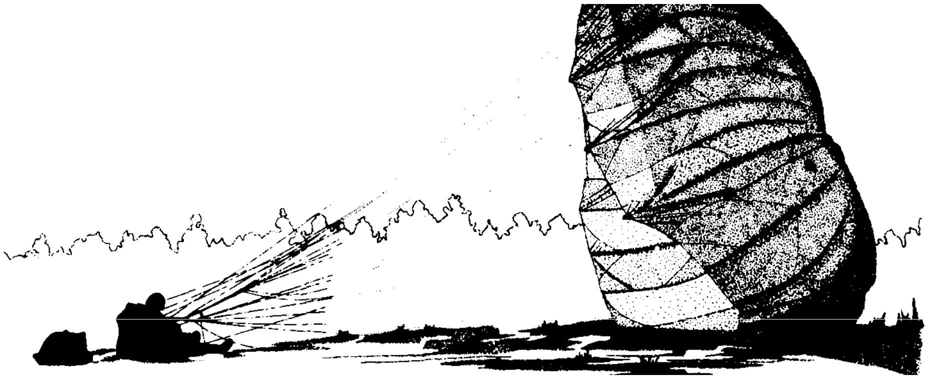


Line of Site and Zone of Entry

Chapter 7

LINE OF SITE

The line of site (LOS) is an unobstructed view from point A to point B. Requests for LOS products are becoming more frequent just as the effective ranges of our weapons, radar, and communications equipment are increasing. We can only realize the effectiveness of long-range weapons with ranges of over 4,000 meters and of current corps and division communications equipment with ranges of 50 to 60 kilometers if the equipment is emplaced properly in areas containing equivalent-distance LOSs or groups of LOSs (as in fields of fire).

The seven methods for determining LOS are--

- Ground truth (occupy positions), which is the most reliable, least likely, and least convenient method.
- Elevation layer tints, which do not consider refraction or the curvature of the earth.
- Survey intervisibility formula, which adds constants for curvature of the earth and refraction but does not consider vegetation height.
- Analytical Photogrammetric Positioning System (APPS), which is only as good as equipment accessibility, operator training, and data-base accuracy.
- Profile (topographic map) method is the old, faithful method, almost universally known, but which does not consider refraction or curvature of the earth.
- Aerial photography (the floating line method), which is better used for short distances.
- MICROFIX, which is accurate, dependent on access to digital terrain elevation data (DTED), and useful for a wide variety of product.

As a terrain analyst, you must often determine if one location can be seen from another location or if terrain is blocking the view. Intervisibility is the ability to see from one object or station to another and is important to determine LOS. It can be a tactical means of identifying defiladed areas for maneuver units or effects of direct fire on ground forces. The best way to determine intervisibility is to physically occupy each station. Since you cannot always be in the physical area, however, you must use topographic maps and aerial photographs. You must be able to plot coordinates on stereo-paired photos and construct a profile of a topographic-map area.

Topographic Map Method

Make sure you have your photo interpretation kit. It contains a photo plot, your remote-sensed imagery (RSI), straightedge, pin vise and pin, point designation grid (PDG) template, and a mission directive that contains location instructions.

Step 1. Look at your mission directive to obtain information about the location you will profile. The directive will also tell you which points to plot on the map. Use the UTM coordinates on the map to plot the two points.

Step 2. Draw a line across the area to be profiled connecting the two points you have just plotted. This is the profile line. Figure 7-1 shows an example.

