concepts for more details on how to evaluate soil consistence. Additional information on soil consistence can be found in the publication *Soil Taxonomy* (USDA-SCS, 1975) and the *Field Book for Describing Soils* (USDA-NRCS, 2002).

If the soil is very plastic and very sticky with wet consistence, it contains expansive clay mineralogy and is classified UNSUITABLE for an onsite soil absorption system.

Wet consistence is more reliable than moist consistence for the determination of clay mineralogy since water may be added by the evaluator to obtain wet consistence. Moist consistence on the other hand, depends on the available moisture at the time a soil sample is collected. Wet soil consistence should always be determined when the evaluator speculates that the site has expansive clay mineralogy.

If the soil is classified UNSUITABLE because of structure or clay mineralogy, it may be changed to PROVISIONALLY SUITABLE if an investigation determines that a modified or alternative septic system would function appropriately on this site. See *15A NCAC 18A.1956* or *.1957* for the rules governing installation of modified or alternative septic systems.

The suitability of a soil for onsite system installation, based on consistence measured at either wet or moist soil conditions, is shown on Table 4.5.5.

4.5.5
Soil Consistency Criteria For Siting Septic Systems

Table 4.5.5 Soil Consistency Criteria for Siting Septic Systems

Clay Mineralogy	Suitability	Evaluated at Moist Water Content	Evaluated at Wet Water Content
Slightly expansive (includes non-expansive)	SUITABLE	Loose, very friable, friable, or firm	Non-sticky, slightly sticky to sticky or non-plastic, slightly plastic to plastic
Expansive	UNSUITABLE	Very firm or extremely firm	Very sticky, very plastic

Reference
15A NCAC 18A.1941(a)(4)

Organic matter.

Organic soils, soils with 20 percent or more organic matter by weight to a depth of 18 inches or greater, are always UNSUITABLE as locations for onsite systems. These soils remain wet throughout most of the year because they drain too slowly. Organic soils may also burn or subside causing the onsite system to be destroyed.

Soil Wetness.

Adequate treatment of wastewater can only occur in well-aerated soils. When the soil is wet, soil voids are filled with water and there is insufficient soil aeration to properly treat wastewater. Since wet soils do not allow adequate treatment of wastewater, onsite systems cannot be installed in wet soils.

Soil color is used to indicate soil wetness. Once the soil colors and the depth of these colors have been determined, the soil can be classified for suitability on onsite system installation based on wetness.

Chroma is the relative strength, purity, or saturation of the color of the soil. Chromas of two on the Munsell color chart, either in mottles or as a solid soil mass, often indicate wet soil. The wetness could be caused by a seasonal high-water table, perched water table, tidal water, soils that are saturated during the rainy season or movement of groundwater into and through the soil. The relationships between the depth to the soil with chroma two less color and the site suitability for installation of an onsite system are presented in Table 4.5.6.

Table 4.5.6 Soil Wetness and Site Suitability

Table 4.5.6 Soil Wetness and Site Suitability

Soil Wetness Depth (from Soil Surface)	Suitability
> 48"	SUITABLE
36 - 48"	PROVISIONALLY SUITABLE
< 36"	UNSUITABLE

Sometimes soil color is an artifact of the original parent material and is not indicative of soil wetness. Soil colors of chroma 2 or less, which are relic from minerals of the parent material shall not be considered indicative of a soil wetness condition.

Other site characteristics can be used to indicate soil wetness. Vegetation and landscape position can be used as an initial indicator of wet areas. The presence of waterborne vegetation and a depressional landscape position would suggest that identified gray colors are most likely due to soil wetness and not relic parent materials.

Soil Wetness

If the site has been drained, the soil must be evaluated for soil wetness by monitoring the site with monitoring wells from December through March to determine the water table depth.

In the Piedmont, interceptor drains may be used for controlling perched water tables. In the mountains, these drains can divert laterally moving water in colluvial soils. In the Coastal Plain, ground-water-lowering devices, such as subsurface tiles, ditches, or pumped drainage, are frequently used, when the soil texture is Group 1 or Group 2 and other soil properties are suitable.

