LANDSCAPE PERFORMANCE SERIES

Capitol Valley Ranch – Pitkin County, CO
Methodology for Landscape Performance Benefits
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Environmental

Reduces atmospheric carbon by more than 8.7 tons annually through 137 trees planted on the property, approximately the same amount of CO_2 released by burning 884 gallons of gasoline.

The research team counted all trees on site and measured their DBH (at 4.5 ft from ground). The research team then entered these measurements into the tree value calculator (http://www.treebenefits.com/calculator/).

The calculation tool estimated the amount of atmospheric carbon reduction from these trees. This total is 17,473 lb 17,473 lb / 2,000 lb/ton = 8.7365 tons.

The amount of carbon dioxide released by burning a gallon of gasoline was found here: http://www.epa.gov/cleanenergy/energy-resources/refs.html.

It is 0.00892 metric tons / gallon of gasoline.

0.00892 metric tons = 19.67 lb CO2 / gallon of gas. This is confirmed by the 19.64 lb CO_2 / gallon of gas reported here: http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11.

8.7 tons = 17,400 lb 17,400 / 19.67 = 884.60 gallons of gasoline.

Limitation
1) Some of the aspen trees have multiple trunks. There is no feature in the calculator to accommodate this so each trunk was treated as an individual tree.

Saves over an estimated 1,000,000 gallons of irrigation water and 400 lb of fertilizer annually by limiting lawn area to 5,440 sf, 7% of the total planted area on the entire 35-acre site.

The total area of native plantings was assessed from AutoCAD planting plans. Areas of lawn were assessed in the same way.

Total Area of Irrigated Lawn: 5,440 sf

Total Area of Native Plantings: 72,147 sf

(High Altitude Pasture Mix: 63,153 sf + Crested Wheat: 7,672 sf + Wildflower Sod: 1,322 sf = 72,147

sf)

Total Area: 77,587 sf

(72,147 sf + 5,440 sf = 77,587 sf)

Maintenance records were not available for this property. However, records for a similar property nearby in Pitkin County were available. That property uses 2 pounds of fertilizer per 1,000 square feet of lawn to be applied 3 times per year.

2 lb / 1,000 sf X 3 times per year = 6 lb / 1,000 sf per year

6 lb X 5.44 = 32.64 lb of fertilizer per year are needed on the existing lawn.

6 lb X 77.587 = 465.522 lb of fertilizer per year would be needed if all planted area was lawn.

32.64 / 465.22 = 0.07016 or about 7% of the amount of fertilizer is needed compared to a traditional lawn. This is a reduced consumption of 93%.

Saves 465.522 – 32.64 = 432.882 lb of fertilizer saved per year.

Maintenance records were not available for this property. However, records for a similar property nearby in Pitkin County were available. That property irrigates lawn with 1 inch of water per week during the 24 weeks of the maintenance (snow-free) season.

1 in of water per week X 24 weeks = 24 in of water per year = 2 ft per year

2 ft X 5,440 sf = 10,880 cu ft of water per year current condition

2 ft X 77,587 sf = 155,174 cu ft of water per year if entire area was irrigated lawn

10,880 / 155,174 = 0.0701 or about 7% of the amount of water is needed compared to a traditional lawn. This is a reduced consumption of 93%.

1 cu ft = 7.48 gallons

10,880 cu ft X 7.48 = 81,382.4 gallons

155,174 cu ft X 7.48 = 1,160,701.52 gallons

1,160,701.52 gallons – 81,382.4 gallons = 1,079,319.12 gallons of water saved per year.

Limitation
1) The irrigation regime used for these calculations follow the maintenance schedule of a nearby property that, while comparable, may not reflect the exact maintenance needs of this property.
2) The maintenance records used for the calculations come from a nearby property that, while comparable, may not reflect the exact maintenance needs of this property.
3) The fertilizer type is not specified in the records, so the exact contents (especially nitrogen content) is unknown.

Social

Provides pleasant outdoor spaces with 77% of outdoor recreational areas in the human comfort zone in the morning, 42% in the afternoon, and 48% in the evening during the summer. Landscape design techniques such as building orientation, thermal massing, and tree placement were used to modify the microclimates of the

outdoor spaces.

The landscape architect's design was directly based on the goal of creating comfortable outdoor spaces. This was achieved through a consideration of the natural environment present on the site and the relative placement of different elements in the landscape such as the home, patio, plantings, and hardscape. In addition, the materials used also affect the creation of comfortable microclimates. The flagstone of the hardscape, for example, acts as a thermal mass that collects heat when exposed to direct sun and then radiates it out when in the shade.   Sheltered courtyards are created on both the north and south sides of the house for use during different seasons and times of the day. For example, the north side is used during hot days and the south side is good for winter and evenings or mornings. There is a fireplace on each side (front and back) of the residence which also allows people to be comfortable outside on cooler days and evenings. These factors can be quantified through in-situ measurements compared against an established metric that defines the conditions conducive to human comfort.

Using the Human Comfort Zone developed by Victor Olgyay (1973), temperature, relative humidity, and wind velocity were measured on site three times (morning at 9:15 am, afternoon at 12:30 pm, and evening at 5:00 pm) on June 18, 2013 at sixty six points throughout the landscape. The measurement device used was a Kestrel 4000 Pocket Weather Tracker. Wind speed accuracy: ±3%. Temperature: ±1°C. Relative humidity accuracy: ±3%. (http://www.forestry-suppliers.com/product_pages/View_Catalog_Page.asp?mi=71381&title=Kestrel%AE+4000+Pocket+Weather%99+Tracker%99%3CBR%3ETakes+weather+monitoring+to+a+new+level%21)

Temperature was recorded once it stabilized; relative humidity was taken at that same time. Wind velocity represents the maximum reached while the temperature was stabilizing. Measurements were taken facing northeast, with the Kestrel device approximately eighteen in away from the body and not in the shadow of the operator.

