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Manual of Build-Out Analysis

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MANUAL OF BUILD-OUT ANALYSIS

by

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Sheila

This is OK, although only of historical interest.

The one with the problem had some thing about appreciation on value in the table

B

Bruce

Series Editor: Christine Reid

Thank you. Sheila

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TABLE OF CONTENTS

OVERVIEW

This Manual introduces the planning tool of build-out analysis and describes the data requirements, materials, and techniques necessary to complete both the graphic and numerical portions of the analysis. It is targeted at Planning Boards and Commissions, conservation and citizen groups concerned with growth management, and professionals in the fields of administration and planning. Although written for use in Massachusetts, it is equally applicable anywhere the necessary data can be assembled.

Completion of a build-out analysis results in mapped and tabular information that shows visually what a landscape *could* look like, and numerically what the resulting population *could* be, given continued growth subject to the zoning ordinances and subdivision control regulations in place at the time of the analysis. As such, it can serve as an inspiration and a catalyst for a process to restructure applicable planning and zoning mechanisms to more faithfully reflect the needs and aspirations of a community.

The final product is a paper base map, colored to show both lands constrained from further development and lands available for some form of conversion. In addition, a "see-through" overlay is produced, showing the pattern and intensity of potential development on the buildable lands over a certain period of time. One overlay can be prepared showing the town completely built-out, or a set of complementary overlays can be made which illustrate growth at several points in the future (e.g., 20 years, 50 years, and fully developed). The numerical analysis, as a derivative of the base map, quantifies the extent of the transformation in terms of acreage consumed, and the number of new housing units, residents, and school children.

INTRODUCTION

Historically, municipalities throughout New England have historically maintained a strong tradition of home rule. Many of the functions normally assumed by county or regional bodies in other parts of the country are instead performed by individual towns. In Massachusetts, for example, most planning, zoning, and subdivision control authority resides at the municipal level. While there are some definite advantages to local autonomy, small and rural towns often lack the necessary resources and/or expertise to adequately plan for, or manage, rapid ex-urban growth. In addition, towns frequently plan and zone with little regard to, or consultation with, their neighbors. The result is often a fragmented patchwork of land uses and regulations devoid of any regional cohesion or a long-term vision.

As small towns grow, residents rely upon the zoning regulations they adopt at Town Meeting to protect them from inappropriate sprawling development and to maintain the rural ambiance of their town's landscape. Unfortunately, the bulk of what constitutes conventional zoning and subdivision regulation does not ensure this outcome, but instead mandates some form of conversion and development on all buildable land. In fact, these regulations serve more as suburban *development standards* than as protectors of natural resources, open space, or historic character. It is no surprise that many residents are repeatedly disillusioned as the classic, New England pattern of town and country settlement gives way to an undifferentiated "sprawl" of residential housing, office parks, and commercial "strips." Reflecting on these transformations, frustrated residents echo sentiments such as, "We thought our community was protected because we have zoning," or, "There was so much open countryside here just a few years ago - what happened?"

A common reaction to increased development pressure is to raise the minimum residential lot size in the mistaken belief that as new homes are spread farther apart, the town's open, rural character will be retained. Unfortunately, the result is usually just the opposite. The remaining open land is consumed at an even faster rate as property is divided into larger lots and mini-estates. In addition, such development nearly always converts the entire property parcel into privately-owned houselots, leaving no residual open space for farming, forestry, recreation, or wildlife habitat.

The depletion of farm, forest, recreational lands, scenic roadsides, and other valued open spaces often occurs incrementally over years and decades. Unfortunately, this often means the public does not become aware--or alarmed--about the situation until there is little left to be saved (Figure 1).

Introduction to Build-Out Analysis

One way for towns to anticipate, and therefore prevent, this unfortunate outcome is to preview or "test" their existing zoning ordinances and subdivision controls by performing a *build-out analysis*. This planning tool can be used to estimate the impact of cumulative growth upon a town's land area once all developable land has been consumed and converted to the uses permitted under the current regulatory framework. It is also valuable in showing *where* new growth can occur in town. What is more, it is well within the abilities and resources of most small towns to conduct this type of study themselves, without the expense of an outside consultant. The outcome can be particularly enlightening when the regulatory "status quo" does not seem to be working, or when there is good reason to predict that growth pressures are likely to increase in an area. This type of analysis can also be performed on a micro scale to

Figure 1. Incremental build-out of Longmeadow, Massachusetts: 1942, 1957, 1987

demonstrate potential outcomes for specific areas such as highway or river corridors, business districts, or individual farms.

The build-out analysis extends a town's existing zoning and subdivision regulations into the future to illustrate the pattern that development can take when all remaining buildable land has been consumed. It does not predict *when* final build-out will occur, but it does accurately portray the potential for wall-to-wall residential subdivisions, shopping centers, and office parks given the full implementation of the existing land-use regulations. The numerical extent and spatial arrangement of this development can then be evaluated. This glimpse into the future can be shocking, given the inherent vulnerability of the rural countryside for conversion to more suburban uses. The results of this exercise will help town officials make more informed decisions concerning the direction of future planning and zoning initiatives.

The information in this Manual was derived from work conducted at the Center for Rural Massachusetts while preparing build-out analyses for the Massachusetts towns of Ashby, Deerfield, Hadley, Huntington, Littleton, Sheffield, Southampton, West Stockbridge, Whately, Williamsburg, and Windsor. Additional exposure to this technique resulted from the author's work in the Connecticut towns of Bolton, Andover, Coventry, and Columbia; in the New York communities of Chester, Essex, and Pawling; and on the Hawaiian Island of Kauai.

Summary of Essential Steps

Working with source maps of the study area, lands constrained from development by virtue of public ownership, deed restriction, utility easements, preexisting development, or natural factors (e.g., wetlands, floodplain, steep slopes) are delineated

and then subtracted from the gross land surface in the study area. This process of elimination yields the "net usable land area" (NULA) which, for the purpose of this investigation, is considered to be developable land. Needless to say, the more inclusive and precise the definition and identification of constrained lands, the more accurate will be the final estimation of available lands.

Once the NULA has been established, the town's subdivision, road, and minimum lot size and frontage requirements are applied across these developable lands in all zoning districts (residential, commercial, industrial, etc.), as if all the lands available for development were to be instantly consumed for their "highest and best" use. In this way, a reasonable estimate of potential new units can be determined. From this number, projections for associated population growth, infrastructure needs, and increases in school-age children and traffic can be made. These results can be portrayed graphically (charts and maps) and numerically (tables).

It is suggested that the emphasis of the build-out analysis be on *residential* units. Commercial and industrial activity, although potentially generating traffic problems or requiring water and sewer infrastructure, is much more limited in spatial extent, results in no direct addition of residents or school-age children, and is considerably more difficult to quantify accurately. As an alternative, a community may wish to undertake a zoom build-out for a particular area of town or stretch of road zoned commercial or industrial, comparing how it might look built-out under existing zoning and under a creative alternative which includes provisions for setbacks and screening, side and rear parking, reduced curb cuts, and open space protection.

SOURCES OF DATA

Much of the baseline information for the build-out analysis is available from existing maps, although these are often found at different scales (see below). Recent aerial photos are also useful for determining new residential units or other development. Additional zoning and property parcel information can be obtained at local town offices. Typically the Planning Board, Accessor, and Conservation Commission are excellent sources for mapped information on a town. In some cases, local land trusts or conservation groups may have access to mapped information about protected lands or sensitive habitats. It is also beneficial to check with the local Regional Planning Commission and appropriate state agencies (e.g., Department of Environmental Management, Department of Fisheries, Wildlife, and Environmental Law Enforcement), as much of the preliminary mapped information may already be available from these offices.

In Massachusetts, general sources of information include:

U.S. Soil Conservation Service (USDA): medium-intensity soil maps with manuals explaining the different soil types and their development suitability

U.S. Geological Survey (USGS): topographic quadrangles. Often available at local book or outdoor recreation stores. Be sure to purchase the most recent map(s) available and to get a copy of the key to mapping symbols.

Cartographic Services, UMASS/Amherst (413) 545-0359: all manner of maps (including many topographic maps) for sale, along with excellent advice.

Resource Mapping/Land Information Systems, Dept. of Forestry and Wildlife Management, UMASS/Amherst (413) 545-3589: a GIS mapping laboratory and research center with assorted aerial photos and land-use maps for sale.

Standardization of Map Size

Mapped information comes in a variety of different sizes, or scales. In order to utilize this information, mapped features will need to be *traced* directly from the original maps onto some form of composite map. To do this accurately, all of the source maps must be of the same scale. In most cases, at least some photo-reduction or enlargement will be necessary in the course of preparing the base map. This is best accomplished by a copy shop capable of handling large-format maps (30 to 36 inches). Note that if extensive size adjustments are required, the cost can be a significant part of the budget.

Map Scales

Scale is defined as the relationship between a set distance on the map and a corresponding distance on the earth's surface. Two types of scales--ratio and specific--are commonly used; they are simply different ways of expressing the same thing and, as such, are interchangeable. In a *ratio* scale, one unit of anything equals a certain number of the *same* thing on the ground. An example of this type of scale is 1:24,000, where one inch (or foot, or yard) on the map equals 24,000 inches (or feet, or yards) on the ground.

Whatever units of measure are used, the ratio between what is on the map and what is on the ground remains constant.

The second type of scale is an exact delineation of what a *specific* interval on the map equals on the ground, (e.g., what one inch on the map translates into in terms of feet on the ground). Scales that are used in *site-specific* planning are often in the 1" = 40´ or 1" = 100´ range. These scales produce sizeable, more detailed maps and therefore are commonly referred to as large-scale maps. A build-out analysis performed at these scales would be very accurate, but impractical due to its large final size--approaching a wall mural--and lengthy preparation time.

When referring to maps, the terms "small-" and "large-" scale can be confusing. Small and large are really just relative terms that have meaning only when comparing two different maps. Maps of small areas, such as property parcels, are called *large-scale* maps because they provide larger, more detailed information. Conversely, maps of larger areas contain less detailed information for the same given area and are referred to as *small-scale* maps. As shown in Figure 2, a larger, ratio scale of 1:24,000 (1" = 2,000´ as a specific scale) will provide far more detail than a smaller scale of 1:62,500 (1" = 5,208´ as a specific scale).

For most towns in Massachusetts, a specific scale in the range of 1" = 800´ to 1" = 1,200´ is appropriate, depending upon the size of the town. In this way the entire map will fit on the 36-inch-wide paper commonly available at most art and graphic supply stores.

