Final Report
Innovative Cattle Heavy Use Area Protection Using Wood Chip Surface
a Pennsylvania Chesapeake Bay Conservation Innovation Grant – FY 2018

Grantee Name:
Bradford County Conservation District

Agreement Number:
69-2037-18-003

Project Manager:
Nathan Dewing, Agricultural Team Leader, Bradford County Conservation District

Project Time Frame:
January 16, 2018 – September 30, 2019

Final Report Submission Date:
January 31, 2020

Project Deliverables Completed:

1. Implementation of a woodchip based heavy used area protection (HUAP) system that consists of NRCS conservation practices 561,313,634, 635 and 560 and monitoring of the system performance.
2. Detailed documentation of the woodchip HUAP system including components, sizing and recommended amounts, implementation costs, quantified environmental benefits (e.g. reductions in runoff & nutrients).
3. One field day open to the public to promote the practice as a viable conservation alternative. Held April 6, 2019 with 65 people attending, a mix of farmers and industry service providers.
4. Produce a fact sheet and a short video (YouTube style) to educate and inform other producers.
5. Produce an educational report to distribute to conservation and Ag community.
6. Participation in at least one NRCS-approved event during the grant period. Project summary was presented to NRCS state technical committee on April 18, 2019.
7. Reports and documentation as required by this agreement.

Background Photo: Woodchip pad
May 1, 2019 (confinement day #122)

Executive Summary

This project demonstrates livestock heavy use area protection using a wood chip surface. Livestock confinement often stresses producers, animals, and natural resources. Traditional concrete surfaces work well, but are costly, and continual use wears on animal health. Dewy Meadows Farm in Warren Center, Bradford County, PA, a 50 head cow/calf, grass fed, rotationally grazed beef operation, partnered with the Bradford County Conservation District to install and operate this demonstration. A wood chip pad was constructed with an impermeable clay subgrade and perimeter berm containing a grid of perforated pipes under 18 inches of clean stone, overlain with 12 inches of screened wood chips for a wearing surface. Precipitation and liquid waste collected on the open-air pad drains through the wood chips and stone and is collected at the end of a pipe and treated via irrigation onto a vegetated treatment area in the pasture. Funding contributors include Landowner, NRCS Conservation Innovation Grant, PA DEP Small Business Advantage Grant, and PA REAP tax credits.

Feed and water are supplied at an adjacent, concrete lane where the heaviest manure concentrations develop. Manure is regularly scraped from the feed lane to a manure storage for field application as appropriate. Manure removal from the wood chip pad is accomplished seasonally. During the first confinement season, the wood chip pad received no maintenance intervention.

The first season of continuous confinement spanned 139 days from December 30, 2018 – May 17, 2019. The wood chip pad quickly dried following precipitation events, providing a relatively dry bedding surface. Daily labor was minimized. Cattle remained clean. The top four inches of wood chips were soiled with manure while the lower eight inches remained clean. After cattle went to pasture, soiled wood chips were removed from the surface using a tractor and back-blade, requiring the removal of approximately six inches of wood chips. These were then replaced with clean chips for the next confinement season.

The wood chip pad was conservatively sized for 50 Animal Units @ 200 ft^2 each. Other sources suggest sizing at 100 ft^2/AU. Stocking rate during the first season was 40 Animal Units (250 ft^2/AU). Rainfall and effluent volumes were logged and show that on average, volume of effluent collected equates to 73% of precipitation volume (including runoff from concrete feed lane and manure stacking area). The average of six samples show an effluent analysis of 5.06 lb N – 0.49 lb P – 7.65 lb K (lbs/1,000 gal). These numbers in conjunction with annual rainfall averages may help with effluent treatment designs.

Wood Chip Pad in use on 4/17/19, day #108 of confinement

Cost for the wood chip pad construction was $32,200. For stocking rates ranging from 100 ft^2/AU to 200 ft^2/AU, cost equates to $322/AU - $645/AU, or $3.22/$ft^2$. Engineer's estimate for an equivalent 75 ft^2/AU concrete pad = $37,245 ($745/AU; $9.93/$ft^2$). Annual maintenance cost to remove soiled wood chips and replace with new totaled $3,180 ($32 - $64/AU).

When compared with traditional concrete, wood chip pads can offer implementation cost savings and superior livestock comfort and performance. They provide more space for confined livestock but require a larger footprint. They can reduce daily maintenance time but will require above average attention to management details.

Introduction

This project demonstrates using a wood chip surface for livestock heavy use area protection as an alternative to concrete. Our aim is to explore heavy use area protection options that can perform better and cost less.

The challenges presented by outdoor livestock confinement are well understood. Livestock confinement often stresses producers, animals and our natural resources. Wet and muddy conditions add significant stress to livestock. Manure concentrations in these areas are high and storm water runoff carries excess sediment and nutrients to surface and ground water. Solutions are varied, but most commonly utilize concrete. This project demonstrates a surface alternative to concrete. Concrete effectively contains nutrients and handles long term abuse, but is costly, and farmers often want livestock off concrete when possible to minimize feet and joint stress. Wood chip pads have been used for livestock confinement in European countries for many years, but the practice is seldom used in the US. Wood chips over a drainage system can provide a soft, relatively dry wearing surface with benefits for livestock comfort and performance, while lowering construction costs and capturing the concentration of nutrients for efficient distribution across the farm.

