

TN22-023: Outbreak Report

An Outbreak of Shiga Toxin-Producing *E. coli* O157:H7 Associated with a Goat Husbandry Summer Camp in Rutherford County, Tennessee – June 2022

Background

On Wednesday, June 22, the Tennessee Department of Health (TDH) was notified of an ill child hospitalized in Florida with Shiga Toxin-Producing *E. coli* (STEC) O157:H7 after attending a goat husbandry summer camp at a local farm in Rutherford County, Tennessee. The TDH received a second call on Saturday, June 25 from the same mother stating she knew of a 2-year-old patient hospitalized at Vanderbilt in Nashville, TN with hemolytic uremic syndrome (HUS) and reported that this child's older brother had attended the same camp. The Foodborne and Enteric Diseases (FED) Program staff searched Vanderbilt Medical Center's electronic medical records confirming the child had STEC and was admitted for HUS. On the morning of Monday June 27, the FED team initiated an outbreak investigation.

The farm hosting the summer camp, "Farm X," included many attractions for families such as a petting zoo, pony rides, splash pad, walking trails, various fields and three food service establishments. During the summer months, Farm X held multiple five-day summer camps teaching animal husbandry for children ages 6-10. Among other activities, children pick out a baby goat and care for it the remainder of the camp. Children attended camp during the day and return home each afternoon. Three of these camps took place in 2022 prior to the TDH investigation: June 6-10 (Week 1), June 13-17 (Week 2), and June 20-24 (Week 3). Farm X typically hosts three weeks of camp followed by two weeks of no camp.

Methods

Epidemiology

A list of 82 Summer Camp participants from weeks 1, 2 and 3 and their parent/guardians' contact information was obtained from Farm X for case finding and exposure assessment. TDH staff sent an online survey to all parents/guardians on Friday, July 1 to provide information about the outbreak and conduct interviews. Questions included symptom profile and duration, illness outcomes, days/weeks of camp attendance, food history specific to lunches and other foods served at the camp, and camp activities. Cases were classified using the following case definitions:

Confirmed Case

- **Primary** Confirmed Case: A person who attended any of the three Farm X Summer Camps from 6/6/22 – 6/24/22 and tested positive for STEC with a specimen collection date after 6/6/22.
- **Secondary** Case: A household member or close contact of a Farm X Summer Camp attendee who tested positive for STEC with a specimen collection date after 6/6/22.

Probable Case

- **Primary** Probable Case: A person who attended Farm X Summer Camp and became ill with diarrhea* within 10 days of attending the Farm X Summer Camp without laboratory confirmation.

- Secondary Probable Case: A household member or close contact of a Farm X Summer Camp attendee that became ill with diarrhea* within 10 days after encountering a primary probable case.

***Diarrhea:** Defined as at least 3 or more loose stools within a 24-hour period

Data were collected and stored in REDCap. The survey was open from Friday, July 1 at 5PM to the afternoon of Friday, July 8. A reminder was sent to camp contacts on Tuesday, July 5 at noon. Odds ratios and Fisher's exact p-values were calculated to help narrow down different possible exposures of interest on the farm and at the summer camp. If a person did not complete the survey, they were excluded from the analysis.

Environmental Health

On June 28th and 29th, FED and Mid-Cumberland Region Environmental Health staff conducted an environmental assessment (EA) at Farm X. Property owners, management and several staff members were in attendance. The aims of EA activities included an onsite interview and observation, collection of camp attendee registration, goat assignment records, and environmental sampling.

A total of 28 environmental and water samples were collected by the TDH during the site visits (See Appendix II). All samples were delivered to the Tennessee State Public Health Laboratory (SPHL) on the same day of collection. Farm X also collected thirteen goat stool samples, independent of TDH sampling, for testing at Tennessee Department of Agriculture's C.E. Kord Animal Health Diagnostic Lab (Kord Lab) and water samples for testing at a private laboratory in Nashville named Micobac.