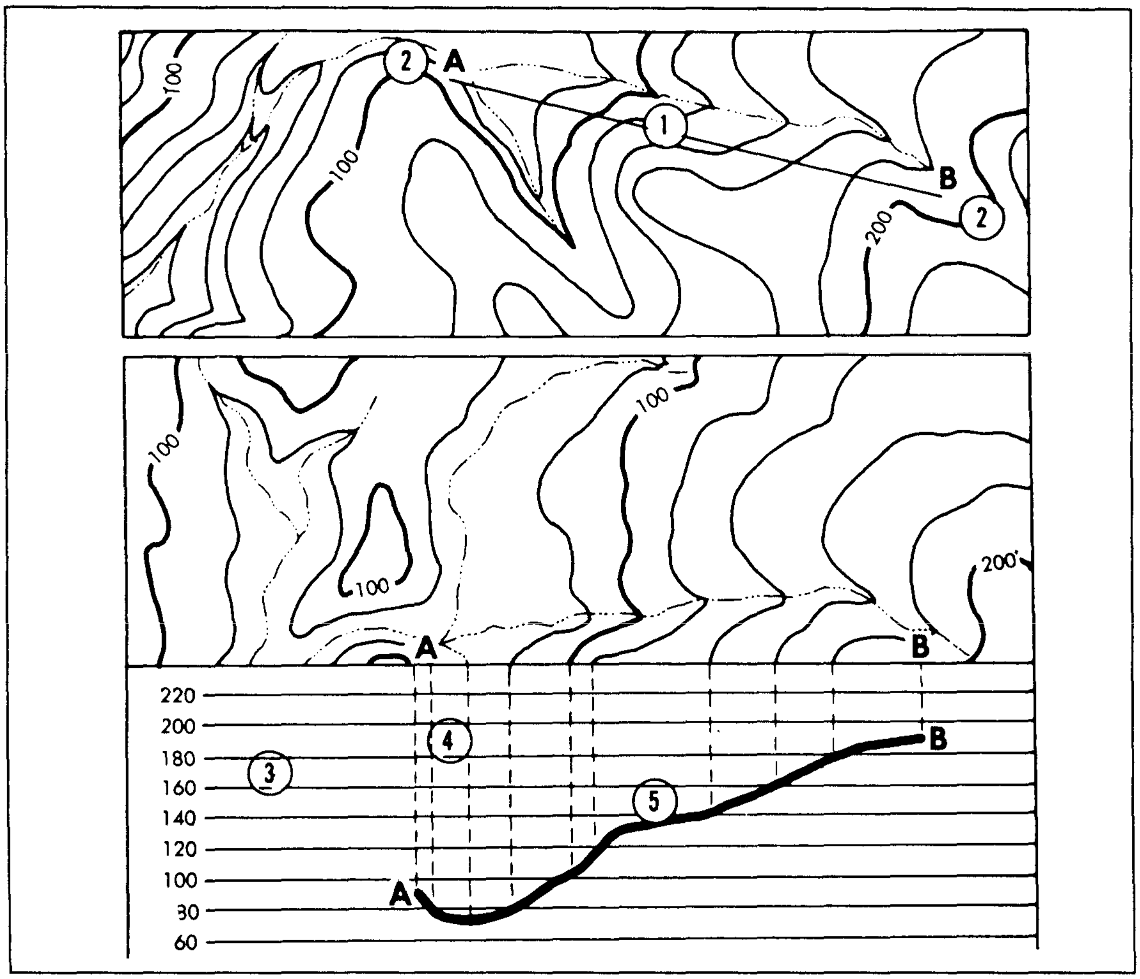


Figure 7-1. Topographic map example

Step 3. Increase the value of the highest contour line. This will become the upper-line measurement on the numbered profile lines. Start by looking at the map and identifying the highest contour line that either crosses or touches the profile line you have just drawn. Next, look at the bottom of your map and identify the contour interval; for example, it may say "contour interval 20 meters." Increase the highest contour line by the contour interval. For example:

Highest contour line = 200 meters
Contour interval = 20 meters
200 + 20 = 220 meters

Step 4. Decrease the value of the lowest contour line that touches or crosses the profile line. This will become the lowest line measurement on the numbered profile lines. Again, use the contour interval from the map. Decrease the lowest contour line by the contour interval. For example:

Lowest contour line = 80 meters
Contour interval = 20 meters
80 - 20 = 60 meters

Step 5. Prepare a profile. A profile is a side view of terrain along a line between two points. On a blank sheet of paper, draw a straight line the same length as the profile line paper. Each line represents a contour value line that crosses or touches the parallel line. The highest elevation is at the top, the lowest is at the bottom. Draw two additional lines at the top and bottom so that one line is above the highest elevation and the other is below the lowest elevation. Number all lines to the right or left in sequence, with the highest value at the top. The dotted lines at 220 and 60 are the two added lines.