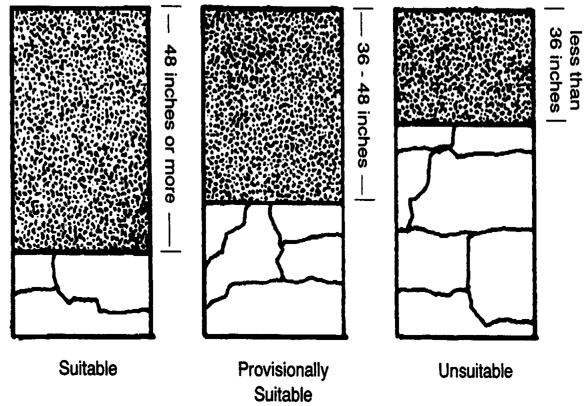
If the soil is UNSUITABLE because of wetness, the classification may be changed to PROVISIONALLY SUITABLE if an investigation determines that a modified or alternative septic system would function appropriately on this site. See *15A NCAC 18A.1956 or .1957* for the rules governing installation of modified or alternative septic systems. Direct monitoring of the water table as prescribed in *15A NCAC 18.1942* may also be utilized to demonstrate that soil wetness as determined by soil color is not accurate for this site.

Soil Depth

Soils must have enough depth so that wastewater is properly treated. Research performed by Bauma and Reneau has demonstrated for most soils that there must be at least 12 inches of suitable soil under an absorption trench to properly treat septic tank effluent. Cogger has demonstrated that this depth must be increased for sandy soils. Soil depth from the soil surface to the saprolite, rock, or parent material is a major factor in determining the suitability of the site for onsite systems. See Figure 4.5.3 for a drawing showing soil depth requirements, as stated in the rules.

Figure 4.5.3
Soil depth
and site suitability

Figure 4.5.3 Soil depth and site suitability.



Aerated soil with more than 12 inches beneath the trenches is generally required to treat wastewater adequately. However, a total of 48 inches of acceptable soil is necessary for conventional onsite system installation. If the total soil depth is between 36 inches and 48 inches, a modified onsite system can be installed, requiring 12-24 inches of soil above the trench, a 12 inch trench, and 12 inches below the trench.

Reference
15A NCAC 18A.1943(b)

The only soil depth requirement exception is for sites with less than 36 inches and the site evaluation has determined that a modified or alternative system can be installed. For instance, site suitability for low-pressure pipe systems must be based on the first 24 inches of soil beneath the naturally occurring soil and surface. See *15A NCAC 18A.1956* or *.1957* for the rules governing installation of modified or alternative septic systems.

Reference
15A NCAC 18A.1957(a)(2)(B)

Soil depth and slope.

On steep slopes, the depth of soil required for installation of trenches may be greater than on sites with little or no slope. This extra soil depth is needed to keep the bottom of the trench level and at the proper depth on the sloping site. For example, if a treatment and disposal field has a slope of 60 percent and a modified conventional system with a trench depth of 24 inches is to be installed, then the minimum soil depth at the lowest elevation must be 57.6 inches. This depth is required because on a 60 percent slope with a 36 inch wide trench, there is a difference of 21.6 inches between the uphill and downhill sides of the trench. To keep the downhill side of the trench 24 inches deep and to have 12 inches of soil under the trench bottom, there must be 57.6 inches (21.6 + 24 +12) of total soil depth.

See Figure 4.5.4 for another explanation of the extra depth of soil required to install trenches on slopes. Table 4.5.7 lists the differences in the uphill and downhill sides of a trench for trenches of various widths on various slopes.

Figure 4.5.4
Difference in depth
in inches between uphill
and downhill side of trench.

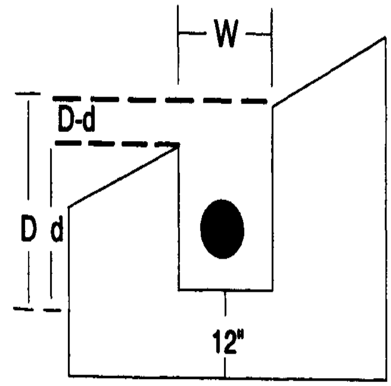


Figure 4.5.4 Difference in depth in inches between uphill and downhill side of trench.

Example: For a trench width (W) of 36 inches and a slope of 40 percent, the difference between the uphill and downhill side of the trench (D-d) is 14.4 inches. For a trench depth (d) of 18 inches and a minimum separation from trench bottom of 12 inches, the required minimum soil depth is 18+12+14.4 = 44.4 inches.

Soil Depth and The Use of Saprolite.

Reference
15A NCAC 18A.1956(6)

If soils are not deep enough to install an onsite system but are underlain by saprolite, the site may be reclassified as PROVISIONALLY SUITABLE under certain conditions. A trench or pit investigation of the saprolite must be conducted in order to determine if the following physical properties and characteristics are met:

- Saprolite must have weathered from igneous or metamorphic rocks;
- Saprolite texture must be sand, loamy sand, sandy loam, loam, or silt loam;
- Clay mineralogy must be SUITABLE (non or slightly expansive);
- Moist saprolite consistence must be loose, friable to very friable or firm for more than 2/3 of the material;
- Wet saprolite consistence must be nonsticky or slightly sticky and nonplastic or slightly plastic; and
- The saprolite must have no open and continuous joints, quartz veins, or fractures relic of parent material to a depth of 2 feet below the proposed trench bottom.

