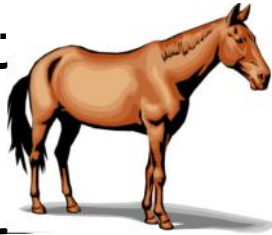


Notes from....



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Operating a horse stable creates a significant environmental foot print. In the past, I've detailed the extraordinary efforts taken to minimize the runoff from rainstorms. Now we are focusing on reducing the amount of water and electricity the stable will consume.

The vast majority of water used by the stable is for the purposes of dust control. So we must first begin by having a true picture of the percentage of dust the arenas have. In the science of soil the language that is used comes from sieve tests. A sieve test is a series of pans that have screens of differing holes (see photo on right). A soil sample is shaken through the succeeding smaller screen openings and the amount that is captured by each screen is weighed. From here the soil particle sizes as a percentage can be determined. Now the language of numbers replace the qualitative terms like course, fine or dusty.

In late January, representative samples were taken from the two main riding arenas. Sifting these produced the following particle distribution results.

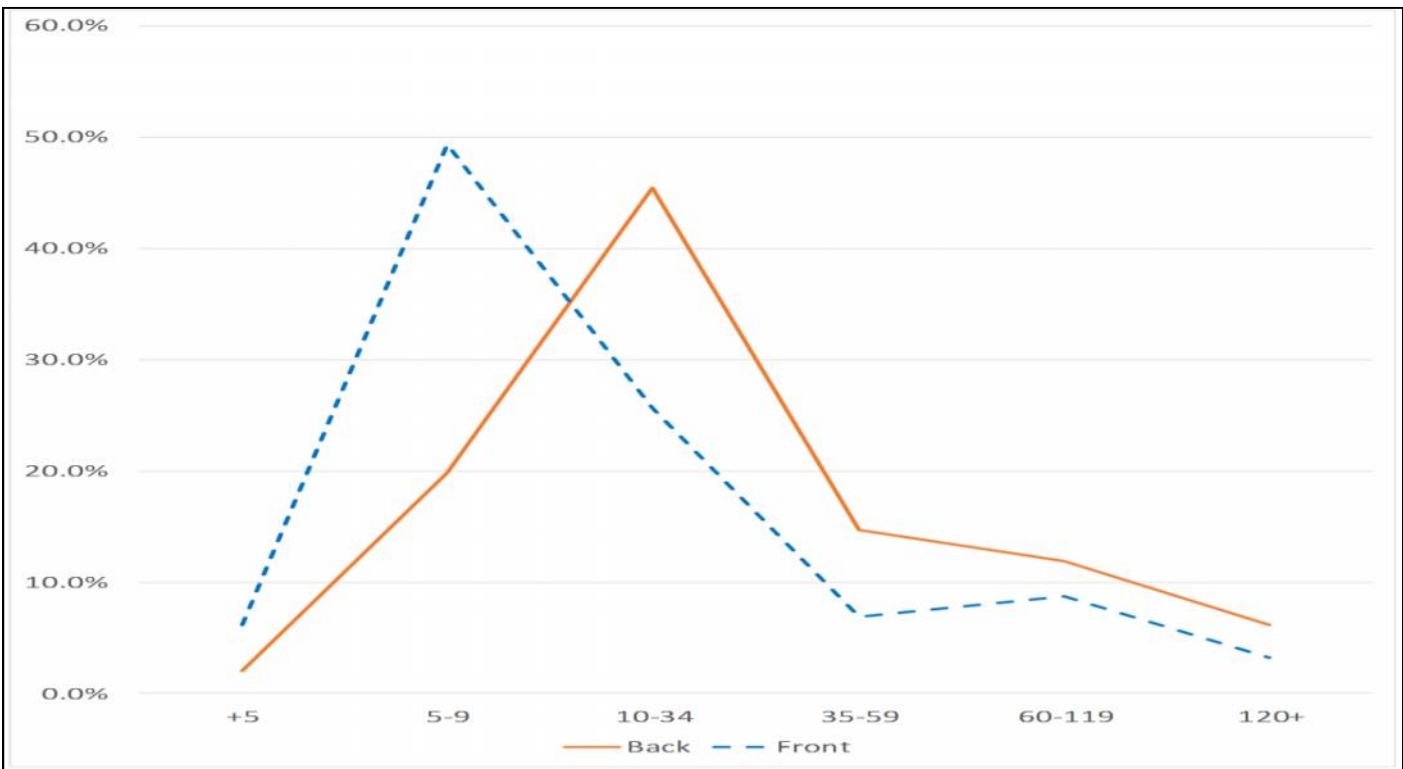


This photo shows only 3 pans. Typical sets have 6 or more.