Next, place your lined sheet of paper against the profile line on the map. Extend dotted, vertical (perpendicular) lines from every point on the profile line to the corresponding value line. Place a tick mark where each perpendicular line crosses the profile line. This will ensure the contour value for each profile below a map. Look at the perpendicular extensions from the contour lines to the corresponding value line.

Step 6. Interpolate hill and valley lines. Interpolation is a method of determining the highest elevation of a hill and the lowest point of a valley. Since they are either higher or lower than the known elevations, determine them separately. On the profile, insert the interpolated lines between the other contour-value lines.

To estimate the height of a hill using the interpolation method, add half the contour interval to the known elevation. For example:

Known elevation = 200 meters
Contour interval = 20 meters
1/2 Contour interval = 10 meters
200 + 10 = 210 meters
Interpolated value = 210 meters

To estimate the bottom of a valley using the interpolation method, subtract half the contour interval from the known elevation. For example:

Known elevation = 80 meters
Contour interval = 20 meters
1/2 Contour interval = 10 meters
80 - 10 = 70 meters
Interpolated value = 70 meters

Step 7. Draw interpolated perpendicular lines extending to the corresponding value lines. Notice how close they are to the highest and lowest elevation lines.

Step 8. Draw a dark line connecting the perpendicular lines. Smooth, natural lines represent hills and valleys. V- or U-shaped lines represent streams. Figure 7-1 illustrates a completed profile.

Aerial Photography Method

Step 1. Orient the aerial photos for stereo viewing. Ensure that shadows of features such as bridges, riverbanks, and low buildings appear to fall toward you, the viewer.

Step 2. Locate the PDG coordinates on each photo. PDG coordinates provide a means of locating (plotting) points that represent features, targets, and positions on an aerial photograph. Look in your mission directive to identify the PDG coordinates of two points for each photograph. Place a grid over each photo, beginning with the left one, and locate the grid square containing the point you will plot. Using the standard "read right and up," plot each point according to its PDG coordinates. Use the standard map scale of 1:25,000, so you can use a map protractor for plotting. Plot the points in order of the first point on the left photo, first point on the right photo, second point on the left photo, and second point on the right photo. Finally, enter the coordinates in the marginal information area on each photo.

Step 3. Pinprick the points on the photos, in the same order as in step 2.

Step 4. Draw a connecting line between the points you have pin pricked and connect points 1 and 3 on the left photograph. Next, connect points 2 and 4 on the right photo. At this time, take a moment to cheek your work to make sure it is accurate. The points you have plotted must correspond to the location in the mission directive.

Step 5. Place the stereoscope over the aerial photographs, with the left lens placed over the left photo and the right lens over the right photo. Look through the stereoscope and adjust the photographs slightly so you will get the best possible stereo images. Features will appear to be three-dimensional if you have obtained stereovision.

Step 6. Determine intervisibility. After positioning the stereoscope over the photos, look through your stereoscope. The two lines will fuse into one line. If it appears to float above the ground, you have determined intervisibility. If the line appears to cut through the ground, you have not. By determining intervisibility between two points, you have also determined LOS between them.

ZONE OF ENTRY

Categories

A zone of entry (ZOE) is any area in which forces, supplies, or equipment can be placed within reach of an objective area. In most situations, it may also be a zone of exit. Be prepared to show good exit zones from each ZOE, as exit zones play a key role in the selection of ZOEs. Types of ZOEs are existing airfields, air landing zones (ALZs), helicopter landing zones (HLZs), paratroop/resupply drop zones (RDZs), ports, and amphibious landing beaches.