Saprolite depth. When saprolite is used rather than soil to treat wastewater, a separation distance of 24 inches is necessary between the bottom of the trench and any weathered rock or bedrock (Figure 4.5.5). If the trench is places partially in soil and partially in saprolite, then the separation distance is 24 inches – x, where x is the depth of the soil in inches (Figure 4.5.5). For example, if a 12 inch trench was composed of 9 inches of soil and 3 inches of saprolite, then the total depth of saprolite necessary to treat the wastewater would be 15 inches (24 inches – 9 inches = 15 inches).

**Figure 4.5.5
Trench placement
in saprolite soil and a mixed
soil/saprolite.**

Figure 4.5.5 Trench placement in saprolite soil and a mixed soil/saprolite.

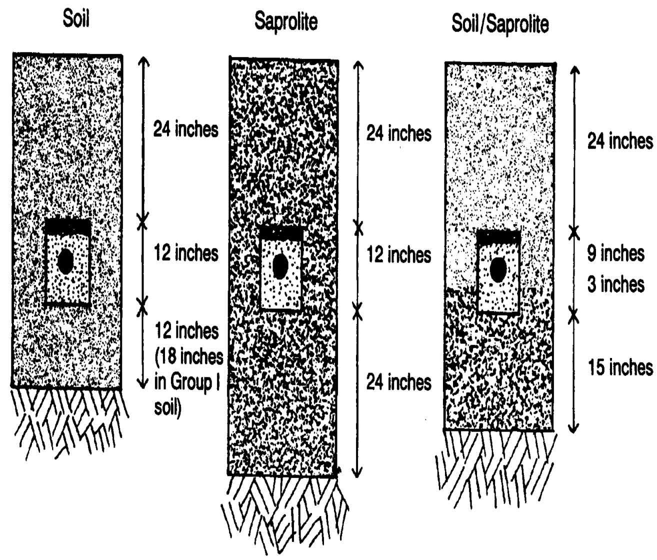


Table 4.5.7
Soil Wetness Depth and Site Suitability

Table 4.5.7 Soil Wetness and Site Suitability

Slope	Trench Width (Inches)							
(%)	12	15	18	21	24	27	30	36
2.0	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.7
4.0	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4
6.0	0.7	0.9	1.1	1.3	1.4	1.6	1.8	2.2
8.0	1.0	1.2	1.4	1.7	1.9	2.2	2.4	2.9
10.0	1.5	1.5	1.8	2.1	2.4	2.7	3.0	3.6
12.0	1.4	1.8	2.2	2.5	2.9	3.2	3.6	4.3
14.0	1.7	2.1	2.5	2.9	3.4	3.8	4.2	5.0
16.0	1.9	2.4	2.9	3.4	3.8	4.3	4.8	5.8
18.0	2.2	2.7	3.2	3.8	4.3	4.9	5.4	6.5
20.0	2.4	3.0	3.6	4.2	4.8	5.4	6.0	7.2
22.0	2.6	3.3	4.0	4.6	5.3	5.9	6.6	7.9
24.0	2.9	3.6	4.3	5.0	5.8	6.5	7.2	8.6
26.0	3.1	3.9	4.7	5.5	6.2	7.0	7.8	9.4
28.0	3.4	4.2	5.0	5.9	6.7	7.6	8.4	10.1
30.0	3.6	4.5	5.4	6.3	7.2	8.1	9.0	10.8
32.0	3.8	4.8	5.8	6.7	7.7	8.6	9.6	11.5
34.0	4.1	5.1	6.1	7.1	8.2	9.2	10.2	12.2
36.0	4.3	5.4	6.5	7.6	8.6	9.7	10.8	13.0
38.0	4.6	5.7	6.8	8.0	9.1	10.3	11.4	13.7
40.0	4.8	6.0	7.2	8.4	9.6	10.8	12.0	14.4
42.0	5.0	6.3	7.6	8.8	10.1	11.3	12.6	15.1
44.0	5.3	6.6	7.9	9.2	10.6	11.9	13.2	15.8
46.0	5.5	6.9	8.3	9.7	11.0	12.4	13.8	16.6
48.0	5.8	7.2	8.6	10.1	11.5	13.0	14.4	17.3
50.0	6.0	7.5	9.0	10.5	12.0	13.5	15.0	18.0
52.0	6.2	7.8	9.4	10.9	12.5	14.0	15.6	18.7
54.0	6.5	8.1	9.7	11.3	13.0	14.6	16.2	19.4
56.0	6.7	8.4	10.1	11.8	13.4	15.1	16.8	20.2
58.0	7.0	8.7	10.4	12.2	13.9	15.7	17.4	20.9
60.0	7.2	9.0	10.8	12.6	14.4	16.2	18.0	21.6