Sampling points are seen below in Figure 1.

**Figure 1.** Sampling locations of bioclimatic study on June 18, 2013

Data gathered on site for each point is seen in Figure 2.

Location	Point	Evening time	Rh	Temp	comfort?	Afternoon time	Rh	Temp	comfort?	Morning time	Rh	Temp	comfort?
Agricultural Irrigation Ditch	1	5:06	19.5	84.9	hot & dry	12:35	20.0	81.9	hot	9:16	40.5	66.2	cold
Agricultural Irrigation Ditch	2	5:07	18.9	82.6	hot & dry	12:36	23.8	79.1	comfort	9:21	43.2	65.9	cold
Agricultural Irrigation Ditch	3	5:08	22.2	79.2	comfort	12:37	25.8	78.2	comfort	9:21	43.1	68.0	comfort
Agricultural Irrigation Ditch	4	5:09	21.5	79.9	comfort	12:38	24.6	77.1	comfort	9:22	41.1	70.6	comfort
Agricultural Irrigation Ditch	5	5:12	21.0	80.5	hot	12:39	24.1	76.9	comfort	9:23	37.0	72.0	comfort
Agricultural Irrigation Ditch	6	5:14	23.8	82.6	hot	12:40	22.9	78.6	comfort	9:25	39.5	69.4	comfort
Agricultural Irrigation Ditch	7	5:15	24.1	81.4	hot	12:41	19.6	79.5	dry	9:26	42.1	73.5	comfort
Agricultural Irrigation Ditch	8	5:16	23.5	77.7	comfort	12:42	20.6	81.0	hot	9:27	39.2	78.9	comfort
Agricultural Irrigation Ditch	9	5:17	23.7	78.6	comfort	12:43	19.6	75.2	dry	9:28	32.3	72.0	comfort
South Lawn	10	5:19	18.6	83.3	hot & dry	12:43	21.4	75.3	comfort	9:29	41.1	73.6	comfort
Sun Terrace	11	5:21	22.7	78.9	comfort	12:44	19.9	75.6	dry	9:29	37.2	72.6	comfort
Sun Terrace	12	5:21	23.7	79.2	comfort	12:45	18.5	78.4	dry	9:30	40.7	78.0	comfort
Sun Terrace	13	5:23	22.2	80.0	comfort	12:46	21.5	80.0	comfort	9:31	35.0	76.6	comfort
Sun Terrace	14	5:24	22.7	79.2	comfort	12:47	19.7	80.6	hot & dry	9:32	32.0	81.0	hot
Sun Terrace	15	5:25	22.7	81.4	hot	12:48	17.8	77.9	dry	9:34	29.8	76.8	comfort
Sun Terrace	16	5:26	21.1	79.1	comfort	12:49	21.4	79.6	comfort	9:36	34.4	75.3	comfort
Sun Terrace	17	5:28	23.1	76.7	comfort	12:50	20.6	77.9	comfort	9:39	35.7	71.9	comfort
Sun Terrace	18	5:29	24.7	76.8	comfort	12:51	23.0	78.1	comfort	9:43	35.0	75.8	comfort
South Lawn	19	5:30	21.2	76.6	comfort	12:52	18.3	78.1	dry	9:45	39.5	78.5	comfort
South Lawn	20	5:31	21.6	77.0	comfort	12:52	21.4	76.1	comfort	9:49	34.3	79.2	comfort
South Lawn	21	5:32	22.5	76.9	comfort	12:55	19.0	78.6	dry	9:51	37.4	79.1	comfort
South Lawn	22	5:33	25.0	77.6	comfort	12:56	19.3	71.1	dry	9:52	41.0	77.5	comfort
South Lawn	23	5:34	23.1	75.2	comfort	12:57	20.7	80.8	hot	9:53	38.3	80.6	hot
South Lawn	24	5:36	22.9	77.8	comfort	12:59	20.1	77.5	comfort	9:55	38.8	72.9	comfort
Swimming Lap Pool	25	5:38	21.6	82.2	hot	1:02	19.1	79.1	dry	9:57	38.0	77.9	comfort
Swimming Lap Pool	26	5:43	20.1	93.3	hot	1:03	17.8	82.8	hot & dry	9:58	38.4	77.9	comfort
Swimming Lap Pool	27	5:51	22.4	83.5	hot	1:05	20.4	77.1	comfort	9:59	31.5	80.1	hot
Swimming Lap Pool	28	5:52	23.0	78.2	comfort	1:07	16.8	78.1	dry	10:01	33.8	76.6	comfort
Swimming Lap Pool	29	5:53	20.9	79.1	comfort	1:08	23.0	79.2	comfort	10:02	35.2	74.8	comfort
Swimming Lap Pool	30	5:55	21.7	76.7	comfort	1:10	18.6	83.9	hot & dry	10:03	41.3	69.1	comfort
Sun Terrace	31	5:56	23.3	75.8	comfort	1:12	21.1	78.9	comfort	10:05	34.6	77.9	comfort
Sun Terrace	32	5:57	21.4	77.8	comfort	1:14	20.2	76.6	comfort	10:06	31.3	76.5	comfort
Swimming Lap Pool	33	5:58	19.7	77.0	dry	1:18	19.4	74.2	dry	10:07	35.9	69.7	comfort
Swimming Lap Pool	34	6:00	18.7	78.7	dry	1:19	22.8	74.9	comfort	10:08	35.7	74.3	comfort
Swimming Lap Pool	35	6:02	20.6	82.5	hot	1:20	22.8	75.7	comfort	10:09	38.2	76.0	comfort
Swimming Lap Pool	36	6:03	18.1	82.6	hot & dry	1:21	21.6	74.3	comfort	10:09	33.0	74.6	comfort
Swimming Lap Pool	37	6:04	20.5	82.5	hot	1:23	21.5	77.9	comfort	10:10	33.4	76.2	comfort

