Survey Results for the Tisbury Great Pond Watershed Agricultural Sourced Nitrogen Load

Dukes Soil Conservation District with Funds from the Massachusetts Executive Office of Energy and Environmental Affairs

Input and Support provided by the Martha's Vineyard Agricultural Society, the Martha's Vineyard Commission and the Island Grown Initiative

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BACKGROUND AND INTRODUCTION:

The Dukes Conservation District (the District) applied for and received funding under the Conservation District Innovative grant program through the Executive Office Energy and Environmental Affairs Division of Conservation Services for an initial proposal submitted in 2016. The proposal was made in light of the Mass Estuaries Project (MEP) report on Tisbury Great Pond (TGP) that found that, of the local control sources of nitrogen loading to the Pond, agriculture was the largest source. A brief summary of the MEP nitrogen budget is provided in the Appendix, pages 10 to 11. The District proposal was aimed at accomplishing two primary goals:

- to confirm the MEP loading figures for agriculture and
- to identify those farms that are large sources of nitrogen in order to explore the potential for farm plans and technical assistance from the Natural Resources Conservation Service (NRCS) to reduce nitrogen losses.

Partners in the survey portion of the grant included the Martha's Vineyard Commission (MVC), the Island Grown Initiative, Martha's Vineyard Agricultural Society (MVAS) and the NRCS. The survey was carried out by Don Liptack, former District Conservationist for southeast Massachusetts, the Cape and Islands with NRCS.

A survey was developed (see Appendix page 12 and 13 for blank form) that would identify farm fertility practices for crops and numbers of livestock on each farm. The MVC provided the District with maps and a database of lots within the watershed that were identified as having agriculture from their Geographic Information System – Assessor's database. The District hired Don Liptack, former Soil Conservationist with NRCS, covering the Vineyard as well as southeast Massachusetts. Don Liptack was familiar with the farms in the watershed and knew many of the farmers.

The survey was carried out with 28 farmers working about 60 parcels of land throughout the watershed. In the interest of protecting farm confidentiality, which the District believed was crucial to getting reliable information, farm names are not included in this report.

The goal was to gather enough information to create a farm nitrogen budget for each operation. The budget would include all fertilizers applied to cropland as well as nitrogen estimates for livestock waste using standard livestock excretion rates. Making a determination as to how much of the nitrogen applied on the farm would leach and contribute to the TGP nitrogen load was beyond the scope of the proposal. Leaching losses are complex and determined by numerous factors including the solubility of the nitrogen source, the proximity of substantial precipitation following application date, preceding soil moisture conditions, soil

type and percolation rate among others. The MEP model for agricultural sources estimates the following leaching loss rates as follows: 40% of livestock sourced nitrogen, 33% of synthetic nitrogen fertilizer applied to row crops, 25% of that fertilizer applied to hay and pasture, 10% of that used in greenhouses and 5% of the nitrogen content in large compost piles.

In order to directly compare the nitrogen budgets between the MEP model and the District survey, leaching losses were backed out of the MEP model to provide farm nitrogen budgets defining total nitrogen applied to the ground. The two budgets were not the same. Among the most common reasons for differences between the two estimates were:

1. farms no longer active,
2. new farms not present when the MEP model was prepared,
3. differences in fertilization practices (i.e. many hay and pasture fields are not fertilized at all) and
4. changes in livestock populations.

COMPARISON OF MEP AND SURVEY BUDGETS: A SUMMARY

The MEP determined that the nitrogen load to TGP from agricultural sources alone was 6,508 kilograms or 14,350 pounds. When the leaching loss is backed out from all sources to determine the pre-loss TGP watershed nitrogen budget from all farm sources, the load is 36,500 pounds plus an entry made for two large compost piles that total 42,800 pounds. Total nitrogen budget is 79,300 pounds.

The leaching load from the compost operations would be 5% of the starting figure or 2,140 pounds which is 15% of the total load attributed to agriculture (14,350 pounds). Compost operations are certainly sources of nitrogen to TGP but whether this nitrogen should be attributed to agriculture is a legitimate question as it is used for landscaping projects throughout the Island. Furthermore, it includes some livestock manure from the TGP watershed that is already accounted for in the on-farm budgets.