The three considerations of ZOEs are customers, terrain, and climate. Customer consideration includes unit type and size, movement plans, and equipment type, size, and loads. Terrain consideration includes vegetation, slope, surface materials, obstacles, and surface drainage. Climatic considerations include temperature, air density, air pressure, wind, speed, and visibility. See Figure 7-2 for potential obstacles.

Airfields

POTENTIAL OBSTACLES FOR ENTRY ZONES		
Ditches	Tree stumps	Cuts and fills
Embankments	Stone walls	Hedge rows
Large rocks	Bushes	Scattered trees
Boulders	Buildings	Barbed wire fences
Wood fences	Minefields	Cemeteries
Quarries	Levees	Karst topography
Ruins	Towers	Overhead power lines
Rice paddy dikes		Overhead telephone lines

Figure 7-2. Potential obstacles for entry zones

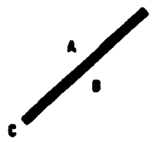
Description

You can select existing airfields as potential ZOEs if they meet the minimum size requirement dependent on the type of aircraft to be used. The easiest way to show an existing airfield on a ZOE overlay is to use the same symbol that is used on the transportation overlay, so the customer will know the runway length, width, orientation, and pavement status.

Criteria

Airfields should accommodate the maximum size aircraft, have airfield facilities, and be in correct orientation to the map scale. See Chapter 2 for information concerning the elements of an airfield. See Figures 7-3, 7-4, 7-5.

AIRFIELDS



Line denotes orientation
A.—Length in meters
B.—Width in meters
C.—P = Paved, U = Unpaved
Operational unless labeled

Figure 7-3. Airfield data

Aircraft	Overall dimensions (ft)			Weight (1000 lbs)		Takeoff (ft)*	
	Length	Width	Height	Basic	Maximum takeoff	Ground run	To clear 50 ft
OV-1B	41.7	48.0	13.0	10.98	15.79	1410	2185
OV-1C	41.0	42.0	13.0	10.01	14.82	1440	2230
OV-1D	41.3	48.0	12.7	15.50	17.50	1650	2280
U-8D	31.5	45.3	11.6	4.99	7.30	1455	2400
U-8F	33.3	45.9	14.2	5.49	7.70	1065	1660
U-21A	35.8	45.9	14.2	5.38	9.50	1500	2000
C12A	43.9	54.5	15.4	12.50	17.30	2200	
C12C/D	43.9	54.5	15.4	12.50	16.90	2200	

*At sea level, 59° F, no wind, hard surface

Figure 7-4. Characteristics of fixed wing Army aircraft

Airfield Type	Runway Length ft	Runway Width ft	Runway Shoulder Width ft	Total Aircraft Traffic Area* 1,000 sq ft
Battle Area				
Light Lift and Medium Lift	2,000	60	10	223
Forward Area				
Liaison	1,000	50	NA	37.5
Surveillance	2,500	60	10	337
Light Lift and Medium Lift	2,500	60	10	358
Support Area				
Liaison	1,000	50	NA	50
Surveillance	3,000	60	10	490
Light Lift and Medium Lift	3,500	60	10	753.5
Heavy Lift	6,000	100	10	1,421
Tactical	5,000	60	4	1,071
Rear Area				
Army	3,000	72	10	882
Medium Lift	6,000	72	10	2,362
Heavy Lift	10,000	156	10	3,926
Tactical	8,000	108	20	1,989

*This area includes parking, runway, taxiway, and warm-up apron

Fiure 7-5. Minimum airfield requirements

Air Landing Zones

Description

ALZs are entry zones used by fixed-wing aircraft to access objective areas. They can include beaches, dry lake beds, sections of highway, and other areas that meet the criteria. Areas are classified as hasty or deliberate based on the anticipated type of missions or load requirements in a given area within the theater of operations. Hasty ALZs are unimproved surfaces good only for marginal weather operations and are unusable during prolonged periods of poor weather. Deliberate ALZs have all-weather capability and are usually permanent installations with control towers, runways, and taxiways. Deliberate classifications meet existing airfield criteria.