Location	#	Time	Temp	Hum	Condition	Time	Temp	Hum	Condition	Time	Temp	Hum	Condition
Solar Panel Array	38	6:06	17.6	88.5	hot & dry	1:24	21.9	81.9	hot	10:12	37.3	75.6	comfort
Solar Panel Array	39	6:08	19.4	83.9	hot & dry	1:25	20.1	80.8	hot	10:13	35.0	76.4	comfort
Solar Panel Array	40	6:09	25.4	78.5	comfort	1:27	18.4	74.1	dry	10:14	36.5	79.0	comfort
Solar Panel Array	41	6:10	22.5	77.6	comfort	1:33	21.5	77.9	comfort	10:15	36.5	78.8	comfort
Outdoor Living Room	42	6:12	25.1	79.6	comfort	1:34	26.2	80.2	hot	10:16	41.6	81.0	hot
Outdoor Living Room	43	6:13	22.0	79.8	comfort	1:36	18.8	82.2	hot & dry	10:17	33.7	80.2	hot
Outdoor Living Room	44	6:14	21.3	78.6	comfort	1:38	18.5	77.8	dry	10:18	33.5	81.8	hot
Outdoor Living Room	45	6:15	19.2	79.6	dry	1:40	21.3	84.9	hot	10:20	35.2	78.9	comfort
Outdoor Living Room	46	6:16	18.1	80.0	dry	1:42	19.5	81.7	hot & dry	10:20	35.2	79.4	comfort
Outdoor Living Room	47	6:17	19.4	79.6	dry	1:43	16.4	81.8	hot & dry	10:21	33.3	76.8	comfort
Raised Vegetable Garden	48	6:18	19.7	78.1	dry	1:44	15.0	80.5	hot & dry	10:22	32.5	75.5	comfort
Raised Vegetable Garden	49	6:20	18.3	79.6	dry	1:45	16.5	81.7	hot & dry	10:24	40.4	75.9	comfort
Raised Vegetable Garden	50	6:22	17.1	82.5	hot & dry	1:46	19.7	82.7	hot & dry	10:25	37.5	82.3	hot
Raised Vegetable Garden	51	6:23	20.3	80.7	hot	1:47	16.5	82.2	hot & dry	10:27	34.8	85.5	hot
North Trees and Berm	52	6:24	21.3	77.8	comfort	1:50	15.8	88.5	hot & dry	10:28	35.4	84.6	hot
North Trees and Berm	53	6:25	24.2	75.8	comfort	1:52	16.3	85.8	hot & dry	10:29	30.1	82.1	hot
North Trees and Berm	54	6:26	21.6	77.0	comfort	1:54	15.8	82.1	hot & dry	10:30	29.7	81.0	hot
North Trees and Berm	55	6:28	21.4	75.9	comfort	1:56	17.1	82.5	hot & dry	10:31	28.3	86.0	hot
North Trees and Berm	56	6:29	20.5	76.3	comfort	1:58	18.2	84.1	hot & dry	10:32	32.2	81.6	hot
North Trees and Berm	57	6:29	20.8	75.6	comfort	2:00	21.3	84.2	hot	10:33	35.1	79.6	comfort
North Trees and Berm	58	6:30	21.6	74.8	comfort	2:02	19.6	83.1	hot & dry	10:34	39.4	75.4	comfort
Gravel Entry Drive	59	6:31	20.3	75.3	comfort	2:03	21.1	83.5	hot	10:35	38.6	74.9	comfort
Gravel Entry Drive	60	6:33	18.9	75.8	dry	2:05	15.9	86.6	hot & dry	10:36	39.6	82.3	hot
Arrival Court	61	6:34	19.1	75.7	dry	2:06	15.7	84.5	hot & dry	10:38	31.5	80.8	hot
Arrival Court	62	6:35	19.7	75.1	dry	2:07	16.4	82.8	hot & dry	10:39	32.2	84.5	hot
Arrival Court	63	6:36	21.2	75.5	comfort	2:09	15.6	88.0	hot & dry	10:41	29.4	85.5	hot
Arrival Court	64	6:36	21.4	74.5	comfort	2:10	17.9	87.5	hot & dry	10:42	29.9	88.2	hot
Arrival Court	65	6:37	18.7	75.4	dry	2:12	16.9	83.3	hot & dry	10:44	27.6	86.2	hot
Arrival Court	66	6:39	17.0	77.7	dry	2:13	16.7	84.6	hot & dry	10:46	28.7	83.5	hot

Figure 2. Temperature and relative humidity data gathered at sampling locations in morning, afternoon, and evening.