Size	Description	Front %	Back %
+5	Small Pea Gravel	6.1%	2.0%
5-9	Course Sand	49.3%	19.9%
10-34	Medium Sand	25.6%	45.4%
35-59	Fine Sand	6.9%	14.7%
60-119	Very Fine / Near Dust	8.7%	11.9%
-120	Dust	3.2%	6.1%
		100.0%	100.0%

As can be seen from those results, the front arena has more large particles, less midrange, and less dust. The back arena has more midrange and more dust particles. Dust is defined as 120 mesh size or smaller. On Page 2, these results are graphed.

A few words on dust. A 12" rock will not blow away even in the heaviest of winds. But if you crush it down to a fine powder, just taking a step into it will create dust. So how can that be? Isn't it the same rock? In science, an important equation is the ratio of surface area to volume. A large boulder's volume increases at a cube rate, but the surface area increases at a square rate.



To keep it simple let's look at the difference between two cubes. One is 12" and the other is 1"

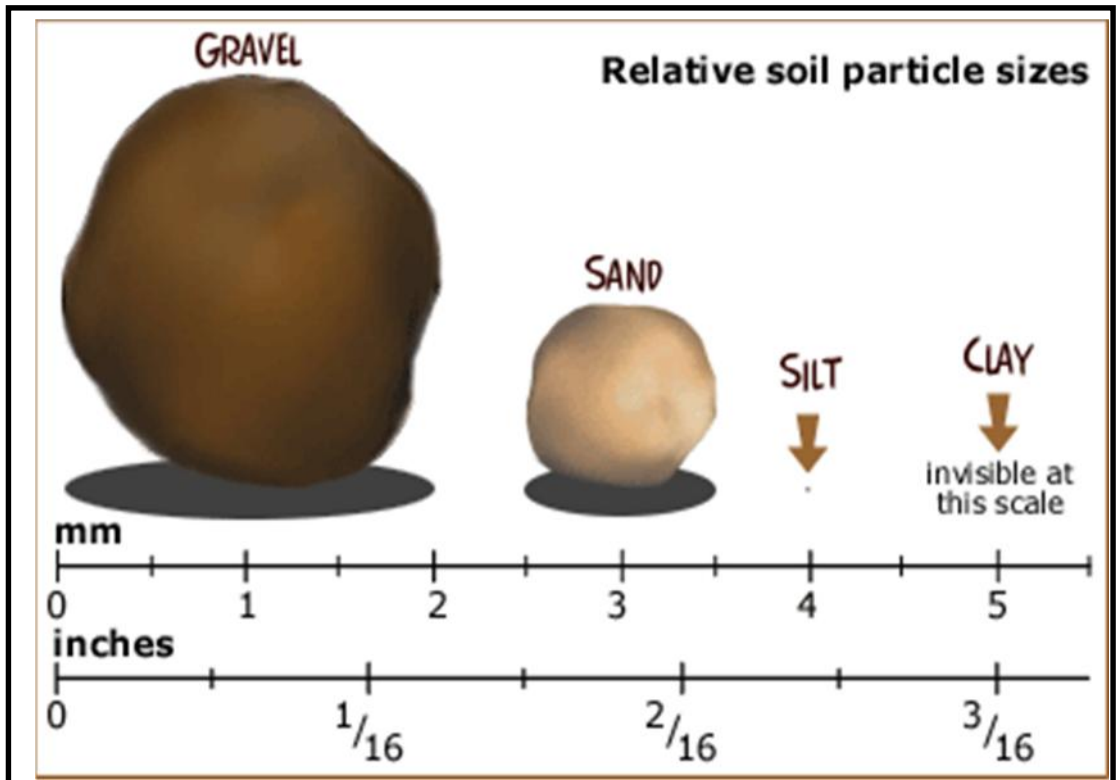
Surface Area	$\frac{12''}{6}$	$\frac{1''}{6}$
Vol.	864	1
Ratio S.A.:Vol	1:2	6:1

dislodging effect for the #120 dust than the #5 sand. So we can see that particle size is everything when it comes to dust.