Laboratory

Samples received at the SPHL were tested by polymerase chain reaction (PCR) and if PCR results were positive, isolation of the bacteria was attempted. If isolation was successful, the isolates were sent to the sequencing department for whole genome sequencing (WGS). After initial analysis by the Kord Lab, any specimens where STEC was isolated were sent to the SPHL for WGS. Samples initially tested by the SPHL that were unable to grow STEC were sent to the United States Department of Agriculture (USDA) Agroecosystem Management Research Unit for repeat testing, as this USDA laboratory specializes in animal and environmental STEC testing.

Results

Epidemiology

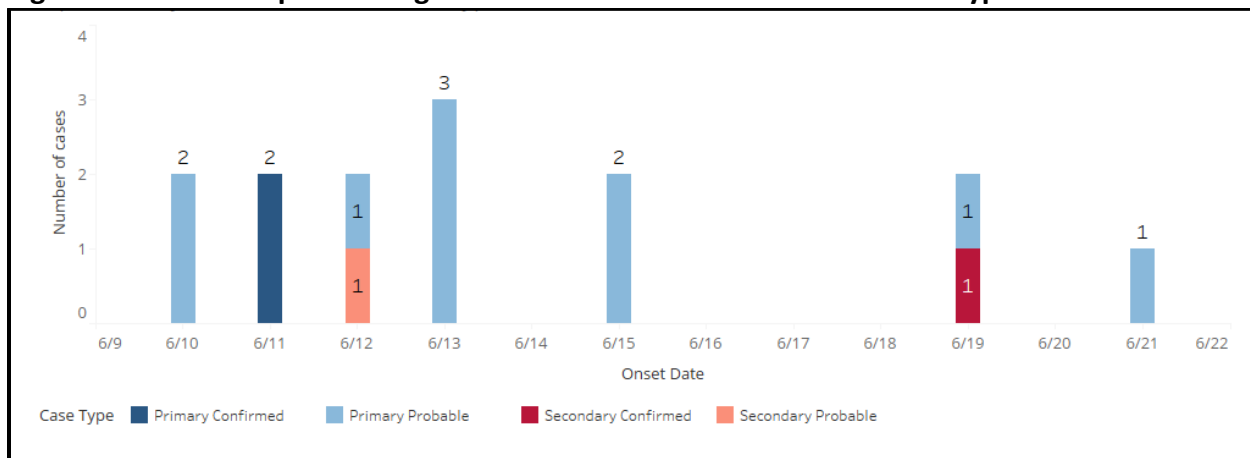
Eighty-two summer camp attendees were present at Farm X from 6/6/22 – 6/24/22. Fifty-three (65%) surveys were completed using an outbreak-specific questionnaire with twelve cases and fifty-eight controls included in the final analysis.

Twelve primary cases (2 confirmed, 10 probable) and two secondary cases (1 confirmed, 1 probable) were identified. Onset dates ranged from June 10 to June 21, 2022. The epidemiologic curve supports the likelihood most ill primary cases were exposed sometime during the week they attended camp; ten of twelve primary cases attended between June 6 and June 10. The median duration of illness was 4.5

days (Range: 2-20 days). Five cases (36%) were female. The median age among cases was 6 years. Two cases (one primary and one secondary case) went to the ER and were hospitalized. The secondary hospitalized case developed HUS and passed away. Fourteen (100%) cases reported diarrhea, seven (50%) reported stomach cramps, six reported fever (43%), and 5 (36%) reported nausea. The number of new cases peaked on June 13 with three cases stating they began feeling ill on this day.

Campers were served six food options and engaged in seventeen activities (see Appendix I for the full food and activity analysis). When comparing cases with controls (non-ill persons) who attended the camp, none of the food items or activities were statistically significantly associated with illness. Given the camp food and activity schedules were consistent between weeks and most campers ate every food and participated in almost every activity, it is difficult to make meaningful comparisons along these lines. The only statistically significant difference between cases and controls was that cases were more likely to attend camp during week one (OR: 13.1, 95% CI 2.59, 66.57) which is reflected in the epi curve (Figure 2).