The data were interpolated using the Kriging method in ArcMap10.1, the results of which are shown in Figures 3a-3i below. These images show general climatic trends across the site for wind velocity, relative humidity, and temperature for morning, afternoon, and evening on June 18, 2013.
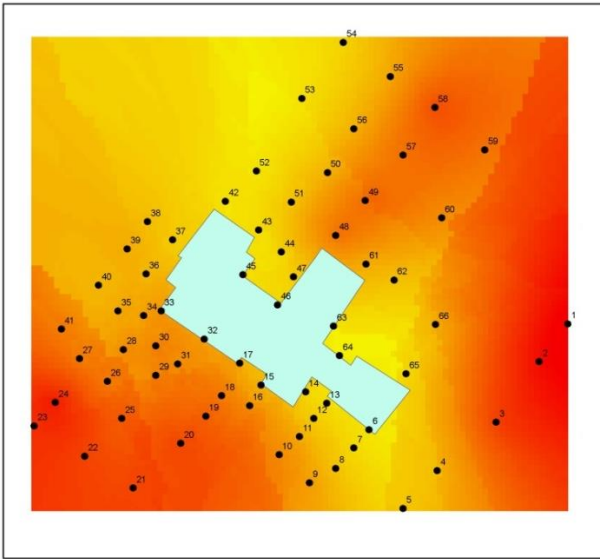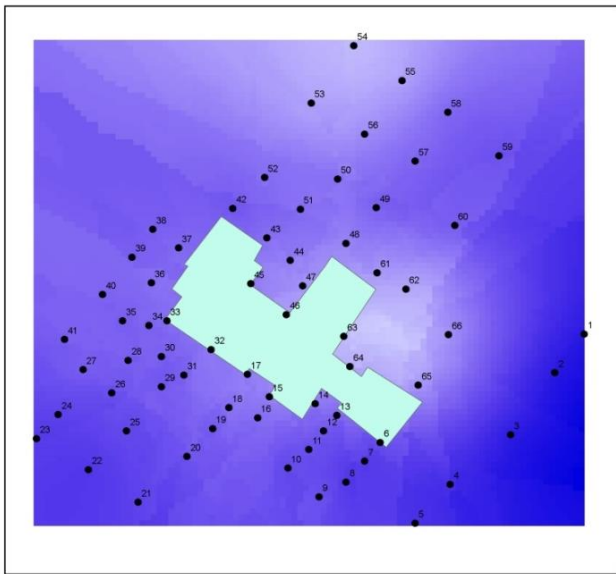
Figure 3a. Morning wind velocity

Figure 3b. Morning temperature

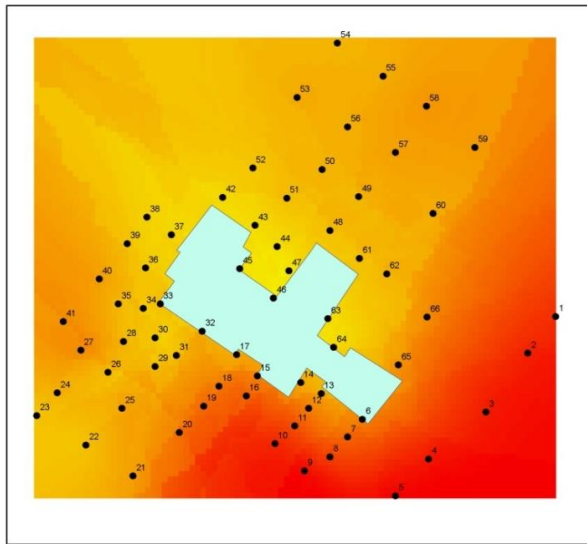**Figure 3c.** Morning relative humidity

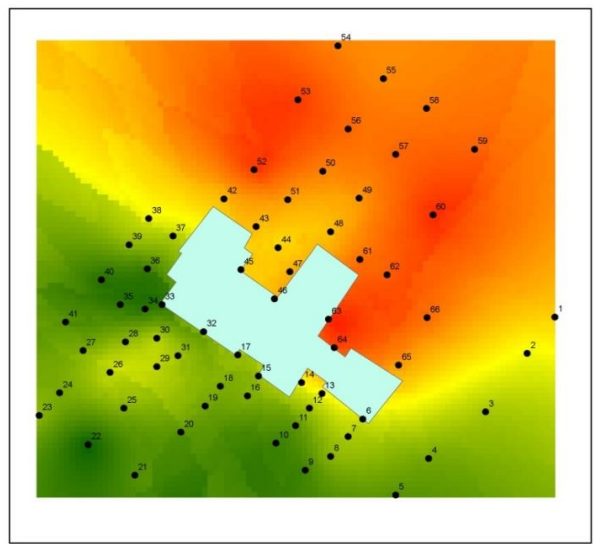**Figure 3d.** Afternoon wind velocity

Figure 3e. Afternoon temperature
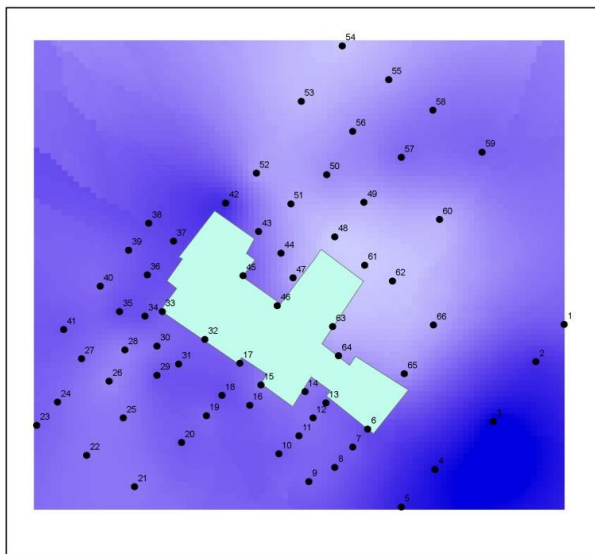
Afternoon Relative Humidity