The other annoyance with dust is that a little dust nobody notices, but slight increases are perceived as much more than the percentage increase. So the "perception" of dust is not equally related to the "actual dust percentage." The perception of dust is

So the smaller cube has 12 times the surface area for a given unit of volume, which means that when the wind blows it has 12 times more effect. So in an overly simplified explanation a 10 mph wind will have the equivalent of a 120 mph wind on the smaller rock.

So what is the ratio between a #5 mesh sand and a #120 dust particle? In this case the difference is that any disturbance will have 48 times the



far greater with minor increases in dust percentages.

To reduce the dust, we apply water. Why does water control dust? The water molecule through adhesion weakly binds the dust particles together. Making them act like larger particles than they actually are. Thus the surface area to volume ratio is reduced. But as the water evaporates, the particles return to their more smaller, easier disturbed ratio.

Thus, as an arena is perceived as dustier faster than actual dust percentages increase. As a result we must then add even more water to keep the dust particles bonded. Unfortunately slight increases in dust have another deleterious effect. Their presence greatly increases capillary action, thus drawing more water to the very top of the footing, and greatly increasing the evaporation rate of any moisture in the footing. Now the dust seems to come even faster, because the water applied to control it evaporates even faster than if the footing were courser.

The science of evaporation which is a function of: soil composition, air temperature, humidity, wind, and length of day is quite well understood. For all regions the amount of water that evaporates from the above has been quantified and easily available to even the causal google user. This rate that water is required is known as the Evaporative Transpiration Rate (commonly referred as the "ET rate"). The ET rate also includes a factor for the amount of water that a plant will use, besides the amount of water that will evaporate directly from the soil. If we strip out the plant's transpiration portion, and increasing the ET rate for the constant turning of soil from tractoring and horse, and adjusting for specific the dust portion that will increase evaporation even more, we can then easily develop a water budget by the type of footing and the time of the year. All this is simple spreadsheet stuff.

Each year the stable is given an allocation of water for dust control and landscape irrigation. That allocation is broken down for each month based on the ET rate for our local area. So in January, the stable's allocation is very small because it is winter with probable rain, plus cold,

short days. On the other end the stable's allocation is higher for August which is longer, hotter, with a lower likelihood of rain.

Knowing the ET rate, and the soil make-up of each arena, allows us to calculate the required quantity of water to maintain a certain moisture level. So to put is simply, the finer the soil, the larger the amount of daily watering is needed to control the dust.

If we add up all the square footage of arenas / turnouts, plus a small amount of landscaping, and then divide this by the water district's monthly allocation, we thus arrive at a water budget for each arena. To encourage conservation the water district has a tiered rate plan. If we use less than our allocation, the per unit cost is less. Conversely, if we exceed our allocation then we enter the penalty zone. The rate goes like this.

0-40%	of allocation usage = 44% discount
40-100%	of allocation usage = 0% discount
100-110%	of allocation usage = 115% penalty
110-120%	of allocation usage = 434% penalty
+120%	of allocation usage = 963% penalty