Dewy Meadows Farm in Warren Center, Bradford County, Pennsylvania partnered with the Bradford County Conservation District to install and operate this demonstration. Owner/operators Andrew and Sally Dewing rotationally graze 100% grass fed, black angus beef cattle, totaling approximately 20 cows and 30 young stock on 100 acres. They have been extending the length of the grazing season, but still require supplemental feed for much of the winter. Typical of many beef production farms, confined cattle were previously fed in an outdoor lot. Tributaries flanked the outdoor barnyard on two sides, leading to significant nutrient and sediment loss to surface water.

Aerial view of completed project (4/17/2019). Previous unimproved holding area was in the same location.

The plan was to design and install a cattle heavy use area protection made mostly of a drained wood chip pad with a minimal concrete feed lane and concrete manure stacking pad. Our main technical advisor has been Dr. Joshua Faulkner, *Research Assistant Professor, Farming and Climate Change Program Coordinator, University of Vermont Extension Center for Sustainable Agriculture*. Dr. Faulkner has experience with wood chip pad installation and operation at several sites in both West Virginia and Vermont, and provided invaluable guidance for the design, construction, and maintenance of this project.

Project objectives were to decrease nitrogen, phosphorus, and sediment entering surface water, demonstrate innovative HUAP surfacing and runoff collection, quantify volume and nutrient content of effluent collected through the system, and to spark innovative thinking for farmers in the Chesapeake Bay watershed and beyond.

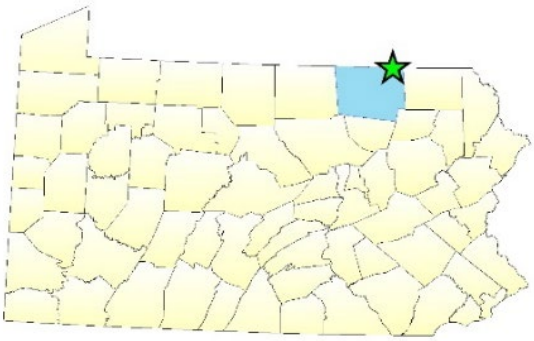


Figure 1 – Project Location

Methods

Design

The wood chip pad was conservatively sized for 50 Animal Units (AU) @ 200 ft^2 each (1 AU = 1,000 lb live weight). [1]Other sources suggest sizing at 100 ft^2/AU. Comparing these values with NRCS references suggesting 300 ft^2/AU for unpaved areas, we chose a rate in between. Stocking rate during the first season was 40 Animal Units (250 ft^2/AU). Higher stocking rates could be observed by limiting the herd to a portion of the pad. Wood chip pad dimensions are 100' x 100'. We advise a layout as close to square as possible, or in a rectangular layout, allowing livestock to access the pad along its long side.

Options for utilizing the effluent mainly include storage for field application or application to a vegetated treatment area (VTA). If manure storage already exists (with enough capacity), this would likely be recommended. For this project, irrigation to a vegetated treatment area is being used. The VTA was designed using PA NRCS standard 635 "Vegetated Treatment Area". Effluent is collected in a buried 2,000-gallon pre-cast concrete tank. A 2 hp pump on a float switch moves effluent to a 360-degree irrigation nozzle applying 40 gallons per minute over a 78 ft radius (0.44 acres).

Wherever this practice is used, feed and water must be provided on an adjacent, hardened area, where manure can be routinely removed. High manure concentrations at feed and water locations would overwhelm and eliminate drainage functions of the wood chip pad. The wood chip pad can be constructed adjacent to existing infrastructure for feed and water. In this case, existing facilities were inadequate, so a new concrete feed lane and adjacent manure stacking area were planned into the project. Design options of concrete feeding areas, waterers and manure storage are numerous and completely site specific. The feed lane was designed 12 feet wide and runs the entire 100-foot length of the wood chip pad. Cattle can enter and exit the feed lane along its entire length to minimize concentrated cattle traffic on the wood chips. Feed and water are only accessible when standing on the concrete. This is very important to minimize manure deposited on the chips. Feed is through slant bars along the curb opposite the wood chip pad. Waterers are placed on the wood chip pad side of the feed lane but are only accessible from the concrete. The feed lane is flanked by a 12-inch high curb along the feed manger and an 8-inch high curb along the wood chips which the cattle can easily step over. These have both been adequate to contain manure if the feed lane is cleaned regularly (two times per week). Manure is routinely scraped from the feed lane directly to the adjacent concrete manure stacking pad. The manure stacking pad was conservatively sized for 75% of the manure over a six-month period. Runoff from the concrete feed lane and manure stacking area drains into the wood chip pad for 100% containment of nutrients.

The wood chip pad perimeter fence was constructed of high tensile woven wire, five feet high, with one strand of smooth, high tensile, hot wire along the inside top. The fence has worked very well. Gate entry is 20 feet wide with stable access road to allow delivery of wood chips directly onto the pad.