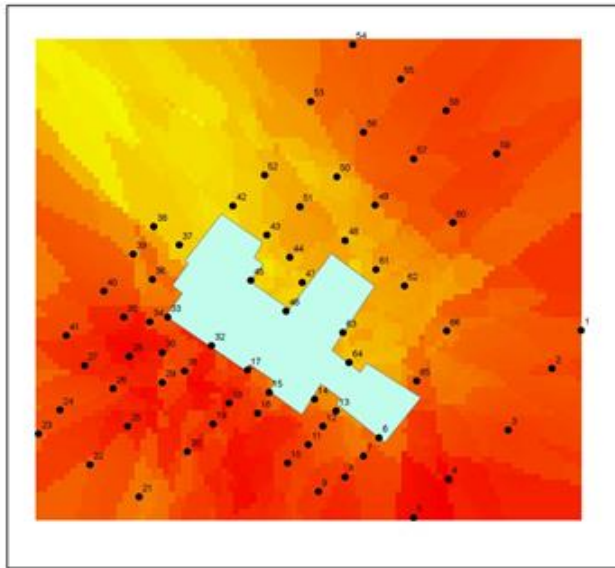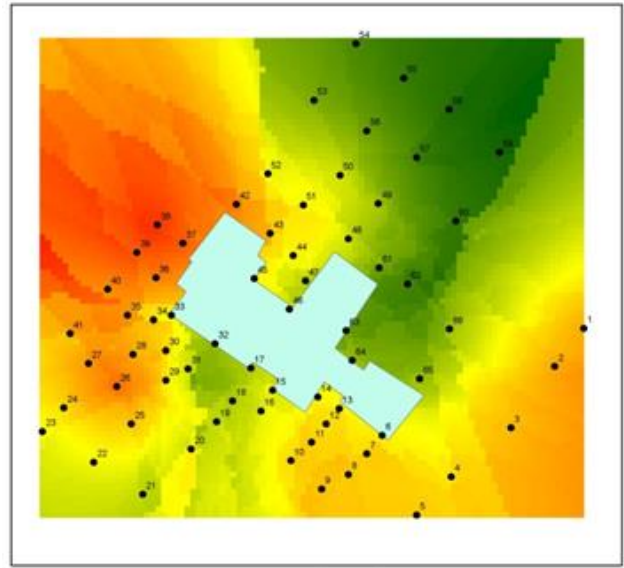**Figure 3f.** Afternoon relative humidity

Figure 3g. Evening wind velocity
Figure 3h. Evening temperature
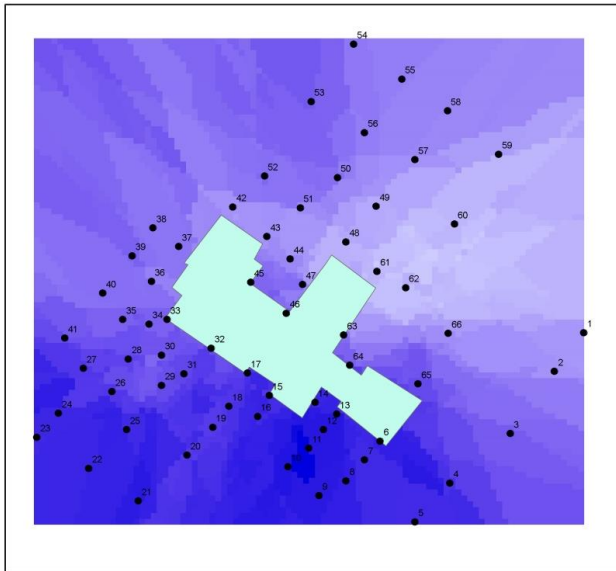
Figure 3i. Evening relative humidity

Temperatures and corresponding relative humidity data were entered into a human comfort chart (Figures 4a-4c). This chart uses a relationship between relative humidity and temperature to set guidelines for human comfort. The blue points are the data with temperature on the Y axis and