Figure 2. TN22-023 Epidemiological curve of illness onset date and case type



Environmental Health

On 6/25/22 Farm X voluntarily closed the facility. During the EA on 6/28/22 the food service aspect of the farm was not operating and general inquiries about food service and preparation were made. No ill food handlers, ill farm staff, or camper illnesses were reported to the farm owners during the three weeks of camp. There were no reports of foodservice system changes during this time and no disruptions in water, sewage, or power were reported. There were no maintenance activities reported for kitchen equipment and the kitchen was in good repair. Farm X owners reported that only pre-cooked food was served to campers and fresh watermelon was offered as an optional selection. Fresh raw, preformed beef burgers were prepared on Thursdays and Fridays and cooked to order but were not offered to campers. FED staff recommended cleaning and sanitizing all food contact surfaces in the kitchen and separating staff duties between farm/animal handlers from food handlers.

There were several handwashing and hand sanitizing stations throughout the facility. The outdoor handwashing stations observed were manually activated by depressing a foot bulb on ground and supplied with cold water (both municipal and chlorinated spring-sourced), soap, and towels. Farm X’s

policy requires handwashing immediately following goat handling and prior to food service for campers. For smaller children, Farm X reported that step stools are provided, and staff assists them with pumping the water. Several porta-potty restrooms were provided throughout the facility and are maintained by the staff. Waste contents are removed by third-party, porta-potty vendor. No fecal incidents reported amongst campers during any week of camp.

On 6/28/22 investigators collected twenty environmental samples (See Appendix II Samples # 1-20) and on 6/29/22 collected eight water samples (See Appendix II Samples 1.W– 8.W). Farm X was able to provide investigators with the camp registration contact list, goat assignment records, lists of daily camp activities, and food service menu calendar. During the onsite visits the farm appeared to be in good repair and the animals seemed well cared for and healthy.

In response to the outbreak, Farm X expedited the already scheduled demolition of the barn housing the baby goats, euthanized two baby goats who had tested positive for STEC, moved the rest of the herd off the property, and indefinitely ceased the animal husbandry aspect of the summer camp. During the closure of the farm, Farm X reportedly consulted with veterinarians from the United States Department of Agriculture (USDA) and the Tennessee Department of Agriculture (TDA). Lastly, to better understand how similar operations address pathogen transmission risk reduction, Farm X reported consulting with other farming operations including visiting three petting zoos.

On 7/18/22 Farm X reopened for summer camp, without the goat husbandry component, and to the public on 7/21/22.

Laboratory

The SPHL received a total 33 environmental samples, eight water samples, and three clinical samples. One clinical specimen was collected in Florida and analyzed for whole genome sequencing by the Florida Department of Health State Laboratory. Of the 33 environmental samples one was a goat feed sample, seventeen were goat stool specimens, and fifteen were environmental swabs. Thirteen of the goat stool specimens were collected independently by the owner of Farm X and were initially analyzed at the Kord Lab. Fifteen of the environmental samples (one goat rectal swab and fourteen goat fecal samples) that initially were unable to grow STEC were sent to the USDA Agroecosystem Management Research Unit for repeat testing. In total, 45 specimens were collected in response to this outbreak (see Appendix II: Table 2).

Of the 45 samples collected for this outbreak nine were positive for STEC representing three different serotypes: H14 (2 environmental), O157:H7 (3 clinical, 2 environmental), O26 (2 environmental) (See Appendix II: Table 2). One of the H14 specimens was collected by Farm X and initially tested at the KORD laboratory; neither of the H14 or O26 serotypes were associated with clinical illnesses in this outbreak. All five O157:H7 specimens were closely related by WGS. The two environmental samples were from a wooden post inside the barn where the baby goats resided (See Appendix II Sample #12) and from a runny stool (animal origin not confirmed) collected outside on the side of the barn where the baby goats would congregate (See Appendix II: Table 2, Sample #6). Sample 12 was isolated and sequenced by the SPHL and sample 6 was isolated by the USDA's Agroecosystem Management Research Unit followed by sequencing at the SPHL. All five samples were closely related with a maximum of nine SNPs and average of four SNPs distance between isolates (Figure 3). In terms of alleles, which more closely reflect the core genome, four of the five specimens were zero alleles apart (Figure 4). Allele information for the missing

specimen is unavailable since it was collected in Florida and the two fecal samples (N22165515-01V and N22165515-01W) were isolates generated from the same specimen (See Appendix II: Table 2, Sample #6).