The system was designed to be completely uncovered. The eight-inch high feed lane curb along the wood chips was constructed with two-inch wide slots spaced 12 feet apart to allow water drainage from the feed lane into the wood chip pad. After the first confinement season, the farm installed a roof over the feed lane and feed manager. Along with feed efficiency, benefits of the roof include diverting clean water, dryer (more stackable) manure, and lower effluent volume. Roof water is collected and diverted from contact with manure using roof gutters and an underground outlet.

[1] Woodchip Pads for Livestock – University of Vermont Extension Fact Sheet

Subgrade

The site chosen was on high clay content soils suitable for an impermeable subgrade. A perimeter drain was installed around three sides to lower the seasonal-high water table. An impermeable subgrade is necessary to protect ground water and to contain nutrients for collection and utilization. To best fit the site, the pad subgrade (and wood chip surface) slopes 1.0% - 2.0% toward the low point where all effluent ends up in one pipe. We believe this slope is not required but improves drainage efficiency. To maximize drainage from the pad, the subgrade was constructed with a ridge-and-valley pattern at 10-foot intervals, with a run of perforated drainpipe to be placed in each "valley".

Subgrade shaped in ridge and valley pattern to expedite drainage.

Construction began by stockpiling topsoil and organic matter. The pad site was excavated to grade achieving a flat area with elevations matching what would become the "valley" elevations of the undulating subgrade. Clay soil was then compacted in six-inch lifts around the perimeter constructing a berm to contain all effluent. The berm was built to an elevation six inches higher than finished wood chips. Six-inch high "ridges" were then built into the subgrade by carrying in clay soil with a skid steer and tracking the raised areas into place. After much discussion about how best to construct the undulating subgrade, the contractor reported that this method was indeed best. After all soil was in place, the entire subgrade was rolled with a light, smooth drum roller to help seal and smooth the surface. Geotextile (ADS 8 oz non-woven) was placed over the entire subgrade for weight distribution and to maintain separation between drainage materials and the clay subgrade.

Geotextile placed over subgrade, under perforated pipes. Along bottom of photo is the solid PVC collection pipe, placed at -1.0% grade from left to right.

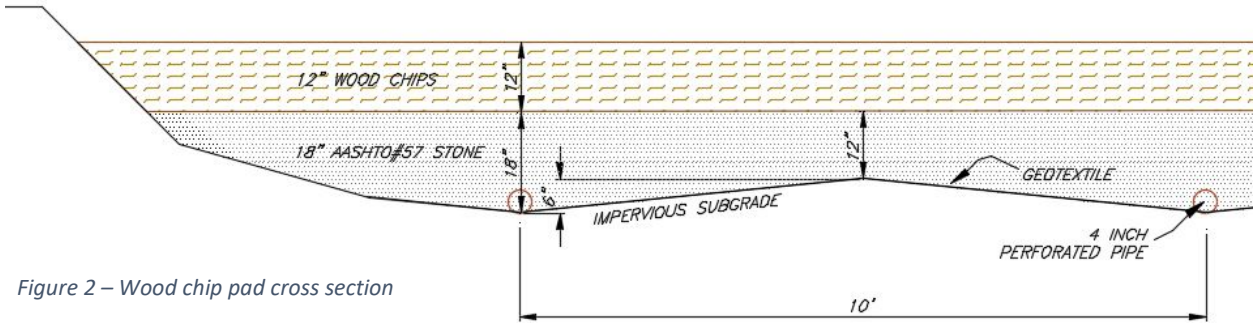


Figure 2 – Wood chip pad cross section

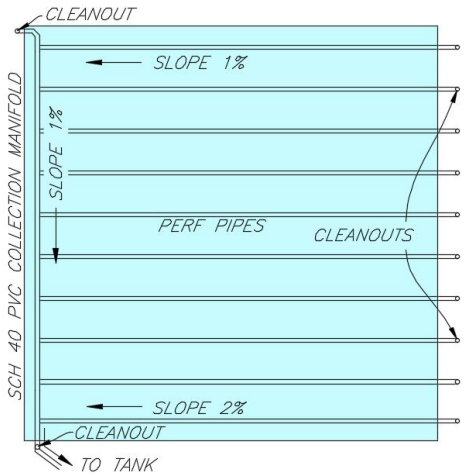


Figure 3 - Plan view of the pipe drainage system beneath the wood chip pad.

Clean #57 stone being placed over perf. pipe.

Clean-out at start of each perforated pipe.

Ready to place wood chips atop #57 stone.

Drainage

The drainage system begins with the placement of 4" perforated pipe in each "valley" of the undulating subgrade. ADS 3000 Triple Wall pipe with two rows of perforations at 120 degrees apart was used. Perforations were placed facing down. Perforated pipes were sloping toward the manifold collection pipe at slopes varying from 1% to 2%, and the collection manifold pipe slopes at 1% to the low point of the subgrade. The manifold pipe then continues as solid schedule 40 PVC to the collection tank. Clean-outs were installed at the start of each perforated pipe run and at each end of the manifold collection pipe.

