

# Sand lanes – get the gold standard for pennies

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## Abstract

Sand is the best bedding for freestall-housed dairy cows; however, sand-laden manure presents several handling issues. Well-designed sand lanes separate sand from manure, minimizing handling issues at relatively low costs. Reclaimed sand can be as clean, or cleaner than, new sand in well-designed and operated systems. Sand reclamation rates vary from 60 to 98%, so the design and operation of the sand lanes is important. Sand lanes can be used with flush barns and with barns that scrape alleys to flumes or collection pits. Advantages of each will be discussed.

**Key words:** cattle, dairy, housing

## Résumé

La litière de sable offre le plus d'avantages pour les vaches laitières en stabulation libre. Toutefois, le fumier de vache chargé de sable est de manutention difficile. Des allées de sable bien conçues peuvent séparer le sable du fumier permettant ainsi de minimiser les problèmes de manutention à moindre coût. Le sable récupéré peut être aussi propre ou même plus propre que du sable nouveau dans les systèmes bien conçus et maintenus. Le taux de récupération du sable varie entre 60 et 98%. Il est donc important de bien concevoir et de maintenir les allées de sable. Des allées de sable peuvent être utilisées dans les fermes qui nettoient le fumier à grande eau ou dans les fermes qui transportent le fumier mécaniquement dans des fosses déversantes ou des canaux. Les avantages associés à chaque type seront discutés.

## Introduction

Sand is recognized as the standard of bedding for freestall-housed dairy cows. Impact areas include improved milk production, improved SCC premium, reduced number of clinical mastitis cases, reduced number of lameness treatments, reduced cost of replacement heifers, and potentially reduced cost of bedding if recycled.<sup>1</sup> Recycled sand bedding can have issues with organic matter contamination. Sand lanes use gravity to separate sand-laden manure into heavier reusable sand and less-dense manure for disposal. These systems can be designed with a minimum of pumps and labor for all steps in the sand reclamation, and manure removal processes. The guidelines that follow are for conceptual purposes, and the services of a knowledgeable engineer and experienced builder are recommended.

## Sand Lanes

Sand lanes are concrete alleys 11 to 12 feet (3.3 to 3.7 m) wide, 10 inches (25.4 cm) to 4 feet (1.2 m) deep, and 150 to 300 feet (46 to 91 m) or longer used to separate sand from manure. Slopes range from flat with intermittent 1-inch (2.5 cm) “water falls” to .25% slope. Principles of operation are that sand-laden manure mixed with water will separate into its components by density differentiation over the course of a lane that allows deceleration of the suspension. The sand lane is usually accompanied by a dewatering floor that drains back into the sand lane.

A travel speed of 5 feet (1.5 m)/second will move sand, and it will settle out of suspension when the speed slows to 1½ feet (0.46 m)/second. At less than 1 foot (0.30 m)/second, solids will settle out of the suspension. Length of sand lane becomes important to provide space for the separation to occur due to flow rate deceleration. As sand accumulates in the lane, the flow rate will decrease. Sand is removed from the lanes every few days to weekly and placed on a dewatering floor. The best designed dewatering floors allow the liquid to drain back into the sand lane. Best management of the sand piles includes turning of the piles weekly for 2 to 4 weeks to promote liquid coming out of the sand. Dewatering floor should be sized to hold 6 weeks' capacity for turning reclaimed sand and receiving new sand.

Many experts suggest that organic material levels of 4 to 5% or higher in reclaimed sand is of questionable quality, while others report organic material levels as high as 9% without milk quality issues. Dairies that have an abundance of recycled sand tend to bed stalls more deeply than those that purchase new sand. This may be the reason for fewer milk quality issues. Flushing the sand with more water, or water with a lower level of total solids, decreases the organic material level in the sand. Water with 1 to 2% total solids is preferred.<sup>3</sup> Longer sand lanes facilitate flushing with more water. The skill of the loader operator at discerning sand that is clean from dirty sand is also a factor. Skilled operators may choose to push dirty sand to the front of the sand lane to be rewashed. This can compensate for a sand lane that is too short to some extent.

Adequate clean flush water for the sand lane is a common limitation of sand lanes. Twenty to 40 gallons (75.7 to 151 L) of flush water/cow/day is desired.<sup>3</sup> Most flush water is pulled from a lagoon by a floating pump that pulls water from 2 feet (61 cm) below the surface. This level is expected to be the cleanest water in an undisturbed lagoon.

This system presents water supply problems whenever the lagoon is pumped down. Some systems compensate for this by using storm and runoff collection-pond water during these times of shortage. Most have been surprised how quickly these supplies are depleted because these systems are not a closed loop. Our most common systems now being built are 2-stage lagoons separated by a weep wall. Separated manure from the sand lane flows into the first lagoon. A weep wall retains up to 60% of the solids in the first lagoon. Sloped screen and screw press separators retain 20% of the solids at best; cow manure is 13% total solids. The addition of flush water and retention of solids in the first lagoon can reduce flush water total solids to less than 2%. Flush water is taken from the second lagoon by a floating pump. Most of the pumping for field application is from the first lagoon. A valve can be closed between the 2 lagoons so water from the second lagoon is retained for flush when the first lagoon is pumped empty. Two-stage lagoons with a weep wall between them have fewer issues with odor because the flush water has lower levels of organic material. This is especially important in flush barns, as flush water is released every few hours and if this water has odor it creates an undesirable neighborhood situation.