Figure 7-6 shows symbols for ALZ criteria. See TM 5-330 and FM 100-27 for specific information.

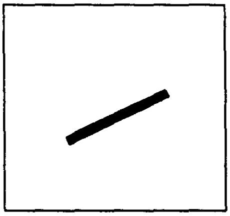


Figure 7-6. Air landing zone symbol

Criteria

- Undissected
- % Slope - per 100-foot horizontal distance
- No obstructions within glide angle of ALZ
- Oriented with prevailing winds
- Suitable Surface Materials and Surface Roughness

Procedures

Refer to FM 5-330 to determine proper values, then use the following formula to compute ALZ length:

ALZ Length = TGR + ALT Cor + Temp Cor x SF + Slope Cor

Round Up.

Note: Round up the final ground run length to the next highest 100 foot value.

Example. ALZ length of 3,120 feet is rounded up to 3,200 feet.

Where:

TGR = Takeoff ground run at mean sea level and 59°F.
ALT Cor = Pressure altitude correction.

Add the dh value of entry zone based on FM 5-330 to the altitude of the entry zone, then increase the TGR by 10 percent for each 1,000-foot increase in altitude.

Temp Cor =Temperature correction. If the corrected ground run obtained in the previous computation is 5,000 feet or greater, increase the ground run by 7 percent for each increase in temperature above 59°F; if less than 5,000 feet, increase by 4 percent per 10° above 59°F. If the temperature is less than 59°F, no correction is required.

SF =Safety factor, Multiply the corrected ground run obtained in the previous computation by 1.5 for rear- area ALZs and 1.25 for support, forward, and battle area airfields.

Cor =Effective gradient correction. Increase the corrected ground run obtained in the previous computation by 8 percent for each 1 percent of effective gradient over 2 percent.

Round up =Round the final ground run length up to the next larger 100 feet.

Compare the final ALZ length and width to the minimum runway length and width shown in TM 5-330 and use the larger of the two lengths and widths.

Helicopter Landing Zones (HLZs)

HLZs are entry zones in which helicopters access an objective area. They are terrain and climate dependent. Even under the best weather conditions, using a vertical approach and departure, the helicopter requires flat and obstacle-free open areas and a surface material that will support the heavy loads of the aircraft. The load factor, elevation, and air temperature determine whether the helicopter can take off and land vertically. Helicopter approach and departure angles that are not vertical require longer distances to clear obstacles surrounding the edges of the entry zone.

Criteria
- Undissected
- Less than 15 percent slope (See FM 90-4)
- Minimum size should be based on METT-T (20 - 75m guide, minimum distance for a single helicopter)
- No vertical or ground obstructions greater than or equal to 18 inches
- 10:1 obstacle clearance ratio
- No dust, debris, or loose snow near LOC
- Stable soils

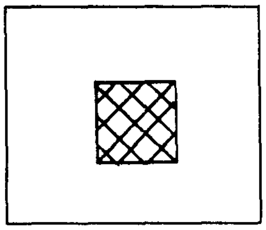


Figure 7-7. Helicopter landing

Use the following formula to compute the size of the HLZ during daylight:

$$LS = \frac{2\,(RTZ + HO)}{\tan DA}$$

Where: LS = diameter of helicopter site
2 = safety factor
RTZ = radius of touch zone
HO = height of obstacle
DA = tangent of departure or approach angle in degrees, whichever is smaller

Compare the final HLZ length and width to the minimum length and width shown in FM 5-35. See Figures 7-8 and 7-9.