Restrictive Horizons

Reference
15 NCAC 18A.1944(a)

The depth where restrictive horizons are located is important when determining the suitability of a site. Since restrictive horizons retard wastewater flow, the presence of these horizons, if they are too close to the soil surface, can disqualify a site for onsite system installation.

As defined in the rules, restrictive horizon means

> **"a soil horizon that is capable of perching groundwater or sewage effluent and that is brittle and strongly compacted or strongly cemented with iron, aluminum, silica, organic matter, or other compounds. Restrictive horizons may occur as fragipans, iron pans, or organic pans, and are recognized by their resistance in excavation or in using a soil auger."**

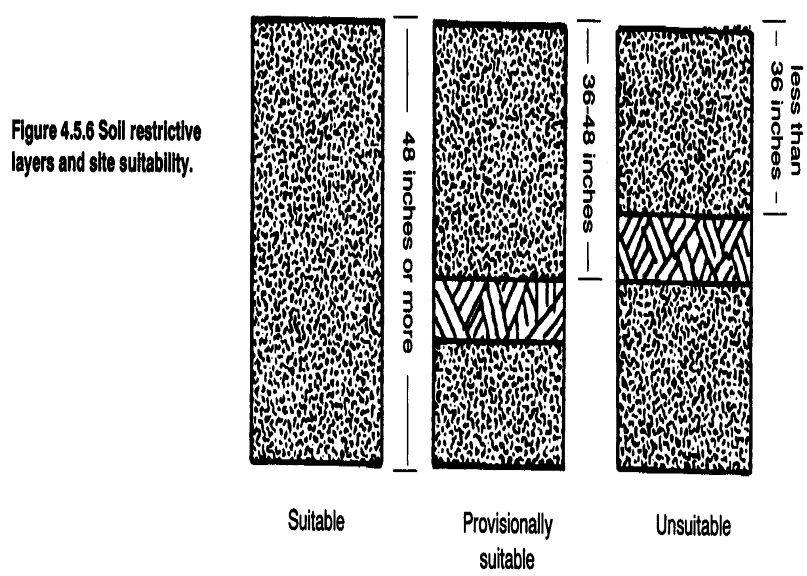
For purposes of site evaluation, restrictive horizons are defined as layers of material that are at least 3 inches thick and are continuous in a horizontal direction. See Figure 4.5.6, which shows the relationship between restrictive horizon depth and suitability for onsite system installation.

Reference
15A NCAC 18A.1944(b)

The only exception to the restrictive horizon depth requirement is for sites where the restrictive horizon is less than 36 inches from the surface and where the site evaluation has determined that a modified or alternative system can be installed. See *15A NCAC 18A.1956 or .1957* for the rules governing installation of modified or alternative septic systems.

Restrictive horizons will cause a soil wetness condition to occur above them. If the restrictive horizon is less than 3 inches thick and is discontinuous horizontally, the wetness condition may be reclassified PROVISIONALLY SUITABLE when artificial drainage is installed.

Figure 4.5.6
Soil restrictive layers and site suitability.



Available Space

Available space for onsite systems depends on both the area of acceptable soil and site conditions and the required separation distances between the onsite system and buildings, water supplies, and other structures.

Onsite Space Needed.

Reference
15A NCAC 18A.1945(a)

Sites for onsite systems must be large enough to allow installation and proper functioning of the systems. There must be enough area for the treatment and disposal field so that the system has long-term reliability. (See Section 4.6 for information on long-term acceptance rates of septic wastewater.)

Reference
15A NCAC 18A. 1945(b)

In addition to the area needed for the treatment and disposal field, sites must be large enough area for a repair or replacement system that is set aside. The repair area would be used to install another treatment and disposal field if the original treatment and disposal field fails.