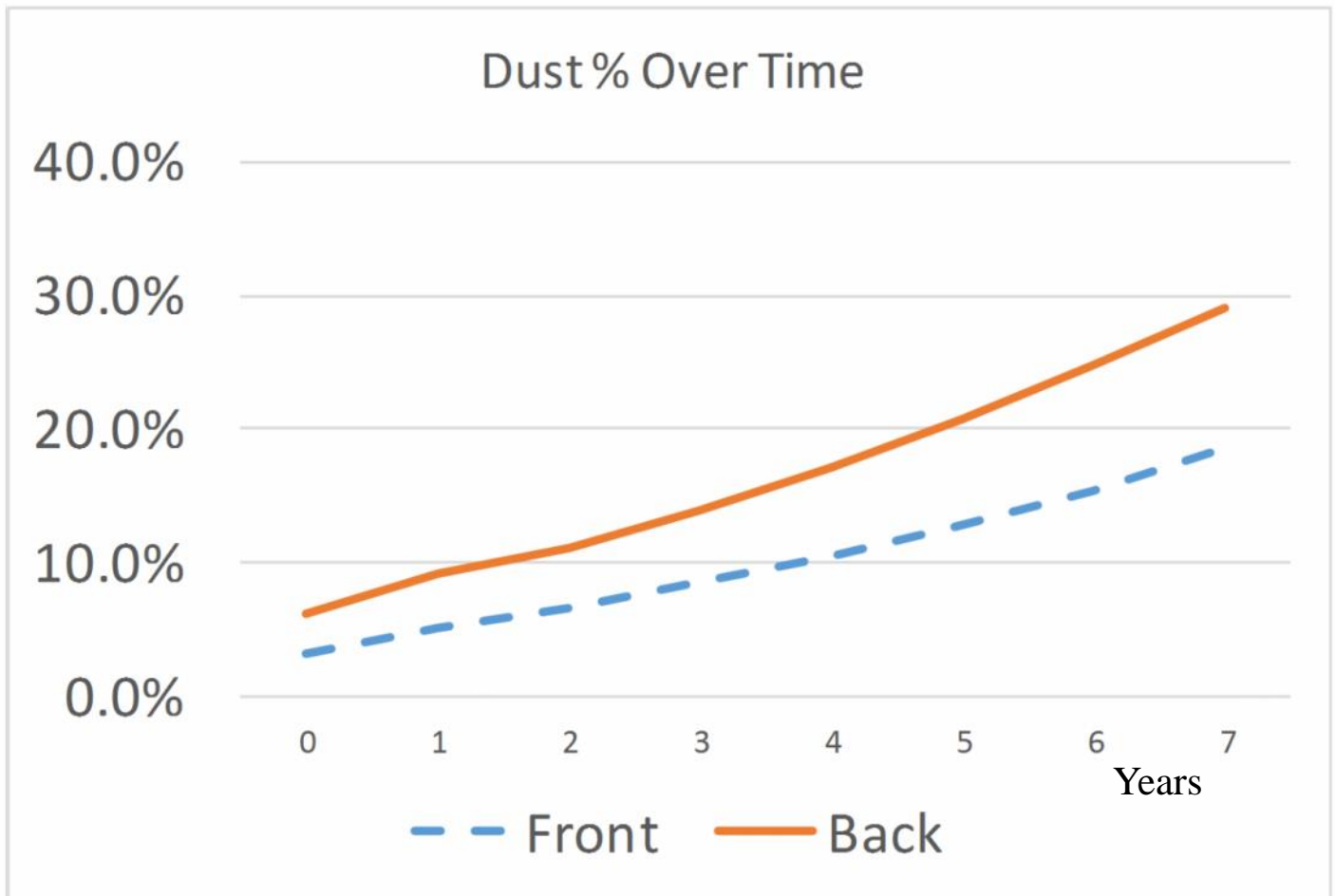
So as you can see going just slightly over the allocation can be quite expensive. If we go just 20% over, the penalty is horrendous.

We can now take each arena's soil type (as determined from performing a sieve test), the monthly ET rate allocation, and the above rate structure and develop an expected cost for watering each arena. What we find is that any marginal increases in the dust percentages have dramatic effects on the costs to water an arena. Not only is the actual amount of water greater, but the price of any penalty for exceeding the allocation exacerbates the total cost. In the months of July – September, the watering costs for the back arena will be 14 times the costs of any other arenas, or an additional 700,000 gallons for this year. In dollar terms, an additional \$1,000 per month.

We can also make a good guess as to future dust levels based on the existing footing particle distribution. Using historical trends, we can assume that the footing will be crushed so that after 1.25

years, the footing will be reduce to the next size. Now we see how much the dust percentage will increase over time, and that increase will result in an even greater demand for water to keep the dust in abeyance. The following graph shows the “dust trend”.

observe dust in the back arena. Using the more conservative numbers, we will need to apply more than the extra 700,000 gallons this year. Looking at the dust chart, future years will take even more water. It doesn't take a rocket scientist (or quantum mechanic) to see that in today's drought