The District Survey nitrogen budget for the watershed from agricultural sources is 30,500 pounds, not including an entry for 42,800 pounds from the commercial landscaping compost piles. The District load is about 20% less than the MEP budget despite an added source of 2,450 pounds from a new farm operation not included in the MEP model. As explained below, one primary reason for this difference is significantly less fertilizer application to farm pastures.

Livestock Sources Background:

In the survey, the amount of nitrogen excreted by livestock on a daily basis was used to determine the livestock portion of the total farm budget based on animal type and population.

Livestock produce large amounts of nitrogen which is applied to the ground surface and may be taken up by growing pasture grasses during the growing season but not so much during the winter months. Manure and bedding from barns may also become a nitrogen source if not handled and stored properly until application to fields. The livestock excretion figures are shown in Table 1. These figures were used in both the MEP and District models.

TABLE 1 Livestock Nitrogen Excretion Rates in Pounds Used by MEP and District

	Steers and Cows	Horses	Sheep and Goats	Pigs	Piglets	Poultry
N produced in #/day	0.337	0.196	0.044	0.088	0.004	0.0026
#/year	123	71.5	16.1	32.1	1.5	0.95

Nitrogen Budget Breakdown and Comparison- Livestock

The total nitrogen budget attributed to livestock waste in the MEP model was 15,900 pounds sourced from a livestock population of: 16 steers, 50 dairy cows, 74 horses, 145 sheep, 3 pigs, 30 piglets and 88 poultry.

The total nitrogen budget attributed to livestock waste in the District model was 21,878 pounds sourced from a livestock population of: 33 steers, 44 dairy cows, 93 horses, 168 sheep, 38 lambs, 52 pigs, 76 piglets and 2,542 poultry. Forty of the increased pig population is the result of a farm situated in the watershed but with these animals housed outside the watershed. The load from this source can be taken from the total livestock budget reducing it to 20,598 pounds. Nearly all of the poultry increase is from a new farm not in operation at the time of the MEP model. The budget from this source is 2,450 pounds of additional nitrogen. The other changes to the livestock population are believed to result from real, on-farm changes in livestock numbers and possibly, a more complete and accurate count in the District model.

MEP budget from livestock— 15,900 pounds/year

District budget from livestock— 20,598 pounds/year

The District budget from livestock could be reduced further by approximately 600 pounds from one operation to account for barn stall manure removal to a covered pile that is regularly removed to a composting operation. A second farm also provides manure to a composting operation but the manure is stacked uncovered until it is removed.

Nitrogen Budget Breakdown and Comparison-Hay and Pasture

Hay crop area was determined to be 262 acres contributing 9,018 pounds to the total MEP budget. Pasture area was 237 acres adding 7,196 pounds to the total budget. Both figures were reduced in the MEP model by about 10% from the actual agronomic rate to account for areas that did not appear to be fertilized to the full application rate.

In the District model, hay land comprised a total of 347 acres although this includes approximately 100 acres that serves both hay and pasture. The total budget for this crop type was 6,410 pounds.

In the District model, pasture totaled 170 acres with a nitrogen budget of 1080 pounds.

The combined acreage in both models is close to agreement, the MEP indicating 498 acreage of grass while the District survey found 517 acres. The pasture budget is significantly smaller in the District budget compared to MEP model largely because of the substantial acreage that the farmers indicate are not fertilized with anything other than animal droppings.

Total nitrogen budget for both uses breaks down as follows:

MEP Model—16,214 pounds/year

District Model—7,490 pounds/year

Nitrogen Budget Breakdown and Comparison- Vegetables, Nursery and Greenhouse

The MEP model estimated a total area in row crops of 46.8 acres (vegetables, greenhouse and nursery) receiving an annual nitrogen application of 4,449 pounds. The application rate from these figures is 95 pounds of nitrogen per acre. The District model found 34 acres receiving an annual application of 2,391 pounds of nitrogen. The application rate based on these figures is 70 pounds of nitrogen per acre.

In the District survey, there was a clear reduction in land formerly devoted to growing crops from the MEP model prepared in 2011.

MEP budget for crops— 4,449 pounds/year

District budget for crops-- 2,391 pounds/year

SUMMARY AND CONCLUSIONS

The District survey used the same basic methodology as was used in the MEP model for farmland sources of nitrogen. The District survey was not able to speak with all farm operators, so the budget includes four “no farmer input” entries where standard farm agronomic

fertilization rates per acre were used to determine those budgets. The number of entries in the MEP model that were made as "no farmer input" is believed to be a larger but unknown number.

