Sheep Pasture Rotation and Grazing Plan for the Verogy Bristol Solar One Project in Bristol, CT

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Exhibit B
Grazing Plan – Bristol Solar One, Verogy, November 2020

Introduction

Ground-mounted solar sites, by nature of their design, have ample fenced areas. The fencing at solar sites is uniquely suited to serve as grazing areas or be subdivided into grazing paddocks in a pasture rotation with sheep. The perimeter fencing also serves as predator deterrent, the solar panels provide shading and shelter for inhabitants, and the solar arrays provide palatable pasture species for ruminant nutrition. In turn, rotationally grazed sheep provide adequate and comparatively cheap vegetation management, optimal ground coverage and thus reduced erosion and run-off, as well as agricultural usage of lands that can add to the viability of farming communities.

The Verogy Bristol Solar One Project, located in Bristol, CT, is planned for approximately 12.6 acres. Sheep grazing will be used to control vegetation at the project site to:

- Prevent panel shading from vegetation,
- Control and remove invasive and unpalatable plant species,
- Avoid the growth of brush and woody species under the solar panels,
- Maintain a diverse forage population to support optimal sheep nutrition,
- Encourage flowering forb and plant species to maximize pollinator habitat,
- Optimize sequestered soil carbon through increasing top-soil amount and root matter,
- Control erosion.

To achieve these goals a rotational grazing system will be implemented. Rotational grazing is a technique where animals are moved as one group, from one pastured area ("paddock") to the next (Hodgson, 1979). Only one paddock is grazed at any given time throughout the rotation, while the other paddocks are given a rest period to achieve pasture regrowth. Compared to continuous or extensive grazing, rotational grazing inhibits weed growth, improves the health of pasture, sustains healthy vegetation, and improves sheep health.

Rotation planning

The Verogy Bristol Solar One Project was assessed for a planned grazing rotation based on the preliminary panel layout, and 12.6 acres fenced area under panels. The grazing plan requires division of the solar array into smaller grazing units, known as *paddocks*. The site layout can be subdivided into 3 different grazing paddocks with Electronet® fencing (Figure 1). The Electronet® is a portable fence that is a product familiar to farmers in in the grazing community. It is a white, lightweight fence that is energized using a portable battery, battery/solar, or 110V power supply. This fencing is simple to power on/off and will only be located inside the fenced areas. Its use is to facilitate grazing inside the permanently fenced areas only. The Electronet® will be installed by the grazing manager according to the grazing plan.

Two fence lines will be required to divide the array into three paddocks, fence line 1 and 2 (Figure 1). Fence line 1 is approximately 422 feet in length, fence line 2 is approximately 967 feet in length. The length of one roll Electronet® is 164 feet, resulting in a total of three rolls for fence line 1 and six rolls for fence line 2.

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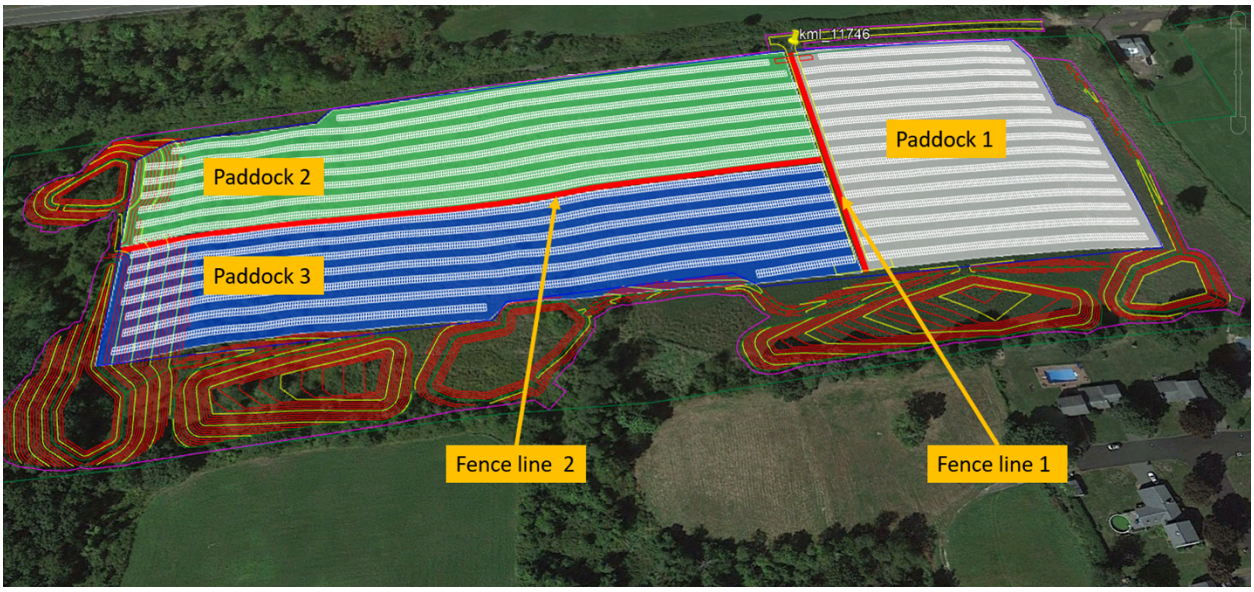

Figure 1. Verogy Bristol Solar One Project Site Layout with distinctly colored sections. Please note that this is an approximation and subject to change.

- Paddock 1 (3.8 acres)
- Paddock 2 (4.7 acres)
- Paddock 3 (4.1 acres)

The number of grazing paddocks in each array is dependent on a unique set of factors. The number depends on size and layout of the permanently fenced array, panel orientation, and space used for access roads, inverter pads, and other non-forage producing areas.

Acreage

The sheep flock is sized to cover the three grazing paddocks in a full rotation, i.e. the amount of sheep needed to graze Paddock 1, 2, and 3 with 3.8, 4.7, and 4.1 acres, respectively, in a +/- 45-day rotation. The precise number of days per paddock may be adjusted over the season by the flock manager, depending on weather and forage growth conditions. The number of sheep determined by the grazing plan can be found in

Table 1. Grazing Plan Verogy Bristol Solar One Project, found on page 4.

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Table 1. Grazing Plan Verogy Bristol Solar One Project

	Item	*Paddock 1*	*Paddock 2*	*Paddock 3*	*Total*
Acreage	Array size, ac				12.6
	Number of paddocks				3.0
	Paddock size, ac	3.8	4.7	4.1	4
	Rest period, days				45.0
	Days in paddock				15.0
Sampling and analysis	Vegetation cover: %, ac	80% 3.0	80% 3.8	80% 3.3	80% 10.1
	Biomass / yard², lbs	1.5	1.5	1.5	1.5
	DM % / yard², lbs	18% 0.3	18% 0.3	18% 0.3	18% 0.3
	DM / ac, lbs	1,307	1,307	1,307	1,307
	DM / paddock, lbs	3,983	4,903	4,328	13,214
	Refusals: %, lbs	30% 1,195	30% 1,471	30% 1,298	30% 3,964
	Total paddock DM, lbs	2,788	3,432	3,030	9,250
Feed intake	Average sheep weight, lbs				160.0
	DM Intake: % BW, lbs				3.5% 5.6
Totals	**Total acreage**				**12.6**
	Total sheep				**36.7**
	Stocking rate				**2.9**

The rest time for a given grazed area is largely guided by management for the sheep flock's health. The rest time can be considered the window during which the sheep are not present in a given area and the space is given a rest. The pasture rest period (time between grazing periods) in the US Northeast should not be less than 40-days to minimize internal parasite pressure for sheep. Internal parasites are a health risk to the sheep but not to humans. Internal parasites of sheep are not zoonotic, but a threat only to the health of sheep. This health risk to sheep is minimized by following the following prescriptive grazing plan.

A common internal parasite specific to ruminates is the stomach nematode *H. contortus* or barber pole worm. It has a life cycle of 40 days; thus, a clean pasture can only be achieved with rest periods of 40+ days to avoid reinfection through ingestion of larvae. However, in effective grazing regimens with parasite-resistant sheep flocks, exceptions can be made by the flock manager if the vegetation pressure is too high to adhere to a 40-day rest period before re-grazing.

<u>Sampling and analysis</u>

In newly commissioned solar sites, full vegetation coverage cannot be expected in the first 1-2 years. Additionally, access roads, inverter pads and other site infrastructure will reduce the overall vegetation cover. Our estimate for NY State solar sites lies between 65 and 85% vegetation coverage for new sites. This number should be estimated and considered separately for each individual paddock. This number will be adjusted over subsequent years and grazing seasons.

As previous management regimes for solar sites might consist of hay fields, crop fields, marginal pastures or brush areas, the vegetation coverage is expected to be heterogeneous. Therefore, vegetation sampling must be performed to determine sheep stocking rate and density, which is a requirement prior to establishing a grazing rotation. Tabular dry matter and nutrient values as they are published for uniform stands of established crops, hay field or other, are not adequate for evaluating solar array site vegetation for grazing. A detailed organic matter (OM) vegetation sampling protocol is published on the American Solar Grazing Association (ASGA) website. The grazing rotation will largely depend on the amount of forage dry matter (DM) growing within the individual areas. Manager may perform vegetation sampling at intervals to analyze the nutritional value of the forage.

Forage analysis laboratories such as Dairy One provide detailed analyses that can be used to calculate the available DM per grazing paddock from submitted OM samples. Dry matter is a percent of total percent plant weight minus water content. These DM values are necessary to establish the amount of available feed for sheep, and eventually the sheep stocking rate and density. Typically, pasture DM values in the Northeastern US for well-maintained pastures are between 18-25%, depending on the season.

Typically, well managed Northeast pastures can achieve yields above 2,500 lbs DM per acre. The yield in the grazing plan draft above is substantially lower; it is expected that the solar array pastures will take time after establishment to reach their potential. It is necessary to plan a grazing rotation prior to the grazing season, which would be used to guide a flock manager's rotation plan. The flock manager would then use his/her own experience and observation to decide daily if the rotation plan is reasonable and responsible, and to make necessary adjustments in rotation days and stocking rates.

Pasture utilization should be between 70 and 85% to ensure optimal regrowth and animal nutrition. Thus, pasture refusals (uneaten vegetation remaining after grazing) should be part of the calculation and should be between 15% and 35%.

Two examples of common adjustments to rotation plans include: First, in late spring after rain events and with the warming weather, stocking rates may have to be increased to be able to clear the vegetation growth. Secondly, in the summer, sheep may have to be moved from paddock to paddock faster than they were in spring or fall due to the slowed growth of dormant cool-season vegetation.

Feed Intake

It is recommended to graze uniform animal groups that are either dry (non-lactating) ewes, open (non-pregnant) ewes, ewes in their early stages of pregnancy, yearling ewes or growing lambs of at least 60 lb. (or alternatively, 50% of their mature body weight in case of small breeds). In the case of groups of growing lambs, the lambs should be of the same sex or the males should be castrated.

Table 2. Body weight and feed intake

Breed	***Stage of production***	***Body weight, lbs***	***Feed intake, DM %BW***	***Feed intake, lbs DM***
Katahdin hair sheep	Growing lamb, 50% mature BW	65	2.5	1.6
	Yearling	110	3.0	3.3
	Open, dry ewe	130	3.5	4.6
Polypay composite	Growing lamb, 50% mature BW	80	2.5	2.0

	Yearling	130	3.0	3.9
	Open, dry ewe	160	3.5	5.6
Texel	Growing lamb, 50% mature BW	90	2.5	2.3
	Yearling	150	3.0	4.5
	Open, dry ewe	180	3.5	6.3

Depending on the breed and uniformity of the group of sheep, an average weight for the individual animals in the flock can be determined. Table 2. Body weight and feed intake, gives an overview of BW (body weight) and feed intake across popular Northeastern sheep breeds. According to NRC nutritional requirements for small ruminants (NRC, 2007), daily DM consumption per animal can be estimated as a percentage of bodyweight.

Totals

These calculations can be used to determine the optimal number of sheep per paddock according to body weight and stage of production. By using this with the chosen grazing rotation days (or rest period), the stocking rate (the necessary sheep number for the calculated grazing time within each paddock) can be calculated, and the optimal grazing flock size calculated.

On the 12.6 acre Verogy Bristol Solar One project, the grazing plan allows for 37 mature ewes managed in three grazing paddocks, a stocking rate of 2.9 sheep per acre, and 15 grazing days per paddock with a 45-day rest period.

Animal welfare recommendations

Regardless of season, ad libitum clean and fresh water access is crucial for animal welfare (NRC, 2007). Site-specific amenities like well water or connection to municipal water lines are ideal, but transported water is typical of solar grazing operations. For sheep of the recommended production stages (non-lactating and > 60 lbs growing lambs), water requirements are very low in spring and fall. Typically, dry, non-gestating ewes will consume between 5 and 10 % of their BW water daily.

Granulated mineral feed must be available ad libitum and contain adequate concentrations. Mineral feed should be offered in troughs that can be moved with the flock according to the rotation and rotation days. Mineral feed is specially blended and commercially available for sheep producers (Cargill, 2019).

Sheep will be visually inspected on every rotation day by the flock manager. A closer inspection of each member of the flock is recommended at regular intervals (every 6 weeks on site), including parasite monitoring or treatment with a FAMACHA (FAffa MAlan CHArt) protocol (Wyk and Bath, 2002), and 5-point checks (Bath and van Wyk, 2009).

Each spring, before the flocks begin the grazing season, certain protocols are recommended to ensure they are in optimal health before their work at the solar site begins:

- Feet must be checked and trimmed,
- Ear tags replaced or added, in compliance with USDA regulations,
- Wool sheep must be shorn,
- Wool sheep should be tail-banded,

- Body-condition scores should be recorded to monitor nutritional and health status across the grazing season,
- ***Sheep should be kept in a dry lot on hay 24 hours prior to moving on site in Spring and de-wormed with a commercially available de-wormer to prevent parasite infections on site.***

Literature

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