relative humidity on the X axis. The solid red line delineates the area considered to be comfortable. Points inside this red box indicate that climatic conditions at the time the data was gathered at that location were within the human comfort zone.
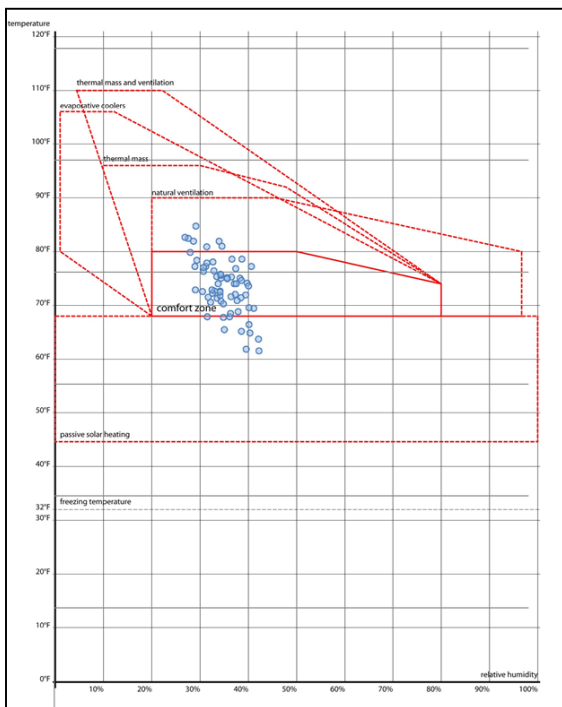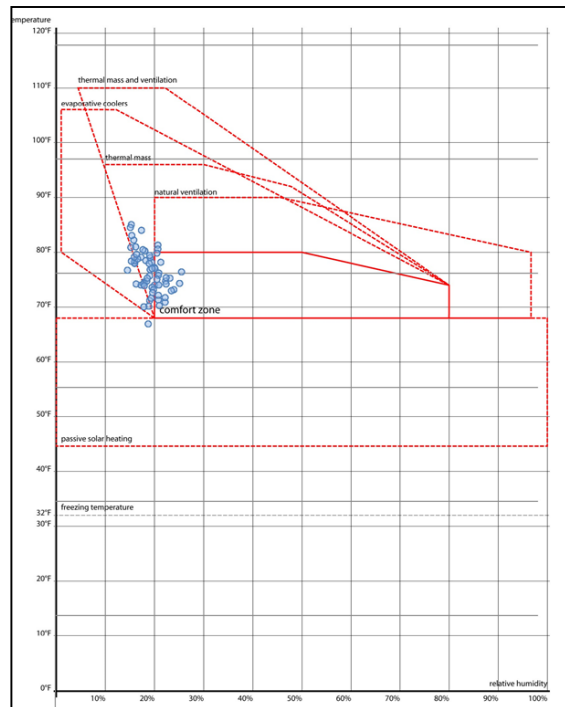

Figure 4a. Morning comfort chart

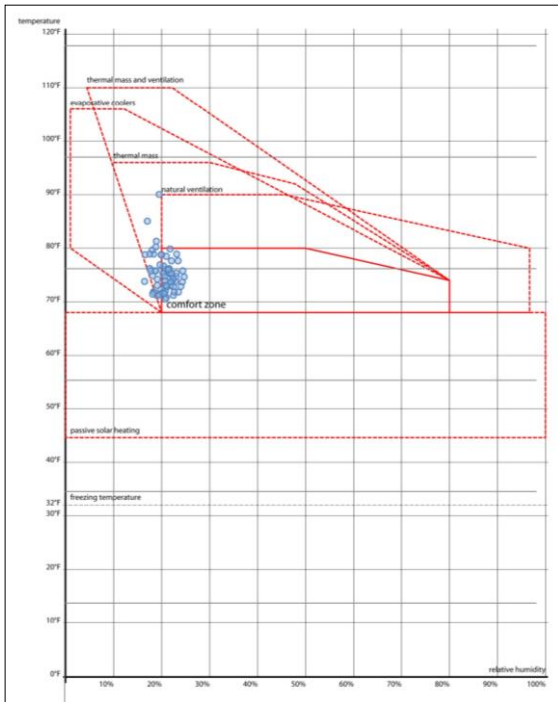

Figure 4b. Afternoon comfort chart

Figure 4c. Evening comfort chart

Of all the sampling locations, the outdoor "spaces" (e.g., Sun Terrace, Swimming Lap Pool, Outdoor Living Room, and Raised Vegetable Garden) were factored into the percentage. Of the 31 data points gathered in these spaces, 24 are considered to be in the comfort zone in the morning, 13 in the afternoon, and 15 in the evening.

Percent of outdoor spaces that fall into human comfort zone:
Morning: 24 / 31 = 77%
Afternoon: 13 / 31 = 42%
Evening: 15 / 31 = 48%

Limitations:
1) Because points were not sampled simultaneously, temperatures changed dramatically by the time data were gathered over the entire site.
2) Because some locations took much longer to have the temperature stabilize than others, the maximum wind velocity represents varying lengths of time.

Reduces visibility of the house from the nearby ranch road by nearly 100%, reducing visual impact on the pastoral setting for nearby homeowners and other road traffic.

Panoramic photographs of the site were taken from the end of the public road leading to the house (Figure 3). This location was chosen because it is the closest vantage point to the home available to the public. Below procedure followed the methodology developed by Clay and Marsh (1997) and Chen *et al.* (2009).

Figure 3. Panoramic photograph showing the view of the property from the end of the public road

Photographs of the home were taken from the same angle and combined with on-site observations to create a silhouette of the home (Figure 4) as it appears from the same vantage point as the panoramic photo above.