In the rules, the definition of the repair area is

> **"an area, either in its natural state or which is capable of being modified, consistent with these rules, which is reserved for the installation of additional nitrification fields and is not covered with structures or impervious materials."**

The size of repair areas must conform to the rules for the design criteria of conventional sewage systems (*15A NCAC 18A.1955*), modifications to septic tank systems (*15A NCAC 18A.1956*), alternative sewage systems (*15A NCAC 18A.1957*). Innovative Sewage Systems (*15A NCAC 18A.1969*) or Pretreatment Systems (*15A NCAC 18A.1970*). For example, the initial system may be a conventional septic system with four trenches, 9 feet on center and 80 feet long; and the replacement may be a low pressure pipe distribution system with 10 trenches, 5 feet on center, and 80 feet long. The repair area must also conform to the necessary setbacks. The Improvement Permit must designate the original system layout, repair area, and type of replacement system.

Reference
15A NCAC 18A.1945(c)

There are exceptions to the repair area criteria described above. If a site or tract of land meets all of the following criteria then it is exempt from the repair area space requirement when all the following exist:

- The lot or tract of land was on record with the Register of Deeds at the court house on January 1, 1983;
- The lot is of insufficient size to satisfy the repair area requirements; and
- A system of no more than 480 gallons design daily flow is to be installed.

Lots exempt from the replacement system area requirement must reserve the maximum feasible area for repairs or expansion of the initial system.

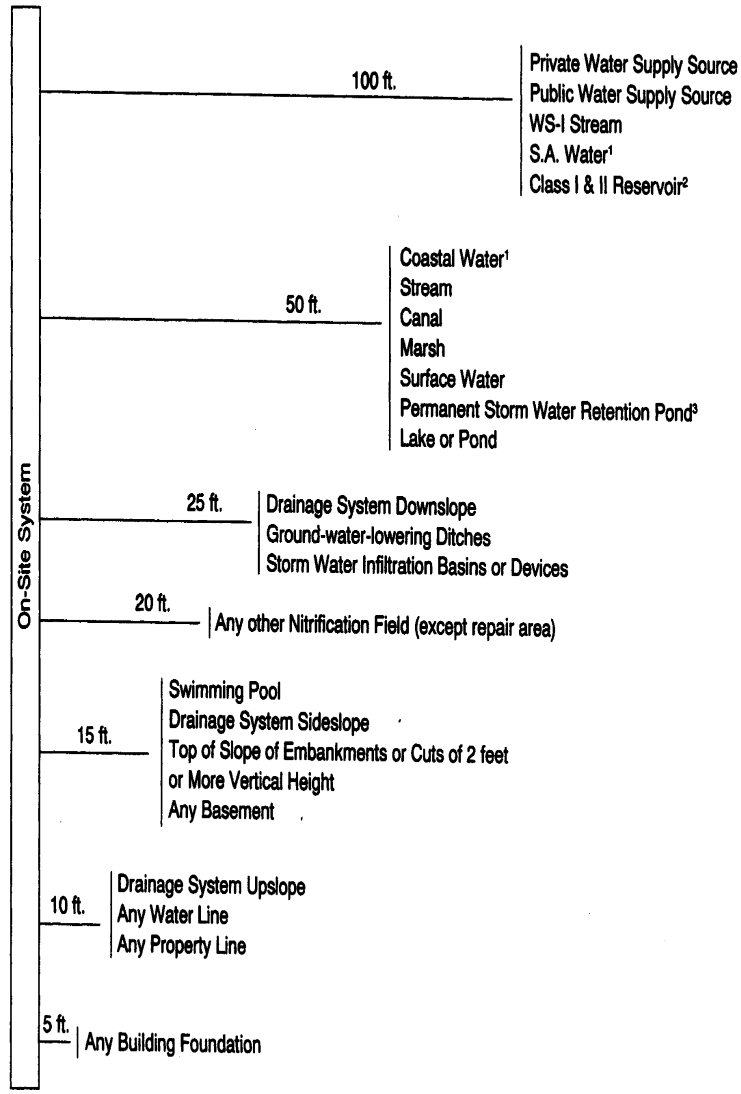
Horizontal distance placement requirements.

A site must have enough space to install the onsite system and to keep a separation between the system and certain features or structures. Onsite systems must be set back certain distances from water supply sources, streams, lakes, drains, buildings, property lines, and other features. These minimum setback distances are to protect water wells, streams, and homes from pollution by the onsite system. They allow sufficient areas to install the system and space for the treatment and disposal of wastewater.

Placement distances for conventional and modified onsite systems are presented in Figures 4.5.7- 4.5.9 on the following pages:

Figure 4.5.7
Onsite treatment and disposal system component placement Distances for flows fewer Than 3,000 gallons/day.

Figure 4.5.7 On-site treatment and disposal system component placement distances for flows less than 3,000 gallons/day



NOTES:

[1] From "mean high water mark"— see definition in 15A NCAC 18A. 1935(15).