On top of the perforated pipe is placed 18" of clean, AASHTO #57 (2B) stone. Maximum depth of stone is 18 inches, so there is approximately 12 inches of stone over top of the ridges in the subgrade. The final stone surface slopes 1.0% - 2.0% exactly matching slopes of the subgrade. This stone was by far the largest material expense. Clean, #57 stone is considered essential for protection of pipes and longevity of drainage.

Wood Chips

With pipes and drainage stone in place, a 12-inch thick layer of wood chips is placed directly on top of the stone. Since the stone surface ideally will never be reached or disturbed during annual wood chip maintenance, care was taken when placing wood chips to not disturb the leveled stone, maintaining a uniform wood chip-stone interface. The final wood chip surface slopes 1.0% - 2.0%, exactly matching slopes of the subgrade. This slope is not required. A finished surface with these slopes did not appear to cause migration of wood chips.

Most important is that wood chips are large enough and screened to be free of fine particles and long fibers that would impede drainage. Look for chips processed for commercial heating applications, called "bole" chips. Recommended chip size is 2" x 2" x 0.25". Chips used in this project were closer to 1" square. Wood chip species is not as important. Hardwoods are expected to last longer, absorb less water, and produce more runoff. In this case, chips are predominantly ash with some red maple. Care was taken to begin with a smooth, uniform wood chip surface so that depth of manure solids mixing with chips would be uniform across the entire pad.

Effluent Data

Rainfall and effluent monitoring began along with the first confinement period in January 2019 and continues to present. Rainfall is monitored by using an automatic data logging rain gauge by Onset. Effluent volume collected is being monitored by an electromagnetic flow meter in the pump transfer line just before the irrigation nozzle. A data logger connected to this flow meter captures flow volumes with a date/time stamp, so we know when, and how much water is pumped to the filter area. With these we can compare volume of precipitation received with volume of effluent collected.

Six effluent samples were taken on four different days between March 20 and May 15. Four of the samples were collected where the wood chip pad collection system outlets into the tank. Two samples were taken at the VTA by catching water as it was irrigated. We assume that nutrient content will vary depending on flow rate from the wood chip pad, especially considering that runoff from the manure stacking area is included. We attempted to collect samples during varying flow conditions, but a more thorough study would be required to understand these differences.

Findings

Effluent Data

For the purposes of this report we are evaluating rainfall and effluent data for May and June 2019. Our precipitation data is not valid when snow fall is included. Average rainfall for May and June in Bradford County totals 7.00 inches. On-site totals for May-June 2019 were 10.44 inches. The effluent volume collected equates to 73% of precipitation volume for this period. We have no comparison data from a concrete lot for a comparable herd. We expect that due to larger area/AU on a wood chip pad, that runoff volume will be similar between the two systems, if not slightly higher for a wood chip pad.

Table 1 - Rainfall vs. effluent volumes

Month	Rainfall (inches)	Precip (gallons)	Effluent (gallons)	% of Precip
May, 2019	5.3	43,608	33,157	76%
June, 2019	5.14	42,292	29,636	70%
Total	**10.44**	**85,900**	**62,793**	**73%**

Effluent samples were submitted as manure and analyzed by Penn State University Ag Analytical Services Laboratory in State College, PA. An average of the six samples gives us an effluent nutrient content of 5.06 lb N – 0.49 lb P_2O_5 – 7.65 lb K_2O (lbs/1,000 gal).

Table 2 - Effluent analysis results

Sample Date	Note	N total	P_2O_5	K_2O
3/20/2019	tank - trickle flow	6.84	0.47	13.74
4/15/2019	tank - moderate flow	8.17	0.61	6.39
4/17/2019	tank -moderate flow	8.84	0.54	6.31
4/17/2019	irrigation - same time	2.75	0.44	5.11
5/15/2019	tank - low flow	1.92	0.45	7.57
5/15/2019	irrigation - same time	1.83	0.41	6.79
Average =	**(Units = lbs/1,000 gal)**	**5.06**	**0.49**	**7.65**

Total effluent collected during the confinement season = 122,840 gallons (January 1 – May 31, 2019). On-site precipitation in 2019 for this period exceeded 18 inches compared to the average 12.91 inches. See Appendix 2 for an evaluation of the Vegetated Treatment Area (VTA) design. The VTA turned out to be under-sized for 2019 effluent analysis and volume. 2019 Nutrient balance on the VTA = -83 lb N/ac, -77 lb P/ac, and -1,936 lb K/ac, which means all nutrients were over-applied. If re-evaluating this design, with these numbers, three irrigation sprinklers would be required to spread effluent over a large enough area (1.3 ac) for proper nutrient application. Significant potassium over-application should also be considered by the farm operator. This supports the use of manure storage as a preferred alternative for effluent utilization.

Construction Cost

Total cost for the entire project was $102,800. Construction cost of the wood chip pad portion alone totaled $32,200. If we consider stocking rate ranging between 100 ft^2 – 200 ft^2/AU, construction cost equates to $322/AU - $645/AU, or $3.22/ ft^2. Funding sources used include Dewy Meadows Farm, USDA-NRCS Conservation Innovation Grant, PA DEP Small Business Advantage Grant, and PA REAP Tax Credits.

