

Displacement Height

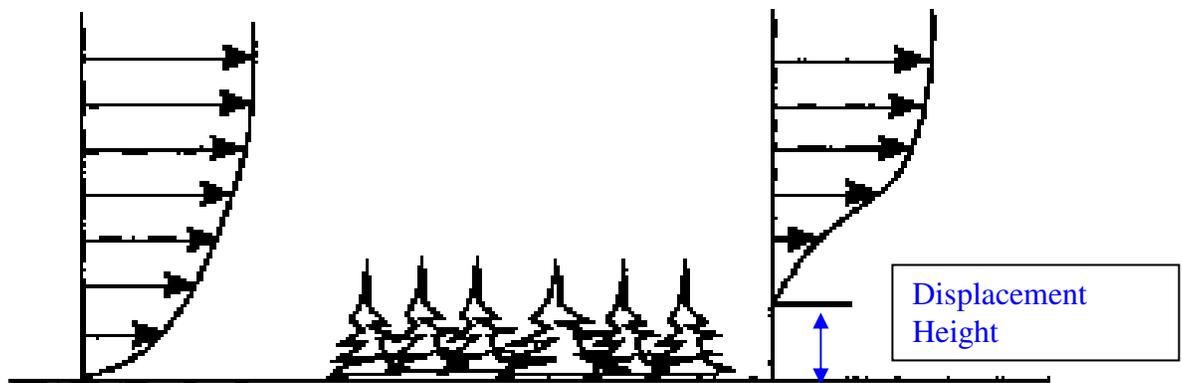
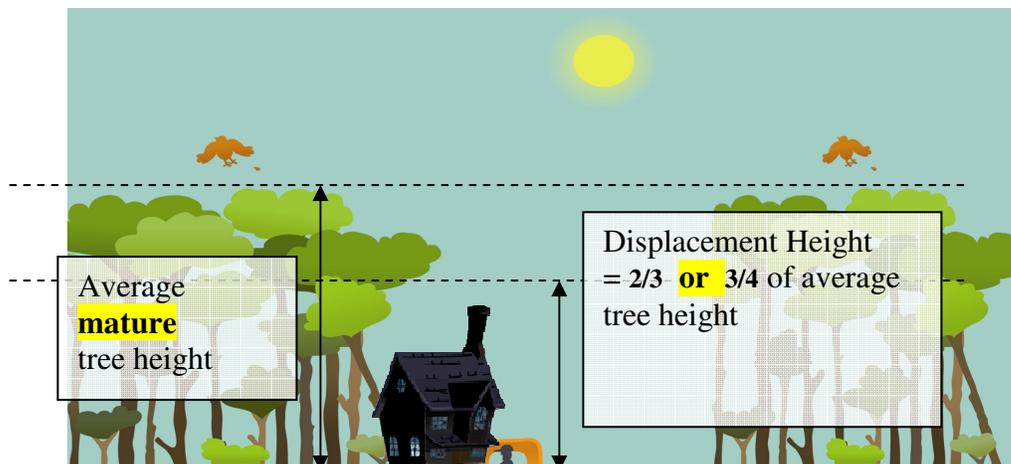
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Wind maps do not take into consideration dense groves of trees¹ upwind or clusters of buildings that are not common on the landscape, so we have to make adjustments to the wind speed accordingly.

In a situation like the one pictured below where the site is surrounded by dense trees or if there is a grove of trees upwind of the site, the wind speed calculation must be modified to account for these obstacles. This is done by adjusting the tower height by an amount known as the “displacement height” resulting in a new “effective tower height” to be used in the wind speed calculations. The displacement height accounts for the trees (or buildings in a suburban or residential urban area), by raising the effective ground level and the wind profile.

When to use Displacement Height?

- 1) If the trees in a prevailing wind direction have a depth of 50’ or more (making them a “grove”) AND
- 2) If the grove of trees is closer than 10x the average mature height of the trees in the grove. For a 50’ average height, the grove must be at least 500’ away to negate its effect.



Wind Profile raised by an amount = Displacement Height

¹ A Grove of trees is defined for our purposes as a collection of trees with a depth of 50’ or more; not a tree line of a single row of trees.

Calculating Displacement Height

Tree Displacement Height = $2/3 \times$ Prevailing Mature Tree Height for **Deciduous** trees
or
= $3/4 \times$ Prevailing Mature Tree Height for **Evergreen** Trees

Residential Displacement Height = Height half way between the eaves and the peaks of the houses (if trees are not causing displacement)

Industrial Displacement Height = Prevailing Height of Flat Roofed Buildings
(if trees are not causing displacement)

Prominent Hill Displacement Height = Difference in elevation of base of tower to top of hill.
You only need to use this if the hill is not picked up by the wind maps 200m x 200m grid accuracy. (You will be able to see this by looking at the Arcreader at a scale of 1:24,000)

Example

If the average mature deciduous tree height 200' away is 60' then the displacement height is equal to $2/3$ s of this or 40'. If the average mature evergreen tree height 200' away is 60', then the displacement height is equal to $3/4$ ths of this or 45'. For mixed tree groves, use the more conservative $3/4$ ths height.

Adjusted Wind Speed

The effective wind map height now becomes:

Effective Wind Map Height = 60m + Displacement Height (in meters)

1 foot = 0.304 meters

Using the Seventh Wind Performance Calculator, the wind speed and output of the turbine at 120' is determined by using the effective wind map height = (60m + DH in meters) as the wind map height input. The tower height input is the actual tower height.

Example

If a grove of deciduous trees 200' away at a given site is an average of 60' tall (so DH = 40' = 12m), then the wind speed at 120' will be calculated by using [60m + 12m (40') = 72m] as the input for Wind Map Height in the Performance Calculator, so that it will extrapolate the wind speed at hub height down from a wind map height = [60m + DH] instead of from 60m.

Note that the turbulence intensity should be set to 20% over groves of trees, and to 25% for urban and dense suburban locations.

More than 1 Prevailing Wind Direction

Also take a look at the wind rose. If the wind is coming from an open direction 60% of the time and from a densely obstructed direction 40%, then, to get the estimated annual output, use the output calculator taking into account the displacement height to compute 40% of the output and use the actual wind map height of 60m to compute 60% of the output.

Annual Output = (.4 x (Output using [60m + Displacement Height])) + (.6 x (Output using 60m))