[2] From "normal pool elevation"

[3] From "flood pool elevation"

Figure 4.5.8
Onsite disposal system placement distances for flows greater than 3,000 per day with one or more treatment and disposal fields receiving more than 1,500 gallons per day.

Figure 4.5.8 On-site disposal system placement distances for flows greater than 3,000 gallons per day with one or more treatment and disposal fields receiving more than 1,500 gallons per day.

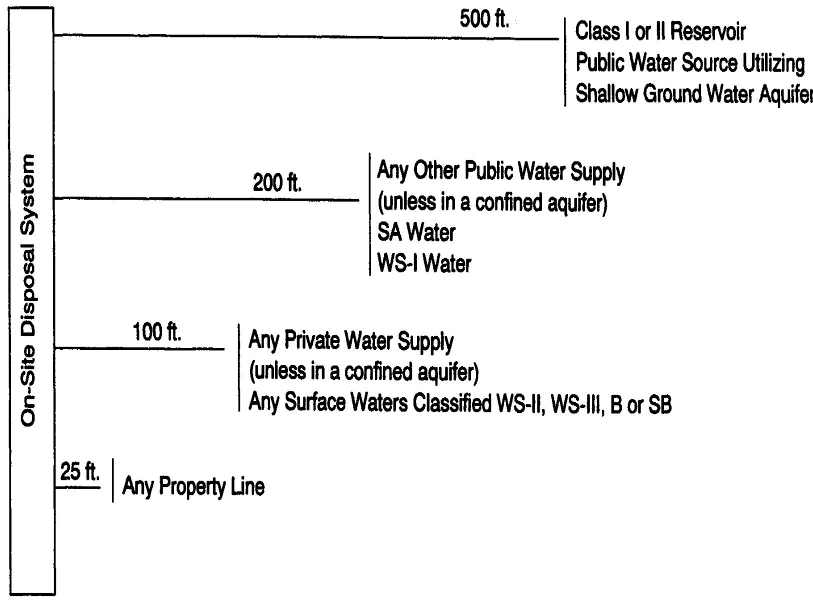


Figure 4.5.9
Onsite system placement distances for collections sewers, force mains, and supply lines.

Figure 4.5.9 On-site system placement distances for collection sewers, force mains, and supply lines.

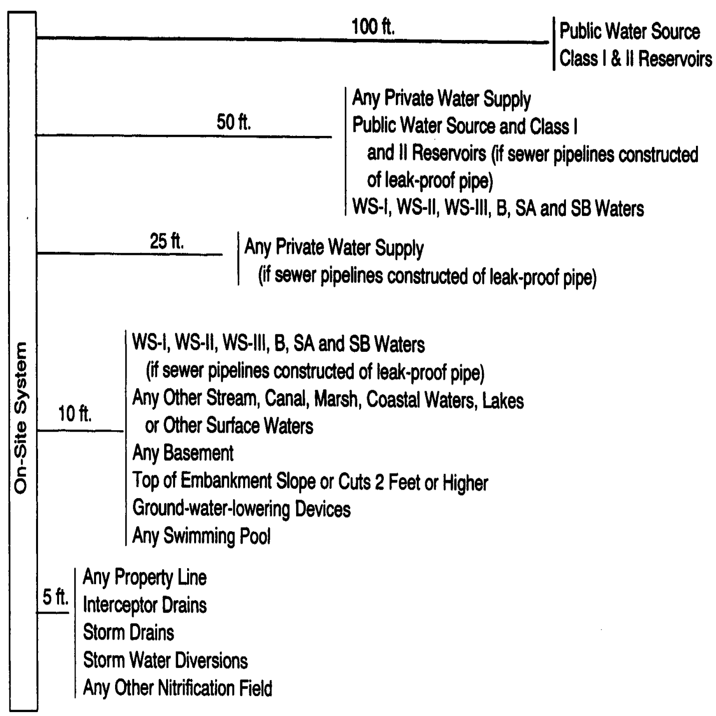


Table 4.5.8
Location of Sewer Lines

Reference
15A NCAC 18A.1950(f,g,h)

Rules for the placement of sewer lines crossing a water line, a storm drain, and a stream are presented in Table 4.5.8.