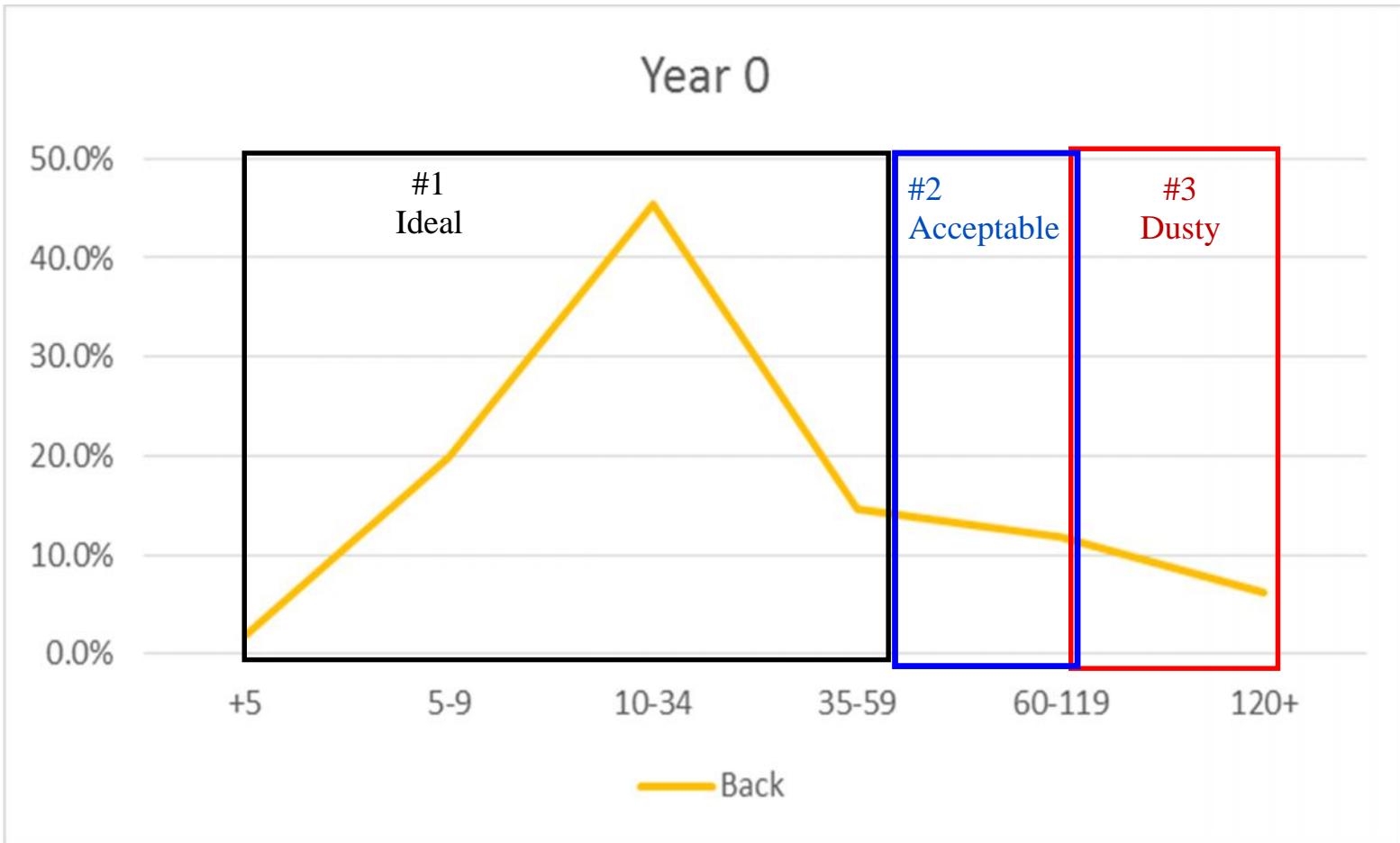
While these costs may seem high, in reality it's probably higher. When we water in the morning, there is less wind, and the relative humidity is high. This translates into a decent percentage of the water that leaves the sprinkler actually landing on the arena surface. When we need to add more water in the afternoon, a much smaller percentage of water makes it to the arena footing. Depending on the weather conditions, it can easily be less than 30% that actually gets to the footing. I've observed boarders taking upon it themselves to turn on the sprinklers when the Santa Ana are blowing 20 mph. On those days, 30% would be hopeful.

During the last two months we have tested our theoretical findings and found that the calculations were indeed too low, as we still

this is a shameful waste of precious water. We expect the possibility that our allocation may be reduced as California enters a very likely 4th year of drought, and we should act proactively.

Now we have developed a quantified and testable footing standard to shoot for. The following graph shows the sizes and percentages of each that will be our goal. In a perfect world we would have footing that is in the black box (#1) with some from the blue box (#2) in the percentages shown. The red box (#3) means problems!