Figure 3. TN22-023 Screenshot of NCBI Pathogen Detection Isolate Viewer

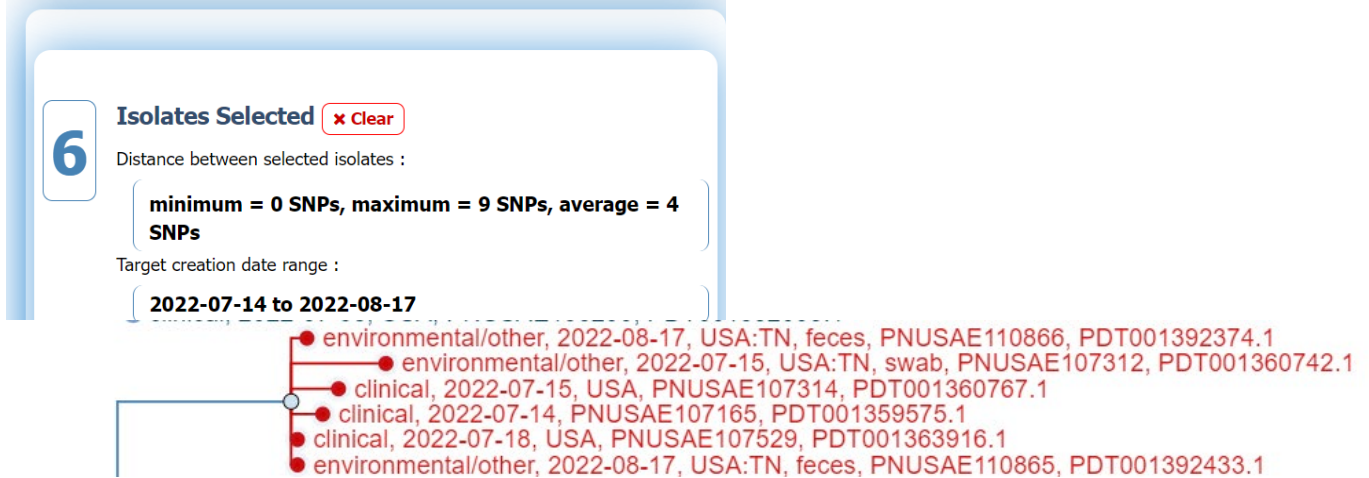


Figure 4. TN22-023 Bionumerics Allele Results

wgMLST (Core)	SourceSite	SourceType	Allele_code
N22165521-01	Swab	Environmental	EC1.0 - 9.1.3.190.4
N22E174096-01	Stool	Human	EC1.0 - 9.1.3.190.4
N22165515-01V	Feces	Animal	EC1.0 - 9.1.3.190.4
N22165515-01W	Feces	Animal	EC1.0 - 9.1.3.190.4
N22E167166-01	Stool	Human	EC1.0 - 9.1.3.190.4

Discussion & Conclusion

It is well documented that Shiga Toxin-producing *E. coli* (STEC) resides in the gastrointestinal tract of ruminant animals such as cattle, goats, sheep, deer, and elk without causing illness ([Source CDC¹](#)). STEC outbreaks have also been well documented specifically in the petting zoo environment both in the United States and globally ([Austria 2015²](#), [Florida 2007³](#), [Virginia 2022⁴](#), [Connecticut 2016⁵](#), [Florida, and Arizona 2004 and 2005⁶](#)).