Use the following formula during hours of darkness:
LS (Daylight) x 1.43 = LS (Darkness)

Helicopter	Overall dimensions (ft)			Weight (1000 lbs)		Takeoff (ft)*	
	Length	Width	Height	Basic	Takeoff	Ground run	To clear 50 ft
OH-6A	30.30	26.30	8.20	1.16	2.70	0	0
OH-58A	41.00	6.60	9.65	2.76	3.00	0	0
OH-58C	42.00	6.60	9.40	2.92	3.20	0	0
UH-1D	57.01	48.00	17.16	4.92	9.50	0	0
CH 47	99.00	59.16	18.70	23.00	33.00	0	0
CH 54	88.41	72.00	25.33	19.82	42.00	0	0
AH-1	52.97	44.00	11.00			0	0

*At sea level, 59° F, no wind, hard surface

Figure 7-8. Characteristics of Army helicopters

Where: LS (Daylight)= Diameter of landing site during daylight
1.43 = Safety factor for darkness
LS (Darkness)= Diameter of landing site during darkness

Drop Zones (DZs)

Helipad or Heliport Type	Landing pad Length ft	Landing pad Width ft	Landing pad Shoulder Width ft	Taxi/Hover Lane [1] Width ft	Runway [2] Length ft	Runway [2] Width ft	Runway [2] Shoulder Width ft
Forward Area							
OH-6A	12	12	NA	75	NA	NA	NA
UH-1H	20	20	NA	140	NA	NA	NA
CH-47	50	25	NA	180	NA	NA	NA
CH-54	50	50	NA	200	NA	NA	NA
Support Area							
OH-6A	12	12	10	100	NA	NA	NA
UH-1H	20	20	10	200	NA	NA	NA
CH-47	50	25	10	240	450	25	10
CH-54	50	50	10	250	450	50	10
Rear Area							
OH-6A	25	25	25	100	NA	NA	NA
UH-1H	40	40	25	200	NA	NA	NA
CH-47	100	50	25	240	450	40	25
CH-54	100	100	25	250	450	60	25

[1] Taxi/hover lane is used for takeoff and landing where provided; length is variable
[2] Where runway in not shown, takeoff and landing are on taxi/hover lane

Figure 7-9. Minimum helipad and heliport requirements

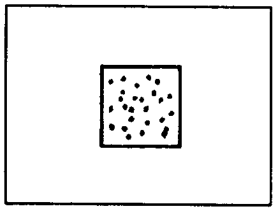


Figure 7-10. Drop zone symbol

DZs are entry zones in which troops or materials are delivered by parachute within a close proximity of an objective area. They are sometimes called resupply drop zones, when supplies are delivered to troops.

Criteria

- Undissected
- Less than 10 percent slope is preferred, 30 percent is allowable for supply drops
- Within 30km of a key city
- DZ near LOC
- No instructions within 1km
- Must have routes of entry or exit
- DZ has accessible cover and concealment
- Minimum width and length is dependent on the type, formation and speed of the aircraft, surface winds, the number of personnel or type of cargo being dropped, and visibility.
- For more information see FM 100-27.

Ports

Description

Ports may be used as entry zones when ships deliver troops and equipment close to the objective area. The selection of a port as an entry zone is based on geographic loceation, climatic conditions, and existing port facilities. Considerations include basin protection, bottom condition, shore area, communications, and water depth.

PORT CATEGORIES			
Category	Vessel	Water depth	Other
Deep draft*	Naval	10 meters	
	Container	10-15 meters	
	Bulk carrier	12-18 meters	
	Tankers	10-28 meters	
Shallow draft**	Lash	2 meters	2 meters
	Seabee	3.4 meters	31 meters
	Barge	38 meters	38 meters
*Each vessel hatch requires 30 meters of wharf space, with the wharf at least 30 meters wide.			
** The wharf length must be 12 meters.			

Figure 7-11. Port categories

Port categories are deep draft, which includes ocean-going vessels, and shallow draft, which includes lighters, barges, and landing craft. See Figure 7-11.

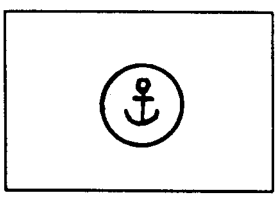


Figure 7-12. Port symbol

Criteria

- Water depth greater than 2 meters
- Minimum length 30 meters per hatch
- Exit route to Main Supply Route (MSR)
- Near LOC
- Near facilities

DMA Pub 150 lists ports worldwide. See also FM 5-35.