Table 4.5.8 Location of Sewer Lines

	Separation Distance/Sewer Line Location	Required Construction
Water lines	Sewer lines may cross a water line if 18 inches of clear separation distance is maintained, with the sewer line passing under the water line.	If conditions prevent 18-inch separation from being maintained or whenever it is necessary for the water line to cross under the sewer, the sewer line shall be constructed of ductile iron pipe or its equivalent and the water line shall be constructed of ferrous materials equivalent to water main standards for a distance of at least 10 feet on each side at the point of crossing, with full sections of pipe centered at the point of crossing.
Storm drains	Sewer lines may cross a storm drain if 12 inches of clear separation distance is maintained.	Sewer lines may also cross a storm drain if the sewer is of ductile iron pipe or encased in concrete or ductile iron pipe for at least five feet on either side of the crossing.
Streams	Sewer lines may cross a stream if at least three feet of stable cover can be maintained.	Sewer lines may also cross a stream if the sewer line is of ductile iron pipe or encased in concrete or ductile iron pipe for at least 10 feet on either side of the crossing and protected against the normal range of high and low water conditions, including the 100-year flood/wave action. Aerial crossings shall be by ductile iron pipe with mechanical joints or steel pipe. Pipes shall be anchored for at least 10 feet on either side of the crossing.

Source: *Laws and Rules for Sewage Treatment and Disposal Systems*. 1992. North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Health On-Site Wastewater Section.

Some exceptions to the rules and general provisions for separation distances are listed in Table 4.5.9.

Table 4.5.9
Additional Rules for
Locating Onsite Systems

Reference
15A NCAC 18A. 1950 (b)

Reference
15A NCAC 18A. 1950(c)

Reference
15A NCAc 18A. 1955(e)

Reference
15A NCAC 18A.1950(i)

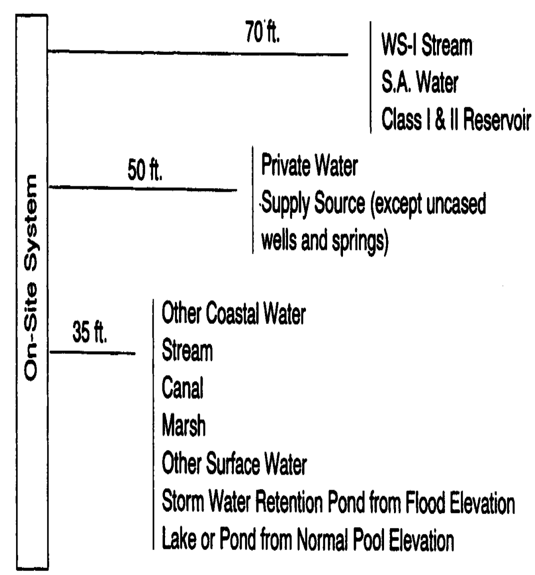
Table 4.5.9 Additional Rules for Locating On-Site Systems

Wastewater System Component	Location and Construction Requirement
Ground absorption sewage treatment and disposal system and repair areas.	May be located closer than 100 feet from private water supply but no closer than 50 feet. Springs or uncased wells that are down slope and used as a drinking water source require 100 foot separation.
Treatment and disposal fields and repair areas.	These fields cannot be located under paved areas or areas that have vehicle traffic. If pipe runs under vehicle traffic areas, then the conveyance pipe must be made of ductile iron or an equivalent pipe, or a Schedule 40 PVC, PE or ABS pipe must be instal
Septic tanks, lift stations, wastewater treatment plants, sand filters, and other pre-treatment systems.	These structures cannot be located in areas of frequent flooding (more often than the 10-year event) unless they are watertight and can operate during a 10-year storm. All mechanical and electrical equipment must be placed above the 100-year flood level o

If the sewage is pretreated, placement distances can be reduced. These distances are presented in Figure 4.5.10 for aerobic treatment units and Figure 4.5.11 for TS-1 and TS-II systems.

Figure 4.5.10
Onsite system
placement distances
from individual aerobic
sewage treatment units.

Figure 4.5.10 On-site system placement distances for individual aerobic sewage treatment units.



Additional Evaluation Factors

There are a number of situations where other factors, in addition to the above six site factors, must be considered.

High-Capacity Wells.

All pumping wells create a cone of influence, an area around the well where the groundwater level is lowered by the withdrawal through the well. High-capacity wells, such as community, municipal, and industrial water supply wells, pump more water and have much larger cones of influence than household wells. These large cones of influence must be considered when locating onsite systems. Thus, onsite systems may need to be located much farther away from large wells than the required 100 feet, as shown in Figure 4.5.7.

Large Onsite Systems.

Reference
15A NCAC 18A.1946(4)

For onsite systems discharging more than 3,000 gallons per day, certain information must be collected to predict the height of the water table mound below the treatment and disposal field and the flow rate of the wastewater from the treatment and disposal field trenches. Soil borings to depths greater than 48 inches, permeability and hydraulic conductivity measurements, and water level readings must typically be collected. If these measurements indicate that the water table will not remain two or more feet below the treatment and disposal field or that the wastewater will rise to the surface, the site must be classified as UNSUITABLE. More detail on conducting site evaluations for large systems can be found in Section 4.6.