The panoramic photograph and silhouette were imported into Adobe Photoshop 6.0 (Figure 5). The silhouette image was resized to match the scale of the panorama. The histogram feature in
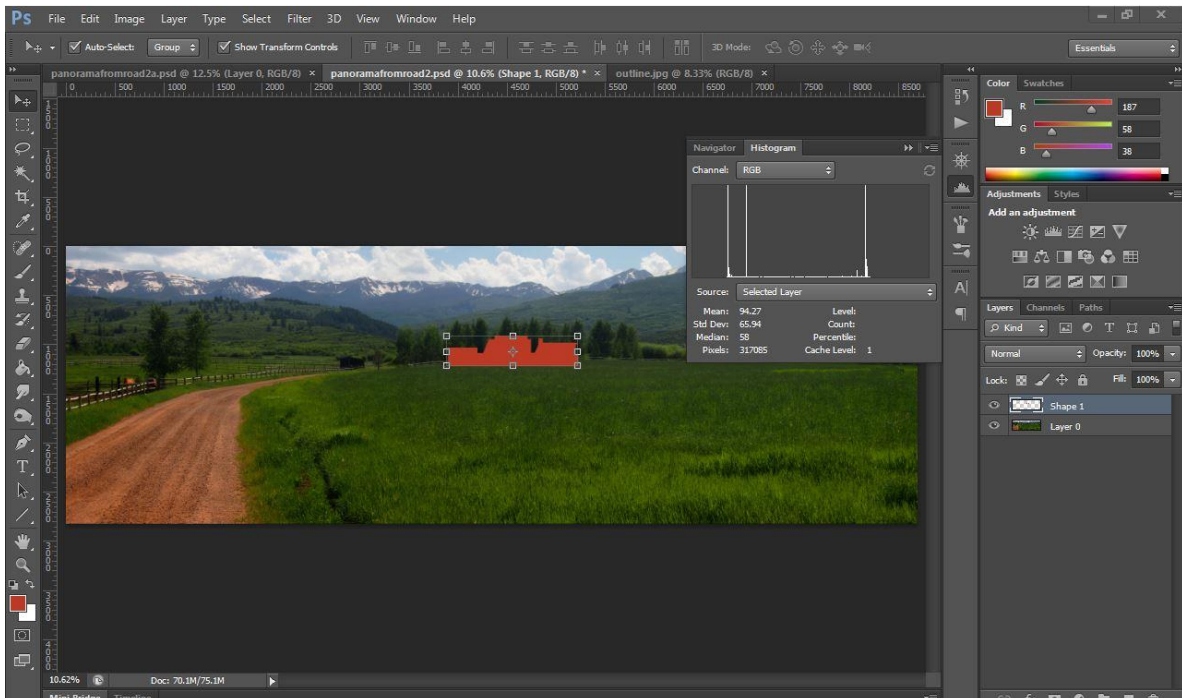
Photoshop was used to measure the number of pixels present in the silhouette layer. This is the number of pixels that would be visible if no buffer were present.

Figure 5. Pixel count for the selected layer (building silhouette)

There are a total of 317,085 pixels in the silhouette. Note that the Cache Level on the Histogram has been set to 1 to ensure that the entire layer is being evaluated, not a random selection (to save time, Photoshop will often survey a random selection of pixels to create the histogram, thus limiting the count to ¼ or ½ the actual number present).

The silhouette layer was moved underneath the panorama layer and the wand tool, set on a very low tolerance, was used to erase those parts of the panorama image that lie on the far side of the planted berm and tree buffer. This revealed the silhouette in just those areas that are not covered by berms, plantings, or trees in front of the home (Figure 6).

Figure 6. Removing the background revealed the visible parts of the building silhouette

Finally, the layers were merged and the visible parts of the building silhouette were selected. The histogram function was used again to determine how many visible pixels from the silhouette remained (Figure 7).
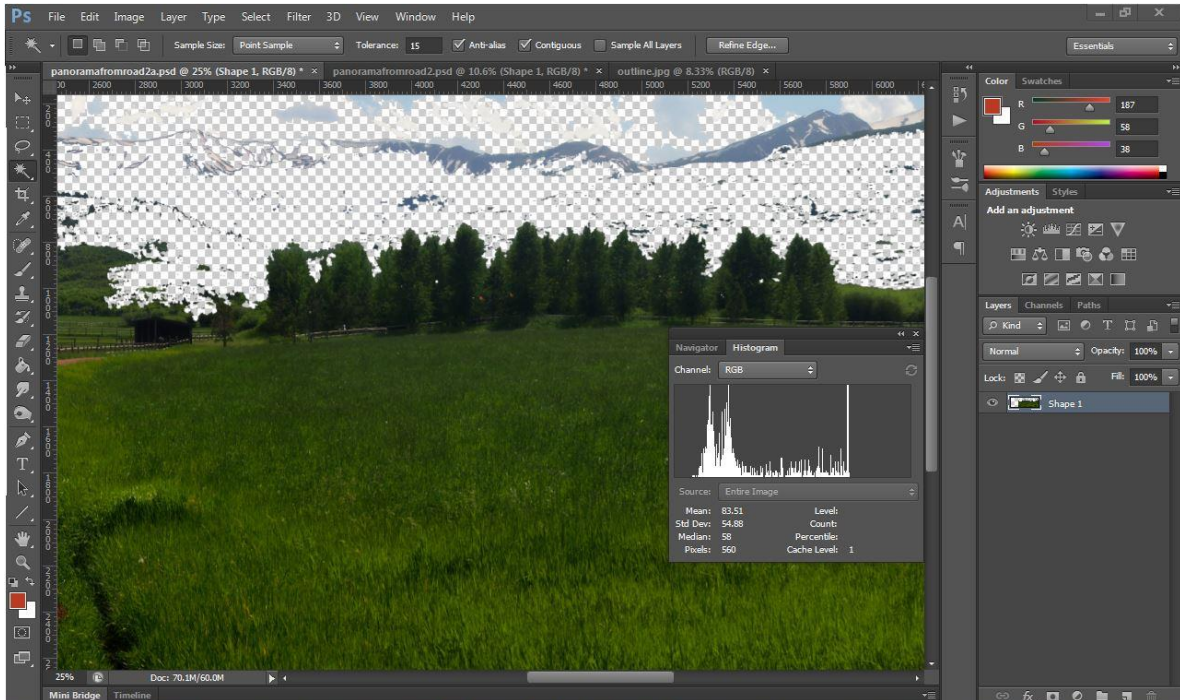
A total of 560 pixels are visible.

560 / 317,085 = 0.00177 or approximately 0.18%.

100% - 0.18% = 99.82% of the view of the home is blocked from the vantage point.