The entries made in this report for the MEP nitrogen budget were determined by backing out the leaching factors for each farm entry from their model. This step is complicated by a number of entries that were made with a modified formula to more accurately reflect actual fertilization to fields where the farmer indicated a specific rate different from usual agronomic rates. These entries to the MEP model in virtually all cases would lower the nitrogen load from standard agronomic rates for fields where it was clear that there was little or no applied fertilizer.

At least one third of the 49 parcels indicated as hay and/or pasture were substantially reduced contributors to the overall nitrogen budget in the District survey model because of zero or significantly lower than typical fertilization rates. This was particularly the case for pasture areas where the standard practice is to apply no fertilizer other than livestock droppings that is counted under the livestock source category. The result was that the District budget for pastures was about 6,100 pounds less than the MEP model.

Average fertilization rates for row crops in the District survey were found to be about 73% of those used in the MEP survey- in part because the District survey typically found a lower application rate of nitrogen.

The livestock portion of the District budget was significantly larger than the MEP model- 20,598 pounds compared to 15,900 pounds. The 4,500 additional pounds for this source in the District budget represents a 30% increase over the MEP budget. Of this about 3,700 pounds are the result of two new farm operations not in place at the time of the MEP model preparation.

The District survey produced a total watershed, farm-related nitrogen budget of 30,500 pounds per year. The MEP budget was 36,500 pounds. The difference between the two budgets is 6,000 pounds or a 16 percent lower load determined by the District survey.

Regardless of how the sources of nitrogen are broken down (wastewater, fertilizer, manure, runoff and acid rain), the total load entering the Great Pond is the same. This is so because the MEP model brings together the nitrogen load, the flushing of the pond to the ocean and the nitrogen content found in the water column that results from the first two to provide the best statement of inputs, outputs and resulting water quality. So, although the District model indicates a smaller nitrogen load for the agricultural portion of the total, that only indicates that the other sources are larger, not that the total load to the Great Pond is lower.

One primary consideration that came from the District-MEP survey comparison was the fact that large commercial scale composting was counted as an agricultural enterprise in the MEP model adding about 42,800 pounds to the total nitrogen budget for the watershed. This figure includes an unknown portion of livestock manure already counted in the livestock portion of the model that is brought from the farms to the composting operations. Whether or not this source is labelled "agriculture", it is an important component to the nitrogen load to the Great Pond.

Another important result of the District survey has been to bring farm operators for a number of large nitrogen budget contributors into contact with the NRCS for farm planning and best management practice solutions for their nitrogen budget.

Table 2 summarizes the results of the survey in comparison to MEP nitrogen budget figures.

ACKNOWLEDGEMENTS

This survey could not have been completed without the cooperation of the farm operators in the watershed. Nitrogen is an expensive fertilizer that farmers do not want to lose to the groundwater. In part, the lower fertilization rates found in the District survey could be the result of rising cost of nitrogen fertilizers since the MEP model was completed (Draft model completed in 2011). Maximum conversion of all nitrogen sources to harvested crop is the bottom line interest of both farmers and those interested in reducing the nitrogen load to Tisbury Great Pond.

Adam Turner, Sheri Caseau and Chris Seidel at the MVC provided the maps and spreadsheet database prepared for the original MEP land use model which made the survey possible and allows the comparisons made in this report. The MV Agricultural Society and Island Grown Initiative provided early input to the survey and helped to get the word out to the farm operators. The West Tisbury Conservation Commission supported the grant application and Maria McFarland and Prudy Burt provided helpful input to the report.

The survey report was supported by a grant directed to Conservation Districts by EOEEA in both Fiscal Years 2017 and 2018.

Don Liptack provided both expertise in farm practices and knowledge of local farms as well as a commitment to getting the survey done. Great effort was put into bringing those farm operators with large, problematic nitrogen budgets into contact with NRCS. Data collected in the survey was processed and this report prepared by Bill Wilcox, Dukes Soil Conservation

District Chair and former MVC Water Resources Planner who put together the draft MEP land use nitrogen model.