In June and July of 2022, the TDH investigated an outbreak of STEC *E. coli* O157:H7 associated with Farm X in Tennessee. Survey responses did not show any statistically significant results in terms of food or camp activity exposures, however attending during the first week of camp (June 6, 2022 – June 10, 2022) was significantly associated with illness. One explanation for this could be that this first week coincided with a period of increased STEC shedding in baby goats, which can happen due to increased stress or environmental changes ([Factors Associated with STEC Shedding in Cattle⁷](#)). Based on the laboratory and epidemiologic findings, this outbreak likely occurred due to close contact with baby goats during their time at the camp. Illness of others who did not attend camp were attributed to secondary

exposure to their infected household member. This hypothesis is further strengthened by there being no reports of illness from general admission customers before, during, or after the three weeks of summer camps in question.

During the site visits at Farm X, we reviewed the National Association of State Public Health Veterinarians (NASPHV) Animal Contact Compendium and Resources ([NASPHV Animal Contact Compendium](#)⁸) document. Farm X had awareness of the Compendium and complied with the majority of recommendations potentially limiting additional transmission. Farm X voluntarily closed the farm for three weeks. Upon reopening they removed the baby goat care aspect from camp activities and increased risk communication language on their website and on signage throughout the farm.

STEC is naturally found in the intestinal tracts of healthy ruminant animals like cattle, sheep, and goats ([Source CDC](#)¹). Proper hand washing is a key control measure to prevent infection with STEC and other harmful germs. The process of vigorously scrubbing the hands with running water and soap helps to remove germs. Use of alcohol-based hand sanitizer can reduce the number of germs on hands but does not replace washing with soap and water ([Source CDC](#)⁹).

TDH recommended they continue to provide an adequate number of accessible hand washing stations (supplied with soap, water, and paper towels), maintain appropriate educational signage throughout the facility, enhance educational messaging on their website, continue to explain this risk on their camp registration forms, and to complete a facility consultation with the University of Tennessee Extension agricultural professionals.

The TDH FED concluded that this outbreak was associated with direct contact with goats infected with STEC O157:H7 with secondary transmission from cases. Control measures in place at the farm to minimize transmission may have reduced additional illnesses and enhanced control measures to reduce risk were recommended.

Appendix I: Epidemiological Results

Table 1: Bivariate analysis showing relationship between week of attendance, meals eaten, and activities among primary cases and controls.

Exposure	Cases		%	Controls		AR	Odds Ratio (95%CI)	p-value
	Exposed	Not Exposed		Exposed	Not Exposed			
Weeks attended								
<i>Week 1 (June 6 - June 10), n(%)</i>	10	2	83%	16	42	28%	13.1 (2.59, 66.57)	<0.001
<i>Week 2 (June 13 - June 17), n(%)</i>	2	10	17%	23	35	40%	0.3 (0.06, 1.52)	0.190
<i>Week 3 (June 20 - June 24), n(%)</i>	0	12	0%	21	37	36%	0.2 (0.01, 1.05)	0.103
Meals served								
<i>Hamburger/Cheeseburger</i>	7	5	58%	45	13	78%	0.4 (0.11, 1.49)	0.274
<i>Hot dog</i>	7	5	58%	45	13	78%	0.4 (0.11, 1.49)	0.274
<i>PB&J (Uncrustables)</i>	6	6	50%	34	24	59%	0.7 (0.2, 2.45)	0.750
<i>Cheese pizza</i>	9	3	75%	49	9	84%	0.6 (0.12, 2.44)	0.420
<i>Chicken tenders</i>	9	3	75%	43	15	74%	1 (0.25, 4.39)	0.999
<i>Fruit (any)</i>	7	5	58%	43	15	74%	0.5 (0.13, 1.77)	0.304
<i>Other</i>	2	10	17%	11	47	19%	0.9 (0.16, 4.47)	0.999
Food purchased at farm	8	4	67%	48	10	83%	1.5 (0.17, 13.5)	0.999
Food brought from home	4	8	33%	26	32	45%	0.8 (0.21, 3.22)	0.999
Activities								
<i>Crafts (i.e. rope making, tye dye)</i>	10	2	83%	58	0	100%	0.1 (0, 1.9)	0.144
<i>Games (i.e. sponge relay, duck duck water)</i>	10	2	83%	50	8	86%	0.8 (0.15, 4.34)	0.678
<i>Interact or touch baby goats</i>	10	2	83%	56	2	97%	0.2 (0.02, 1.42)	0.133
<i>Pony rides</i>	10	2	83%	48	10	83%	1 (0.2, 5.5)	0.999
<i>Animal education</i>	10	2	83%	49	9	84%	0.9 (0.17, 4.91)	0.999
<i>Splash pad</i>	10	2	83%	54	4	93%	0.4 (0.06, 2.3)	0.272
<i>Water slide</i>	10	2	83%	53	5	91%	0.5 (0.08, 2.78)	0.595
<i>Archery</i>	9	3	75%	43	15	74%	1 (0.25, 4.39)	0.999
<i>Wagon ride</i>	8	4	67%	50	8	86%	0.3 (0.08, 1.32)	0.199
<i>BB guns</i>	9	3	75%	37	21	64%	1.7 (0.41, 6.99)	0.526
<i>Play on playground</i>	10	2	83%	56	2	97%	0.2 (0.02, 1.42)	0.133