Almost without exception, maps of different scales will require standardization before they can be used as overlays. Prior to calculating a magnification or reduction factor, the "before and after" scales of both maps must be standardized as either ratio or

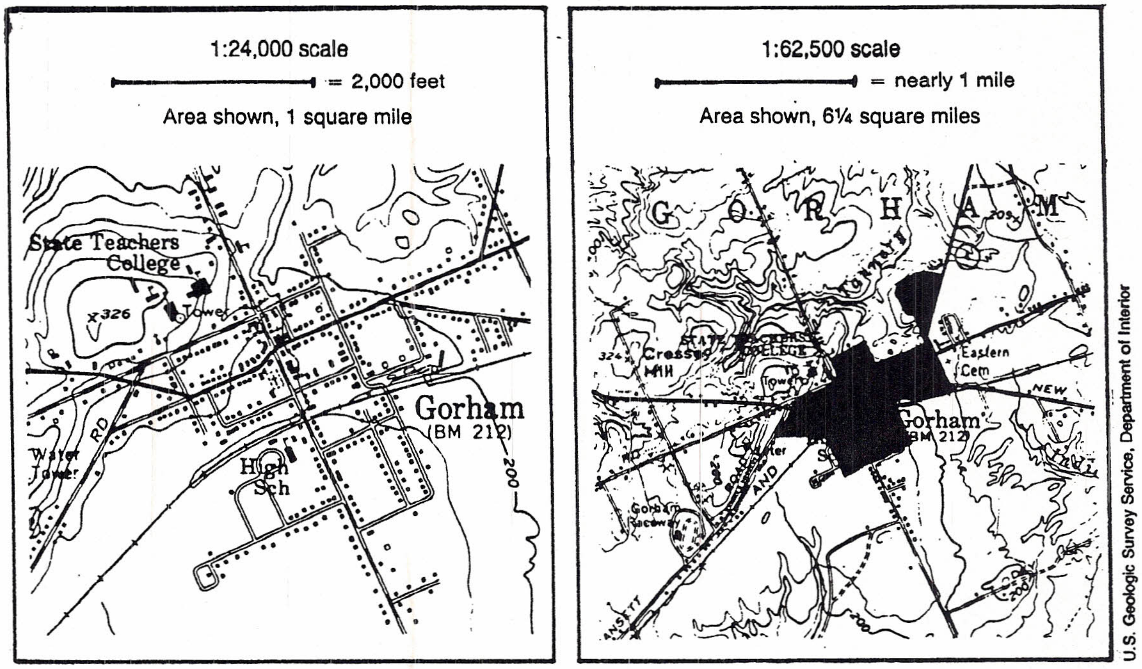


Figure 2. Comparison of a large-scale map (left) and a small-scale map (right).

specific. The following example illustrates how to standardize the frequently encountered ratio scale on a USGS topographic quadrangle, and how to calculate the magnification factor needed to produce a specific scale appropriate for a finished build-out analysis map.

EXAMPLE

Problem:

Given a USGS topographic scale of 1:25,000, what *magnification* factor will be used to increase the size of the map so the finished scale is 1" = 1,000´?

Solution:

Change both scales to ratio (or specific, if you wish). Since there are 12 inches in one foot, conversion of 1,000´ to 12,000" yields 1" = 12,000". This is the same as a ratio map scale of 1:12,000.

To determine the magnification factor, use the following equation:

$$1/25{,}000 * X = 1/12{,}000$$

where "X" represents the unknown magnification factor. (In this equation you are multiplying the smaller map by a magnification factor of greater than one to generate the larger map.)

Perform the necessary algebra to solve for X.

$$1/25{,}000 * X = 1/12{,}000$$

$$X/25{,}000 = 1/12{,}000$$

$$X = 25{,}000/12{,}000$$

$$X = 2.083$$

Answer:

2.083 is the exact magnification factor to use to bring the smaller map up to a scale of 1" = 1,000´.

The same methodology can be used to calculate a *reduction* factor. A simple modification of the initial equation is all that is necessary. For example, start with $1/12{,}000 * X = 1/25{,}000$, where X is a fractional reduction factor (less than one) that is multiplied by the scale of the larger-sized map in order to produce a smaller map.

EXAMPLE

Problem:

Given a series of assessor´s maps at a specific scale of 1" = 400´, find the *reduction* factor necessary to match a base map scale of 1" = 1,000´.

Solution:

Since both maps are already in specific scale, no standardization is necessary.

Use the same type of equation for reduction and solve for X.

$$1/400 * X = 1/1{,}000$$

$$X/400 = 1/1{,}000$$

$$X = 400/1{,}000$$

$$X = 0.4$$

Answer:

0.4 is the exact reduction factor to use to bring the assessor's maps down to the appropriate size.

To determine if the enlargement or reduction performed by a copy shop is precise, an easy checking system is recommended. If a magnification factor of 2.083 is required, then a 10-inch line drawn on the border of the original map should show up as 20.83 inches on the enlargement. Similarly, for a reduction factor of 0.4, a 10-inch line will show up as 4 inches on the reduction. Drawing a measured line in the border of the original map will enable you to check the precision of the final copy size before

proceeding. The longer the line drawn, the more accurate it will be as a checking device.

NOTE: Despite your best efforts and careful attention to detail, there will be some distortion as the various maps are enlarged or reduced, and eventually overlain upon one another. Although you should strive for the best results possible, this small margin of error will not affect the end products or the underlying message being portrayed by the build-out analysis.

BASIC SUPPLIES

When completed, the build-out map will consist of a paper base map, colored to show both constrained and developable lands, and clear overlay sheet(s) depicting the potential development on those lands. The materials needed to produce these maps, and to conduct the numerical analysis are listed below.

1. double-sided drafting film - Purchase a minimum of 3 feet by 5 feet.

2. black-line, diazo paper - In theory, a sheet 3 feet by 5 feet is all that is required, but it generally comes in larger rolls. Get the thickest paper available. (**NOTE**: This paper is *not* needed if a large-format copy machine is used instead of a diazo machine.)

3. clear polyester film - Try to obtain *polyester*, which is more resistant to tearing than acetate; use the thickest film possible.

4. drafting pens - Three tip sizes can be interchanged onto one pen body; recommended tips are 0.5 mm, 0.8 mm, and 1.3 mm. Clean tips thoroughly after each use to prevent clogging.

5. black drafting ink - Use waterproof ink specifically designed for use on drafting film.

6. ink eraser - Purchase one that is imbibed with erasing fluid or it will not work on waterproof ink.

7. T-Square (36-inches long)

8. triangular straight-edge - Check to see it has a double "ink edge" to prevent smearing.

9. ruler - The most versatile is a three-sided ruler, with engineering "scales."

10. flexible ruler with ink edge - Useful for copying gradually curving road lines. Also helpful for those of us with shaky hands!

11. "exacto" knife - Essential for precise cutting of finished products; scissors are not recommended.

12. "press-on" lettering - Many sizes and styles are available. A good standard set is Helvetica medium - 84 pt., 42 pt., and 24 pt.

13. marker pens - These are used to color the paper base map. They come with fine and broad tips; both tip sizes are useful depending upon the size of the area to be shaded. The following colors are appropriate for most build-out maps: black, light brown, light orange, green, and blue.

14. soft brush - Helpful in keeping work surface free of eraser debris.

15. pressure-sensitive graphics tape - Get a solid line for the map's outer border, and a dashed line for the municipal border. (In the case of an irregular and curvy municipal border, it may be easier to draw it in with pen rather than use the tape.) If there are major state and interstate highways in town, black tape (solid or hatched) usually produces a neater look than pen.

16. drafting film conditioner - This is a powdered substance that prepares the surface of the drafting film to take ink after erasing.

17. dot-grid or planimeter - One or the other of these devices is necessary to determine the area of various parcels on the base map.

18. black electric tape - Used to edge the borders of the base map and overlay(s). This helps reduce wear and tear on the maps and is essential if you plan to punch holes along the top edge for hanging.

NOTE: If you are not familiar with any of these materials, take this list to an art or graphic supply store for clarification.

CREATING THE BASE MAP

Creating the base map is the bulk of the work in the overall build-out analysis. Great care must be exercised in constructing the base map as it is the foundation for determining the NULA and for the subsequent numerical analyses. Although the final base map will be on colored-up paper, all of the initial drawing is done on thick, double-sided drafting film. Drafting film is better suited for this purpose because mistakes are more easily erased: paper is far less forgiving. Once all the available information has been rendered on the film, paper prints (ready for coloring) can be easily produced on a diazo ("blueprint") machine or with a large-format copier.

The following features should appear on the base map:

* Black-line perimeter border (*optional* if binding the map sheets with electrical tape)
* Dashed-line municipal border(s)
* North arrow
* Legend
* Title block
* Scale

Within the municipal border, the following information is shown:

* Existing roads
* Developed lands
* Public lands and lands permanently constrained from development through deed restrictions, conservation easements, etc.

* Water bodies and major rivers
* Wetlands
* Floodplains (if regulated)
* Steep slopes
* Developable lands (NULA)

<u>Getting Started</u>

What follows is a step-by-step description of the process for adding each component to the base map. These steps are not necessarily presented in any specific order since that may vary with individual preference. However, when the resource layers (wetlands, slopes, etc.) are added, you will need to decide which features are most important to show on the map. For example, if an area has steep slopes and is also under state ownership, you will need to decide under which of these categories you will display the area when preparing the base map. As with any lengthy and detailed work, a comfortable work surface with ample lighting is essential to one's spinal and mental well-being. A tiltable drafting table with direct incandescent light is optimal.

Use the T-square and exacto knife to cut out a suitably-sized piece of drafting film. The first step (and this *should* be the first step) is to trace the outline of the municipal border on the drafting film. Use USGS topographic quadrangles for this purpose once they have been properly enlarged and taped together. Care must be taken in selecting an appropriate finished scale so that the entire outline of the town fits within the confines of the 36-inch-wide paper. Space must also be provided for a border line (if used) and for the title block, north arrow, legend, etc. The final orientation of the town on the film should be such that when the map is presented, the north

arrow is as near to vertical (pointing up) as possible. Most viewers relate best to this orientation.

Included below is a brief description of each of the map components. Figure 3 shows a sample paper print of a base map, along with an idea of how the various elements might be arranged.

Black-Line Perimeter Border (optional)

This is a cosmetic touch that sets off the map by framing it with a solid black line. The line should be applied to the drafting film using pressure-sensitive drafting tape between 1/8 and 1/4 inch thick. Leave a 1/2 to 3/4 inch margin between the outside of this line and the edge of the film; this should also be the minimum distance between the inside of the line and any mapped feature or lettering.

If you decide to edge the border of the paper map and overlay(s) with electrical tape, the black perimeter line is not needed since both function to define the border. Taping the edge of the map and overlay(s) is done at the end of the entire mapping process.

Dashed-Line Municipal Border

It is important to clearly delineate the boundary of the study area (e.g., town border, watershed basin, etc.) with a dashed line. A suggested pattern is one long dash followed by two short ones. This and other patterns are available in pressure-sensitive drafting tape. Where the municipal border is highly irregular (i.e., curving switchbacks, as are often found along meandering streams), it may be more practical to hand draw the border using a thick pen or marker.

