Physiology of the Eye

Field of View - Vertical Plane

The field of view in the vertical plane is typically measured from an eye height of five feet (5'-0") (Smardon et al. 1986).

The normal sight line depicts the field of view without movement of the eye or head from a fixed position or object. This field of view has been measured at a range from 10 degrees to 15 degrees from the horizon sight line, as shown in Figure 1. This gives an overall normal sight line field of view of 20 to 30 degrees in the vertical plane (Dines and Harris 1998, Nelson and English 2008).

Easy eye movement depicts a field of view measured with no head movement and maximum vertical movement of the eye, without loss of focus on the object. On average for humans, this field of view is a total of 60 degrees or 30 degrees above or below the horizon sight line, as shown in Figure 1 (Smardon et al. 1986).

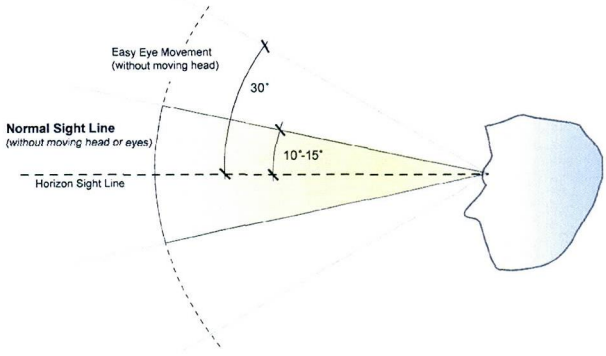


Figure 1- Diagram illustrating the typical field of view of a human without movement of the head or eyes.

Field of View - Horizontal Plane

For evolutionary reasons, the extreme perimeter of human vision is really only for sensing motion and large-scale objects (e.g., the lion suddenly approaching you from the side).

The central angle of view is approximately 40-60 degrees directly in front of the eyes and is what most influences human perception of a scene, as shown in Figure 2. Subjectively, this would roughly correspond with the angle over which a viewer could recall objects from a scene if he/she had kept their eyes in the same position (Forum 2008).

A 35 mm camera equipped with a 50 mm lens takes a +/- 45 degree field of view in the horizontal plane and best represents and records the central angle within the normal human field of view (Nikon 2008).

Figure 2 illustrates the typical field of view that wide angle, normal, and telephoto lenses capture. The field of view captured by the 50 mm lens is 45 degrees and has the closest relationship to the central angle of the human field of view, without distortion of the object's scale in the captured scene (Smardon et al. 1986).

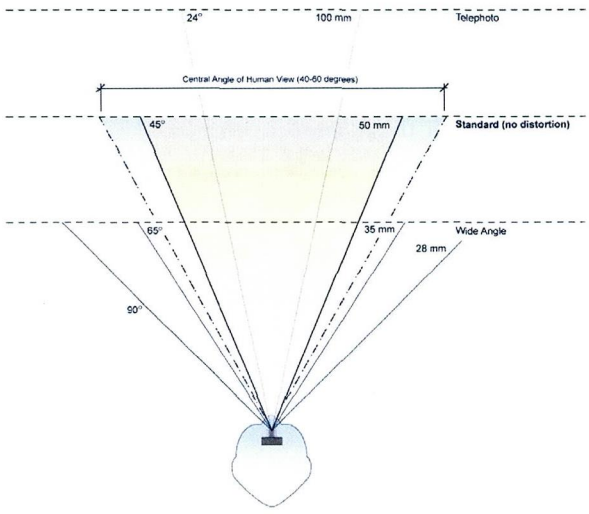


Figure 2- Diagram illustrating a comparison to the central angle in the human field of view in the horizontal plane with a 35 mm camera and various lenses (Smardon et al. 1986, Forum 2008).

Definition of Looming

Looming: 1. "to come into view as a massive, indistinct, or distorted image."
2. "to appear in the mind in an exaggerated and hostile form."
3. "to seem imminent."
- Webster's II New Riverside Dictionary 1998

Visual Looming: "the expansion of the projection size of an object on the retina, is usually the indication of an approaching object. It is normally perceived as a threat for a possible collision and is known to elicit reactive behaviors in animals." *-Caviness 1962*

Looming in Architecture and Urban Design

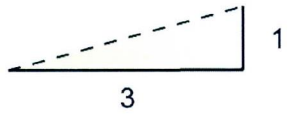
In the 1400s, Alberti noted "A proper height for a building around a square is one-third of the breadth of the open area," to avoid the sense that a building is too high or out of scale with it's surroundings (Alberti-Translation 1965).