*A continuity correction of 0.5 or 1 was applied when cell values are zero. Fisher Exact p-values used. Two cases excluded from these analyses as they were not camp attendees.

Appendix II: All Samples Table

Table 2. Summary of Sample Results

Sample Number	Description	Source	Type	Serotype Result	Sequencing Notes
1	TITAN GOAT SWAB	Stool/goat	Swab	:H14	
2	SNICKENS GOAT SWAB	Stool/goat	Swab	Negative	
3	KIRA GOAT SWAB	Stool/goat	Swab	Negative	
4	FLIP GOAT SWAB	Stool/goat	Swab	Negative	
5	SOLID STOOL #1	Stool/goat	Stool	O26	
6	RUNNY STOOL #2	Stool/goat	Stool	O157:H7	Matches sample 12, and case 1,2,4
7	GOAT FEED	Barn environment	Food	Negative	
8	GATE METAL SWAB	Barn environment	Swab	Negative	
9	WOOD SWAB	Barn environment	Swab	Negative	
10	BARN STOOL SAMPLE	Barn environment	Stool	O26	
11	WOOD FROM BARN SWAB	Barn environment	Swab	Negative	
12	INSIDE WOOD SWAB	Barn environment	Swab	O157:H7	Matches sample 6, and case 1,2,4
13	OUTSIDE METAL SWAB	Barn environment	Swab	Negative	
14	OUTSIDE WOOD POST SWAB	Barn environment	Swab	Negative	
15	TREE BARK SWAB	Barn environment	Swab	Negative	
16	STOOL SPECIMEN #4	Stool/goat	Stool	Negative	
17	WOOD POST SWAB	Barn environment	Swab	Negative	
18	PORTA POTTY #1	Port-o-potty	Swab	Negative	
19	PORTA POTTY #2	Port-o-potty	Swab	Negative	
20	PORTA POTTY #3	Port-o-potty	Swab	Negative	
1. W	BABY LOT DRINKING TROUGH WELL	Barn environment	Water	Negative	
2. W	POND UNTREATED WELL	Barn environment	Water	Negative	
3. W	MOTHER GOAT WATER SOURCE	Barn environment	Water	Negative	
4. W	WATER PIPE CONNECTING	Barn environment	Water	Negative	
5. W	PUMP TO SPLASH PAD	Water activity	Water	Negative	
6. W	SPLASH PAD	Water activity	Water	Negative	
7. W	MUNICIPAL HAND WASHING STATION	Wash station	Water	Negative	
8. W	WELL HAND WASHING STATION	Wash station	Water	Negative	
Case 1	Stool	Human	Stool	O157:H7	Matches sample 6,12 and case 2,4
Case 2	Stool	Human	Stool	O157:H7	Matches sample 6,12 and case 1,4
Case 3	Stool	Human	Stool	Negative	
Case 4	Stool	Human	Stool	O157:H7	Matches sample 6,12 and case 1,2
Kord Laboratory		Goat/Titan	Stool	:H14	
Kord Laboratory		Goat/Snickers	Stool	Negative	
Kord Laboratory		Goat/Snickers	Stool	Negative	
Kord Laboratory		Goat/Snickers	Stool	Negative	
Kord Laboratory		Goat/Chase	Stool	Negative	
Kord Laboratory		Goat/Chase	Stool	Negative	
Kord Laboratory		Goat/Kira	Stool	Negative	
Kord Laboratory		Goat/Kira	Stool	Negative	
Kord Laboratory		Goat/Kira	Stool	Negative	
Kord Laboratory		Lamb/Fonza	Stool	Negative	
Kord Laboratory		Lamb/Fonza	Stool	Negative	
Kord Laboratory		Goat/Titan	Stool	Negative	
Kord Laboratory		Goat/Titan	Stool	Negative	