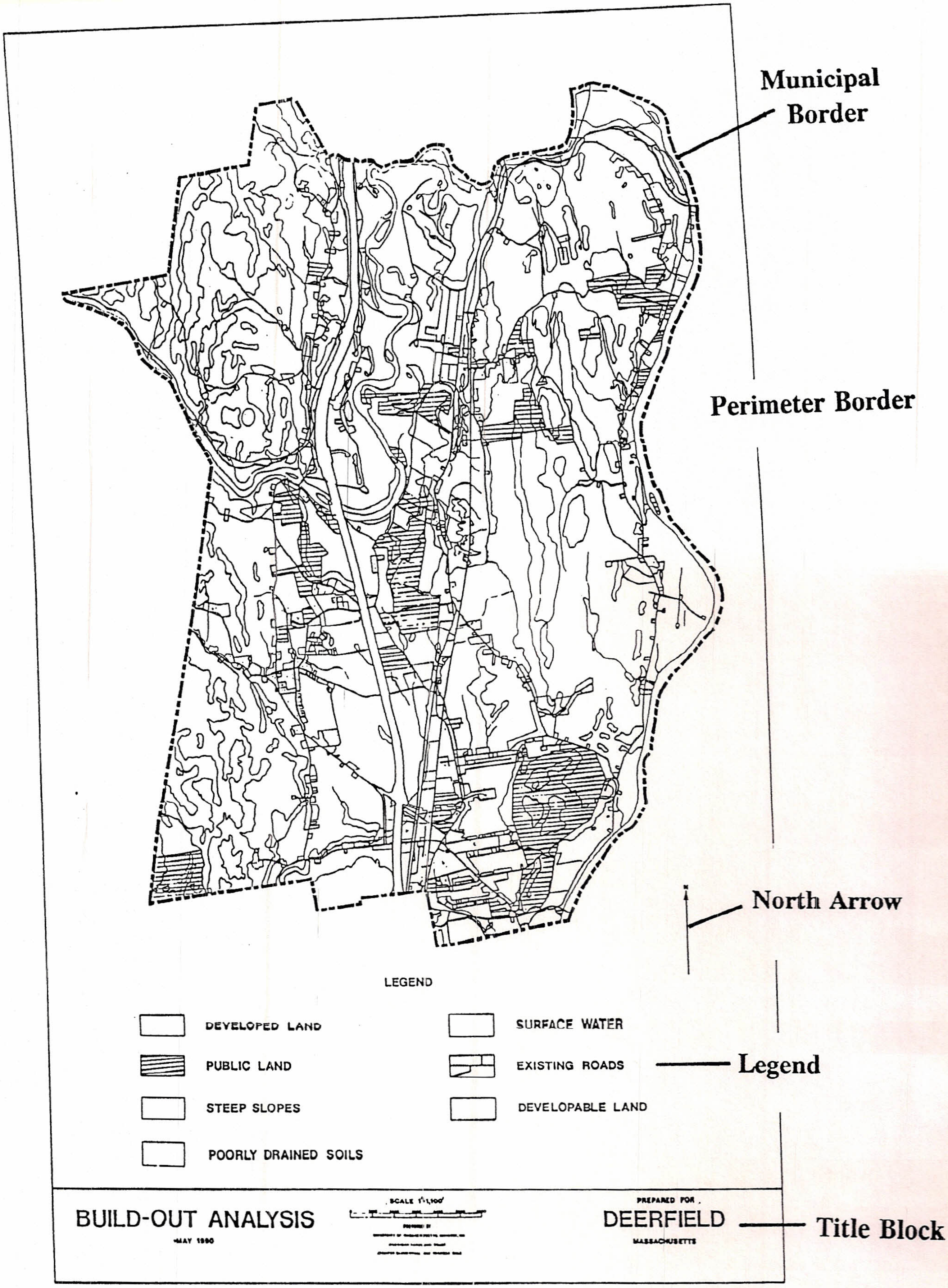


Figure 3. Paper print of a base map generated from drafting film, indicating locations of perimeter border, municipal border, north arrow, legend, and title block.

North Arrow

There is considerable flexibility in the placement and design of the north arrow, but be sure the arrow points toward "true" (directional) north rather than magnetic north. (USGS maps are oriented toward true north; surveyor's maps often use magnetic north.) You may wish to consult other maps for design inspiration, or use one of the ready-made north arrows available at most graphic supply stores.

Legend

The legend identifies and defines mapped features. A well-conceived legend will increase the audience's understanding and effective use of the map. Be sure to leave ample space for the legend; press-on letters of intermediate size (42 pt.) work well for this purpose. The top line should say LEGEND, starting at the left margin. Each successive line down from this should start at the left margin with an outline box (approximately 1" x 2"), a set space, and then a short title (see Figure 3). Standard titles for a build-out map include *Developed Land, Public Land, Steep Slopes, Wetlands/Poorly Drained Soils, Surface Water, Existing Roads,* and *Developable Land.* At a later stage, these outlined boxes will be either colored-up or filled with a symbol of a mapped feature. In addition, be sure to leave space at the bottom for one additional legend box and entry to be added when creating the overlay.

Title Block

The title block generally looks best at the bottom, running the full length of the map and separated from the rest of the material by a horizontal line. Use upper-case, press-on letters as shown in Figure 3. The following information is generally shown:

* Title of Map - "Build-Out Analysis," in the largest letters
* Date of Map - date of completion, (month and year)
* Study Area - name of town, county or region, and the state
* Client or Sponsor - name of the group that commissioned the study
* Preparer - name of individual or organization who prepared the map
* Sources - list of sources (e.g., USGS, Tax Assessment Maps, etc.) in smallest letters. Including sources on the map may result in an overcrowded looks; listing them on the map is optional since this information should also be included in the accompanying report.
* Scale - The scale should be stated in two ways. The first is with scale "bars," one in feet and the other in miles. The second representation is in words, with the lettering positioned over the scale bar reading SCALE 1" = 1,000´, or whatever it is. Figure 4 includes several examples of scales.

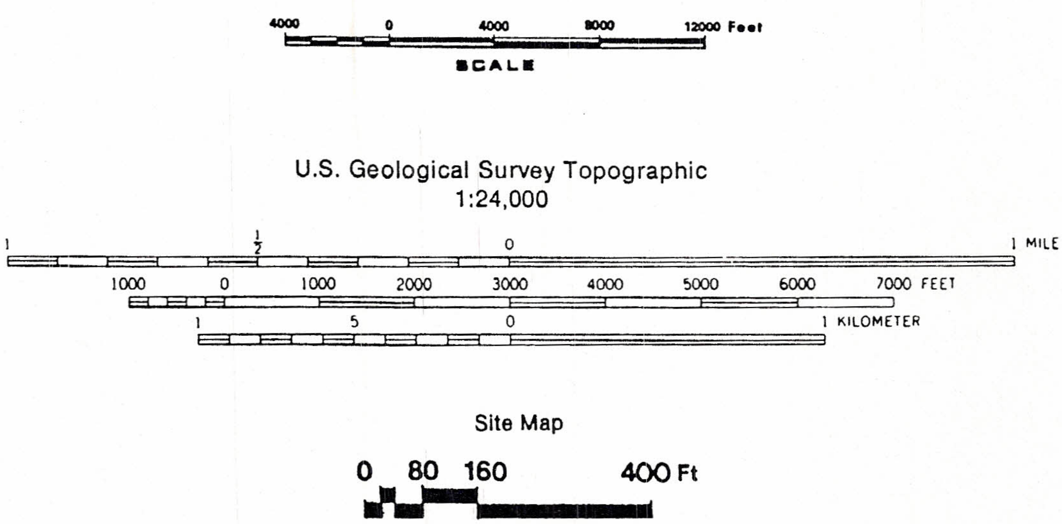


Figure 4. Examples of scale bars.

Existing Roadways

After the municipal border is outlined, the drafting film can be easily re-aligned as an overlay on top of any other map of the same scale. Once precisely positioned over the most recently photo-revised USGS map, existing roadways can be traced onto the film using different width pen tips to differentiate among local roads, state roads, and interstate highways. Where wide rights-of-way can be identified, as is often the case bordering limited-access highways, blacken in the entire area. Allow adequate time to make sure these roadway lines are drawn in smoothly, using the flexible ruler if needed. Solid black or black-hatched pressure-sensitive tape may also be used instead of a pen to delineate major highways. This works well for roadways that are fairly straight, and results in a neater overall appearance.

Developed Lands

Accurately representing developed lands on the base map can be the most arduous--and perhaps the most arbitrary--phase of the process. First, the drafting film (complete with town border and roads) is placed over the USGS map. The location of every structure (signified by a solid black or purple rectangle or square) should be noted by placing a "dot" on the film. Next, aerial photos (if available) are used to add more recently-constructed building. In some cases, you may also wish to use a different symbol such as a square or star to show approved but as yet unbuilt projects. The Planning Board is the best source for this information.

When complete, every dot represents some kind of structure, although the majority will probably be single-family, detached homes. The next step is to draw individual lot-lines around each of the structure dots. This is a bit tricky and involves some intuition

(or educated guesswork). These lot areas will eventually be blacked entirely to represent lands that are already developed.

Lot areas are delineated according to the dimensions, size, and frontage requirements specified in the current zoning regulations. Without a current parcel map (see below), there is no way to know just how large or small an individual lot is from a dot on a map. However, the underlining assumption in build-out analysis is that *all* available land will be fully utilized. Therefore, landowners will sell off any lands they own in excess of that which is required for a legal building lot around their existing structure. To be realistic, nearby barns and other "outbuildings," depicted on USGS maps as hollow rectangles and squares, should be included in the lot area retained with a principal structure. Thus, a single structure along a highway can simply be enclosed by a square or rectangle that contains the minimum legal lot size and adequate frontage distance on the street, in accordance with the applicable regulations for the underlying zoning district. Extensive residential subdivisions, with curvilinear streets and houselots laid out in a "grid" pattern, can be outlined and blackened in their entirety. In more arbitrary spatial layouts, aerial photos may help to make these designations more accurate. *Take heart: this is a process in which experience with parcel maps and practice drawing in parcel boundaries will greatly increase your proficiency!*

Parcel Maps: If the Town Assessor has a current property parcel map at the correct scale, the task of drawing in lot lines is much simpler and a very accurate depiction of developed lands can be made. With information on the location of any structures, the parcel boundary, and the underlying zoning, it is possible to assess a given property for its further development potential. Parcels lacking sufficient area and/or frontage to accommodate another structure may be colored entirely. Where a parcel

contains both a structure *and* enough additional acreage for other structures to be built, only the legal lot around the building itself and its frontage along the street should be darkened.

NOTE: Before continuing to the next step, you should identify your priorities in terms of mapped resources. If, for example, a site's status as public land is more important to you than illustrating its steep slopes, these ownership patterns should be illustrated next. They will then supersede the color category used for steep slopes drawn in at a later stage.

In addition, as irregular shapes are scribed onto the film, whether they be water bodies, wetlands, or areas of steep slope, be sure to note what they are so that they can be easily differentiated from one another when it comes time to color the base map. For example, a lightly drawn "S" within a boundary will distinguish it as an area of steep slopes rather than a wetland. Another method is to use a different line type for each of the designations (e.g. continuous line for water bodies, dotted for wetlands, dashed for steep slopes, etc.).

Public and Protected Lands

For the purpose of build-out analysis, lands are considered constrained from further development by virtue of deed restriction and/or ownership by a municipality, by the state or federal government, or by a non-profit conservation organization or land trust. Although exceptions do exist, this is a conservative, but prudent, assumption to make.