Hydraulic conductivity measurement techniques and other tests in relationship to some soil morphological characteristics. Hydraulic conductivity is the measure of the rate water moves through the soil. The rate of water movement through a soil is influenced by texture, structure, and mineralogy, because these soil morphological characteristics determine the size and the connectivity of the pores, which in turn determines the speed of water movement. Hydraulic conductivity measurements may be required, in addition to the normal size evaluation, to determine site suitability. With large systems, where the flow to a single nitrification field is more than 1,500 gallons per day. For the design of artificial drainage systems used to modify sites for onsite systems. When pretreatment systems are proposed to reduce required system area or depth.

In most situations, the usual site evaluation is enough to determine the suitability of the site or lot for onsite systems. For sites located on benchmark soils (soils that are typical to North Carolina), additional information on hydraulic conductivity is available.

Hydraulic conductivity tests. Determining hydraulic conductivity requires a proper test method. Many hydraulic conductivity tests have been devised and are in use in different areas. A good source for information on hydraulic conductivity tests is the article by Amoozegar and Warrick, 1985, in Appendix B.

The two methods most commonly used in North Carolina when the soil hydraulic conductivity measurements are necessary are the constant-head permeameter test and the auger-hole pump out test.

Constant-head permeameter test. The constant-head permeameter, also called the shallow well pump-in method, is a common technique used to measure saturated hydraulic conductivity. This test works best where the water table is relatively deep. A source of water is required to saturate the soil for this test. See the publication by Amoozegar and Warrick, 1985, or Appendix 2, for more information on constant head permeameter tests.

To run the test, a hole is bored to a desired depth and enough water is poured into the hole to maintain a certain depth of water in the hole, usually 6 inches (for a 2.5 inch diameter hole). After a while, the flow rate of the water out of the hole through the soil will be constant. This flow rate should be measured, along with the diameter of the hole, the depth of the water in the auger hole, and the distance between the bottom of the hole and any restrictive layers. Equations provided in Appendix B are used to calculate saturated hydraulic conductivity from the measurements.

Auger-hole pump-out test. The auger-hole pump-out method, or auger-hole method, is the most commonly used test to measure saturated hydraulic conductivity where the water table is near the surface. More details on this test can be found in the article by Amoozegar and Warrick, 1985, in Appendix B.

In this test, a hole is dug below the water table, using a soil auger to minimize soil disturbance. The hole needs to fill with water and be pumped out several times before the actual test. When the test begins, the groundwater is allowed to rise in the hole to the level of the water table. Then, the water is pumped out of the hole and the rate at which the water rises in the hole is measured.

To calculate the saturated hydraulic conductivity, the depth of the water in the hole, the diameter of the hole, and the distance between the restrictive layer below the hole and the bottom of the hole must be determined. Several different calculation techniques can be used. See Appendix B for more information on this test.

As mentioned above, there are a number of methods for determining hydraulic conductivity. In Methods of Soil Analysis, Amoozegar and Warrick have separated shallow water table methods from deep water table methods. The methods described by Amoozegar and Warrick are listed below. More information can be found in Appendix B.

Shallow water table methods include the auger-hole pump-out method, the piezometer method, and other techniques. Deep water table methods are the double-tube, the shallow well pump-in, the cylindrical permeameter, the infiltration-gradient, and the air-entry permeameter methods. Since North Carolina uses site evaluation to determine site suitability, it is essential to evaluate all six factors—slope and landscape position; soil morphological characteristics; soil wetness, soil depth; restrictive horizons; and available space—and to compile them into a suitability rating. An aquifer test which utilizes a pumping well and recovery well may be needed for hydraulic conductivity measurement when large systems are sited.

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Reference
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If the ratings are the same for all six evaluation factors, then that rating is the site's classification. For example, on a site where each individual factor is designated as SUITABLE, the site would receive a SUITABLE classification.

If some of the site evaluation factors are different, then the most limiting factor that cannot be corrected determines the overall site suitability classification. If, for example, one of the six factors is deemed UNSUITABLE and cannot be corrected, then the site will be classified as UNSUITABLE. Several examples of uncorrectable limiting factors are listed below:

- The setbacks from existing wells on the property or on adjacent property are not far enough away (as specified in the rules) from the proposed onsite system;
- A dissected toe slope or depression is part of the site's landscape position;
- The slope is greater than 65 percent and
- The clay mineralogy is 2:1.

References

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