* Highlighted fields are genetically related by whole genome sequencing

Appendix III: Camp schedule for Week 1 (June 6-10)

Monday		Wednesday		Friday	
8:45 - 9:30 Rope Making		8:45 - 9:15 Animals	<i>Feed Baby goats</i>	8:45 - 9:15 Snack	
9:35 - 9:55 Snack		9:20 - 9:40 Snack		9:20 - 9:55 Playground	
9:55 - 10:25 Animals	<i>Picked Baby goats</i>	9:45 - 10:15 Playground		10:00 - 10:25 Wagon Ride	
10:30 - 11:00 Tye Dye Shirts		10:20 - 11:00 Archery		10:30 - 10:55 Pony Rides & Barrel Train	
11:05 - 11:35 Playground		11:05 - 11:35 Lunch		11:00 - 11:25 Education (Chicken)	
11:40 - 12:20 Lunch		11:40 - 12:10 Education (Animals Around Us)		11:30 - 12:00 Lunch	
12:25 - 1:15 Splash Pad (includes changing clothes)		12:15 - 1:20 Splash Pad (includes changing clothes)		12:05 - 12:35 Game of choice	
1:20 - 1:50 Craft		1:25 - 2:05 Game (Sponge Relay)		12:40 - 1:30 Water Slides (includes changing clothes)	
1:55 - 2:25 Game (Balloon Toss)		2:10 - 2:30 Concession Time		1:35 - 2:55 Scavenger Hunt & Make Ice Cream	
2:55 - 3:15 Concession Time		2:35 - 3:20 Craft (Paper Roll Bug)		3:00 - 3:30 Get Ready for Parents	
3:20 - 3:45 Archery		3:25 - 4:00 Get ready to leave		3:30 Parents may start to arrive	
3:45 - 4:00 Get ready to leave				4:00 Done	
Tuesday		Thursday			
8:45 - 9:15 Animals	<i>walked & took pic</i>	8:45 - 9:05 Animals	<i>Give Baby goats Bath</i>		
9:20 - 9:50 Snack		9:10 - 9:25 Snack			
9:55 - 10:15 Playground		9:30 - 10:00 Playground			
10:20 - 10:50 BB Guns		10:05 - 10:30 Wagon Ride			
10:55 - 11:25 Craft (Paint Rocks)		10:35 - 11:05 Craft (Bug on Leaf)			
11:30 - 12:00 Lunch		11:10 - 11:40 Lunch			
12:05 - 12:35 Game (Duck, duck, water)		11:45 - 12:40 Water Slides (includes changing clothes)			
12:40 - 1:30 Splash Pad (includes changing clothes)		12:45 - 1:15 Education (Chicken)			
1:35 - 2:05 Map		1:20 - 1:50 Game (Sponge Relay)			
2:10 - 2:40 Craft or game		1:55 - 2:25 Craft (Make Butter)			
2:45 - 3:15 Concession Time		2:55 - 3:25 Concessions			
3:20 - 4:00 Get ready to leave		3:30 - 4:00 Get ready to leave			
				<i>Showed Baby goat to parents</i>	

Citations

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