TABLE 2: SURVEY AND MEP ACREAGE and NITROGEN BUDGET RESULTS (in pounds)

SOURCES	Hay	Pasture	All Crops	Livestock	TOTAL
DISTRICT	6,410	1,080	2,391	20,598*	30,479
acreage	356.7	187.6	34.1		
MEP	9,019	7,196	4,449	15,828	36,500
acreage	262	237	46.8		

- ***This figure is reduced by 1,280 pounds to account for pigs kept outside the watershed***
- ***Note that the nitrogen from compost operations is not included here***

Livestock Head Count

Livestock Type	DISTRICT COUNT	MEP COUNT
Steers	33	16
Cows	44	50
Hogs	52*	3
Piglets	76	30
Horses	**94**	**74**
Sheep/Goats	**168**	**145**
Lambs	**38**	**--**
Poultry	**2,542**	**88**

*40 of these animals are housed outside watershed and not counted as nitrogen budget entries
NOTE: Substantial poultry count in the District results is from a new farm operation.

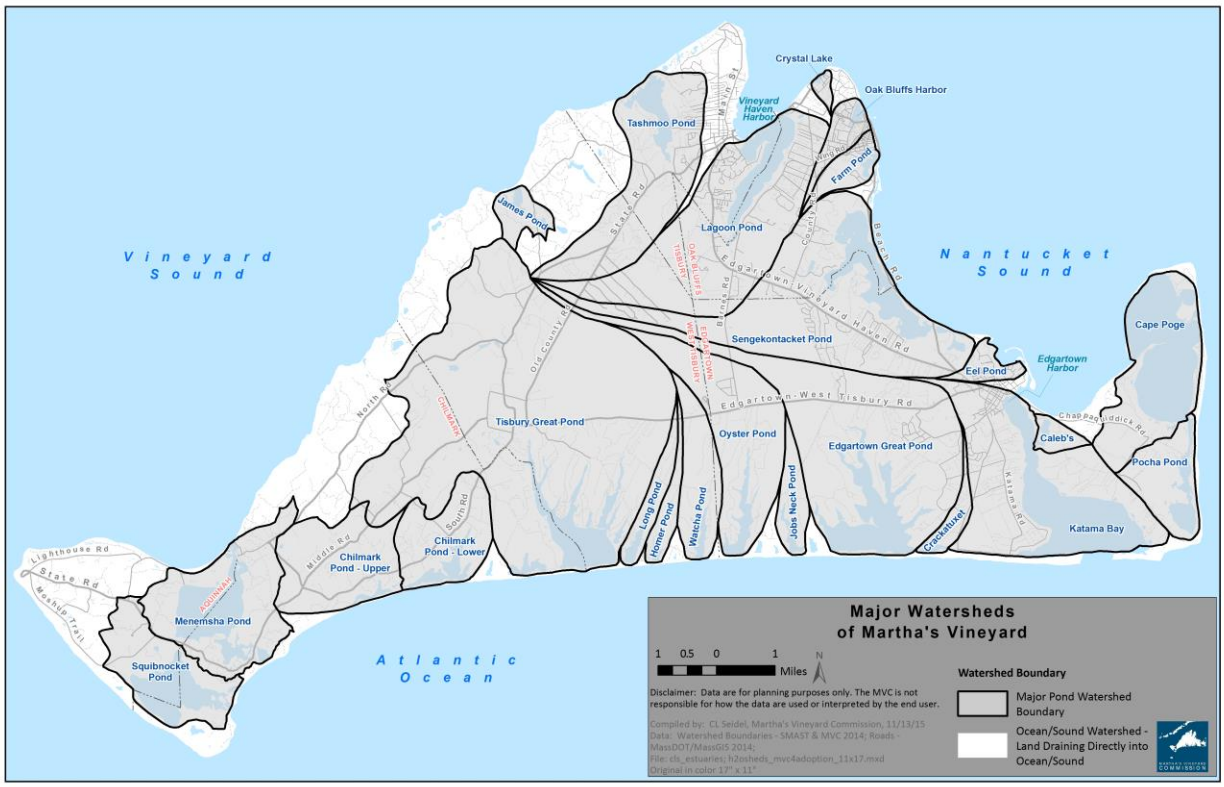
APPENDICES

REFERENCES

Tisbury Great Pond Watershed Land Uses and Nitrogen Loads

The MEP report was released in 2013 and finalized in 2015. The watershed delineation was carried out by MVC staff and reviewed by MEP and US Geological Survey personnel. The watershed was determined to include 11,102 acres shown in Figure 1 taken from the MVC mapping provided to MEP. This area includes 8 sub-watersheds, all contributing groundwater or surface flow in the form of two major streams to Tisbury Great Pond.