Table 3 - Project cost summary

Item		Cost
Wood Chip Pad	$	32,227.54
Concrete Scrape Lane	$	20,955.94
Manure Stacking Area	$	22,748.46
Waste Water Transfer and Filter Area	$	11,028.93
Barnyard Perimeter Fence	$	4,406.73
Access Road	$	11,397.19
Total	**$**	**102,764.79**

Table 4 - Wood chip pad cost breakdown

Item	Quantity	Cost
Excavation	Lump Sum	$ 9,027.00
Goetextile	2 rolls	$ 965.00
Pipe	1,100 ft	$ 647.50
#57 Stone	602 ton	$ 9,968.97
Wood Chips	aprx 95 ton (385 yd^3)	$ 4,820.00
Perim Drain	532 ft	$ 4,942.07
Labor	Lump Sum	$ 1,857.00
Total		**$ 32,227.54**

A comparable concrete barnyard sized for 50 AUs @ 75 ft^2 each = 3,750 ft^2. With a layout measuring 50' x 75' surrounded with 2 ft curb including required subsurface drainage, the cost estimate for a comparable concrete barnyard = $37,245. This equates to $745/AU, or $9.93/ ft^2.

Wood chips soiled to 4" depth. Clean chips and stone beneath.

Maintenance

The first season of continuous confinement spanned 139 days from December 30, 2018 – May 17, 2019. The wood chip pad received no maintenance intervention during the entire confinement period. The pad dried quickly following precipitation events, providing a relatively dry bedding surface throughout the confinement period. Cattle remained clean. Evaluation of the wood chip pad during confinement showed that the top four inches of wood chips were soiled with manure while the lower eight inches remained clean. Time lapse photography of the confinement period gives a sense of drainage performance and can be accessed at www.bccdpa.com/woodchip.

The first confinement period ended May 17, 2019 when cattle went to pasture. Wood chip pad maintenance was performed July 4, 2019. Soiled wood chips were removed from the surface using a tractor and


Six inches of soiled chips removed with back-blade.

back-blade, requiring the removal of approximately six inches of wood chips. Soiled wood chips were piled in the empty manure stacking area and remained until field application in November 2019. No efforts were made to stir the chip pile to encourage composting. Wood chips did not show significant signs of breakdown by the time of field application. New wood chips totaling 50 ton (200 yd^3) were delivered in July and spread to bring the wood chip pad back to its original 12-inch thickness. The second confinement season began November 15, 2019. Cost of annual wood chip pad maintenance totaled $3,180 which equates to $32 - $64/AU. Wood chip pad cleaning in the off season required a full day of detail work to separate soiled chips and prepare for re-surfacing. This level of management effort and interest will be essential for prolonging effective wood chip pad drainage.

Table 5 - Wood chip pad maintenance cost - July 2019

Item	Quantity	Units	Unit Cost	Cost
New Wood Chips	55	ton	$ 40.00	$ 2,200.00
Tractor - remove soiled chips	4	hrs	$ 75.00	$ 300.00
Skid Steer - stack old and place new chips	8	hrs	$ 75.00	$ 600.00
Additional Labor[2]	4	hrs	$ 20.00	$ 80.00
Total[1]				**$ 3,180.00**

[1] This is considered annual maintenance cost for the wood chip pad only (does not include manure handling from scrape lane or manure stack).

[2] Hand labor to clean corners and misc. areas throughout wood chip pad

The "daily" maintenance routine during confinement included scraping manure from the feed lane two times per week with a skid-steer, maintaining an efficient manure stack, and monitoring effluent pump operation. Maintenance time for manure and wastewater handling totaled approximately 1 hour per week. No additional bedding was used. Manure storage capacity was adequate. Routine manure scraping from the feed lane is important to minimize the amount of manure being tracked by cattle from the feed lane to the wood chip pad.

Design Evaluation

Wood chip pad performance met expectations and design components are sound recommendations. The feed lane slotted curb along the wood chip pad allowed some water to escape, but manure retained a significant amount of moisture. Allowing runoff from the manure stacking area to drain through the wood chip pad worked very well. This method of runoff collection required no maintenance during the confinement season. Manure remained stackable (approximately 4 feet high) in the uncovered storage and did not migrate to the wood chips.

Deliverables

These improvements are now continuously containing nutrients and sediment that were previously being lost to surface water on the farm. Annual savings are estimated to be 3,762 pounds of nitrogen; 2,394 pounds of phosphorus; and 1,080 pounds of sediment.

A public open house/conservation field day was held at Dewy Meadows Farm on April 6, 2019. Sixty-five farmers and industry service providers attended the event.

A project summary was presented to the NRCS Pennsylvania State Technical Committee in Harrisburg, PA on April 18,2019. Approximately 20 committee members were present.

Two additional products developed along with this final report include a two-page fact sheet and a web video. Both summarize design and management of the wood chip HUAP. All project publications and media can be accessed from the BCCD web page at www.bccdpa.com/woodchip.