Public lands may or may not have been previously mapped. Towns that have completed Open Space Plans or Master Plans are likely to already have maps delineating

public lands. USGS topographic maps include the outlines of cemeteries, as well as most state and federal parks, forests, and wildlife management areas, and similar holdings. Parcel maps are another accurate source of information. However, in order to be useful (i.e., traceable onto the base map), these must be reduced to the same scale as the base map.

In the event that no mapped information is available, an acreage figure for public lands may be obtained from the Town Assessor. This value, although not mappable in any meaningful way, can be used in the numerical analysis described later in this manual.

Water Bodies and Major Rivers

The locations of lakes and major rivers can be taken from the USGS topographic maps and are added to the base map using drafting pens. Major rivers are defined as those with a visible width on the USGS maps. Disregard streams that are represented by a single line; these smaller watercourses are generally included within the "wetlands" designation described below.

Wetlands and Floodplain

Wetlands may be delineated in a number of ways depending on the criteria used and the source of information. In general, these areas are unsuitable for development due to the presence of standing water, a seasonably high water table, and/or poor drainage characteristics (i.e., periodic saturation) during most or all months of the year. While there are a number of wetland types, including marshes, swamps, bogs, and some floodplains, in all cases their soil characteristics make building structures or roads impractical, if not illegal, under Massachusetts wetlands protection legislation.

The best source of mapped information on wetland soils is the county office of the Soil Conservation Service (SCS). The SCS publishes a soil survey and maps for every county in Massachusetts, usually at a scale of 1:24,000 or 1:25,000 (Figure 5). Once these maps are enlarged and pieced together, the appropriate soils groupings can be traced onto the base map.

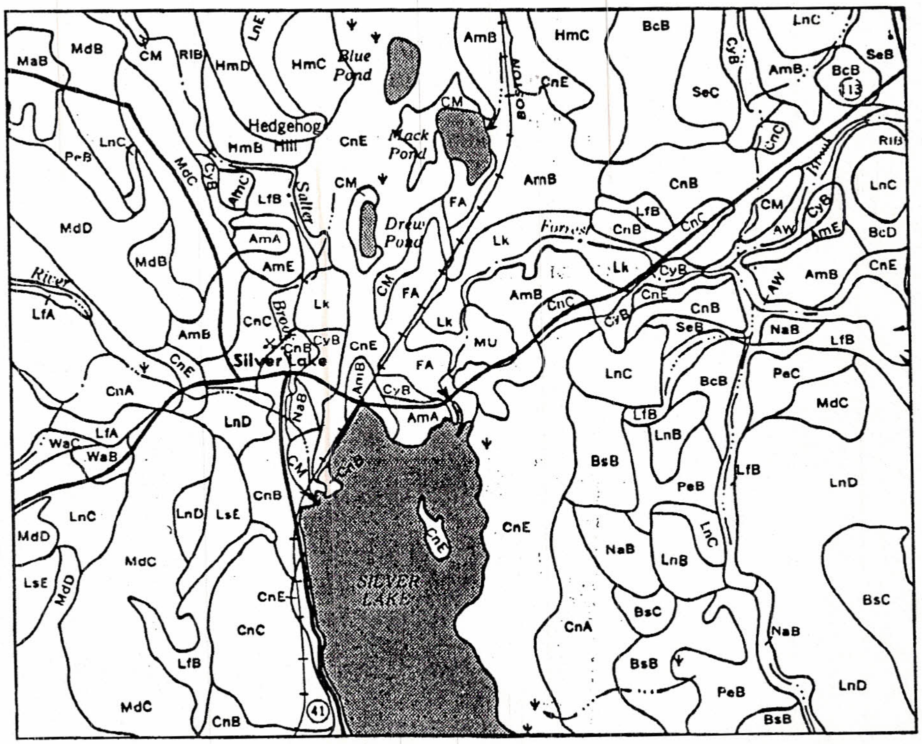


Figure 5. A standard Soil Conservation Service map; text accompanying the maps explains the symbols and soil characteristics.

Soils that should be included as wetlands for the purposes of build-out analysis are aggregated as *Inland Wetland Soils*. This includes poorly drained soils, very poorly drained soils, and alluvial soils, as defined by the National Cooperative Soil Survey.

* *Poorly drained soils* have a water table at or near the surface from late fall to early spring. These soils occupy nearly level and very gently sloping areas.

* *Very poorly drained soils* have a water table which remains at or above the surface most of the year. These soils occupy level or depressed areas.

* *Alluvial soils* are formed from sediments deposited by water on floodplains, and consist primarily of sand and gravel. They occupy nearly level areas and are subject to stream flooding. These soils can actually range from very poorly drained to excessively drained.

Soil survey maps from SCS are an excellent guide for identifying areas dominated by wetland soils. At the published map scale, however, the smallest areas which can be represented are approximately two to three acres. Therefore, smaller areas of wetland soils may actually occur within mapped areas of non-wetland soils, and vice versa. Although the use of SCS data is appropriate for build-out analysis, no map based on this level of soils information can take the place of a detailed, on-site evaluation of a parcel for determining the precise location and extent of its wetlands.

The best way to locate and scribe wetland soils boundaries onto the base map is to first make a list of all of the map units in the county's survey which qualify as wetland soils. The SCS has, in some cases, already performed these aggregations on a statewide basis. These units will generally be designated with only two letters; a third letter is only used to indicate a slope steeper than would be found in wet areas. Some examples of qualifying units are Am (Alluvial land), Pk (Peat and Muck), and Sa (Saco fine sandy

loam). With this list in hand (and soon to be in memory!), outline all the matching soils boundaries onto the drafting film.

Several other sources of wetlands information are also available to augment the SCS soil classifications. On USGS maps, wetlands are depicted as swamps with a symbol resembling a clump of grass. The U.S. Fish and Wildlife Service's wetlands maps also provide detailed delineations of what they consider to be wetlands as interpreted from aerial photographs. If time and resources permit, the most comprehensive delineation of wetlands would ideally incorporate information from each of these sources.

Steep Slopes

While state regulations in Massachusetts restrict construction in or near wetlands, no such statutory limitations exist for building on steep inclines, however inadvisable it may be. In many cases, engineering costs and access function as the limiting factors. Most towns, as a part of their subdivision control laws, specify that new streets cannot exceed a maximum slope of 10 or 12 percent. Although this requirement discourages extensive new development in hilly terrain, it allows subdivisions to be created, often with deep roadway "cuts" and "fills" to meet street construction standards.

Slope, as a measure of surface steepness, is defined as the ratio of vertical "rise" to horizontal "run," or "rise-over-run" (Figure 6). It is represented as a percentage by the following formula:

RISE/RUN * 100 = % SLOPE

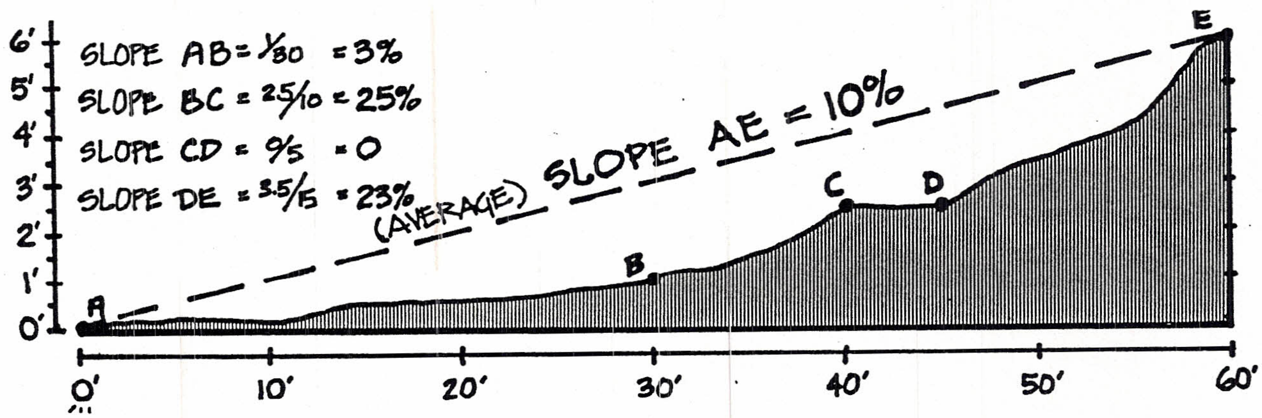


Figure 6. Hillside with an average slope of 10 percent.

Substituting in the appropriate heights and distances, the slope of the hillside in Figure 6 can be expressed with this equation:

$$6 \text{ ft}/60 \text{ ft} * 100 = 10\% \text{ slope}$$

Therefore, on this grade, for every 60 feet of horizontal travel, 6 feet in elevation is gained (or lost).

For the purposes of build-out analysis, a slope "threshold" is selected by the preparer beyond which development will not occur. Limits can range from 15 percent (conservative) to 25 percent (stretching it). Twenty percent is a safe compromise. The exceptions to these thresholds will be few, and can be ignored for this exercise.

Of course, in the real world there is no absolute cut-off. Thus, a more realistic way to portray slope constraints is to divide the land area into three categories of steepness: less than 15 percent slope, 15 to 25 percent slope, and greater than 25 percent slope. Subsequently, in the numerical analysis, development can be differentially ascribed to lands in each category, (e.g., full development density, as permitted by the zoning, on

slopes less than 15 percent, one-half density on slopes between 15 and 25 percent, and no development on slopes greater than 25 percent).

To delineate areas of steep slope on the base map, a vertical and horizontal measure must be known. USGS topographic maps include both these pieces of information. The scale of the map allows ready measure of the horizontal distance, while the contour lines show the elevation above sea level at any given point. Contour lines are actually *iso-elevation lines*, along which the vertical height above sea level remains constant (Figure 7). Generally, the contour interval on USGS topographic

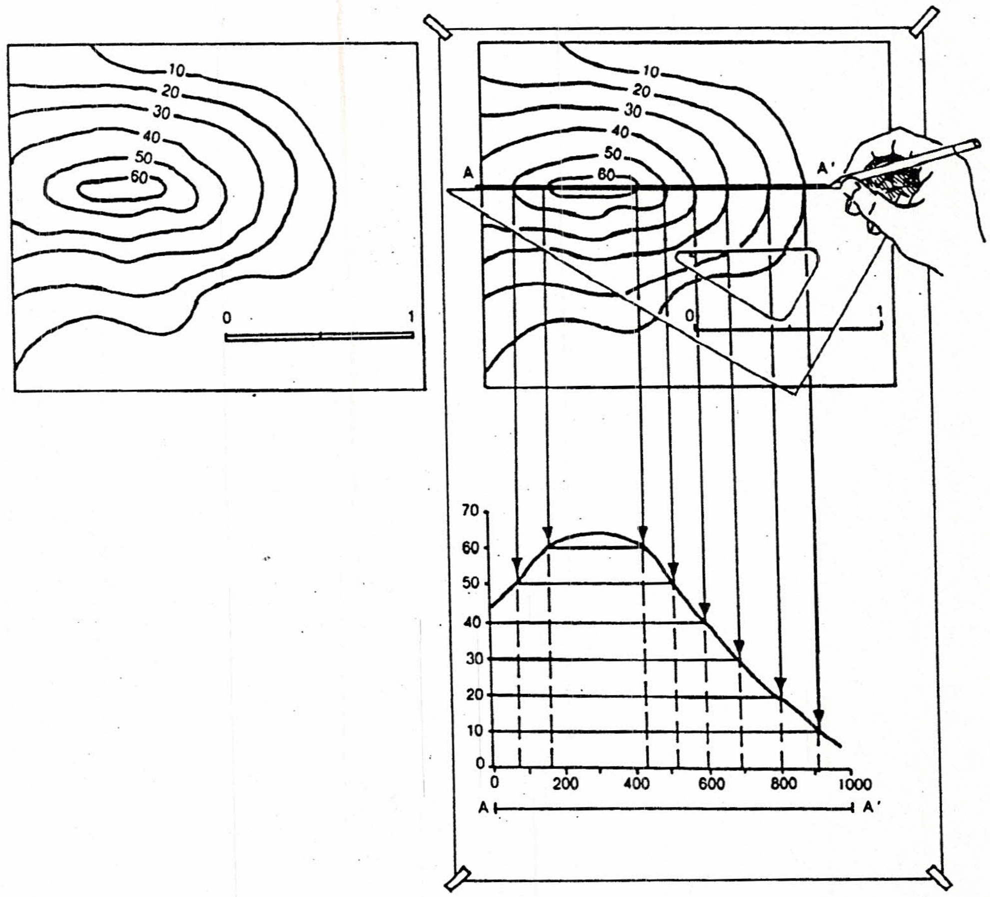


Figure 7. Contour lines on a topographic map.

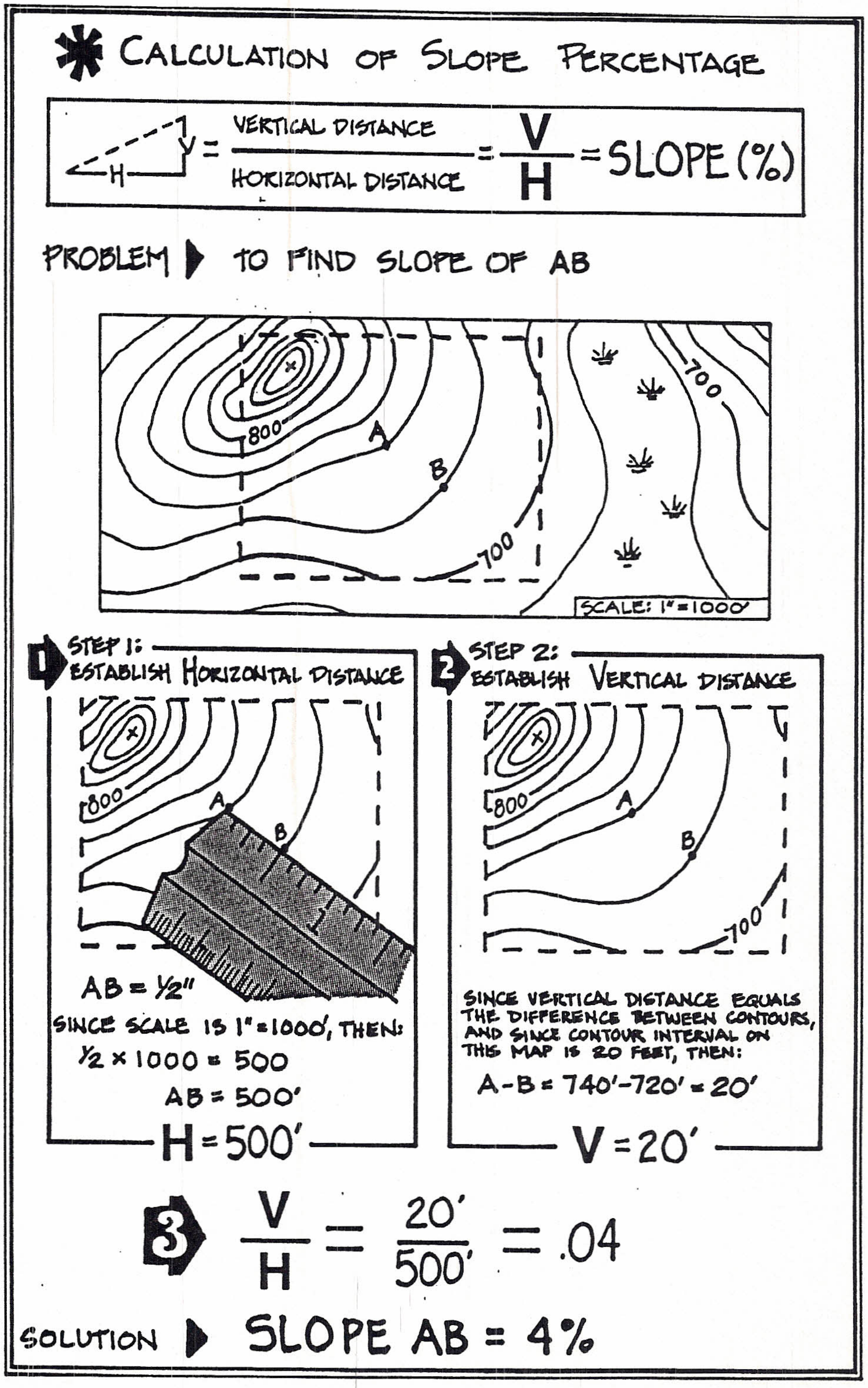


Figure 8. Calculation of slope percentage from a topographic map.

maps is 10 feet, meaning the distance between one contour line and the next corresponds to an elevational change of 10 vertical feet either up or down. (On USGS maps which have already been revised to a metric scale, the interval between lines is 6 meters.) The closer the contours are to one another, the smaller the horizontal distance necessary to rise a given amount--or the steeper the slope. It is the combination of changing contour lines (rise), and the scale (run) which enables a definition of slope on these maps (Figure 8).

To transfer the appropriate slope boundaries onto the base map, position the drafting film over the USGS map and outline the appropriate slope areas using a drafting pen. The following example illustrates the methodology:

EXAMPLE

Problem:

Outline all areas with a slope of greater than 15% on a USGS topographic map that has been blown up to a scale of 1" = 1,000′, with a contour interval of 10 feet.

Solution:

The areas to be outlined on the base map are those which contain contours of a certain closeness to one another. *The determination of just how close together the contours must be is the crux of this exercise.* USGS topographic maps show every fifth contour line darker than the rest; these darker contour lines are the best ones to use as a guide for this exercise. On a map with 10-foot contour lines, the dark lines allow you to create, in effect, a 50-foot contour interval. (On a metric scale map with 6-meter contours, the dark lines create a 30-meter interval.)

1. Determine the horizontal distance (run) between the darker contour lines for a slope of 15 percent. To do this, use the slope equation RISE/RUN * 100 = % SLOPE, with a RISE of 50 feet, and a desired SLOPE of 15 percent.

Substituting, the equation becomes:

$$50 \text{ ft/RUN} * 100 = 15\%$$

Solving:

$$50 \text{ ft/RUN} = 0.15$$

$$\text{RUN} = 50 \text{ ft}/0.15$$

$$\text{RUN} = 333 \text{ feet}$$

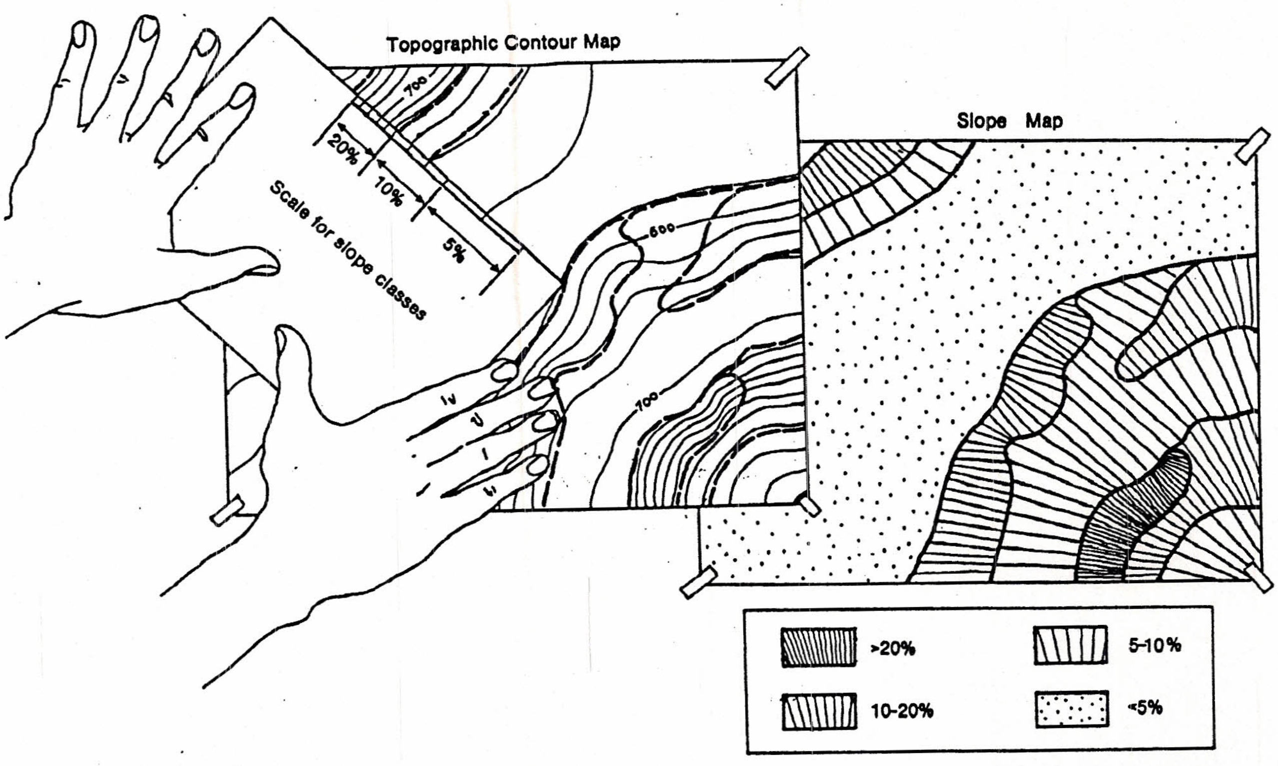
2. Determine what 333 feet is on the map (i.e., how long a 333 foot line would be). At the map's scale (1" = 1,000′), 333 feet on the ground would be:

$$1 \text{ inch} * 333 \text{ ft}/1{,}000 \text{ ft} = 0.333 \text{ inches on the map.}$$

3. Outline areas on the map where the *dark* contours are closer together than 0.333 inches. To do this, make a small "scale" on a scrap piece of drafting film that shows the distance of 0.333 inches. Use this as a "see-through" guide for measuring the perpendicular distances between the dark contours. To avoid confusion during this stage, ignore the light contour lines.

Methodically review the map searching for areas where the dark contour lines are relatively close together. Find a point where two *dark* contour lines fall just within the 0.333-inch guideline and mark the point with a dot. Move the edge of your guideline along the outermost contour line until the interval between the two lines exceeds the 0.333-inch guide. Place a dot on the line you have been following, and then "jump" to

the next *dark* contour line and mark that point with another dot. Follow that contour, comparing the interval between it and the next contour line until you once again reach a point where the two dark lines are greater than 0.333 inches apart. Mark it with a dot, and proceed to "jump" once again to the next dark contour line, repeating the procedure until you have completed an area or go off the map (Figure 9).



Source: *Landscape Planning: Environmental Applications* by William M. Marsh. New York: John Wiley & Sons c copyright 1983. Reprinted by permission of John Wiley & Sons, Inc.

Figure 9. Use of a scale to draw boundaries around areas of similar slope.

Connect the dots to enclose the area of steep slope. Follow the contour lines when the dots are on the same line. Depending on your preference, the "jumps" may be drawn as straight, abrupt lines, or as rounded curves.

Use this method to identify and outline all areas with a slope of 15 percent or greater.

Result:

Based upon these outlines, *two* slope categories have actually been created: enclosed areas of greater than 15 percent slope and excluded areas of less than 15 percent slope.

Follow the same procedure to identify the areas which exceed 25 percent in slope. This will yield the *three categories* of slope called for in build-out analysis. Finding the areas of 25 percent slope or greater will be relatively easy since they almost always fall within those areas already identified as having a slope of 15 percent or greater. If several categories of slope are to be identified, a lightly-drawn notation in the appropriate areas will avoid confusion later on.

Developable Land

Any land not falling within one of the categories designated above is considered part of the town's net usable land area (NULA). It is identified as "developable land" in the map's legend. This is where future growth can occur, and, more importantly, it represents the town's remaining *developable* farmland, forests, and open space. The spatial distribution and overall extent of these parcels is the most revealing and useful information generated thus far in the build-out analysis.

Making the Print

At this stage, all the necessary mapped data has been transferred onto the drafting film. Check it carefully, erase any errors or smudges, and spray it with a fixative.

A black-and-white paper print can now be made from the drafting film. A diazo ("blue-print") machine with 36-inch wide, black-line, presentation paper produces very good copies. Copy shops with large-format duplicating (xerox) machines can also produce the paper map. For the best results, have the copy made onto "vellum" rather than regular "xerox" paper to avoid smudging of the black lines later on.

Coloring the Print

Almost everything *within* the municipal border should be colored as to category (e.g., steep slopes, wetlands, etc.). Care should be taken in this process, as mistakes at this point can ruin the paper print. However, in the event of an unacceptable error, a new paper print can easily be reproduced from the drafting film.

Use assorted marker pens to color the areas within the various boundaries and the legend boxes (Figure 10). Try both fine and broad tips depending on the size of the area being darkened. Since some colors tend to bleed more than others, practice with each pen before using it on the final map.

The following color scheme shows a typical array for a build-out map:

developed land/road rights-of-way	black
surface waters	medium blue
wetlands/floodplain	green
steep slopes	orange
public and protected lands	light brown
developable lands	pale yellow

The paper base map reveals much about the land surface and topography of the study area. In addition, the blackened areas, when viewed together, show the "pattern" of settlement throughout the town or study region. While concentrations of developed lands provide insight into past trends, large areas of pale yellow (unconstrained and developable lands) provide a view of future possibilities--and the future is what a build-out analysis is all about.

CREATING THE OVERLAY

The next phase of the analysis is creation of an overlay for the base map. This portrays in a conceptual way the potential spatial arrangement of new streets and structures that *could* be built at some point in the future (Figure 11). That point is taken to be when *all* developable land has been consumed through subdivision into smaller lots, none of which may be further reduced in size or developed to a greater density under current zoning ordinances and subdivision control regulations. As unlikely as it may seem, build-out is not an implausible outcome, as many "old-growth" communities in metropolitan regions will attest.

Procedure

The overlay material is a clear polyester film, not to be confused with "acetate" which tears easily. Cut a sheet large enough to cover the entire base map and transcribe the municipal boundary onto the polyester using a drafting pen, marker, or pressure-sensitive tape.

Next, looking through to the base map but working on the polyester overlay, add one additional entry line to the legend column. This should consist of another outlined box, a space, and the title POTENTIAL NEW DEVELOPMENT. Use press-on letters of the same size and darkness as those used for the rest of the legend. This part of the legend will only be visible when the overlay is in place.

With the polyester lined up to match the municipal border on the base map, the next step is to add in frontage lots and to create new subdivision roads, shared driveways, cul-de-sacs, etc., as permitted under the existing zoning. Using a bright red

marker or drafting pen with red india ink, new buildings and roads are drawn on the polyester film over those areas on the base map which are pale yellow, representing developable lands. The goal is to show full development on these lands, given the constraints of the current regulatory framework. The density and arrangement of new development is dictated by the lot-size and road-frontage requirements found in the current zoning. As a town may have several zoning districts, these dimensional requirements may change with location.

Another variable which influences lot size is slope. If three categories of slope were identified, three development densities should be assumed. On slopes of less than 15 percent, the development density can be that indicated in the zoning; in areas with slopes of 15 percent to 25 percent, development density should be reduced and may be represented by *doubling* the underlying lot size requirement. Areas with slopes in excess of 25 percent should not be shown with any new development, although they may actually be buildable at very low densities.

The form of these hypothetical streets should roughly adhere to established patterns for grids, loops, cul-de-sacs, and "curvilinear" subdivision roads (Figure 12). It is also useful to refer to realtors' road maps of nearby suburbanized towns to become familiar with these development forms. When adding in new roads, pay attention to the length limits for cul-de-sacs (dead-end streets) as specified in the local subdivision control laws, although in particular cases you may wish to make some longer, as waivers to length restrictions are frequently granted. Also, be aware that new streets generally have an upper limit on gradient: slopes in excess of 10 to 12 percent are often prohibited. Referring to the contour lines in the USGS topographic map will help alleviate this problem when laying out street patterns.

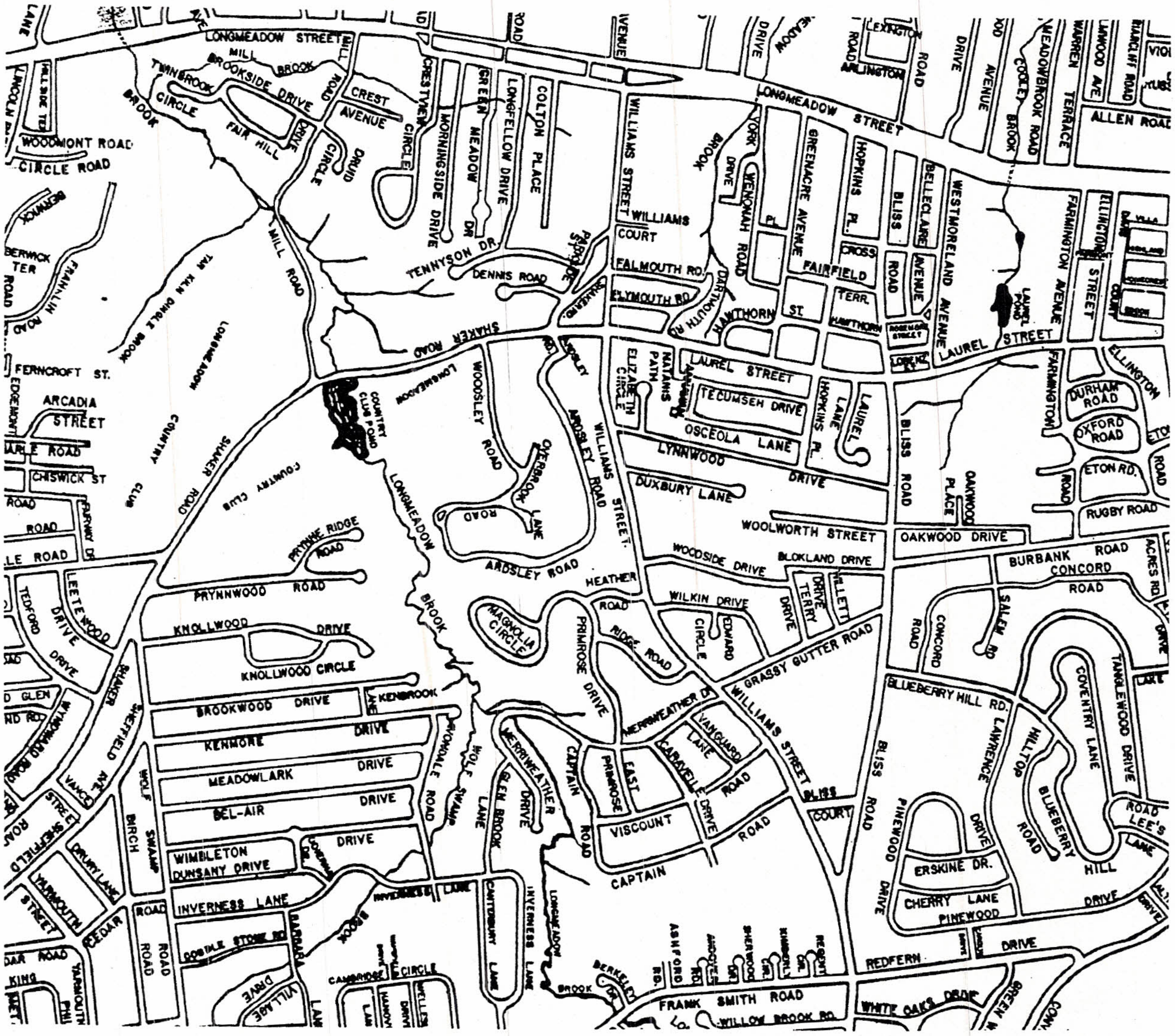


Figure 12. Street map illustrating the pattern of new roadways upon a landscape without severe slope constraints.

Whenever possible, streets should run parallel to contour lines, and cross them diagonally, in order to minimize costly blasting, cutting, and filling. Wetlands restrictions, if applicable, must also be considered; in Massachusetts this generally means wetlands must be separated from new structures and roads by at least a buffer of at least 100 feet.

Bright red dots, representing new structures, are placed along the newly drawn streets to indicate associated structures, whether commercial, residential, or industrial. Red dots should also be added to fill open "gaps" in development along existing roads. The proximity of one dot to another along a road must reflect applicable lot-size and frontage requirements in each zoning district. If development is being shown in commercially- or industrially-zoned districts, the structures are best depicted as larger squares or rectangles, representing supermarkets, shopping malls, factories, and the like. If the intent is to just show residential development, no dots should be placed in districts exclusively reserved for commercial or industrial activity. These lands should, however, be noted on the base map as available for business development.

Dots should be of adequate size and contrasting color so that they stand out when viewed from a distance. This is particularly important for display purposes at public meetings. In cases where there are numerous zoning districts with differing lot-size requirements, a corresponding range of dot sizes is appropriate. Where permitted densities are high (5 to 12 units per acre), one dot may be used to represent more than one residential housing unit. In these cases, the differences in dot types should be noted (e.g., hollow or triangular-shaped dots indicating three or five dwelling units.)