In 1570, Palladio similarly concluded "...none of the buildings built around the square may be taller than a third of the breadth of the square nor less than a sixth; one should go up to the porticoes by steps which should be made as high as a fifth of the column height," as shown in Figure 3 (Palladio-Translation 1997).

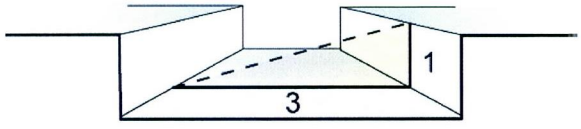
In 1953, Hans Blumenfeld cited the work of H. Maertens –who related the mathematics for the measurement of optics to architectural scale and building design. Blumenfeld explained Maertens' work as follows:

> *the maximum angle at which an object can be perceived clearly and easily, is about 27 degrees, corresponding to a ratio of 1:2 between the size of the object and its distance from the beholder....At an angle of 27 degrees...the object appears...'as a little world in itself' with the surroundings only dimly perceived as a background; at an angle of 18 degrees (1:3) it still dominates the picture, but now its relation to its surroundings becomes equally important. At angles of 12 degrees (1:4) or less, the object becomes part of its surroundings and speaks mainly through its silhouette*
> (Blumenfeld, 1953, as cited in Yang and Putra 2005)

More recently, Speiregen (1965), Lynch (1962), and Ashihara (1983) have all concluded the same height to open space ratios in the correlation of similar optics and perceptual scale studies. Their conclusions on sense of enclosure are summarized in Figure 4 (Yang and Putra 2005).



Architectural Ratio - Comfortable Enclosure

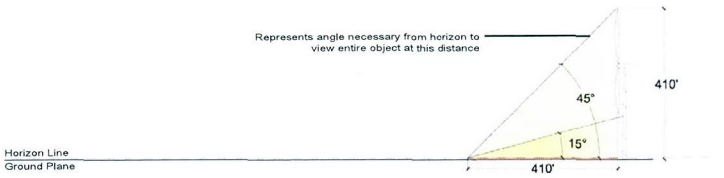


Ratio Applied to Urban Corridor / Plaza

Figure 3 - Architectural ratio of building height to open area for harmonious relationship and human scale.

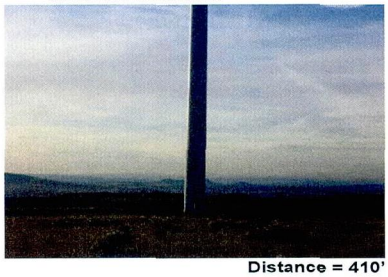
vertical angle	h/d ratio	Spreiregen, 1965	Lynch, 1962	Ashihara, 1983
45	1:1	full enclosure	full enclosure	balance of enclosure
27	2:1	threshold of enclosure	comfortable enclosure	expansive enclosure
18	3:1	minimum enclosure	comfortable enclosure	comfortable enclosure
12	4:1	'loses' its enclosure	enclosure ceases	enclosure ceases

Figure 4 - Architectural studies on the perception of enclosure as compared to vertical angles of enclosure and building height to distance on the horizontal plane (Yang and Putra 2005).

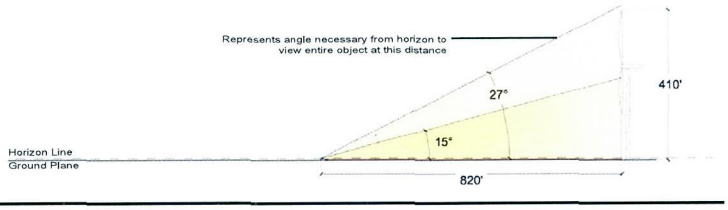


1:1 Ratio Study — Scale: 1"=100'-0"

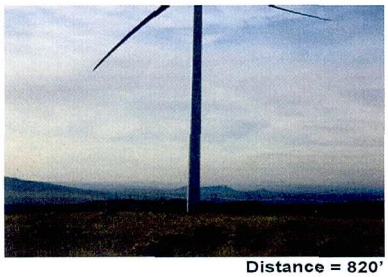
Note: This frame represents approximately what the eye sees without *moving the head or eye; viewing angle is shown at 15 degrees* above and below the horizon line.