Conclusions

When compared with traditional concrete, wood chip pads can offer implementation cost savings and superior livestock comfort and performance. Construction cost savings could range from $420 - $100/AU, depending on stocking rate. Cattle cleanliness has been rated very good which is expected to contribute to livestock growth performance. Lower stocking rates on a wood chip pad, compared to concrete, provide livestock more room with better footing but require a larger footprint and may increase wastewater handling costs. Wood chip pads can reduce daily maintenance time when compared to a concrete lot but will require above average attention to management details.

Appendices

1. Rainfall and Effluent Daily Data Table May 1 – June 30, 2019
2. VTA Design Evaluation
3. Fact Sheet – *"Wood Chip Pads for Livestock – A Case Study"*
4. Project videos (accessible at www.bccdpa.com/woodchip):
    - Project Summary Video
    - Construction Time Lapse Video
    - Cattle Movements Time Lapse Videos (short and long)

Adjacent tributaries run clear.

Concrete, covered feed lane adjacent to wood chip pad

References

Construction Material References

Geotextile – ADS 8 oz non-woven, 1 roll is 300' x 15', coverage approx. 4,200 ft^2
Perforated pipe – ADS 3000 triple wall, 2 rows of perforations 120 degrees apart
Wood Chips – Bole chips from Wagner Millwork, LLC, Owego, NY
Effluent Pump – Goulds, 2 hp, Model 3885 WE2012H, delivering 40 gpm at 98 ft TDH
Irrigation nozzle – Rainbird model 80 EHD – www.rainbird.com
Rain Gauge – Onset Data Logging Rain Gauge Model RG-2 with Pendant data logger
www.onsetcomp.com/products/data-loggers/rg3
Flow Meter – Flomotion Systems MS-2500 Electromagnetic Flow Sensor with ML-110 converter
www.flomotionsystems.com/Flomotion-Systems-Products-db.php?modelselect=ms2500
Flow data logger - Onset HOBO pulse logger model UX90-001
www.onsetcomp.com/products/data-loggers/ux90-001

Contacts

Dewy Meadows Farm, LLC – www.dewymeadows.com
Bradford County Conservation District – www.bccdpa.com
Planner: Nathan Dewing, Agricultural Team Leader, nate.dewing@pa.nacdnet.net
Engineer: Robert Sweppenheiser, District Engineer, rob.sweppenheiser@pa.nacdnet.net
Project Advisor: Dr. Joshua Faulkner, Research Assistant Professor, University of Vermont Extension, Joshua.Faulkner@uvm.edu
Wagner Millwork, LLC – 4080 Gaskill Rd, Owego, NY 13827; (607) 687-5362
Abell Construction, Warren Center, PA – excavation contractor
Creekside Construction, Mill Hall, PA – concrete contractor

Acknowledgements

Bradford County Conservation District would like to thank these partners for helping make this project possible:

Dewy Meadows Farm

BCCD board of directors for your outstanding leadership

University of Vermont Extension

USDA, NRCS – Conservation Innovation Grant

PA Department of Environmental Protection – Small Business Advantage Grant

PA Department of Agriculture - REAP Tax Credit Program

Thank you to the Natural Resources Conservation Service for partially funding this wood chip pad project through its Conservation Innovation Grant.

This publication is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under number 69-2D37-18-003. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. USDA is an equal opportunity employer, provider, and lender.

Dewy Meadows Farm, Wood Chip HUAP

Precipitation vs. Effluent Volumes Daily Data, May-June, 2019

Date	Low Temp (F)	Precipitaiton (inches)	[1] Precipitation (gal)	Effluent (gal)
5/1/19	39.007		0	0
5/2/19	51.523	0.02	165	763
5/3/19	48.517	0.51	4196	866
5/4/19	52.05	0.21	1728	2355
5/5/19	49.228	0.19	1563	759
5/6/19	44.56	0.06	494	1466
5/7/19	41.81		0	0
5/8/19	38.629		0	728
5/9/19	39.196	0.01	82	0
5/10/19	50.819	0.66	5430	0
5/11/19	42.548		0	0
5/12/19	39.007	0.82	6747	0
5/13/19	38.25	0.72	5924	0
5/14/19	40.696	0.13	1070	17113
5/15/19	39.196	0.13	1070	491
5/16/19	39.573		0	809
5/17/19	44.56	0.04	329	0
5/18/19	35.37		0	975
5/19/19	47.088		0	0
5/20/19	52.925	0.11	905	0
5/21/19	38.818		0	820
5/22/19	33.213		0	0
5/23/19	51.523	0.62	5101	1611
5/24/19	44.379		0	0
5/25/19	39.573	0.51	4196	1042
5/26/19	57.785		0	787
5/27/19	43.831		0	803
5/28/19	50.643	0.12	987	0
5/29/19	52.75	0.35	2880	915
5/30/19	56.577	0.09	741	40
5/31/19	49.05		0	814
6/1/19	45.648	0.29	2386	802
6/2/19	46.008	0.32	2633	952
6/3/19	37.679		0	816
6/4/19	34.981		0	0
6/5/19	53.274	0.1	823	0
6/6/19	48.695	0.16	1316	821
6/7/19	41.254		0	0
6/8/19	42.915		0	831
6/9/19	45.466		0	0
6/10/19	48.695	0.55	4525	849
6/11/19	43.648	0.06	494	832
6/12/19	38.629		0	0
6/13/19	51.523	0.45	3703	1699