In the last few months we have taken a hard look at the compost screening equipment to see if it can be altered to capture any sand that meets the above black and blue (#1, #2) boxes



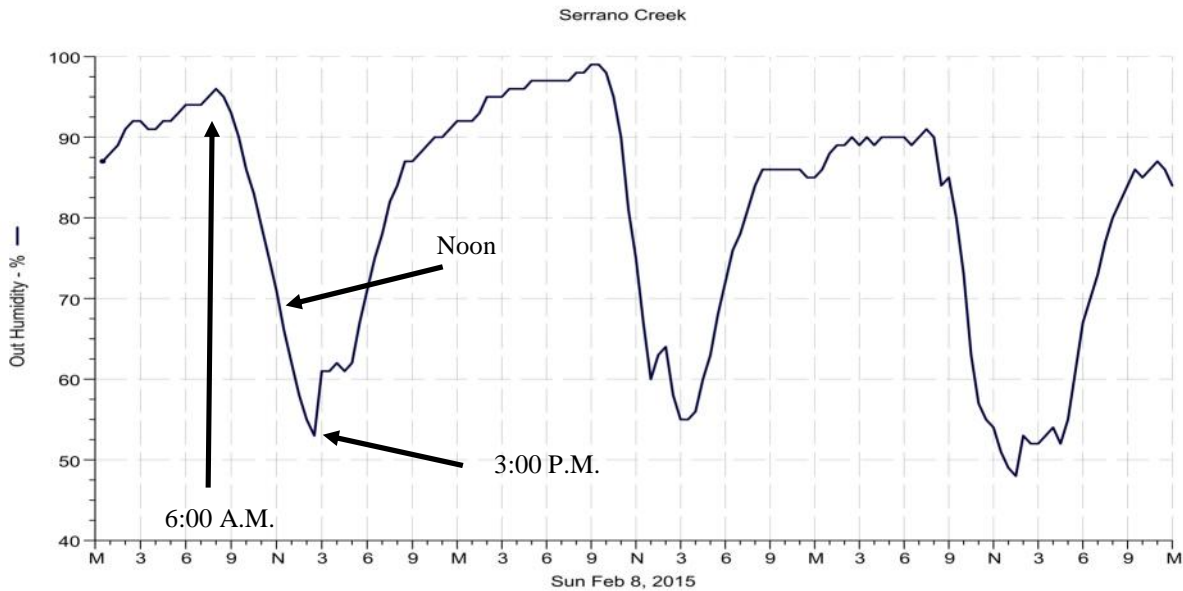
standard, that heretofore was being left in the compost we sold. We were successful in this effort. While it involves some additional screening time, the value derived balances out the additional cost. I've visited and contacted several aggregate suppliers, and none were able to meet our specifications. So it's best we reclaim these materials for our use.

Comparing the ideal particle distribution to the front arena, we see we have too much course material. By adding material in the 10-35 range, the percentage of the course material is reduced. So far we've added 10% by volume to the front arena. This process has been proven to work out nicely.

Removing the other end of the footing distribution (the dust) is more problematic. It seems that this can be accomplished again by using the compost equipment with perforated shaking screen that has holes in which only the dusty material (#60+) combined with a blower is captured. These "fines" will then be combined with the compost to create a planter mix product. By being able to "sell" the #60+ material, we save a big disposal cost.

Given that we expect to save hundreds of thousands of gallons of water, it does seem worth all the effort. We expect that just the screen process will take about 2 weeks. To screen out the dust the footing must be very dry. So we'll wait until at least mid May to start.

Even if all the dust is removed, watering during the incorrect time of day wastes water. Again on hot days with low humidity, much of the water leaving the sprinkler evaporates before landing on the arena footing. Adding the wind that increases as the day heats up, and the percentage of water making it to the arena footing is further reduced. The following chart taken from the stable's weather station shows that watering in the very early morning is done when the humidity is around 90%+. If instead if we water just a few hours later, the humidity has dropped by 50%. Think of the last time you were in Las Vegas, where misters are used for cooling to get this effect.



Currently all of our arenas are watered by manually turning on the sprinklers. To turn them on in the early hours of the morning would require one of the employees to begin work at three in the morning. Also many times when we try to water in the midmorning, there are horses in the arenas; especially on hot days. Thus the arenas aren't watered until much later in the day.