Freezing temperatures can present challenges, but we have successfully operated sand separation lanes at 0° F (-17.7° C). Sand lanes that are placed deeper in the ground can be operated at colder temperatures than those on the surface. The deeper sand lanes require ramp access for a skid loader or payloader to remove the separated sand. Flush barns typically choose to flush more often at colder temperatures to have flow through the lanes, and flumes may be run continuously at subzero temperatures. The principle of moving water not freezing applies here. Flushing of holding pens may be suspended if there is not continuous traffic. Sand removed from lanes during freezing temperatures may not be clean enough without being rewashed.

### Flush Barns

The simplest barns that use sand lanes are flush barns that use large volumes of water to flush alleys every 2 to 6 hours. Labor savings are significant and the barns can be very clean. Brown water is pumped from the lagoon into upright tanks. These tanks for a 250- to 400-cow barn will be 30,000 to 50,000 gallons (113,562 to 189,271 L). Valves open in the floor at the high end of the barn, and 5,000 to 8,000 gallons (18,927 to 30,283 L) of water travels down the alleys removing sand-laden manure. The next alley is usually flushed 30 minutes later. The sand-laden manure in flush water is collected at the end of the barn, travels to the sand lane, where it is separated. If there is enough elevation, the resulting manure solids flow directly into the lagoon. If there is not enough elevation advantage from barn-to-sand lane-to-lagoon, then reception pits with pumps will be needed to transfer to the next stage. Reception pits are best

constructed with minimal corners so agitation is effective. Some of these pits are constructed with ramp access to clean them out mechanically. We have 1 reception pit that lowers a skid loader into it to clean it out.

Flush barns require 2% slope to maintain sufficient velocity or there are issues with sand accumulation in the alleys. If there is not enough flow or velocity, the area most likely not to be flushed is at the curb to the freestalls. This is the area that we most want to be clean because a cow's foot steps there last before entering the stall to lay down. If feet are dirty, they soil the beds and the teats of the cow. One barn with only 1½% slope has attached a scraper to their sand-leveling arm to move sand-laden manure away from the curb. Any sand-bedded barn should be leveled 2 or 3 times daily and the manure and wet spots should be cleaned out when cows are fetched.

Most of our new construction curbs are built in an overhang manner so the flush water can get behind the manure to get it moving. We also build the alleys with slope toward the curb so more of the water flow is toward the curb than down the center of the alley. This is more important at the lower end of the alley than at the top. If we slope the floor too much toward the curb at the top, there won't be enough flow on the rest of the alley at the bottom.

### Scrape Barns

Sand lanes can be used in conjunction with barns that scrape alleys. This is a common retrofit to existing barns or new barns that present a challenge with sufficient slope for flush. Separation occurs when sand-laden manure is mixed with water. This can be done in flumes that transport manure from the barn or in short flumes outside the barn. Mixing flumes shorter than 20 feet (6.1 m) have difficulty sufficiently extracting manure from the sand. Scraping sand-laden manure into a reception pit, adding water, then pumping into a sand lane presents challenges with sufficient water volume and settling of sand in the reception pit. Transport flumes are the preferred of these systems. These flumes are prone to plugging if they have insufficient water flow, stop and start, have restrictions to flow in design, or have turns. Long flumes become plugged when flushed with high-organic-material water or they have restrictions to outflow because of a full pit.

### Economics

Investment in sand lanes and the accompanying dewatering floors, pumps, and tanks range from \$60,000 to \$200,000 for our 150 to 2,000-cow herds. This does not include the costs of earthen lagoons that would be needed for almost any storage system. The cost of sand becomes a major factor in determining the feasibility of these systems. The Dairyland Initiative has a default value of \$6/ton of sand and there are areas of the country where sand is less expensive

than that. New sand would be recommended over recycled sand in those areas. Concrete and mason sands both have few fines and can be separated using sand lanes.<sup>2</sup>

Costs for sand delivery 15 miles (24 km) from St. Henry, OH are \$23/ton for concrete sand and \$26.55/ton for mason sand in 18 to 20-ton loads. At \$23/ton, sand costs 1.15 cents/lb (2.54 cents/kg). At 50 lb (22.7 kg) per cow/day, the cost of bedding is 57.5 cents per day or \$210 per year. Reclaiming 95% of the sand makes the annual bedding costs \$10.49, or a savings of \$200/lb (2.54 cents/kg)/cow/year to apply toward the sand separation facility. The separation facility should last for 20 years with only the pumps and loaders as replaceable items. That means a 150-cow dairy that invests \$60,000 in sand lanes would save \$600,000 in 20 years with repairs on pumps and loaders, electricity, and some labor as the only expenses.

### Conclusions

Sand is the gold standard of bedding for freestall-housed cows. Well-designed sand lanes use gravity to separate sand from manure. Reclaimed sand is processed on a

dewatering floor until it is dry enough for use. The organic material in reclaimed sand is decreased when sand is flushed with larger volumes of cleaner water. Sand lanes can be operated during freezing temperatures with some adjustments. Flush barns with 2% or more slope can reduce labor and create a clean cow environment. Scrape barns can also use sand lanes by mixing the sand-laden manure with water in a flume or reception pit. Sand lanes can give a 10-to-1 economic return over their lifetime.

### References

1. Cook NB, Nordlund K, Brotzman R. Partial budget – mattress to sand conversion. Dairyland Initiative, School of Veterinary Medicine, University of Wisconsin.
2. Gooch CA, Inglis SF. Sand for bedding dairy cow stalls. ProDairy Biological and Environmental Engineering Department.
3. Harner J. Sorting manure – minimizing the mess, Ohio Dairy Veterinarians Meeting. *Proceedings*. 2012; 73.