Dewy Meadows Farm, Wood Chip HUAP

Precipitation vs. Effluent Volumes Daily Data, May-June, 2019

Date	Low Temp (F)	Precipitaiton (inches)	[1] Precipitation (gal)	Effluent (gal)
6/14/19	45.466	0.01	82	0
6/15/19	45.648	0.06	494	0
6/16/19	59.164	1.16	9544	7666
6/17/19	56.404		0	1691
6/18/19	56.577	0.47	3867	2738
6/19/19	59.68	0.01	82	844
6/20/19	63.282	0.15	1234	838
6/21/19	50.466	0.58	4772	3936
6/22/19	47.802		0	0
6/23/19	45.648		0	847
6/24/19	46.188		0	0
6/25/19	56.75		0	0
6/26/19	51.346		0	0
6/27/19	51.874		0	0
6/28/19	54.322		0	850
6/29/19	63.797	0.76	6253	1775
6/30/19	50.29	0.01	82	849
Total			**85,900**	**62,793**
				73%

[1] Area collecting rainfall is 13,200 sq ft (10,000 sq ft wood chip pad; 1,200 sq ft conc scrape lane; 2,000 sq ft conc manure stack area)

Pump breaker had tripped and water was backed up into HUAP drainage stone.

Appendix 2

1/29/2020

Dewy Meadows Farm - Wood Chip HUAP

VTA Design Evaluation

[1] Total Effluent Applied (gal)=	122,840
VTA size (ac) =	0.44
Application Rate (gal/ac) =	279,182

Nutrient	Content (lb/1,000 gal)	Total Applied (lb)	Avail Factor	Total Available (lb)	[2] Crop Need (lb/ac)	VTA Area Required (ac)	[3] Sprinklers Required	Total Available (lb/ac)	[4] Balance (lb/ac)	[5] Balance if larger VTA (lb/ac)
N	5.06	622	20%	124	200	0.62	1.4	283	(83)	170
P	0.49	60	100%	60	60	1.00	2.3	137	(77)	34
K	7.65	940	100%	940	200			2136	(1936)	(448)

[1] Total effluent applied from January 1 - May 31, 2019 = 122,840 gal. Actual Precip >18" compared to 12.91" avg for period.

[2] Crop need based on 4T/ac yield of Mixed Grass

[3] P is limiting for VTA design; would require 3 sprinklers x 0.44 ac each = 1.32 ac total VTA.

[4] This is as-built condition. Nutrient balance on a per acre basis when using only 1 irrigation sprinkler. All nutrients are overapplied.

[5] This is nutrient balance if total avail nutrients are applied to 1.32 ac VTA. N and P are under-applied. K still over-applied by 450 lb/ac.

Bradford County Conservation District
Pennsylvania

Wood Chip Pads for Livestock

– A Case Study –

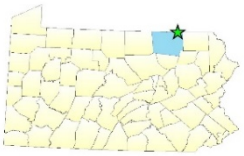


Figure 1 – Project Location

Wood chip pad on 4/17/19 (confinement day #108)

Concrete, covered feed lane adjacent to wood chip pad

Subgrade with ridge-valley shape to expedite drainage

Clean #57 stone being placed over perf. pipe.

Ready for wood chip placement over stone

Introduction

Wood chip surfaces can offer an alternative to concrete for stabilizing livestock heavy use areas. Livestock confinement often stresses producers, animals, and natural resources. Traditional concrete surfaces work well, but are costly, and continual use significantly stresses livestock. Dewy Meadows Farm in Warren Center, Bradford County, PA, a 50 head cow/calf, grass fed, rotationally grazed beef operation, partnered with the Bradford County Conservation District to install and operate this demonstration wood chip pad. The project was partially funded by USDA Natural Resources Conservation Service's Conservation Innovation Grant. Construction was completed in December 2018, and the first confinement season spanned December 30, 2018 – May 17, 2019 (139 days).

The key to the wood chip pad is drainage - moving water away from livestock. The wood chip pad is constructed with an impermeable clay subgrade and perimeter berm containing a grid of perforated pipes under 18 inches of clean #57 stone, overlain with 12 inches of screened, large size wood chips for a wearing surface. Precipitation and liquid waste collected on the open-air pad drains through the wood chips and stone and is collected for treatment. Collected effluent can be placed in a manure storage facility. In this case it is applied to a vegetated treatment area via sprinkler irrigation.

Planning

The wood chip pad was conservatively sized for 50 Animal Units (AU) @ 200 ft^2 each (1 AU = 1,000 lb live weight). Other sources suggest sizing at 100 ft^2/AU (Woodchip Pads for Livestock – University of Vermont Extension Fact Sheet). Wood chip pad dimensions are 100' x 100'. Feed and water must be provided on an adjacent, hardened area, where manure can be routinely removed. High manure concentrations at feed and water locations would overwhelm and eliminate drainage functions of the wood chip pad. The wood chip pad can be constructed adjacent to existing infrastructure. In this case a new concrete feed lane and adjacent manure stacking area were constructed.