Limitation

1) The creation of the silhouette of the building was based on photographs and a visit to the site, but due to the visually impenetrable nature of the buffer we were unable to take photographs that would have allowed the creation of a precise silhouette. This could have been done easily when the house was first constructed and the trees were either not yet planted or much younger and smaller.

Economic

Generates an estimated 1,820 kilowatt hours of electricity monthly, saving $150 dollars in monthly energy costs through 8 solar panels installed in the landscape. This output is more than enough energy to heat an outdoor pool, and the excess goes toward assisting the home water heating system.

The number of solar panels and their sizes were derived through on site observation. There are eight solar panels, each covering 27 sf. The panel model is Gobi 3366 manufactured by Heliodyne, Inc.

The kilowatt hours of energy produced was found by checking the Solar Rating and Certification Corporation Certified Performance Data for the model (http://www.altestore.com/mmsolar/others/GobiPerformance.pdf).

Logically, the output of a solar panel depends on the weather and climate of a given area. In order to arrive at a reasonable average, the kWh output for 'Mildly Cloudy Day' was used instead of 'Clear Day' or 'Cloudy Day' (the other two alternatives). As the application of the panels is to heat a pool in a cool climate, Category B (Ti [inlet fluid temperature] – Ta [ambient temperature] = 9 degrees F) was chosen in preference of the other options (pool heating in warm climate, water

heating in warm or cool climate, industrial process water heating). Thus, the kWh per Gobi 3366 per day is 7.62. With 8 units, this means a total of 8 x 7.62 kWh per day = 60.69 kWh per day on average. 60.69 kWh per day x 30 days per month = 1820.7 kWh per month.

The average price of electricity in Colorado per kilowatt hour was found to be 8.36 cents (source: http://www.instituteforenergyresearch.org/state-regs/pdf/Colorado.pdf).

1820.7 kWh per month x 8.36 cents per kWh = 15221.052 cents per month = $152.21 per month

A survey of the client provided the information that the energy produced is more than enough to heat the pool and that the excess assists the home water heating system, but exact records for the amount of energy used were not available.

Limitations
1) The production capacity of the solar panels may have changed over time from the expected capacity at installation.
2) The price of electricity will fluctuate with the market and may vary significantly for this homeowner from the average paid in Colorado.

Produces an estimated 141 lb of organic vegetables, which have an approximate value of $400.

First, researchers determined the area of the garden by consulting the AutoCAD plans for the site and using the 'area' command. The area is 120 sf.

Next, a resident provided information on the different types of produce being grown through a survey. The four most successful plants grown (spinach, lettuce, onions, and potatoes) were used in the calculations. The amount of each type of produce that can be expected from the garden plot (30 sf per type of vegetable) was calculated using the vegetable garden value calculator found at http://www.plangarden.com/app/vegetable_value/. The total for each type of vegetable is as follows: spinach-15 lb, lettuce-27 lb, onions-69 lb, potatoes-30 lb.

Finally, the monetary value of the produce was calculated by checking prices of organic produce at the local Whole Foods Market, one of the grocery stores where the resident surveyed indicated that produce would be purchased if it were not grown at home. Those prices are as follows:

Spinach $2.99/bunch (~1 lb), Lettuce $2.99/bunch (~1 lb), Onions $1.99/lb, Potatoes $1.99/lb.

Thus, the total value of the spinach is $44.85, the lettuce is $80.73, the onions are $137.31, and the potatoes are $53.73. Total value is $395.77.

Limitations
1) This calculation is based on average harvests for a given type of vegetable. The harvests on this property may be higher or lower due to many factors including elevation, growing season, and temperature.
2) The cost of produce at the local organic food market may change throughout the season. We were only able to survey the prices at one time, and do not have access to the average, maximum, or minimum prices during the year.

Cost Comparison Methodology

By installing solar panels into the landscape to heat the outdoor pool the homeowners saved $58,494.62 in current Pitkin County Renewable Energy Mitigation Program fees. Purchase, installation and maintenance of the units totaled over $24,000.

Pool = 400 sf (summer use only)

Use the REMP calculation sheet found here: http://www.aspenpitkin.com/Departments/Community-Development-Pitkin-County/Building/Building-Energy-Codes/.

The cost of one Gobi 3366 photovoltaic unit is listed as about $630 (http://www.thesolar.biz/solar_hot_water_heating.htm).

According to a paper by Dr. Fariborz Mahjouri and Albert Nunez, CEM that examines the relative cost of solar panel installation, only about 33% of the total cost can be credited to the unit itself. The other costs include logistical, installation, and overhead costs.

$630 / 0.33 = $1909 per unit X 8 units = $15,273 total cost for the photovoltaic cells.

Estimated maintenance costs were given from a solar contractor in Pitkin County for typical solar hot water heater systems as:

Annual maintenance is $200/year for life of the system.

Replacement of the pump and fluid every 10 years at $300-$500 each per replacement.

For this analysis, 30 years was used as an estimated life span given by the contractor.

Annual maintenance: $200 x 30 years= $6000

Replacement of pump: $500 x 3 = $1500 (worst case scenario)

Replacement of fluid: $500 x 3 = $1500 (worst case scenario) (Tierney, 2013)

Total life maintenance: $9000

Total costs: $9000 + $15,273 = $24,273

Limitations
1) The calculations are based on current Pitkin County Renewable Energy Mitigation Program (REMP) calculations. The calculations for the date of installation were not available, and though comparable, would likely have been less.
2) The exact amount paid for the purchase, maintenance and installation of the cells was not available, and the method used to determine approximate purchase and installation prices was based on commercial projects.

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