FIGURE 1: Martha's Vineyard Watersheds



Tisbury Great Pond was determined to be nitrogen limited and presently is receiving nitrogen that exceeds its capacity to process without producing algae blooms and low oxygen levels degrading the bottom habitat, preventing eelgrass colonization and contributing to periodic oyster die off.

The watershed land uses that form the basis of load determination measured by GIS analysis are:

Residential	37%
Public Services	33% (largely the Correllus State Forest)
Undeveloped parcels	24%
Agriculture	5%

Source: Howes et al 2013 page 40

The nitrogen load determination is described in Table IV-1 in the MEP report. The load (excluding atmospheric sources) was determined to break down to two major components: 40% from septic

wastewater sources and 44% from agricultural sources. The other sources include landscape fertilization including lawns and shrubs, runoff from impervious surfaces and landfill leachate. Nitrogen in rainfall that falls directly on the pond or leaches through natural vegetation is the largest source of nitrogen loading but is not controlled at the local level.

Table 1: Nitrogen Loads by Source in Kilograms

Wastewater	Agriculture	Direct rain	Natural surfaces	Fertilizer	Landfill
6,053	6,508	4,551	2,147	1,200	102

From Howes et al (2013) Table IV-2

The agricultural source was characterized in the MEP process based on assessors land use code, farm operator information and aerial photography interpretation. Where farm operator information indicated that no fertilization was used, the nitrogen load determination for that farm was based on that information. Where no specific nitrogen application rates were available, standard agronomic application rates for each crop were used unless visual information indicated reduced fertility was practiced. For livestock manure sources, standard annual nitrogen excretion was based on US Department of Agriculture rates.

DUKES SOIL CONSERVATION DISTRICT **Farm Survey Sheet**

Farm Name _____ Date_____
Assessor's Map ____ Lot____
Person Interviewed:_____
Their position: ____ owner ____ operator _____ other
Best contact number: _____

Parcel Information
Does this parcel contain the entire farm operation in the watershed? _____
If **not** are the other parcel(s) nearby? _____
Is the data reported here solely for this parcel?_____
If **not** what other parcels are included?_____

Livestock Number by type and size (if appropriate)

Number		**Average Weight**	**IF NONE CHECK HERE**
_____	Milk cows	_____	
_____	Beef cattle	_____	
_____	Horses	_____	
_____	Sheep		
_____	Goats		
_____	Poultry		
_____	Llamas or Alpacas		
_____	Pigs		
_____	Other		

SOIL TYPE(S) in fields as labelled below: _____

Fertility Practices

Field identifier	**Acreage**	**Crop**	**Fertilizer type**	**Rate**	**Parcel**

Waste Management: Estimate portion of manure that is dropped in bedding versus left in field _____
_____

Alternatively, what portion of each day are the animals housed? _____

Is there are concentrated feeding area? _____ Is there a concentrated loafing area? _____

What portion or approximate weight of the waste is:
_____ Piled

_____Covered

_____Contained in a pit or other structure

_____ Distributed in the field while grazing

Is there active composting?_____
If so, characterize the pile: _____covered _____ not covered

Is there surface water on site? _____
If yes, is it isolated on the parcel ? (i.e. is there a waterway that extends off site?) _____

Are the animals allowed to graze to the water's edge? _____

What is the distance and slope to surface waters for the following uses?
Manure storage _____ Loafing Area_____
Feed lot _____ Edge of pasture_____
Edge of tilled fields _____

Is this distance an unbroken slope to the water resource?_____

Other Farm Issues Identified:

Cover cropping practices:_____
_____

Is there evidence of soil erosion on site?_____
If yes, describe the evidence, area affected, distance to water resources etc. _____
_____
_____
_____

Is the operator interested in a farm plan or an update to an existing plan?_____
Farm BMP needs or practices to implement:
_____
_____
_____

REFERENCES

Howes, B. L., E. M. Eichner, R. I. Samimy, S. Kelley, J.S. Ramsey, D.R. Schlezinger (2013) Linked watershed-Embayment Management Modeling Approach to Determine the Critical Nitrogen Loading Threshold for the Tisbury Great Pond/Black Point Pond System, Chilmark and West Tisbury, MA University of Massachusetts Dartmouth School of Marine Science and Technology Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection