Map Reading 101:
Using and Reading Maps and Plans

RI NEMO
Adapted from CT NEMO
How do Commissions Communicate?

Through Reports, Maps, and Plans
How most of us react to maps and reports...

As the map is rolled out at the P&Z meeting...
Goals of this Workshop

To Understand:

- the sources of maps and plans
- how maps and plans are used
- fundamental elements of maps and plans
- how to evaluate maps and plans
Maps, Plans...What’s the Difference?

- **Maps** show physical features of the natural or built environment at established scale and orientation.

- **Plans** are engineered drawings made to scale showing existing physical features of a site and **proposed changes** to accommodate development.
Maps are 2-dimensional representations of complex landscapes...at one point in time.
Types of Maps

Paper:
- USGS topography
- USDA soils
- Computer Assisted Drafting (CAD)
- Geographic Information Systems (GIS)

Digital:
- IMS (Internet Mapping Service),
- Geographic Information Systems (GIS)
How Maps & Plans are used?

- Resource Inventories
- Land Use Planning
- Subdivision
- Site Planning
Resource Maps

- Watershed Sub-basins & Surface Water
- Forest & Wetland Resources
- Land Use
Planning/Zoning
Subdivision Plans
How are these maps different?

- They move from general to specific
Key Map Elements

- Title
- North Arrow
- Scale
- Legend
Plan of Proposed Single Family Home
Owner: Jane Q. Public
Plat 4, Lot 36  Town of Beachville, RI
Prepared by: Mary Smith, P.E., RLS.
Scale 1”=40’  Prepared 10/21/04
Revised 11/8/04

Title Block

Key Map Elements

Title
Creation & Revision Dates
Source
Key Map Elements

North Arrow
**Scale**

**Written Scale**

1:12,000 (ratio)
1 in. equals 12,000 in.

1” = 40’ (Equivalent)
1 in. equals 40 ft.
Or 40 scale

**Graphical Scale**

Graphic scales are the most reliable!

Beware of Xerox Distortion
Question: Are Ratio and Equivalent scales different?

Is 1:40 the same as 1” = 40’?

1” = 3.33’

1” = 40’
Legends

Provide a guide to the symbols used

### Legends

<table>
<thead>
<tr>
<th>Watershed Basins</th>
<th>Town</th>
<th>Migratory Fish Runs</th>
<th>Tidal Wetlands</th>
<th>Eelgrass</th>
<th>Water Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Basins</td>
<td>□ Town</td>
<td>□ Fish Runs</td>
<td>□ Tidal Wetlands</td>
<td>□ Eelgrass</td>
<td>□ Water</td>
</tr>
<tr>
<td>□ Streams</td>
<td>□ Lakes</td>
<td>□ Shore</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Urban Growth

- □ Developed before 1985
- □ Turf and Grass before 1985
- □ Water
- □ Undeveloped
- □ Developed 1985-1990
- □ Turf and Grass 1985-1990
- □ Developed 1990-1995
- □ Turf and Grass 1990-1995
- □ Developed 1995-2002
- □ Turf and Grass 1995-2002

#### Legend

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH #1</td>
<td>DTP Location</td>
</tr>
<tr>
<td>PT</td>
<td>PERC Test Location</td>
</tr>
<tr>
<td>WLF</td>
<td>Wetland Line Per Field Investigation</td>
</tr>
<tr>
<td>WLF</td>
<td>Building Lot Setback</td>
</tr>
<tr>
<td>CG</td>
<td>Wetland Flag Number</td>
</tr>
<tr>
<td>WLF</td>
<td>Soil Type Designation</td>
</tr>
<tr>
<td>CrC</td>
<td>Approx. Limit of Soil Types</td>
</tr>
<tr>
<td>......</td>
<td>Soil Erosion Control Barrier</td>
</tr>
<tr>
<td>20</td>
<td>Existing Contours</td>
</tr>
<tr>
<td>120</td>
<td>Proposed Contours</td>
</tr>
<tr>
<td>16.0</td>
<td>Existing Spot Elevation</td>
</tr>
<tr>
<td>20.5</td>
<td>Proposed Spot Elevation</td>
</tr>
<tr>
<td>100`</td>
<td>100' Review Zone</td>
</tr>
<tr>
<td>......</td>
<td>Limit of Vegetation</td>
</tr>
<tr>
<td>......</td>
<td>Existing Ledge Outcroppings</td>
</tr>
<tr>
<td>......</td>
<td>Existing 20% Slope</td>
</tr>
<tr>
<td>PH</td>
<td>Probe Hole Location</td>
</tr>
</tbody>
</table>

No ledge to 24" or mottling/water to 18" encountered in probe holes.
Evaluating Maps

- Type
- Scale
- Slope
- Topography
Map Type

What is the purpose of this Map?

- Town Planning
- Regulatory
- Wetland Impacts (IWW)
- Subdivision (Planning)
- Site Plan (Zoning)
## Scale

<table>
<thead>
<tr>
<th>Larger Scale Map</th>
<th>Large Scale Map</th>
<th>Small Scale Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: 1,200</td>
<td>1: 250,000</td>
<td>1 inch = 3.95 miles</td>
</tr>
<tr>
<td>1” = 100 ft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Map Scale

1 : 24,000
1” = 2000 ft.

1 : 100,000
1” = 1.5 miles

1 : 500,000
1” = 7.9 miles

Large Scale
High detail
Small Area

Small
Low detail
Large Area

Symbology Changes
**Map Accuracy**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 : 24,000</td>
<td>1&quot; = 2000 ft.</td>
</tr>
<tr>
<td>1 : 100,000</td>
<td>1&quot; = 1.5 miles</td>
</tr>
<tr>
<td>1 : 500,000</td>
<td>1&quot; = 7.9 miles</td>
</tr>
<tr>
<td>1/50th&quot;</td>
<td>40 ft.</td>
</tr>
<tr>
<td></td>
<td>158 ft.</td>
</tr>
<tr>
<td></td>
<td>835 ft.</td>
</tr>
</tbody>
</table>

**United States National Map Accuracy Standards** – last revised June 1947

**Horizontal Accuracy**
*Publication scales smaller than 1:20,000 (e.g. 1:24,000, 1:100,000) shall have 90% of all tested features fall within 1/50th inch of their true location.*

**Vertical Accuracy**
*90% of all points tested shall be within 1/2 of a contour interval of true elevation.*
Map Accuracy

United States National Map Accuracy Standards – last revised June 1947

Horizontal Accuracy
Publication scales larger than 1:20,000 (e.g. 1:1200, 1:600) shall have 90% of all tested features fall within 1/30th inch of their true location.

Vertical Accuracy
90% of all points tested shall be within 1/2 of a contour interval of true elevation.
# Map Accuracy

<table>
<thead>
<tr>
<th>Common Data Types</th>
<th>Positional accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:24000 USGS Topo</td>
<td>40 ft. (at original scale)</td>
</tr>
<tr>
<td>1:15840 SSURGO Soils Maps</td>
<td>44 ft. (1/4 ac. min. map unit)</td>
</tr>
<tr>
<td>1:12000 Orthophotography (RIGIS)</td>
<td>33 ft.</td>
</tr>
<tr>
<td>1:24000 Wetlands data from RIGIS</td>
<td>75 ft. (1/4 ac. min. map unit)</td>
</tr>
<tr>
<td>1:5000 Orthophotography (RIGIS)</td>
<td>14 ft.</td>
</tr>
<tr>
<td>Parcel maps</td>
<td>5 – 200 ft. (highly variable)</td>
</tr>
</tbody>
</table>
Factoid: What is an acre?

- 1 acre = 43,560 sq. ft.
- Builder’s acre = 40,000 sq. ft.
Map Scale

- Is the scale appropriate for the purpose?
What scale is appropriate?

Football field

300’ X 160’ = 48,000 sq.ft

Is this bigger or smaller than an acre?
What Scale is Appropriate?

• How big is the football field at different scales?

• What scale is appropriate to locate the field?
What Scale is Appropriate?

1:645,000 1 in = 10.2 mi
What Scale is Appropriate?

1:250,000  
1 in = 3.95 mi
What Scale is Appropriate?

1:100,000  1 in = 1.6 mi
What Scale is Appropriate?

1:24,000 (Topo Maps)  
1 in = 2,000 ft
What Scale is Appropriate?

1:15,840 (Soil Maps, paper)  1 in = 1,320 ft
What Scale is Appropriate?

1:12,000 (soil survey, GIS)  
1 in = 1,000 ft
What Scale is Appropriate?

1:1,200 (Subdivision)  1 in = 100 ft
What Scale is Appropriate?

1:480 (Plans)  
1 in = 40 ft
What Scale is Appropriate?

1:120 (Site Plans)                       1 in = 10 ft
Introducing Slope

• The change of elevation between two points over a given distance…
Percent Slope = \( \frac{\text{Change in elevation}}{\text{Distance}} \times 100 \)

Chg in Elevation = 3 ft
Distance = 6 ft

\((3 \, \text{ft}/6 \, \text{ft}) \times 100 = 50\% \, \text{Slope}\)
Slope

Slope ratio = Distance : Change in elevation

Distance = 6 ft
Chg in Elevation = 3 ft

6 ft : 3 ft = 2:1 Slope
Why is Slope Important?

- Development suitability and impacts highly dependent on slope...
  - site stability
  - drainage
  - flooding
  - erosion
  - safety
Slope is expressed as a percentage or as an angle

- 5% slope = 2.8 degrees
- 10% slope = 5.6 degrees
- 15% slope = 8.4 degrees
- 100% slope = 45 degrees

Tuckermans Ravine, Mt. Washington, NH
70% slope, only 35 degrees
Examples of Slope

Less than 5% Slope:

• require minimal topographical disturbance during construction;
• slopes less than 1% have potential for drainage problems;
• sidewalks are built with a cross-sectional slope of 1-2%
• roads preferred gradient from centerline is 2-3%
Examples of Slope

5-10% Slope:

• require moderate topographical disturbance during construction;
• erosion and sedimentation (E&S) control measures needed;
• max. handicap ramps at 8%;
• max. grade for a parking lot is 5%;
• max. sustained grade a car can climb in high gear is 7%;
• grass often planted to stabilize site.
Examples of Slope

10 - 25% Slope:

• require significant topographical disturbance during construction;
• E&S and runoff control a serious issue;
• greater than 20 - 25% require engineered on-site sewage treatment system;
• some towns do not allow development on “steep slopes”
Seeing the Lay of the Land

- Topography
- contours 1-2-3
- going from 2D to 3D
Topography

Contours: an imaginary line that connects points of equal elevation

Plan View

Terrain relief
Topography

Contours always connect, but not always within the map boundaries...
Topography

Slope direction is calculated perpendicular to the contour lines. 

Water flows downhill...

...so the direction of flow is always perpendicular to the contour lines, since this is the steepest slope.
Topography

Cross-sections are sometimes used to represent 3-D objects in 2 dimensions.

Plan View

Cross Section

Vertical scale sometimes exaggerated to better show change
How to read a topo map...

- **Contour Interval** is the vertical distance between contours, generally 10ft. on topo maps. **Contour lines** never cross each other.

- Every fifth contour line is an **index contour** and is usually labeled.

- **Hilltops** are indicated by progressively smaller, closed contours.

- Contours close together indicate a **steep slope**.

- Contours far apart indicate a **gentle slope**.

- Forest Cover is green.
How to read a topo map...

• A **spot elevation** is a point with a known elevation.

• When contour lines cross a stream, they form a “V” that always points **uphill**.

• A **saddle** is a lower area, often on a ridge, between two areas of higher elevation.

• **Depressions** are indicated by closed contours with inward-pointing ticks.

• A **benchmark (BM)** is a point of known position & elevation used as a point of reference for surveys.
U.S. Geological Survey

Topographic Map Symbols

Use of Color

Blue – used for all water features.
Red – major roads & highways.
Green – identifies vegetation such as forest cover, orchards, etc.
Brown – used to depict contour lines as well as some landform features.
Black – man-made features & all labeling & lettering.
Purple – revisions & new map data.
Your turn!

Find or calculate the following:
- What’s missing?
- highest elevation
- elevation of Pt. A
- the distance between Pts A & B
- the change in elevation between A & B
- the percent slope between A & B
- Which is higher C or D?
- Which direction would water flow from C? D?
- Where would that water leave the map edge?
1. What’s missing?  
   North Arrow, Legend, Source
2. Highest elevation  
   582 ft
3. Elevation of Pt. A  
   570 ft
4. Distance between Pts A & B  
   1,000 ft
5. Change in elevation between A & B  
   100 ft
6. Percent slope between A & B  
   10%
7. Which is higher C or D?  
   C
8. Which direction would water flow from C? D?  

9. Where would that water leave the map edge?
Rules and concepts for delineating watershed boundaries.

• A watershed is a land area draining to a common outlet.

• All land is in a watershed.

• Watershed boundaries can be drawn to show smaller parts of larger watersheds. The terms basin, watershed, subwatershed, drainage area, hydrologic unit, catchment, subcatchment, are used interchangeably to describe a watershed. There are no size rules but in general, the terms “basin” and “watershed” are used to describe larger drainage areas.

• Watersheds can be drawn for any area. The point chosen as the watershed outlet determines the boundaries.. For example, the mouth of the Pawtuxet River as it flows into Narragansett Bay is the outlet for the entire Pawtuxet River watershed, including the Scituate Reservoir and its watershed. At a project scale, the developer will be interested in choosing the point(s) where a stream or wetland leaves the property to identify areas that drain to that site from the property or upgradient of the property.

• Natural drainage patterns may be altered by man made features. For example, roads are often built to follow ridges and other high points, so drainage divides often follow roads. Stormwater drainage systems may redirect water flow away from naturally occurring patterns. In developed areas, field checking is needed to verify water flow direction based on locations of stormdrain inlets and outlets.
Watershed Delineation Example

**Sherman Brook Watershed**

1. **Identify the watershed outlet.** Mark with ○.

2. **Highlight Sherman Brook & other nearby watercourses.**

3. **Try to visualize direction of flow and look for ridge lines & saddles.** Mark high points with x.

4. **If needed, draw arrows to indicate direction of surface flow.**

5. **Trace outline of watershed beginning at outlet, connecting high points.** Cross contours at right angles. Form a closed and continuous boundary.

**Note town boundaries - Sherman Brook Watershed is in two municipalities**