Use of a parcel or Assessor's map can greatly enhance the authenticity of the projected build-out pattern. In most situations properties are developed individually, without prior consolidation of adjacent holdings. Reference to the parcel map can help determine the likelihood of small or large subdivisions in accordance with the size of each available land holding. Unfortunately, parcel maps are not usually available at a scale useful to build-out projects. If making a set to scale is too expensive, at least consult the maps to gain a better idea of the range of typical parcel sizes and shapes.

Without such a "reality check," one has no idea of the actual property boundaries, and can only scale the individual developments in a general fashion. As a guide, refer to some newly-built development configurations. When laying out possible new tract-style subdivisions, allow for a variety of sizes, but keep the limits within the already established precedents for the town.

Phased Build-Out

In towns where total build-out is not likely in the foreseeable future (75 or 100 years), presentation of a completely developed overlay may be too abstract to be meaningful. In such cases, it is recommended that the eventual consumption of all available lands be more realistically depicted with two or three "staggered" overlay sheets. Each sheet would show growth over a set period, for example, over the next 20 years, 50 years, and at complete build-out. The first overlay should depict the addition of structures where frontage is available along existing roadways. Where ten or more years of building permit data are available, the actual number of dots placed on the first layer can reflect the average yearly growth rate as projected for that time period. The next overlay would show consumption of the larger parcels of more easily developed land through subdivision. Finally, lands constrained from conversion by natural or cultural factors are shown to be developed. This later category would include private "estates," remote parcels, areas with slopes of 15 to 25 percent, and quasi-public holdings such as Boy Scout camps.

The multiple-overlay approach is effective in showing how a progressive build-out could occur. As each successive overlay sheet is placed over the last, the spatial distribution of new streets and structures follows the sequential growth pattern commonly seen in towns that are now fully developed. When some form and intensity of development is shown on all unconstrained land (pale yellow on the base map), the overlay is complete.

THE NUMERICAL ANALYSIS

While the base map and overlay provide a striking visual impact, a quantitative expression of the study area's build-out potential can be just as revealing. Most of the information needed to complete this phase has already been determined through the process used to establish "developable lands" (NULA). These lands, rendered in pale yellow on the map, are now further assessed for their "carrying capacity" under current zoning. The numerical analysis can be summarized as shown in Table 1.

Area Measurement

The initial phase of the numerical analysis quantifies the areas delineated by color on the base map. First, a total acreage figure for the municipality (or study region) should be obtained from town records. The mapped areas of public lands, developed lands, steep slopes, wetlands, and surface waters are then measured to determine their respective areas in acres. While a computerized Geographic Information System (GIS) would make easy work of this, without such technology two alternative approaches can be employed: use of a planimeter or a dot-grid. A planimeter is an instrument that measures the area of a plane figure by tracing its outline. While it is the more accurate of the two methods, the instrument itself is tricky to use and expensive to purchase. Because a dot-grid is easier to use and relatively inexpensive, it is described in detail in this manual.

Table 1. Numerical Analysis Summary Sheet

WEST STOCKBRIDGE BUILD-OUT ANALYSIS [1]

TOTAL ACRES	**11,738**
Public Lands	- 34
Developed Lands	- 990
Existing Roads	- 215
Slopes >25%	- 3,075
Wetlands	- 1,186
Surface Waters	- 124

Developable Acres (52%)	**6,114**
New Roads (5%)	- 306
Required Open Space (10%)	- 581

Subdividable Acres	**5,227**

TOTAL NEW UNITS

150	in 0.5 acres zones
518	in 1.0 acre zones
1,561	in 3.0 acre zones

2,229	**TOTAL**

TOTAL NEW RESIDENTS

5,750 (at current 2.58 residents per unit)

COMPARISON

	Present	Built-Out	Change
Developable Land	52%	0%	-100%
Total Units	552	2,781	+403%
Total Residents	1,425	7,175	+403%

[1] Based on information available in 1985

The dot-grid consists of nothing more than a clear sheet of polyester with an outlined pattern of square boxes in which there are regularly spaced black dots. The boxes are typically one-inch square and contain 25 dots; thus, each dot represents 0.04 (1/25) of the area within the box. Knowing the scale of the map in question enables you to measure areas using the dot-grid. For example, for a map with an specific scale of 1" = 1,000′, a one-square-inch box would contain 1,000,000 sq. ft. (1,000 ft. * 1,000 ft.). Since there are 43,560 sq. ft. in one acre, the box contains 22.96 acres (1,000,000 sq. ft./43,560 sq. ft./acre). This means that every dot in the box accounts for 0.9184 acres (0.04 * 22.96 acres).

The clear dot grid is used by placing it directly over the colored base map. The area within a particular border (i.e., all orange polygons, indicating locations with steep slopes) is determined by simply counting up the dots that fall within (or mostly within) those boundaries (Figure 13). Those falling directly on the border-line are counted as one-half of a dot. A hand-held counter with analog readout similar to an automobile's odometer, makes quick work out of counting the numerous dots.

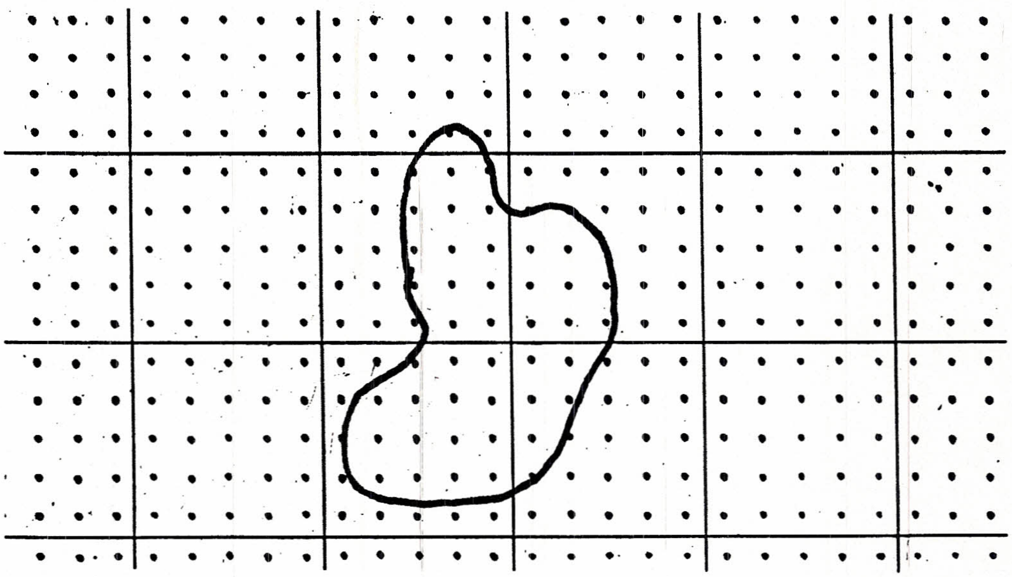


Figure 13. Use of the dot-grid to measure area (45 dots fall within this bounded area).

A determination of the area within the existing road rights-of-way should also be made. To do this, multiply the linear length of all existing town roads (obtained from town records or by measurement) by the municipality's required right-of-way. This will give you a figure in square feet, which is then converted to acres.

EXAMPLE

Problem:

The town of Harrisville has 54 miles of existing roadway. Find the acreage of constrained land along its roads, given a required 50-foot right-of-way.

Solution:

Convert 54 miles to feet:

54 mi * 5,280 ft/mi = 285,120 ft

Multiply the width of the road right-of-way by the length of the town's roadway:

50 ft * 285,120 ft = 14,256,000 sq ft

Convert square feet to acres:

14,256,000 sq ft * 1 acre/43,560 sq ft = 327.3 acres

Result:

Existing road rights-of-way account for 327.3 acres of land.

Developable Acres

Subtracting all constrained areas from the town's total area yields DEVELOPABLE ACRES--all lands colored pale yellow the base map. This provides an interesting perspective on just how "open" a town really is, especially when expressed as a percentage. By using an overlay of the town's zoning districts, the amount of developable land in each use category or density zone (e.g., Rural Residential or Commercial) can also be measured.

Developable acres can be further reduced by subtracting out any acreage consumed in the course of development by new roads and their rights-of-way, and by any dedicated open space required under subdivision control. These amounts should be determined for *each* use/density zone. For example, if the existing requirements for road frontage, rights-of-way, and open space set-asides in subdivisions are known, the reduction of developable land within any use or density district can be calculated.

The required open space should be factored out first by simply reducing developable land by whatever percentage is required for open space under the subdivision control law for the town. It is then necessary to calculate the *percentage* of the remaining developable land that must be allocated for road rights-of-way to access the units that could potentially be built in that use or density district (Figure 14). To determine this figure, calculate the required road right-of-way for each individual, minimally-sized lot in that particular district. For example, given an 80,000 sq. ft. lot with 250 feet of required frontage in a town with a 50-foot road right-of-way, the square-footage of the right-of-way would be:

25 ft. * 250 ft. = 6,250 sq. ft.

The *total* area of road right-of-way *and* lot would then be:

6,250 sq. ft. + 80,000 sq. ft. = 86,250 sq. ft.

Therefore, the portion of developable land in that particular district that will be dedicated to road rights-of-way is:

6,250 sq. ft. / 86,250 sq. ft. * 100 = 7.25%.

Thus, the remaining developable land should be reduced by 7.25 percent. This procedure should be followed for each separate district using the appropriate lot-size, frontage, and right-of-way requirements.

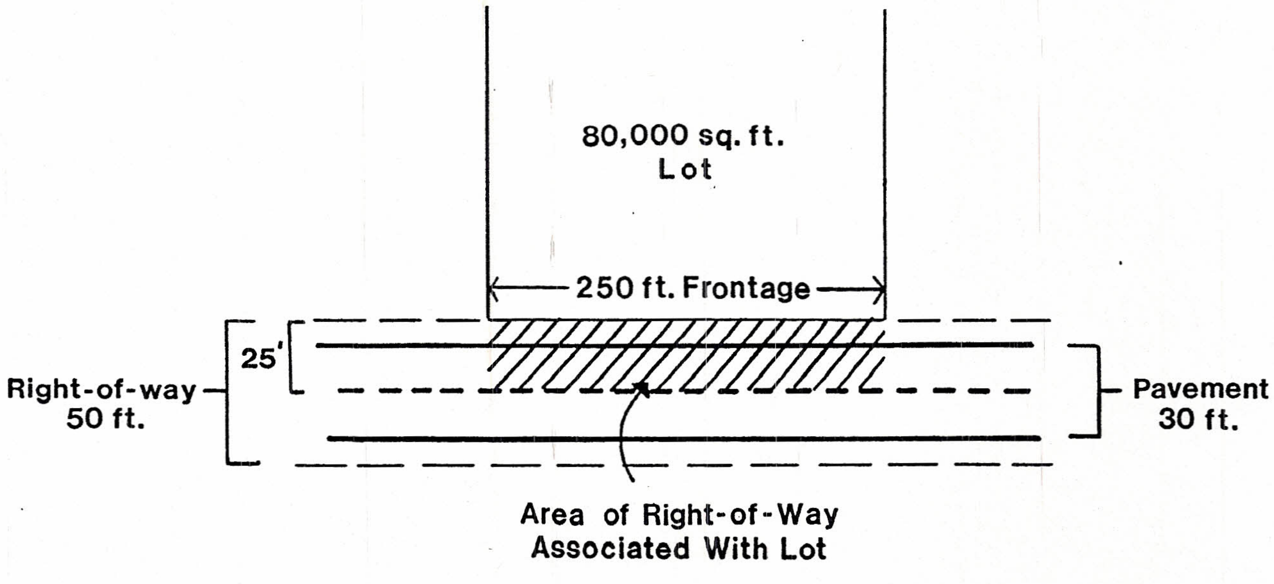


Figure 14. Determination of the area within a road right-of-way.

Subdividable Acres

After following the procedures just described, what remains is called SUBDIVIDABLE ACRES. This is the land area that can go into privately held residential, commercial, and industrial lots. For the purposes of most build-out analyses it will be necessary to calculate only the number of *new residential units* which can be accommodated in each of the zoning districts. In large, undeveloped commercial and industrial districts where residential development is permitted as well, a simple assumption can be made that half the district will be developed for residential use. If, however, these areas are totally unsuitable for residential development, and it is unlikely to occur in there, the districts in question can be discounted from any further calculations.

Housing and Population Analysis

At this stage, having figures for subdividable acres in each district enables a quick, albeit simplistic, calculation of potential new housing units by zoning district. To do this, divide the total subdividable acreage by the underlying residential lot-size requirement. Adding up all the applicable districts will reveal TOTAL NEW UNITS.

Total new units may then be converted to TOTAL NEW RESIDENTS by multiplying by the State's standard for household size per newly constructed unit, or, if available, by a more precise local multiplier. (This multiplier is derived from dividing the number of recent population additions by the number of housing units built in the same period.)

In addition, state or local multipliers can be further applied to yield that portion of the new population which will likely include NEW SCHOOL-AGE CHILDREN. This

figure can be particularly enlightening in view of the fact that school-related costs account for the largest share of most municipal budgets.

As a last step, a comparison table can be made to illustrate the differences between current conditions and those which would be encountered at build-out. These changes can be expressed both as raw values and as percentages. Parameters such as DEVELOPABLE LAND, TOTAL UNITS, TOTAL RESIDENTS, and SCHOOL-AGE CHILDREN should be included in the table.

Another, and perhaps more accurate, way to conduct the housing and population analysis is to actually count all the red dots on the various overlay sheets. Given that topographic, access, and parcel information was used in the placement of each dot, the number of potential units arrived at using this methodology will be less than that produced by the simple calculation described above. This is the method of choice for a more realistic estimate of an area's carrying capacity.

PRESENTING THE GRAPHIC AND NUMERICAL ANALYSES

Mounting

For ease of handling and protection, the colored-up base map should be mounted on some form of hard backing such as foamcore. Professional dry mounting is best. The map will then be free-standing and can be mounted on a wall or leaned on an easel during presentations.

The polyester overlay(s) can be attached either permanently or temporarily to the top of the base map. The overlay(s) should be positioned to be easily brought down over the base map to illustrate the impact of possible new development on the town's open lands. A border of electrical tape around all four edges of the overlays gives them rigidity, makes them easier to handle, and cuts down on wear and tear from regular use. If the base maps is "permanently" mounted on an office wall, a time-proven system is to punch several holes along the top border of the overlays and to use these to hang the polyester sheets on hooks attached above the base map. The polyester overlay(s) can also be attached to the base map using binder clips, a method which works well when on the road. No matter what method you decide to use, care must be taken to ensure that the border lines of both the base map and the overlay(s) are properly aligned.

Presenting the Build-Out Map

When presenting these materials at a public hearing or Planning Board meeting, spend some time discussing the base map before introducing the overlay(s). Explain what each of the colored areas represents, along with some of the sources, methodologies, and assumptions that went into their delineation. Emphasize the extent

of the lands available for new development: this is often a shocking revelation for many town residents.

The presentation of the overlay(s) should be preceded by an explanation that it is a depiction of a *possible* outcome under current zoning by-laws and subdivision controls. Once the overlay is in position, quickly explain that the red lines and dots represent a conceptual depiction of the town once its current zoning is *fully implemented*. Allow some time for the audience to fully absorb this vision of their town, followed by an opportunity for questions and discussions.

Presenting of the Numerical Analysis

The information on the numerical analysis summary sheet should be copied and made available for all in attendance. In addition, a larger version (3 ft. by 5 ft.), can be displayed next to the map itself. While the audience follows along on their own copy, go through the sequence of steps behind the values in the numerical analysis, pointing out the relationship between the map and the numbers that were generated from it.

Finish the presentation with the comparison table, emphasizing the potential changes in both the population and landscape of the town. You may wish to end by returning once again to the map and showing how much "open" land there is in town and how that area could eventually be consumed.

OTHER BUILD-OUT TECHNIQUES

Parcel-Specific or "Zoom" Build-Out Analysis

In certain situations where time or resources are limited, a very credible effort at build-out analysis can be accomplished at the site, parcel, or multi-parcel level. This type of analysis should be limited to developable sites that are both scenic and highly visible from an existing roadway--preferably an area well known to most residents. By focusing the build-out effort on several hundred "meaningful" acres rather than on the entire town, the visual impacts can be more accurately and realistically portrayed. In this way, residents can better appreciate the loss of a known piece of open space.

All of the same techniques described earlier in this manual are applicable to zoom build-outs; however, a more detailed and accurate NULA map may be created through field checking, which is feasible on such a small site. When developing the build-out overlay, the large scale will permit a more precise design of the street layout, and even allow for the addition of hypothetical houselot boundary lines. In general, this close-up approach will reveal a larger number of possible housing units than would be revealed for the same parcel at a town-wide scale.

Computer-Aided Imagery

Zoom build-out analysis may be even more realistically rendered using computer-aided imagery. With this system, all the dimensional details from the site plan (e.g., lot lines, street alignment, rights-of-way, setbacks, frontages, building placement, etc.) are entered into a computer-assisted design (CAD) program. The CAD imagery capability then enables the incorporation of these design dimensions into an actual photograph of a

site. Most effective is to present a pair of photographs which show an existing parcel of farmland with a hypothetical subdivision drawn in one and a business/industrial park drawn in the other. Any photograph taken of a site may be so altered, provided the exact point and direction of the photograph is known. In this way, a given project may be viewed from any number of perspectives.

Viewers not particularly satisfied with what they have seen may wish to make further use of this tool by experimenting with other sets of dimensional requirements for their zoning ordinances. Variations in lot sizes, frontages, setbacks, road widths, landscaping, and open space set-asides can all be tried until the images begin to look more desirable. This is the kind of feedback which is vital to the successful implementation of new zoning ordinances, but unfortunately often missing in the drafting of most zoning bylaws.

Build-Out Using Geographic Information Systems

The rapid expansion of Geographic Information Systems (GIS) as a tool in land-use planning has also raised queries about its use to generate build-out maps. Although the software has yet to be developed to complete the actual build-out overlays on the computer, use of GIS to generate a composite base map may be both time and cost effective depending upon what criteria have already been computerized. In Massachusetts, many Regional Planning Commissions are now using GIS to prepare resource maps of their member towns, adding data layers as time, money, and information become available. These can be compiled and a computerized base map produced over which hand-drawn overlays can be used.

Build-Out as a Comparative Tool

Most of the examples given so far address using Build-Out as a means of showing residents how their town could look if fully developed under existing zoning. It is often the impetus for a town to review its zoning and subdivision regulations to help protect open space and a community's small town character. Some towns, however, have used build-out as a tool to show the difference between build-out under existing regulations and build-out under proposed creative zoning alternatives. The town of Southampton, Massachusetts, for example, is using this approach in revising its zoning and subdivision regulations. Working with the U.S. Forest Service as part of its Urban/Rural Interface Project, the town selected three landscape types (farmland, forested hillsides, and business/commercial highways) to illustrate how a composite of each type of site looks now, how it would look built-out under existing zoning, and how it could look built-out under new proposed zoning. Presenting the different scenarios for each landscape type is proving to be an excellent educational tool; the ensuing discussion has already resulted in changes to the proposed bylaw language in response to citizen concerns and comments.

RECOMMENDATIONS FOR USE

The build-out analysis itself will not solve any problems--it will just highlight the current situation. But the process and final presentation of the results can serve as a catalyst for change in a community. A well-done and skillfully presented build-out analysis is perhaps the single most effective tool to inform residents and officials of the ultimate consequences of *not* revising their present land-use regulations. Zoning that, in the eye of town residents, does not further the public good (e.g., retention of rural atmosphere, open space, recreational lands, aquifer-recharge capacity, etc.) should be examined in greater detail. A build-out analysis can "galvanize" citizens into taking the first steps in this direction. As a popular bumpersticker puts it, "When the people lead, the leaders will follow."

Professional planners and those who serve on town boards that regulate and influence development may already be acutely aware of the inadequacy of existing local ordinances. Unfortunately, that awareness often does not extend beyond these few "insiders." A series of public forums to discuss growth management issues and the implications of the build-out analysis will naturally lead to an examination of more appropriate regulatory mechanisms--the kinds of planning tools and techniques that will both accommodate new growth *and* ensure the retention of open space resources. The reaction to a build-out analysis can become a call for action and for more creative local planning.

Other, more innovative and flexible planning tools may be introduced and assessed for their applicability to a town's particular set of opportunities and challenges. If open, working landscapes are integral to a town's character, then options such as open space

zoning, the purchase of conservation easements and development rights, the transfer of development rights, or agricultural-incentive zoning should be considered. If scenic roads are to retain the characteristics which make them so special, then measures such as site-plan approval, flexible road-frontage requirements, and scenic highway district standards are appropriate. In small, rapidly growing municipalities, demands for services, infrastructure, and schools can easily exceed yearly budgets. In these situations, some growth-rate control can be achieved through phased growth, development scheduling, and building permit cap ordinances. Finally, where new or continuing land conversion threatens to turn country roads into unsightly commercial "strips," the adoption of commercial site-plan approval, curb-cut limits, planned-unit commercial or commercial "cluster" zoning, village-commercial in-fill provisions, architectural design guidelines, and signage standards can be positive steps.

FURTHER INFORMATION

The Center for Rural Massachusetts has a selection of publications and videos available on a wide range of growth management topics. It also offers its services in preparing Build-Out maps or in presenting a Build-Out slide show and workshop. For further information, contact:

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In addition, the Center for Rural Massachusetts' award-winning publication, *Dealing With Change in the Connecticut River Valley: A Design Manual for Conservation and Development*, is available through:

Publishers' Business Service
Post Office Box 447
Brookline Village, MA 02147
1-800-848-7236

Figure 11. Base map with build-out overlay

Fig. 4 Colored-up paper base map.

r.). Colored-up paper base map