Subgrade

An impermeable subgrade is necessary to protect ground water and to contain nutrients for collection and utilization. The site chosen was on high clay content soils suitable for an impermeable subgrade. A perimeter drain was installed to lower the seasonal-high water table. To maximize drainage from the pad, the subgrade was constructed with a ridge-and-valley pattern at 10-foot intervals, with a run of perforated drainpipe to be placed in each "valley". Geotextile was placed over the entire subgrade to maintain separation between drainage materials and the clay subgrade.

Background Photo: Woodchip pad May 1, 2019 (confinement day #122)

Drainage and Wood Chip Surface

Four-inch perforated pipe is placed in each "valley" of the undulating subgrade, sloping toward a solid PVC manifold collection pipe, which carries effluent to a 2,000-gallon concrete tank. On top of the perforated pipe is placed 18" of clean, #57 stone, which is considered essential for protection of pipes and longevity of drainage. A 12-inch thick layer of wood chips is placed directly on top of the stone. Wood chips must be large enough and screened to be free of fine particles and long fibers that would impede drainage. Look for chips processed for commercial heating applications, called "bole" chips. Recommended chip size is 2" x 2" x 0.25". square. Wood chip species is not as important. Hardwoods are expected to last longer, absorb less water, and produce more runoff. In this case, chips are predominantly ash with some red maple, approximately 1" square and supplied by Wagner Millwork, Owego, NY.

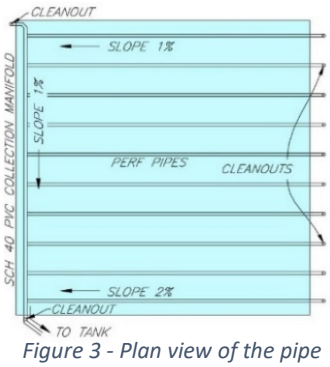


Figure 3 - Plan view of the pipe drainage system beneath the wood chip pad.

Cost

Construction cost of the wood chip pad portion alone totaled $32,200 for the 10,000 ft^2 area ($3.22/ft^2). For stocking rates ranging between 100 ft^2 – 200 ft^2/AU, construction cost equates to $322/AU - $645/AU. A cost estimate for a comparable concrete barnyard sized for 50 AUs @ 75 ft^2 each totals $37,245 ($745/AU, or $9.93/ ft^2).

Table 1 - Wood chip pad cost breakdown

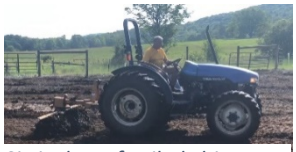
Item	Quantity	Cost
Excavation	Lump Sum	$ 9,027.00
Goetextile	2 rolls	$ 965.00
Pipe	1,100 ft	$ 647.50
#57 Stone	602 ton	$ 9,968.97
Wood Chips	aprx 95 ton (385 yd^3)	$ 4,820.00
Perim Drain	532 ft	$ 4,942.07
Labor	Lump Sum	$ 1,857.00
Total		**$ 32,227.54**

Performance

The wood chip pad received no maintenance intervention during the entire confinement period. The pad dried quickly following precipitation events, providing a relatively dry bedding surface throughout the confinement period. Cattle cleanliness has been rated very good which is expected to contribute to livestock growth performance. Evaluation of the wood chip pad during confinement showed that the top four inches of wood chips were soiled with manure while the lower eight inches remained clean. Time lapse photography of the confinement period gives a sense of drainage performance (www.bccdpa.com/woodchip).

Wood chips soiled to 4" depth. Clean chips and stone beneath.

Wood chip pad maintenance was performed in July. Soiled wood chips were removed from the surface using a tractor and back-blade, requiring the removal of approximately six inches of wood chips. Soiled wood chips were piled in the empty manure stacking area until field application in November. New wood chips totaling 50 ton (200 yd^3) were delivered in July and spread to bring the wood chip pad back to its original 12-inch thickness. Cost of annual wood chip pad maintenance totaled $3,180 which equates to $32 - $64/AU.



Six inches of soiled chips removed with back-blade.

Conclusions to Date

The effluent volume collected equates to 73% of precipitation volume for this period. Analysis of collected effluent shows a nutrient content of *5.06* lb N – *0.49* lb P_2O_5 – *7.65* lb K_2O (lbs/1,000 gal).

When compared with traditional concrete, wood chip pads can:

- Offer implementation cost savings and superior livestock comfort and performance.
- Provide livestock more room but require a larger footprint and may increase wastewater handling costs.
- Reduce daily maintenance time but will require above average attention to management details.

Project related videos along with the full report can be viewed at www.bccdpa.com/woodchip.

The Bradford County Conservation District thanks these partners for making this project possible: Dewy Meadows Farm, University of Vermont Extension, USDA-NRCS Conservation Innovation Grant, PA DEP Small Business Advantage Grant, PA Dept of Agriculture REAP tax credit program

This publication is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under number 69-2D37-18-003. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. USDA is an equal opportunity employer, provider, and lender.