To solve these problems, we are installing a controller that will run the entire arena watering so all the arenas are watered before 6 a.m. This controller is more than just a timer; is a "smart controller". Each hour the water district transmits a signal to tell all the smart controllers in the area what the ET rate was for the last hour. Throughout the day, the computer in the controller collects this information, and depending the sum of the ET rates for the past day, it determines whether to water or not.

We have a certain amount of water flow available based on the size of the pipe that serves the stable. So we just can't turn on all the sprinklers at once. Doing so would result in just a dribble coming out of each. So we must program

the controller to do specific sprinklers in a specific order. This will ensure that we have the maximum pressure to reach the furthest into the center of each arena. This will maximize the amount of water that lands on the arena footing. Also, by individually turning the sprinklers on and off, we will be able to water the arena more evenly. This is because it is possible that a corner sprinkler will need to run less time since it only operates on a 90 degree arc, while sprinklers on the center have a 180 degree arc. Currently several sprinklers are typically turned all at once which results in overwatering

This project will take quite a bit of capital and labor to accomplish. While it's a lot of work, in the long run we hope to be able to maintain our ability to water the arenas. If all goes well, we expect to save hundreds of thousands of gallons of water by just watering during the correct time of day. Not only does it make good economic sense, but saving that much water makes a lot of green sense too. Work on this project has begun, and we hope to have it finished before starting the screening of the back arena in mid May.

We have also completed a census of the number of horses that used the three riding arenas (front, side, back). This was done from January 27th to February 13th, and we made 144 separate observations at random hours between 8:00 am and 7:00 pm, 7 days per week . From that data, we were able to determine the average use for each arena. Page 8 shows the data points for all the stable wonks out there.

Arena	Average Horses	Average Horses Rode
Front	1.78	1.78
Side Arena	.83	.55
Back Arena	.89	.75

Using these utilization rates combined with the monthly costs for each arena, we can make the following observations.

- 1) The front arena has the highest number riders of all the arenas.
- 2) The side arena has the same horse usage as the back arena when including turnout and lunging uses, but less when only counting riders.
- 3) The back arena costs \$50+ more per horse to operate when counting turnouts, lunging, and riders. when only counting for riders it costs more than \$60+ per rider.

The issue for the high per horse cost of the back arena is a combination of high watering costs and the low utilization. Whether we have one horse or 100 horses, the watering, tractoring, and lighting costs are basically fixed. With the removal of as much dust as possible, we hope to solve this half of the problem

In order to increase the usage of this area, we will be creating two arenas in the place of the existing one. The current arena is 25% larger than the front, and yet has half the usage. Simply put said the front arena is 2.5 times more space efficient. By reducing the back arena to slightly smaller square footage size as compared the front arena, we will be able to add another small arena. Page 8 is an aerial view of this modification. This new arena will be similar to the side arena that currently has the same usage as the entire back arena. This will allow riders

in one arena and lunging / turnouts in the other. Hopefully this will increase the total usage in the space. Secondly, we have very strong beginner lessons programs, and the second small arena means that these folks won't have to get lost in one of the big arenas until they are ready to do so. The second smaller arena should make riding in the larger arenas safer and more pleasant for all. There will be 10-15' distance between the two arenas. No doubt

some will complain that occasionally a turned out horse will disturb a rider in the other arena. We could increase the separating distance for these rare occasions, but that means now for all riders the arenas are permanently smaller. We suggest that if a turned out horse is bothering a rider, that the rider could then ride in the center or other end of the arena. This seems like a better solution than reducing the amount of riding surface area. Access to the new back arena will be along Serrano road, and the new training arena will be off the interior road. This arena conversion project is expected to be completed by early July.

—And Lastly—

During the day the stable uses very little electricity. But at night our consumption goes way up because of lighting. At the time the stable lighting was installed, High Pressure Sodium (HPS) lighting was the most efficient standard. Jumping 30 years to today, Light Emitting Diode lighting has greatly increased the efficiency of light per watt of electricity. While LED lights cost much more than HPS, the cost savings makes sense when replacing a failed or old HPS fixture. Because we have gained in efficiency, we can also select fixtures that give more light, while at the same time reducing the total electricity used. This reduction not only saves money, but goes far in reducing the carbon footprint of the stable by reducing the total electrical generation needed by the stable. This conversion program will be on going.