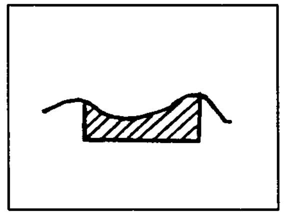


Figure 7-13. Landing beach symbol

Amphibious Landing Beaches

Amphibious landing beaches are entry zones in which troops and equipment are involved in a transition from seaborne to a land attack force within a close proximity to the objective area. The criteria used for determining the location of an amphibious landing zone is based on geographic and climatic conditions at the entry zone. However, due to the transition from sea to land, the geographic conditions are divided into two areas: conditions of the terrain at the entry zone and hydrographic conditions at the entry zones. Additional considerations include weather, extent, depth, and bottom of the sea area, beach approach, beach gradient, and hinterland (depth, concealment and transportation net).

Criteria

- Underwater gradient 30:1
- Lack of underwater obstacles
- Firm bottom
- Trafficable soils exit
- Tide information
- Open, straight-shot of beach -no enemy salients

SYNTHESIS PROCEDURES

Step 1. Review requirements to determine the type and criteria of the ZOE for the projected area.

Step 2. Obtain source material, including base topographic map, aerial photography, and the vegetation, surface configuration, surface materials, obstacles, surface drainage, and transportation factor overlays.

Step 3. From the vegetation-factor overlay, extinct the following No-Go area:

- All built-up areas
- Vegetation categories A2, A3, Bl, B2, C1-C4, D1-D4, E1-E4, F, I, J, K, L, M
- Agriculture (A1) that includes bamboo, rice fields, and vineyards.

Step 4. From the surface-configuration-factor overlay extract the following No-Go areas:

- Any slope greater than 2 percent for ALZs
- Any slope greater than 15 percent for HLZs
- Any slope greater than 30 percent for DZs

Step 5. From the surface-materials-factor overlay extract the following nonacceptable soil types:

- Permanent snowfields
- Peat bogs

- Rock outcrops
- Permanent wet soils
- Surface roughness with a category of 3 or 4

Soil is probably not as important a factor as vegetation or slope. However, powdery, dry soil in arid climates must be considered an impediment to helicopter landing because of the reduced visibility, possible clogging of engine intakes, and revealed helicopter location due to generation of dust plume. Very wet or mucky soil may cause the helicopter wheels to settle into the soil to such an extent as to prevent the accomplishment of the mission. Thus, soil conditions can be dangerous to a helicopter and should always be considered when selecting a landing zone site.

Surface roughness affecting helicopter landing can include rocks, ridges, domes, and sandbars. Skilled terrain analysts must determine surface roughness, visualizing the landform and making decisions concerning surface irregularities. For example, some landforms of glacial origin commonly contain potential obstacles such as boulders that are not mapped topographically and may be too small to be seen on some aerial photography.

Step 6. From the obstacle-factor overlay, extract all obstacles that are within the project area.

The two types of obstacles associated with helicopter landing zone sites are vertical obstacles, which affect helicopter approach to and departure from a landing site, and ground obstacles within the landing site such as rocks, stumps, and holes. Approach and departure obstacles include power lines, transmission towers, and chimneys. These obstacles appear on standard 1:50,000-scale topographic maps from which you can compile a factor overlay. Obstacles within the landing site may not be detected easily. You must rely on ground reconnaissance, low-altitude photography, or local geographic literature.

Step 7. From the transportation-factor overlay, extract all existing airfields that meet the criteria for ZOEs.

Step 8. Evaluate all open areas and select the ZOEs needed for the projected area. If available, evaluate the areas against the CCMs and LOCs of the area.

The criteria for minimum-size requirements depends on a number of factors, including the type and number of aircraft, supplies, or troops to land in the ZOE, temperature, wind, altitude, and geographic location. Therefore, use the criteria listed for minimum areas as a guide and revise it as needed.