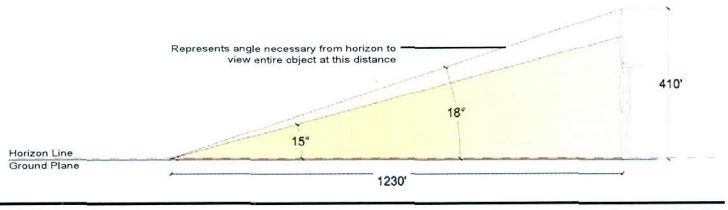
Distance = 410'



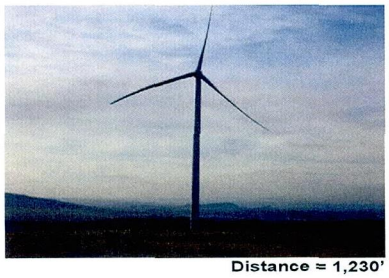
2:1 Ratio Study — Scale: 1"=100'-0"



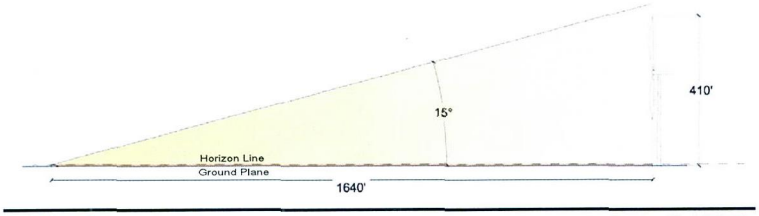
Distance = 820'



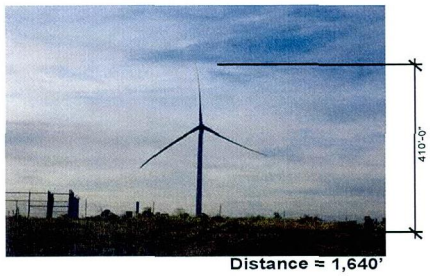
3:1 Ratio Study — Scale: 1"=100'-0"



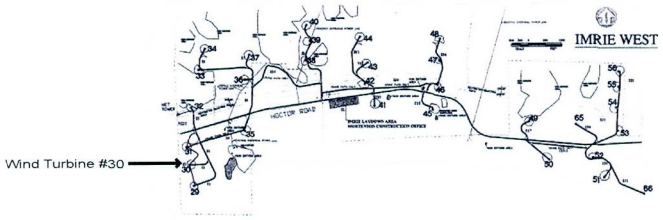
Distance = 1,230'



4:1 Ratio Study — Scale: 1"=100'-0"



Distance = 1,640'



Goodnoe Hills Wind Power Project Study Area N.T.S.

- Turbine Visual Study - REPower Turbine Model MM-92
- Height of Turbine = 410' (top of full vertical blade to base of turbine)

Case Study Site Visit Date: November 24, 2008
- Materials used for Study:
  1. Magellan GPS Unit
  2. Nikon D70 DSLR with 50 mm lens
  3. Three-point tripod set at a 5'-0" representing viewing height

Conditions:
- Weather: Clear, Temperature 42°F
- Terrain: Ridge line with some elevation change

- Study Constants
  - 5'-0" human horizon line
  - Vertical field of view without eye or head movement = 10-15 degrees
  - Distance ratios based on height of turbine blade tip
  - Site Study Turbine #30

EXHIBIT 18.5: Relationship Between Distance & Field of View-Single Image

Case Study: Goodnoe Hills Wind Power Project, Washington

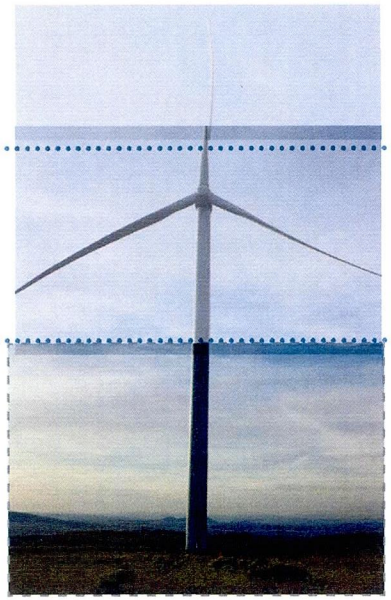
EDAW | AECOM

Date: May 4, 2009

Third 50 mm photo frame upper limit

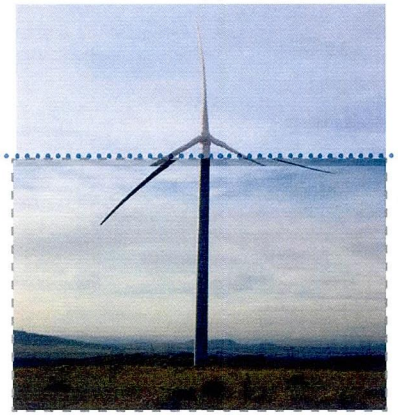
Second 50 mm photo frame upper limit

First 50 mm photo frame upper limit



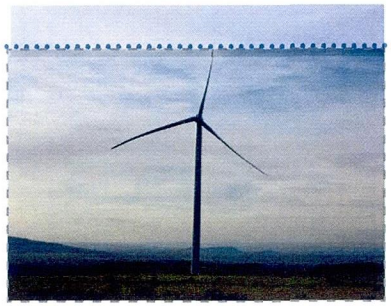
1:1

Base photo taken from **410 linear feet** with 50 mm lens on 5'-0" tripod base. It took approximately two and three quarters full 50 mm frames to complete the full view of the turbine from this distance.



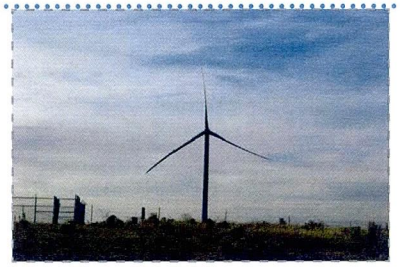
2:1

Base photo taken from **820 linear feet** with 50 mm lens on 5'-0" tripod base. It took approximately one and three quarters full 50 mm frames to complete the full view of the turbine from this distance.



3:1

Base photo taken from **1,230 linear feet** with 50 mm lens on 5'-0" tripod base. It took approximately one and one quarter full 50 mm frames to complete the full view of the turbine from this distance.



4:1

Base photo taken from **1,640 linear feet** with 50 mm lens on 5'-0" tripod base. It took less than one full 50 mm frame to complete the full view of the turbine from this distance.

EXHIBIT 18.6: Relationship Between Distance & Field of View - Multiple Images

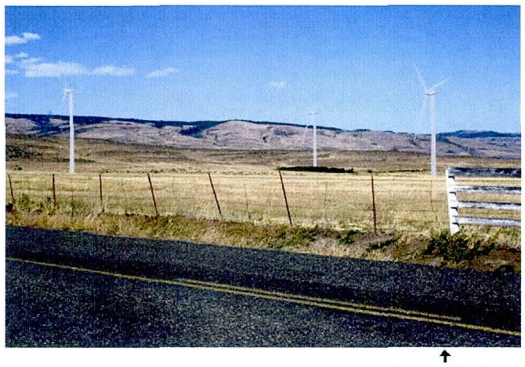
Case Study: Goodnoe Hills Wind Power Project, Washington

Date: May 4, 2009

FDAW | AECOM

BLAU
EXHIBIT 18.6

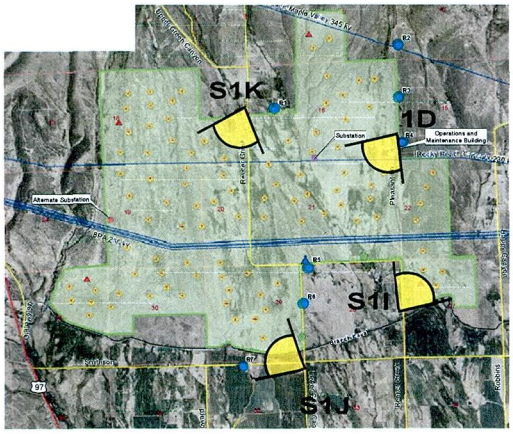
View 1D - 50 mm Simulation

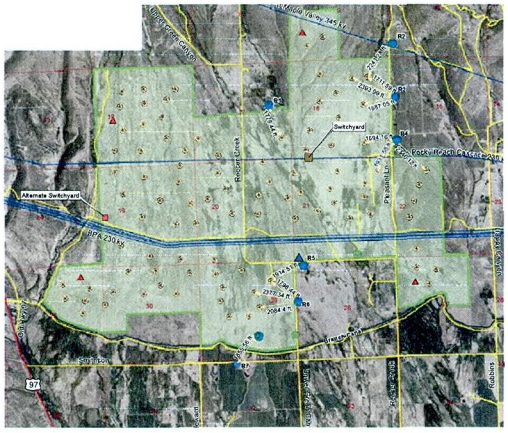


View S1I - 50 mm Simulation

View S1J - 50 mm Simulation

View S1K - 50 mm Simulation





Legend

Viewpoint and direction of view

Non-participating residence

Source: Desert Claim Wind Project, Supplemental EIS 2008

EXHIBIT 18.7: Select Viewpoints & Distance to Closest Residence

Desert Claim Wind Power Project Visual Simulations

EDAW | AECOM

Date: May 4, 2009